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KEY TO PRONUNCIATION.

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

′ (prime), ″ (secondary) accents, to indicate syllabic stress

THE ENCYCLOPEDIA AMERICANA

Duluth, Minn., city and county-seat of St. Louis County, at the western end of Lake Superior, 1,463 miles from New York, 478 miles from Chicago, 400 miles from Milwaukee; and northeast 522 miles from Omaha, 2,370 miles from San Francisco; and southeast from Seattle 1,919 miles, and 498 miles from Winnipeg. Its area is 69 square miles and it extends along Lake Superior, Duluth harbor, and the St. Louis River from Lakeside to Fond du Lac, a distance of 24 miles. Duluth began at the base of Minnesota Point and has spread east and west along the water line, as well as northward upon the face of the great bluff, which, in the course of a mile from the water's edge, rises to a maximum height of 800 feet.

Government.— The mayor, treasurer, comptroller, and two aldermen from each ward are elected by the people for two years; the clerk is appointed by the council. The chief of police, city engineer, city attorney, assessor, the city boards and minor officers are appointed by the mayor.

Municipal Improvements.— Street cleaning is a comparatively easy task, the greater part of the city enjoying the benefit of natural drainage. Street cleaning costs $14,814.20 a year, and street sprinkling, $7,779.74, is assessed to property. The sewage empties, through 40 miles of mains, into Lake Superior and Duluth harbor. Climate, clean streets, and pure water make Duluth one of the healthiest cities in the world, the death rate in 1900 being 13.2.

The city owns the water and gas systems. Water is drawn from a point 10 miles down the north shore of the lake, which is never approached by sewage. The city also owns the gas plant and during its ownership has reduced the price of gas from $1.90 to 90 cents per 1,000. While thus reducing the price of water and gas, the city has spent a great deal of money on depreciated plants. The total cost of these plants to the city is: Water, $2,081,072; gas, $429,860. The police department costs $49,401, and the fire department, $101,933.23 per annum.

The electric street railway system consists of about 50 miles of track, representing an investment of $2,500,000. The Duluth-Superior Traction Company controls the street railway system of both Duluth (Minn.) and Superior (Wis.). The line passes over the great interstate bridge and covers the time between the two cities in 35 minutes. In 1902 there were carried on the street railway system 8,000,000 passengers, and $285,000 was expended in operating expenses.

Public Parks and Cemeteries.— The Duluth park system consists of five larger parks, two smaller ones, and five city squares. Fairmont Park at West Duluth contains 40 acres; Lincoln, at the West End, 50; Central, Central Duluth, 100 acres; Chester Park, East End, 100 acres; Lester Park, extreme East End, 25 acres; Cascade Park, 6th Street and First Avenue west, whose beauties are indicated by its name, covers 4 acres. Portland Square covers a block at West 4th Street and Tenth Avenue east. The main features of this park system is Rogers boulevard, and the parks Fairmount, Lincoln, Central, Chester, and Lester. The boulevard is a drive of 7 miles along the bluffs at a height of 500 feet above Lake Superior, which is itself 600 feet above the level of the sea. From this drive is visible one of the finest views in the world. The chief beauties of Duluth's parks lie in the natural loveliness of forests, streams, rocks, and cascades. There are five cemeteries: Calvary Hill, Forest Hill, Oneota, Park Hill, Scandinavian Union, and Swedish Mission.

Chief Buildings.— Among the chief buildings the Central High School is probably the most extraordinary. It stands on a site more than 200 feet above the lake, site and building occupying a whole block. It has four stories, with commodious attic and basement, and a tower 229 feet high. Other prominent buildings are the Carnegie library, the State Normal School, the Spalding and St. Louis hotels, the Lyceum Theatre, the new buildings in the wholesale district, of which the Marshall-Wells is the largest wholesale hardware building under one roof in the world; the Wolvin building, and the huge elevators and flouring mills; the Board of Trade, and Federal buildings. The Duluth Public Library building was the donation of Andrew Carnegie. The fund was $75,000. The building and grounds represent an outlay of $93,000. The library now contains 40,000 volumes.

Among churches are the Cathedral, and 7 other Catholic churches, 6 Episcopal, 6 Baptist, 1 Christian Science, 2 Congregational, 1 Swedish Covenant, 3 Evangelical, 17 Lutheran, 11 Methodist Episcopal, 1 Unitarian, 1 Salvation Army Corps, and 2 Hebrew synagogues.

Educational and Intellectual Associations.— The city had in 1903 1 high school, 31 elementary and kindergarten schools, with 32 school buildings, an average daily attendance of 8,791 pupils and 258 teachers; 3 Roman Catholic parochial schools, and an Institute of the Sacred Heart. The new State Normal School had 100 pupils at the opening in 1903. The hospitals have a training school for nurses. The value of public property used for school purposes was in 1903 $1,869,700 and the total expenditure for public schools for the school year 1903–4 was $309,773.76. In 1903 Duluth had 2 daily papers, 6 weeklies, and a bi-weekly.

Manufactures.— The manufactures of Duluth, according to the census of 1900, were: Establishments, 433; capital, $8,872,940; employees, 3,998; wages paid, $2,145,444; cost of materials, $5,861,499; total value of product, $10,628,957; lumber and timber product, $3,800,000; planing mill product, $172,943; foundry and machine, $475,848. In 1903 the Great Northern Power Company had acquired practically all the water power available at the head of Lake Superior. This water comes down through a vast drainage through the rapids of the St. Louis River to a point within the city of Duluth. These rapids aggregate a fall of nearly 600 feet. The company divided this power into two systems; the St. Louis Development, under a head of 365 feet, and the Duluth Heights System, under a head of 740 feet. For the first installation on the St. Louis rapids, the company had in 1903 a full-developed plan to build a steel dam 36 feet high and 628 feet across the river at the head of the rapids, thus creating a reservoir or forebay, about one mile square in extent, whence a canal 62 feet in width at the surface and 14 feet deep was to carry the water 2½ miles to the brow of a hill, and thence by a series of wood stave and steel pipes to the main power house at the foot of the rapids under an effective head of 365 feet. The company aims at an ultimate development of 100,000 electric horsepower. This power is to be transmitted not only to Duluth but to Superior, the iron ranges and to other towns a long distance away.

The Duluth Heights System has a capacity of 200,000 horsepower additional, which is to be developed later on under an effective head, estimated at 740 feet, from the bluff directly back of the city of Duluth. The possibilities of the St. Louis water power have been appreciated for many years and engineers have been working on the problem of harnessing it to do man's work for a quarter of a century. The cities of Duluth and Superior voted liberal franchises to the company in 1902 and 1903, and in the latter year were looking forward confidently to developments which would revolutionize manufacturing at the head of Lake Superior. The Zenith Furnace Company, capitalized at $950,000 in 1903, equipped a modern blast furnace at West Duluth with a daily capacity of 250 tons of pig iron. The company in the same year established a coking by-product plant. The company at the same date entered into a contract with the city of Duluth to supply the latter with gas.

Trade and Commerce.— As the western terminus of the marine traffic of the Great Lakes, Duluth holds an important place in world-commerce. For 1902 the aggregate of vessel arrivals and departures at this port was 9,659. The arrivals numbered 4,816 and the departures 4,843. The registered net tonnage of arrivals and departures aggregated 13,927,284 net tons. In 1902 the total receipts of freight at the port of Duluth were 1,291,357 net tons, of a valuation of $31,431,750, and the shipments were 7,884,236 net tons of a valuation of $65,080,803. The total of freight received and shipped was 9,175,593 tons and the valuation of the same was $96,512,553. The shipments of iron ore from Duluth for 1902 were 5,598,408 gross tons, as compared with 3,437,955 gross tons in 1901. Two Harbors, which holds the world's season record for the amount of iron ore forwarded from a single shipping point, is a sub-port of Duluth. Its record in 1902 was 5,605,185 gross tons as against 5,018,197 gross tons in 1901.

Duluth leads all other ports on the Great Lakes in point of vessel tonnage enrolled. It is the port of hail for 331 vessels, having an aggregate gross tonnage of 493,620, as shown by figures in the port collector's office, June 1903. Eleven lines ply regularly in the steamboat merchandise trade of Duluth, carrying both passengers and freight. Of the great number of coarse, bulk cargo lines, the Pittsburg Steamship Company, with 112 boats, controlled by the United States Steel Company, is the first.

The grain elevator storage capacity of Duluth is 17,000,000 bushels. There are two systems, the Consolidated Elevator Company, owning eight houses and having a total capacity of 12,000,000 bushels, and the Peavey system, with a total capacity of 5,000,000 bushels. The latter has the largest concrete elevator in the world and the only one of the kind in the United States. Its capacity is 4,000,000 bushels, and that of the working-house 1,000,000 bushels. For the crop year ending 31 July 1903 the total receipts of grain at Duluth were 26,296,921 bushels, of which the Consolidated received 17,900,000 and the Peavey 8,396,921 bushels.

The lumber shipments from this port for 1902 amounted to 279,787,788 feet. There are five coal docks, with an average storage capacity of about 1,000,000 tons. The receipts for 1902 were 818,532 tons of bituminous and 87,383 of anthracite.

The striking natural feature of the Duluth-Superior harbor is the great breakwater formed during countless ages by the contending waters of Lake Superior and of the St. Louis and Nemadji rivers descending from the heights. The seven miles of this breakwater to the northward is called Minnesota Point. The two miles at the south, from the natural entry to the Wisconsin mainland, is called Wisconsin Point. The Duluth Canal cuts this point about half a mile from the main land, and was originally the work of the people of Duluth, although the United States government subsequently took charge of it; and some years ago undertook the widening of it. It is 300 feet wide and 1,700 feet long and 25 feet deep, running between cement piers 10 feet high, which were completed in 1001 at a cost of $550,000.

Duluth has eight railroads: Great Northern, Northern Pacific, Chicago, Milwaukee & St. Paul; Wisconsin Central; Chicago, St. Paul, Minneapolis & Omaha; Duluth & Iron Range; Duluth, Missabe & Northern, and the Duluth, South Shore & Atlantic.

Headquarters of six of the large constituent companies of the United States Steel Corporation are located in Duluth. They are engaged in the mining of ore on the Missabe and Vermilion ranges north of this city; in the carrying of it over railroads to the shore of Lake Superior, and in the transportation of it from docks here and in Two Harbors to the corporation's smelters and rolling mills in eastern States. The iron output of the ranges is practically controlled by the United States Steel through these constituent companies. The six are: The Minnesota Iron Company, Chandler Iron Company, and Oliver Mining Company, including over a score of mining firms in the combination of the trio; the Duluth, Missabe & Northern Railroad Company, the Duluth & Iron Range Railroad Company, and the Pittsburg Steamship Company.

The most extraordinary feature of Duluth's commerce during recent years is the growth of her wholesale trade, particularly in the line of hardware and groceries, which has spread to the Pacific coast and even to Alaska.

History.— Groselliers, a French fur trader, and his associates were the first white men who visited what is now Duluth. In 1660 they shipped from the head of Lake Superior 60 canoes laden with furs. Daniel Greysolon Du Luth, after whom Duluth was named, was a French officer, who urged by an adventurous spirit led a strong party to the westward, following the line of the Great Lakes. He traded with the Indians at Fond du Lac in 1679, and it has been believed that he at one time maintained a camp on Minnesota Point. It was not until 1854 that the Indian title to the territory on which this city is built was extinguished by treaty. An election for the Territory of Minnesota, the object of it being to choose a delegate to Congress, was held on the unorganized, unplatted town-site of Duluth in October 1855. In May 1857, Duluth was incorporated as a town by an act of the territorial legislature. In 1867 a railroad from Duluth to St. Paul was begun and in 1870 the St. Paul & Duluth, the first railroad, was completed. In the same year Duluth was organized as a city; but the Jay Cooke failure of 1872 was a blow to the new mart of commerce and she relapsed into a village, retaining that status until 1890. Real work for the development of the iron ranges began in 1878, and in 1882 the first iron range railroad was completed between Two Harbors and Vermilion Lake. The hand of panic fell hard on Duluth in 1893 and depression lasted until 1899, since which time the city has enjoyed an exceptional share of prosperity.

Population.— The population of Duluth was 3,470 in 1880; 33,187 in 1890; and 52,969 in 1900. At the last date the foreign-born population was 39.6 of the total, the leading nationalities being as follows: Canadian English, 5,099; Swedish, 5,047; Norwegian, 2,655; German, 1,685; Canadian French, 1,285; Polish, 920; English, 817; Irish, 792; Finnish, 702; Italian, 292.

A. M. Flagg,
Editor Duluth News Tribune.

Duma. See Russia: *Government; History.*

Dumanjug, Philippines, a town of the province of Cébu, situated on the west coast at the mouth of the Dumanjug River, 37 miles southwest of Cébu. Pop. 13,171.

Dumas, dü-mä, **Alexandre,** the Elder, French dramatist and novelist: b. Villers-Cotterets 24 July 1803; d. Puits, near Dieppe, 5 Dec. 1870. He was the son of a Republican general who bore the same name, and grandson of Marquis de la Pailleterie and a negress, Tiennette Dumas. He went to Paris at the age of 20, to push his fortune, and was employed by the Duke of Orleans as secretary at 1,200 francs a year. He now devoted his leisure hours to completing his education, and his ambition prompted him to shine in the field of literature. Some of his lighter dramatic works were rejected by the theatrical directors, some were accepted, and had more or less success, bringing but little fame or profit to their author. At last, in 1829, his drama of 'Henri III.' appeared on the stage of the Comédie Française. It was produced when the battle between the Romanticists and the Classicists was at its height, and hailed as a triumph by the former school. The piece became popular and brought the lucky dramatist the sum of 30,000 francs, and the post of librarian to the Duke of Orleans. The same year appeared his 'Christine,' and in quick succession, 'Anthony'; 'Richard d'Arlington'; 'Térésa'; 'Le Tour de Nesle'; 'Catharine Howard'; 'Mlle. de Belle-Isle,' etc. Dumas had now become a noted Parisian character. The critics fought over the merits of his pieces, and the scandalmongers over his prodigality and *galanteries.* Turning his attention to romance, and desirous of becoming the Walter Scott of his country, he produced a series of historical romances, among which are: 'Les Deux Dianes'; 'La Reine Margot'; 'Les trois Mousquetaires,' which, with its continuations, occupies eight volumes. The 'Comte de Monte-Cristo,' and the 'Memories d'un Médicin,' are also well known through translations to English and American readers. Several historical works also bear his name: 'Louis XIV. et son Siècle'; 'Le Regent et Louis XV.'; 'Le Drame de '93'; 'Florence et les Médicis,' etc. In 1846 he accompanied the Duke of Montpensier to Spain as the historiographer of his marriage; and on his return to Paris he opened a theatre for the purpose of producing only his own pieces; and built a fantastic and costly country-seat, which was known as the Château de Monte-Cristo, and on which he expended 450,000 francs.

It is difficult to come to a satisfactory conclusion as to the merits of this author. Some of his productions are little else than mere translations from English and German sources. His first drama, 'Henri III.,' is but a skilful piece of patchwork, Walter Scott and Schiller furnishing him with the bulk of the material. Equally fatal to his reputation is our knowledge of the fact, gained from a lawsuit he had with the *Presse* and the *Constitutionnel* newspapers, and from a work by Mirecourt, entitled, 'Fabrique de Romans, Maison A. Dumas et Cie.' (Dumas & Company's Romance Factory), that he had arranged to supply those journals during the year with more novels than the most expert scribe could copy in the time, and that he had in his pay numerous hacks who did the serious part of the work. The only claim he could lay to a great number of the productions issued under his name, was that he either sketched the plot or revised them before going to press. Yet of the talent and even genius of Dumas there can be no reasonable doubt; he had great fertility of invention, much humor and gaiety, and genuine dramatic power, as the works that were undoubtedly from his pen sufficiently testify; and it was not till he had secured a front rank in literature by his own exertions that he descended to the unworthy plan of employing assistants to manufacture novels to order. Consult: Blaze de Bury, 'Alexandre Dumas, sa vie, son temps, son œuvre' (1885); Wells, 'Century of French Fiction' (1898); Parigot, 'Le drame d'Alexandre Dumas' (1898); and 'Alexandre Dumas père' (1902); Spurr, 'Life and Writings of Alexandre Dumas' (1902).

Dumas, Alexandre, the Younger, French dramatist and novelist: b. Paris 28 July 1824; d. there 27 Nov. 1895. He was the natural son of Dumas the Elder (q.v.), and while a young man shared his father's life in Paris, and accompanied him on his travels. In 1847 there appeared a collection of his poems under the title 'Péchés de Jeunesse'; his first novel 'Aventures de Quatre Femmes et d'un Perroquet,' was published in the same year; others of his novels are 'Césarine' (1848); 'La Dame aux Camélias' (1848); 'Le Docteur Servan' (1849); and 'L'affaire Clemenceau' (1866). 'La Dame aux Camélias' was dramatized in 1852, and marked the introduction of realism in the treating of social and moral problems on the stage. His other dramas include: 'Diane de Lys' (1853); 'Le Demi Monde' (1855); 'La Question d'Argent' (1857); 'Le Fils Naturel' (1858); 'Un Père Prodigue' (1859); 'L'Ami des Femmes' (1864); 'La Femme de Claude' (1873); 'La Princesse de Bagdad' (1881); 'Denise' (1885); and 'Francillon' (1887). He has also written a few essays, discussing social problems; these are: 'Lettre sur les Choses du Jour' (1871); 'L'Homme-Femme' (1872); 'Question du Divorce' (1880); 'Recherche de la Paternité' (1883). Dumas was made a member of the French Academy in 1874.

Dumas, Jean Baptiste André, zhŏn bäptēst äṅ-drā, French chemist: b. Alais, Gard, 14 July 1800; d. Cannes, France, 11 April 1884. He studied at Geneva, and going to Paris in 1821, was first a lecturer in the École Polytechnique, then professor of chemistry in the Athénée, the École Centrale des Arts et Manufactures (founded by himself), and finally, the Sorbonne. He now wholly devoted himself to chemical studies; and his views on chemical equivalents, and especially his memoir on the atomic theory, soon attracted attention over all Europe. His views on the laws of substitutions involved him in a long discussion with the great Berzelius. His researches in organic chemistry, especially his masterly papers on the ethers, ethereal oils, indigo, and the alkaloids, placed him in the first rank of chemists. In 1849–51 he was minister of agriculture and commerce, and also held offices under the Second Empire. In 1875 he was called to fill Guizot's chair in the Academy. His chief works are: 'Traité de Chimie appliquée aux Arts,' and 'Leçons sur la Philosophie Chimique.' See Maindron, 'L'Œuvre de J. B. Dumas' (1886).

Dumas, Matthieu, French soldier and military writer: b. Montpellier, France, 23 Dec. 1753; d. Paris 16 Oct. 1837. He early entered the French cavalry, took part in the American Revolution, and was employed in the Levant and in Holland. At the commencement of the French Revolution he assisted Lafayette in organizing the National Guard. On the triumph of the extreme party in 1797 Dumas was proscribed, but made his escape to Holstein, where he wrote the first part of his 'Précis des Événements Militaires,' a valuable source for the history of the period of which it treats (1798–1807). After the Restoration, Louis XVIII. appointed him councilor of state and gave him several important appointments connected with the army. In 1830 he aided in bringing on the revolution of July, and after the fall of Charles X. obtained the chief command of all the national guards of France, together with a peerage.

Du Maurier, dü mō-rē-a, **George Louis Palmella Busson,** English artist, caricaturist, and novelist: b. Paris 6 March 1834; d. London 8 Oct. 1896. He belonged to an old French family which had been driven to England by the Revolution, and was a naturalized British subject. He spent some years in France and Belgium, and afterward went to school in London. He soon adopted art as a profession, working as a student in the galleries of the British Museum. Then, returning to Paris, he entered the studio of Gleyre, and next went to Antwerp to continue his artistic training. Returning to London, he began to draw on wood for 'Once a Week,' the 'Cornhill Magazine,' etc., and also exhibited at the Royal Academy. He subsequently joined the 'Punch' staff and became famous through his weekly drawings for that publication. He also illustrated a large number of books, including Thackeray's 'Esmond' and 'Ballads.' A collection of his 'Punch' woodcuts was published in 1880 under the title 'English Society at Home.' In 1891 appeared his first novel, 'Peter Ibbetson,' and in 1894 'Trilby,' a story which had a great popularity both in book form and on the stage. An incomplete novel by him was published posthumously as 'The Martian.' His novels can hardly be looked upon as very serious contributions to literature, but his 'Punch' drawings will no doubt have a permanent value as portraying many of the peculiarities of contemporary society.

Dumb Ague, an irregular intermittent fever, so named from the absence of shivering chills. See MALARIA.

Dumb-bell. See GYMNASTICS.

Dumb-cane, a popular name for a West Indian plant (*Dieffenbachia sequina*) *of the arum* family. The acridity which is characteristic of most of the members of the arum family in this species causes a swelling of the tongue with excruciating pain, if the plant is chewed, and for a time destroys the power of speech, whence its name. Many species and varieties of Dieffenbachia are in cultivation as foliage plants.

Dumbar'ton (ancient LENNOX or LEVENIX), (1) A maritime county of Scotland. Pop. (1901) 113,870. (2) A seaport, and the chief town in the county, on the Leven; 13 miles northwest of Glasgow. Ship-building is the chief business, the six principal yards employing about 4,000 men. The rock and castle of Dumbarton, a short distance from the town, is noted in history. The fortress was erected over a thousand years ago. It is one of the four fortresses stipulated to be kept in repair by the articles of the Union. Pop. (1901) 19,864.

Dumbness, inability to speak. In a very large number of cases it arises from no malformation of the organs of speech, but is a necessary sequence of congenital deafness. A child acquires language by listening to and imitating the speech of its relatives or other people who talk in its presence, and picks up not merely the language of its country, but the exact pronunciation of the locality in which it for the time is. Total deafness, therefore, naturally produces dumbness. Distinct from congenital dumbness is the loss of speech in the case of those who have become affected with aphasia, which results from some disease of the brain, and aphonia, which is due to disease of the larynx or vocal chords. See DEAF-MUTES.

Dum'dum, India, town, municipality, and cantonment in the province of Bengal, five miles east-northeast of Calcutta. The town is famous as being the scene of the first open manifestation of the Sepoys against the greased cartridges, which led to the outbreak of the mutiny of 1857. Pop. (1891, including the military), 21,000.

Dumdum Bullet, a bullet so named after Dumdum Arsenal, the place near Calcutta where it was first made. It is one which instead of having its greatest strength at the point is weakest there, so that in striking a bone it will flatten out and shatter it, and not, like the modern steel-coated, sharp-pointed bullet, make a small hole and pass through without any other effect. At Santiago the Spaniards were charged with cutting off the brass tips of their bullets so that they had the same effect in inflicting jagged wounds as the regular dumdum bullets. Dumdum bullets are now used to some extent by big game hunters. The Hague Peace Congress agreed that dumdum bullets should not be used in war. In the war against the Boers in South Africa (1899–1902) the British were charged with using a modification of this bullet. See BULLET.

Duméril, André Marie Constant, äṅ-drā mä-rē kôṅ stäṅ dü-mā-rēl, French physician and naturalist: b. Amiens 1 Jan. 1774; d. Paris 2 Aug. 1860. From 1801 to 1818 he was professor of anatomy and of physiology of the medical faculty of Paris. His works on natural history and analytical zoology are distinguished both for accuracy of details and for philosophical treatment. In his most celebrated production, 'L'erpétologie générale' (1835–51), which contains the first attempt at a systematic description of all known reptiles, he had Bibron as collaborator.

Dumersan, dü-mär-säṅ, **Théophile Marion,** French playwright: b. Issoudun 4 Jan. 1780; d. Paris 13 April 1849. He was employed in the Paris mint. He wrote many plays, all marked by keen observation and comic spirit. His 'Angel and Devil,' a five-act drama, had a "run" of over 100 presentations; still more successful was his 'Mountebanks,' his masterpiece and a classic in its kind. Other very successful plays written by him are: 'The Wigmaker, or Heads à la Titus'; 'Ridiculous Englishwomen.' Worthy of mention is his volume of 'National and Popular Songs of France.'

Dumfries, dŭm-frēz', a maritime county, Scotland; area 1,098 square miles. The surface is irregular; about one half is good farming land, and valuable minerals are found in the hill sections.

Dumfries, a river port, railroad centre and parliamentary borough, capital of the county of same name, and the chief town in the south of Scotland; on the Nith, about six miles from its junction with the Solway Firth. It is connected with the suburb Maxwelltown (in Kirkcudbright) by three bridges, one dating from the 13th century. Pop. (1901) 72,569.

Dummer, Jeremiah, American scholar: b. Boston about 1680; d. in Plaistow, England, 19 May 1739. He was graduated at Harvard College in 1699, where he was noted for the vigor and brilliancy of his genius. With the purpose of preparing for the clerical profession, he went abroad, and studied in the university of Utrecht. On his return to America he abandoned his chosen vocation, and soon after went to England, where, as agent of Massachusetts, he rendered important services to his countrymen. He was an admirer of Lord Bolingbroke, in whose daring and reckless genius he found much that was congenial to his own character, and in intimacy with whom he adopted something of his moral and religious license. He published theological and philosophical disquisitions in Latin while at Utrecht, and his 'Defence of the New England Charters,' written in England (1728), is admirable both in style and matter. The traditions and records concerning him alike testify to his remarkable powers, and his easy command of them in speaking, writing, and in intercourse with men.

Dummer's War, 1724–5, an episode in the long struggle of the French governors of Canada to check English settlement by inciting the Indians to raids and massacre of the border settlers. It was named after William Dummer, acting-governor of Massachusetts, who organized the resistance against the Indian expeditions sent by Vandreuil, governor of Canada, against the villages of Massachusetts and Maine, and of Vermont where Fort Dummer had been built on the site of Brattleboro in 1724. One of its chief incidents was the aggressive retaliation of Dummer and the victorious assault by the English on Norridgewock, Me., when Sebastien Rale, the Jesuit missionary and Indian leader, was killed with 26 Abenaki Indians, 12 Aug. 1724. The further crushing decimation in Lovewell's fight (q.v.) at Fryeburg, Me., 8 May 1725, led to four Indian chiefs signing a treaty for the Penobscots and other Abenakis at Boston in November 1725, which was ratified by the latter the following year.

Du Mond', Frank Vincent, American artist: b. Rochester, N. Y., 1865. He was a pupil of Boulanger, Lefebvre and Benjamin Constant, and received a third-class medal at the Paris salon in 1890.

Dumont, dü-môṅ, **Albert,** French archæologist: b. Scey-sur-Saône, 1842; d. 1884. He was educated in Paris, and devoting himself to the study of prehistoric, Byzantine, and Christian archæology, published 'De Plumbeis apud Græcos Tesseris' (1870); 'Inscriptions céramiques de Grèce' (1871); and 'Vases peints de la Grèce propre' (1873). In 1874, in Rome, and the following year in Athens, he lectured on archæology and the history of art. In 1878 he was elected rector of the academy of Grenoble, in 1879 rector of the academy of Montpellier, and until his early death was a superintendent of higher education. The most important of his later works is 'Les céramiques de la Grèce propre, vases peints et terres cuites' (1882–90), prepared in collaboration with Chaplain.

Dumont, dü-môṅ, **Augustine Alexandre,** French sculptor: b. Paris 14 Aug. 1801; d. there 25 Jan. 1884. He was a most prolific worker, and his statues are found on or in many of the public buildings and churches of his native city. His most noted productions are, the colossal statues of the 'Genius of Liberty' on the Column of July, made in 1840, and the statue of Napoleon III. on the Column Vendome.

Dumont, Julia Louisa, American educator and writer: b. Waterford, Ohio, October 1794; d. Vevay, Ind., 2 Jan. 1857. She has the distinction of being one of the earliest women of the West whose writings have been preserved. She contributed largely to periodicals both in prose and verse. A collection of her writings was published in a volume, 'Life Sketches from Common Paths' (1856).

Dumont, Pierre Etienne Louis, pē ār ā-tē-ĕn loo-ē dü-môṅ, Swiss scholar: b. Geneva 18 July 1759; d. Milan, Italy, 30 Sept. 1829. In 1785 he became tutor in London to the sons of Lord Shelburne. His superior talents soon recommended him to the illustrious Whigs of that period; with Romilly, in particular, he formed a close friendship. During the early years of the French Revolution, Dumont was at Paris, where he became greatly attached to Mirabeau, regarding whom he has given the world much valuable information in his posthumous 'Souvenirs sur Mirabeau' (1832). In this work he claims to have composed for him many of Mirabeau's most eloquent speeches. In 1791 Dumont returned to England, and formed an intimacy with Bentham (q.v.). This was the event of his life. Deeply convinced of the value of Bentham's views on legislation, he requested him to allow him to arrange and edit his unpublished writings on this subject. Bentham gave him his manuscripts, which Dumont labored earnestly to abridge, elucidate, correct, and simplify. The results appeared in his 'Traité de Législation Civile et Penale' (1802); 'Théorie des Peines et des Récompenses' (1811); 'Tactique des Assemblés Législatives' (1816); 'Preuves Judiciaires' (1823); and the 'Organisation Judiciaire et Codification' (1828). Dumont returned to Geneva in 1814, and became a member of the representative council.

Dumont D'Urville, Jules Sebastien César, zhül sā-bäs-tē-öṅ sā-zär dü-môṅ dür-vēl, French navigator; b. Condé-sur-Noireau, Calvados, 23 May 1790; d. near Paris 8 May 1842. After completing his studies at Caen he entered the navy, in which he ultimately rose to be vice-admiral. He was twice wrecked and on both occasions owed his escape chiefly to self-possession and skilful seamanship. He rendered important service by his search for the remains of the ill-fated expedition of La Pérouse, the survey of long tracts of coast in New Zealand and New Guinea, the discovery of numerous islands and an antarctic continent, and the exploration of very dangerous and still imperfectly known tracts of navigation, as Torres' Straits, in Australia, and Cook's Straits, between the two large islands of New Zealand. To his contributions to geography he was indebted for his nomination to the office of president of the Paris Geographical Society. One fruit of his voyages was the 'Enumeratio Plantarum in Insulis Archipelagi et Littoribus Ponti Euxini' (1822). After his second circumnavigation, he published the 'Voyage de l'Astrolabe' (1830–9), and 'Voyage Pittoresque autour du Monde' (1834).

Dumor'tierite, a native basic silicate of aluminum, of somewhat uncertain composition. It crystallizes in fibrous or columnar forms belonging to the orthorhombic system, and has a hardness of 7 and a specific gravity of about 3.3. It is transparent or translucent, with a vitreous lustre and a blue or greenish blue color, and is strongly pleochroic. Dumortierite occurs near Lyons, France, and also in certain parts of Norway and Silesia. In the United States it is found in New York city, and in Yuma County, Arizona. The mineral is named for Eugene Dumortier, a French palæontologist.

Dumoulin, dü-moo-läṅ, **John Philip,** Canadian Anglican bishop: b. Dublin, Ireland, 1836. He was educated at Trinity College in the city of his birth, and emigrating to Canada was ordained priest in 1863. After an extended experience as a parochial clergyman he was appointed rector and canon of St. James' Cathedral, Toronto, in 1882, and in 1896 was elected third bishop of Niagara.

Dumouriez, Charles François, shärl fräṅ-swä dü-moo-rē-ā, French general: b. Cambrai, 25 Jan. 1739; d. near Henley-upon-Thames, 14 March 1823. He entered the army early in life and at 24 years of age had received 22 wounds, and was made a knight of St. Louis. In 1772, Louis XV. sent him with communications to Sweden, but he was arrested, and for a long time confined in the Bastile. In 1789 we find him a principal director of the Jacobin club, composed of all who aspired to be accounted the friends of liberty. He afterward became a minister of Louis XVI., when he strongly advised the monarch to yield the direction of the interior affairs of the kingdom to the council of the assembly then sitting, and to declare war against the foreign foes of France. The advice was disregarded and Dumouriez was dismissed. Still determined to devote himself to the service of the army, he proceeded to Valenciennes, where he soon gained fame by his valor and his firmness, displayed at the head of the French soldiers, having succeeded Lafayette in the command of the Army of the North. He rendered very important service to his country by the stand he so skilfully made against the Prussian invaders in the forest of Argonne, in September 1792, the famous "Cannonade of Valmy" taking place on the 20th of the same month. His rapid conquest of Belgium followed. Notwithstanding his success, the Directory, not without motive, entertained suspicions regarding his designs. Dumouriez had entered into secret negotiations with the enemy, and learning that an accusation of treason was to be brought against him, he fled to the Austrian headquarters. He refused, nevertheless, to serve against his country; wandering for some time through Europe, and lastly settled in England.

Dun, Edwin, American diplomatist: b. Chillicothe, Ohio, July 1848. He went to Japan in 1873, becoming successively United States second secretary of legation, first secretary of legation, and was from 1893 to 1897 United States minister. During the war between China and Japan the Chinese government placed its interests in Japan in his care.

Dun (Celtic *dun, Irish dūn,* Gael *dūn,* a hill, castle), a word used as a prefix or suffix in the names of cities as, in Augustodunum (Autun), and in many names in Scotland and Ireland, as in Dunblane, Dundee, Dundalk, Dunboyne, etc.

Düna, or **Southern Dvina,** so named to distinguish it from the northern Dvina, a west Russian river, which flows from a small lake near the source of the Volga, in the southwest of the government of Tver, and after a circuitous route of about 650 miles with a generally northwestern trend, empties into the Gulf of Riga, 10 miles below Riga. For some distance it forms the boundary between the governments of Vitebsk and Livonia on the north bank, and Vilna and Courland on the south bank. Although obstructed by rocks and rapids, it is navigable for ocean vessels to Riga, for vessels of lighter draft to Dünaburg, and for flat-bottomed barges almost from its source; it commands a large river traffic; on an average it is icebound 115 days in the year. Canals connect it with the Volga, the Beresina, the Niemen, and Lake Ilmen.

Dünaburg, dü'nä-boorg, or **Dvinsk,** Russia, a fortified town of Russia, government of Vitebsk, on the Düna, 112 miles southeast from Riga. It was formerly the capital of Polish Livonia. It is of great military importance, and carries on a considerable trade. Pop. 72,231.

Dunant, Jean Henri, zhŏṅ ŏṅ-rē dü-näṅ, Swiss philanthropist: b. Geneva 1828. While traveling near the battlefield of Solferino in 1859, he took part in the relief of those wounded in that battle, and realized the inadequacy of the provisions for the work. As the result of his experiences there he wrote 'Un Souvenir de Solferino,' advocating more efficient care of the wounded on the field of battle. He also lectured on the subject before the Society of Public Utility in Geneva, and enlisted the sympathy of the president and other members. A meeting of the society was called to consider the formation of permanent organizations for the relief of the wounded, and from this grew the conference at Geneva in 1864, and the Red Cross Society (q.v.). Dunant devoted his fortune to the organization and work of this society, and was pensioned by the empress of Russia. He has written 'L'Empire Romain reconstitué' (1858); 'Fraternité et Charité Internationales en Temps de Guerre' (1864); L'Esclavage chez les Musulmans et aux Etats Unis de l'Amérique' (1863); and 'La Rénovation de l'Orient' (1865).

Dunbar, Paul Laurence, American author: b. Dayton, Ohio, 27 June 1872, d. 10 Feb. 1906. He was graduated from the Dayton high school in 1891, and from that time devoted himself to literature and journalism. After 1898 he was on the staff of the librarian of Congress. He published 'Oak and Ivy' (poems) (1893); 'Majors and Minors' (1895); 'Lyrics of Lowly Life' (1896); 'Folks from Dixie' (1898); 'The Uncalled,' a novel (1898); 'Lyrics of the Hearthside' (1899); poems of 'Cabin and Field' (1899); 'The Strength of Gideon' (1900); 'The Love of Landry' (1900); 'The Spirit of the Gods,' a novel (1901); 'The Fanatics,' a novel (1901).

Dunbar, William, Scottish poet: b. Salton, Lothian, about 1465; d. about 1525. He was a Franciscan friar, but was often employed by James IV. in affairs of state. Among his works are the panegyric poem 'The Thistle and the Rose,' written (1503) on the marriage of James with Margaret of England, and 'The Golden Targe' (1508), consisting of allegories in the fashion of the time and of Chaucer, among them a poem on 'The Dance of the Seven Deadly Sins Through Hell.' He is at his best in burlesque poetry, as witness the autobiographical 'Visitation of St. Francis.' He is as "rich in fancy as Spenser; as homely and shrewd as Chaucer in the 'Miller's Tale'; as pious as Cowper in his hymns, and as wittily grotesque as Burns in 'Death and Dr. Hornbook.'"

Dunbar, Scotland, a royal and municipal borough and seaport in Haddingtonshire, at the mouth of the Firth of Forth. It is a place of great antiquity, having originated in a castle, once of great strength and importance, which underwent several memorable sieges; on one occasion being successfully defended against the English for 19 weeks by Black Agnes, countess of Dunbar. Queen Mary and Bothwell (1567) took shelter in this castle. In 1650 Cromwell, at the "Race of Dunbar," totally defeated the Scottish army under David Leslie. The harbor, opened in 1844, is not very commodious, but the town is an important fishing station. Pop. 3,545.

Duncan, Adam, Viscount, Scottish naval officer: b. Dundee 1 July 1731; d. Scotland 4 Aug. 1804. He went to sea when young and was a post-captain in 1761. In the following year he served at the taking of Havana; and in 1779 he shared in the victory of Admiral Rodney over the Spaniards. In 1795 he was appointed commander of the North Sea fleet, and in October 1797, won a brilliant victory over the Dutch fleet off Camperdown, for which he was rewarded with the title of Viscount Duncan and a pension of $10,000 a year.

Duncan, Norman, American journalist: b. Brantford, Ontario, Canada, 2 July 1871. He was educated at the University of Toronto 1891–5, entered journalism and is at present (1903) on the editorial staff of the New York *Evening Post*. He has written short stories and sketches for the 'Atlantic Monthly,' 'McClure's Magazine' and others, and has published 'The Soul of the Street: Stories of the New York Syrian Quarter' (1900).

Duncan, Sarah Jeanette. See Cotes, Sarah Jeanette.

Duncan, Thomas, Scottish painter: b. Kinclaven, Perthshire, 24 May 1807; d. Edinburgh 25 May 1845. He began to exhibit at the Scottish Academy in 1828, and became an academician in 1830. The first picture which extended his fame beyond the Tweed, and helped to procure his admission as an associate of the Royal Academy (1843), was 'Prince Charles Edward and the Highlanders entering Edinburgh after the Battle of Prestonpans' (1840). Another famous picture of his is 'Charles Edward asleep after Culloden, protected by Flora Macdonald.' His last exhibited work was the 'Martyrdom of John Brown of Priesthill,' now in the Corporation Gallery of Glasgow. He also executed many portraits.

Duncan, William Wallace, American clergyman: b. Boydtown, Va., 20 Dec. 1839. He was graduated at Wofford College (S. C.) in 1858, becoming a minister of the Methodist Episcopal Church, South, and serving as chaplain of a Confederate regiment during the Civil War. From 1875 to 1886 he was professor of intellectual and moral philosophy at Wofford College. Since 1886 he has been a bishop of the Methodist Episcopal Church, South.

Dun'cansby Head, a picturesque promontory, forming the northeastern extremity of Scotland, in the county of Caithness. It consists of a circular rocky eminence of about two miles in circumference, and is intersected by large ravines and remarkable fissures. About a mile and a half west stood the celebrated John O'Groat's house, of which no trace now remains.

Dunce, a word introduced by the Thomists or disciples of Thomas Aquinas, in ridicule of the Scotists, or disciples of John Duns Scotus, schoolman, who died 1305 A.D., to denote a subtle sophist given to caviling where he cannot refute. When the reaction against the schoolmen took place at the Reformation the merits of those acute metaphysicians were temporarily decried, and the celebrated John Duns Scotus coming in for a more than ordinary share of disparagement, he, though a man of very subtle intellect, was held by the more ignorant or prejudiced of the Reforming party to be a man of invincible stupidity. He was therefore made to stand as the prototype of all modern dunces. Succeeding generations have the unfavorable verdict thus passed on the cultivators of scholastic philosophy. The schoolmen were the intellectual leaders of the age in which they lived, and rendered good service to humanity.

Dunciad, dŭn'sĭ-ăd, **The,** a celebrated satirical poem by Pope, in which he gibbets his critics and foes. The first three books were published in 1728; the fourth book, or 'New Dunciad,' appeared in 1742. Cibber was latterly substituted for Theobald as the hero.

Duncker, doon'kėr, **Dora,** German story-writer and humorist: b. 28 March 1855. The conceits 'Incurable' (1893); 'The Sphinx,' and other tales and comedies, have succeeded; while in 'Modern Masters' (1883) she has evolved excellent character studies.

Duncker, Maximilian Wolfgang, German historian: b. Berlin 15 Oct. 1811; d. Anspach 21 July 1886. Politics interested him in early years, but his later energies were given to elaborate historical investigations, of which the best fruits are: 'The Crisis of the Reformation' (1845); 'Feudalism and Aristocracy' (1858); and the masterpiece 'Ancient History' (1852–7).

Dun'combe, Thomas Slingsby, English politician: b. 1796; d. 13 Nov. 1861. He was elected member of Parliament for Hertford in 1824, assisted in carrying the Reform Bill, and became prominent in the extreme Liberal party. In 1842 he presented the Chartist petition, signed by 3,000,000 of the lower classes, in favor of universal suffrage, vote by ballot, short Parliaments, etc. In 1842 the then home secretary having sanctioned the opening of the letters of Mazzini, Duncombe, in the House of Commons, denounced, with scathing invective, the adoption of the post-office spy system on English soil. He was an earnest advocate of Jewish emancipation; and his motion, 1858, for placing Baron Lionel Rothschild on a committee of the House of Commons was soon followed by the concession of the right of Jewish members to sit in the House of Commons.

Dundalk, dŭn-dâk', Ireland, a maritime town, capital of the county of Louth, on Castletown River. It is an ancient place, and in the battle of Faughart (1318) fought in its vicinity, Edward Bruce, the brother of King Robert Bruce of Scotland, was slain. It manufactures ropes and castings, and the trade, chiefly in cattle and agricultural produce, is extensive. Pop. (1901) 13,067.

Dundas', Henry, VISCOUNT MELVILLE, Scottish statesman: b. Edinburgh 28 April 1742; d. 28 May 1811. He studied at the University of Edinburgh and in 1766 was appointed solicitor-general for Scotland. In 1782 he was appointed treasurer of the navy and made a member of the privy council; but he continued only a short time in office. In 1791 he was made home secretary, and in 1794 became secretary of war. In 1804 he was appointed first lord of the admiralty under Pitt. Next year he was impeached, before the House of Lords, "of high crimes and misdemeanors" in his former office of treasurer of the navy. As the evidence adduced against him did not directly implicate him in the malversation proved against his deputy, he was acquitted. He was long practically the manager of Scottish affairs, and also of those of India.

Dundas', Robert, LORD ARNISTON, Scotch judge, b. 9 Dec. 1685; d. 1753. He was admitted to the Edinburgh bar in 1709, and soon became known as a successful lawyer with forcible and ingenious methods of reasoning. In 1717 he received the appointment of solicitor-general, a crown appointment, which was followed by advancing positions until in 1737 he became a judge, and in 1747 rose to the dignity, which he retained until his death, of lord president of the court of sessions of Scotland. His eldest son, ROBERT, b. 18 July 1713, d. Edinburgh 13 Dec. 1787; was educated at Edinburgh University, studied law at Utrecht and Paris; in 1737 gained admittance to the Scottish bar, and, like his father, rose through successive crown positions to that of lord president of the court of sessions of Scotland, which he attained in 1760 and occupied until his death.

Dundas, Canada, a town in Wentworth County, in the province of Ontario; situated on a bay at the western extremity of Lake Ontario. It is a manufacturing and shipping centre. Pop. (1901) 3,173.

Dundas Island, an island on the coast of British Columbia, separated from the most southerly of the islands of Alaska by Chatham Sound.

Dundas, or Juba, Islands, are a group of about 500 coral islets off the east coast of Africa in lat. 1° S. The group has one safe anchorage.

Dundas Strait, a passage about 20 miles wide, separating Melville Island from Coburg Peninsula in northern Australia.

Dundee, Viscount of. See GRAHAM, JOHN.

Dundee, Scotland, a flourishing borough and seaport in county Forfar, on the Tay, 8 miles from the sea, and 37½ miles northeast of Edinburgh. Dundee in former times was the scene of many battles. Gen. Monk (1651) burned the place and massacred 1,000 of its inhabitants. It has a fine harbor, and splendid docks, and manufactures osnaburgs and other coarse linens, canvas and bagging for export, and colored threads and gloves. Dundee possesses many shipyards, sugar refineries, tanneries, and machine shops. Its linen trade is the largest in Great Britain. Pop. (1901) 160,871.

Dundonald, Thomas Cochrane, 10TH EARL OF. See COCHRANE, THOMAS.

Dundrear'y, Lord, a prominent character in Tom Taylor's well-known comedy of 'Our American Cousin.' The part originally contained but 47 lines, but it was enlarged by the actor, E. A. Sothern, who became famous in this role.

Dune, dūn, a low sand-hill; an accumulation of sand; a hill-fort, or a regular building commonly called a Danish fort. Sand dunes are made by the blowing of sand, this material having been produced by the grinding down of rocks under the influence of breakers on the seashore or coast, or any similar agency. Such sand dunes in many places skirt the shores of Holland, Great Britain, Spain, and other countries, in some places encroaching on and covering what once was cultivated land. Originally the «downs» of England were similar to the dunes. The dunes along the Atlantic coast of the United States have changed materially the form of the coast line; some of these dunes are high hills, and still higher hills are on the coast of some of the islands of the Bahamas.

Dune Plants, plants characteristic of dunes, those somewhat unstable sandy areas formed under the influence of wind. The species capable of withstanding these conditions are few in number and are marked by well developed underground parts, including extensive root and numerous root-hairs, and storage organs, especially rhizomes. They are capable also of being partially buried, without apparent injury. Since some dunes are migratory, or tend to extend over wider and wider areas, thus destroying the natural vegetation, crops, and even orchards and forests, these plants are of special interest. Some of them, especially marram or beach grass, also known as sand reed (*Ammophila arenaria*), are widely planted upon beaches and dunes, to hold the sand and prevent its being blown by the wind. The United States Department of Agriculture, through its division of agrostology, has done immense service to land-owners along the shores of both the Great Lakes and the ocean coasts, in the planting of soil-binding grasses, as the plants are called. In time the planted areas support other vegetation and the dune may be considered conquered. On the other hand, should the dune advance it may disclose in its wake the remains of the vegetation it had buried. In western Michigan sand dunes have buried many peach orchards. In general the vegetation characteristic of dunes consists of xerophytes (q.v.), but the xerophytic character is due to the shifting of the sand and not to the conditions of growth. See DISTRIBUTION OF PLANTS.

Dunedin, dŭn-ē'dĭn or dŭn-ĕd'ĭn, New Zealand, town, capital of the province of Otago; on Otago harbor. It is about nine miles from its port, Port Chalmers, with which it is connected by railroad. Gold discovered nearby in 1861 has caused the recent rapid growth of the town. Wool and gold are the staple exports. Pop. (1901) 24,886; including suburbs, 52,390.

Dunferm'line, Scotland, a town in Fife, 16 miles northwest of Edinburgh. It is a place of antiquity, from 1057 till 1650 a frequent residence of Scotland's kings, and for more than two centuries their place of sepulture. It was here that Charles II. signed the Covenant in 1650. Some of the prominent institutions now in the town are the Carnegie Library and the Carnegie Baths, the schools and the churches. Pop. (1901) 25,250.

Dung-beetle, a name borne by several lamellicorn beetles, of the genera *Aphodius, Bolbocerus, Copris, Geotrupes, Phaneus,* and others. These beetles nest and lay their eggs in the droppings of cattle, and are found throughout America, Europe, Asia, and Africa. An African species is the sacred scarabæus of Egypt (*Ateuchius sacer*).

Dungar'van, Ireland, a municipal borough and seaport in the county of Waterford. It is a resort for sea-bathing. Its ancient castle, situated in the centre of the town, is now used as a barrack. The harbor is shallow and there is little trade. Fishing is the chief occupation. Pop. (1901) 4,850.

Dungeness, dŭnj'nĕs, a headland on the south coast of Kent, 11 miles southeast of Rye. It has a fort and government lighthouse.

Dunglison, dŭng'lĭ-sŏn, **Richard James,** American physician: b. Baltimore, Md., 13 Nov. 1834; d. Philadelphia 4 March 1901. He was a son of Robley Dunglison (q.v.). He was graduated at the University of Pennsylvania 1852, and from Jefferson Medical College 1856. During the Civil War he served as surgeon in the Philadelphia military hospitals. He soon gave up the practice of medicine in order to devote himself to literary work and it is by his contributions to medical literature that he is best known, having edited the 'College and Clinical Record' 1880–99, and written constantly for the leading medical journals. He was also one of the original editors of the Philadelphia 'Medical Times.' He revised and edited the following works of his father: 'History of Medicine' (1872), and 'Medical Lexicon' (1874); translated Guersant's 'Surgical Diseases of Children' (1873); and was author of: 'The Practitioner's Reference Book' (1878); 'Elementary Physiology' (1879); 'The Present Treatment of Disease' (1886).

Dunglison, Robley, American physician: b. Keswick, England 4 Jan. 1798; d. Philadelphia 1 April 1869. He was educated in medicine at London and Erlangen, and appointed professor of medicine in the University of Virginia in 1824. In 1833 he was elected to the chair of therapeutics in the University of Maryland, and in 1836 professor of the institutes of medicine in the Jefferson Medical College of Philadelphia. He published about 20 volumes treating of subjects connected with medical science. They were widely circulated and highly valued in their day, one of them, a 'Dictionary of Medical Science and Literature,' being republished as late as 1874.

Dun'ite, a heavy, dark, very basic igneous rock of the peridotite group. It contains no felspar and consists essentially of olivene and chromite. It is believed that most workable deposits of chrome iron ore were formed by local segregations of chromite in a cooling dunite magma, at least the chromite deposits of North Carolina probably had such an origin. Dunites in common with other rocks of the peridotite group change readily to serpentine, and most deposits of chromite occur in serpentine. See PERIDOTITE.

Dun'kards, Dunkers, or **Tunkers** (Ger. *tunken,* to dip, Lat. *tingere,* Gr. *τέγγειν*) a sect of German-American Baptists, founded by Alexander Mack in 1708 in Westphalia. Persecution at home drove them across the Atlantic. Their doctrines resemble those of the Mennonites (q.v.). They derive their name from their mode of baptizing by immersion. They reject infant baptism; use great plainness of dress and language; refuse to take oaths or to fight; and anoint the sick with oil in order to effect their recovery, depending on this unction and prayer, and rejecting the use of medicine. Every brother is allowed to speak in the congregation, and their best speaker is usually set apart as their minister, ordaining him by the laying on of hands, attended with fasting and prayer. They also have deacons, and aged women for deaconesses. From among the teachers who have been tried, they choose bishops. An elder among them is, in general, the first or oldest chosen teacher in a congregation which has no bishop. Their annual meeting, which is held about Whitsuntide, is attended by the bishops, teachers, and other representatives chosen by the congregations. The important cases brought before these meetings are, in general, decided by a committee of five of the oldest bishops. They will not go to law, and until lately the taking of interest on money was not allowed among them. They celebrate the Lord's Supper, with its accompanying usages of love feasts, the washing of feet, the kiss of charity, and the right hand of fellowship. They believe in general redemption, though it is with them not an article of faith; but they deny that they are Universalists. From the Dunkers, as a sect, must be distinguished the Seventh Day Dunkers, also called the German Seventh Day Baptists. They were established by Conrad Beissel, a native of Germany, who had been educated for the ministry at Halle. When a member of the Dunker society at Mühlbach (Mill Creek), in Lancaster County, Pa., he published (1725), a tract, to prove that the seventh day, and not the first day, was established by Jehovah for ever as the Sabbath. This created some disturbance in the society at Mill Creek, upon which he retired from the settlement and went secretly to a hermitage on the banks of the Cocalico. Having been discovered, and joined by many of the society at Mill Creek, who settled around him in isolated cottages, the first community of Seventh Day Dunkers was established in 1728. In 1733 a monastic society was established, constituting with the buildings subsequently erected by the community, the irregular enclosed village of Ephrata. The habit of the capuchins or white friars was adopted by both the brethren and sisters. Monastic names were given to all who entered the cloister. In 1740 there were 36 single brethren in the cloister and 35 sisters, and at one time the society, including the members living in the neighborhood, numbered nearly 300. The property which belonged to the society by donation, and the labor of the single brethren and sisters were common stock; but none were obliged to throw in their own property or give up any of their possessions. They considered celibacy a virtue, but never required it, nor did they take any vows in reference to it. When two wished to be joined in wedlock, they were aided by the society. In the earlier days the idea of a universal restoration existed among them; but it has never been taught as an article of faith, and is always approached with caution. The Dunkards in this country have dispersed themselves through almost every State of the Union, especially Pennsylvania, Maryland, Virginia, Ohio, and Indiana. In 1900 they reported 2,998 ministers; 1,129 churches; and 111,481 communicants. See GERMAN BAPTIST BRETHREN.

Dunkin, Edwin, English astronomer: b. Truro 19 Aug. 1821: d. 26 Nov. 1898. In 1838 he joined the staff of the Royal Observatory at Greenwich, becoming in 1881 chief assistant, a post which he resigned in 1884. In 1845 he was elected a Fellow of the Royal Astronomical Society, and in 1876 of the Royal Society. From 1884 till 1886 he acted as president of the former body. He published several works, among which are: 'On the Movement of the Solar System in Space determined from the Proper Motions of 1,167 Stars' (1863); 'On the Probable Error of Transit Observations' (1860–64); 'The Midnight Sky: Familiar Notes on the Stars and Planets' (1869); 'Obituary Notices of Astronomers' (1879).

Dunkirk, dŭn'kėrk (Fr. *Dunkerque* or *Dunquerque*), France, town in the department of Nord, on the coast of the North Sea, 40 miles northwest of Lille, at the junction of several canals. Of the public squares, that of Champ de Mars and that adorned by a statue of Jean Bart (1845) are the most noteworthy. There are several interesting churches, among the chief being the church of St. Eloi, built about 1560, with a fine tower about 300 feet high, now used as a belfry; the chapel of Nôtre-Dame des Dunes, founded in 1405 and restored in 1815; and the convent and church of St. Jean-Baptiste. Dunkirk is well protected by several forts, both on the land side and on that of the sea. Its manufactures are extensive, comprising fishing-nets, ropes, sail-cloth, straw hats, starch, soap, leather, earthenware, oil, and chemicals, besides distilling, sugar-refining, and other industries. Dunkirk is the chief port of departure of the French Iceland fishing fleets. The trade is extensive and important. Dunkirk was a town under its present name, which means "the church of the dunes," in the 9th century. It has played a prominent part in many wars, and has been besieged on many occasions. The present commercial importance of Dunkirk dates from the period of the second empire. One of the most famous natives of the town is Jean Bart (1651–1702), the celebrated seaman. Pop. 40,215, with the suburbs Rosendael and Saint-Pol-sur-Mer, about 55,000.

Dunkirk, N. Y., city in Chautauqua County; on Lake Erie, and the Erie, the Nickel Plate, the Lake Shore, the Western N. Y. & P., and the Dunkirk, All. V., and P. R.R.'s; 40 miles southwest of Buffalo. It is a good shipping port, having a good harbor and facilities for freight handling. Its industries include a plant for the manufacture of locomotives, foundry, planing-mills, grain-mills, grain and coal elevators, and various other factories. It is a popular summer resort, with a beautiful park overlooking Lake Erie, and has a public library, orphan asylum, public and parish schools, and a national bank. Pop. 12,500.

Dunlap, William, American dramatist and painter: b. Perth Amboy, N. J., 19 Feb. 1766; d. New York 28 Sept. 1839. He painted George Washington's portrait and for five years (1784–9) worked under West in London. Returning to America he wrote several successful plays, including: 'The Father' (1789), a comedy; 'Leicester' (1794), a tragedy; 'André' (1798), a tragedy. He also published: 'Life of George Frederick Cooke' (1813); 'Life of Charles Brockden Brown' (1815); 'History of the American Theatre' (1832); 'History of the Rise and Progress of the Art of Design in the United States' (1834); and similar works. He was one of the founders of the National Academy of Design.

Dun'lin (*Tringa alpina*), a bird of the genus to which the least and pectoral sandpipers, knot, and stint belong. It is smaller than the common snipe; is in winter ashy-gray above, white below, with dark spots on the breast; in the breeding season it is mottled with rufous above and the breast is crossed with black. The straight bill is adapted for boring in soft soil, and its cavity reaches to the extremity, not, as in the snipe, stopping short of the tip. The dunlin is one of the most common shore birds in northern Europe and Asia, and sometimes wanders into North America, where it is replaced by the closely allied redbacked sandpiper. In Scotland there are several local varieties, those of the east being a half larger than those of the Hebrides. It breeds on moors and marshes along with the snipe and plover, returning after the breeding season to the sandy and muddy reaches of the coast. See SANDPIPER.

Dunlop, George Thomas, American capitalist: b. Otterburn, Frederick County, Md., 25 March 1845. He entered business at 15, and set up for himself as G. T. Dunlop & Co. in 1870, retiring from business with a fortune in 1890. He was for many years director of the Washington & Georgetown Railroad Company, of which he was elected president in 1894. When this company obtained extensive new franchises from Congress, and changed its name to the Capital Traction Company in 1895, he was elected president of the new corporation.

Dunmore, John Murray, EARL OF, English colonial governor: b. 1732; d. Ramsgate, England, May 1809. He was appointed governor of New York in 1770, and governor of Virginia in 1771. He dissolved the Virginia Assembly in 1772, and again in 1774 when it had resolved to keep the day of the closing of the port of Boston as a day of fasting and prayer. In 1775 he removed a powder magazine to one of the English war ships, and the people incensed at this, began armed resistance under the leadership of Patrick Henry. Dunmore was forced shortly after to take refuge on his fleet, and kept up a predatory warfare against the colonists, burning Norfolk in 1776. He was driven from his position on Gwynn's island and finally sent the fleet to the West Indies, and returned to England. He was appointed governor of the Bahamas in 1786. See COLONIAL WARS IN AMERICA.

Dunmore, Pa., a borough in Lackawanna County, on the Erie & L. R.R.; two miles northeast of Scranton. It is the centre of a coal mining district, and has manufactures of silk, iron, and brick. Several public institutions are located here, the principal one being the State Oral School for the deaf and dumb. Pop. 12,600.

Dun'mow, Great and Little, two parishes of England, in the county of Essex. The former contains the market-town of Great Dunmow, on a height above the Chelmer, 32 miles northeast of London. At Little Dunmow are remains of a stately Augustinian priory, founded in 1104. The Dunmow flitch of bacon was a prize instituted in 1244, by Robert Fitzwalter, on the condition "that whatever married couple will go to the priory, and kneeling on two sharp-pointed stones, will swear that they have not quarreled nor repented of their marriage within a year and a day after its celebration, shall receive a flitch of bacon." The prize was first claimed in 1445, 200 years after it had been instituted. After 1751, up to which date only five presentations had taken place, the flitch was not again claimed till 1855; between 1860 and 1877 there were four awards; and three in 1891.

Dunn, Gertrude Colmore Renton, English novelist. She was educated in Germany and Paris, and in 1882 was married to H. A. C. Dunn. After his death she was married in 1901 to H. B. Weaver. She has published: 'Concerning Oliver Knox' (1888); 'A Conspiracy of Silence' (1889); 'A Living Epitaph' (1890); 'A Valley of Shadows' (1892); 'A Daughter of Music' (1894); 'Poems of Love and Life' (1896); 'Love for a Key' (1897); 'Points of View' (1898); 'The Strange Story of Hester Wynne' (1899); 'The Marble Face' (1900).

Dunn, Jacob Piatt, American journalist and author: b. Lawrenceburg, Ind., 12 April 1855. He was educated at Earlham College, Ind., and Michigan University, and was State librarian of Indiana 1889–93, when he became an editorial writer on the Indianapolis *Sentinel*. Since 1886 he has been secretary of the Indiana Historical Society. He has published: 'Massacres of the Mountains, a History of the Indian Wars of the Far West' (1886); 'History of Indiana› (1888), in the ‹American Commonwealth Series›; ‹The Tax Law of Indiana and the Science of Taxation› (1891); ‹The Libraries of Indiana› (1892); ‹The World's Silver Problem› (1894).

Dun'nage, a nautical term applied to loose wood or other miscellaneous substances, used in the hold of a ship to lift the cargo above bilge-water. Again, such articles as old mats or sails stowed among casks and other cargo, to prevent their motion and breakage. See CHOCKS.

Dunne, Edward Joseph, American Roman Catholic clergyman: b. Tipperary, Ireland, 1848. He came to the United States when an infant, was educated at the theological seminary in Baltimore, and ordained priest in 1871. He was appointed bishop of Dallas, Texas, in 1893. His diocese grew steadily under his administration till in 1900 it contained 32 churches and 21 parochial schools.

Dunne, Finley Peter, American journalist and humorist: b. Chicago 10 July 1867. He was educated in the Chicago public schools and entered journalism in 1885. He was city editor of the Chicago *Times* 1891–2; was on the editorial staff of the Chicago *Evening Post* and *Times-Herald* 1892–7; and editor of the Chicago *Journal* 1897–1900. He is author of ‹Mr. Dooley in Peace and War› (1898); ‹Mr. Dooley in the Hearts of His Countrymen› (1898); ‹Mr. Dooley's Philosophy› (1900); ‹Mr. Dooley's Opinions.›

Dun'net Head, a promontory of Scotland, in Caithness, at the western entrance of, and projecting into the Pentland Firth; the most northern point of the mainland of Great Britain. It rises to the height of 400 feet above sea-level. On the northwestern extremity is a lighthouse 346 feet high.

Dunning, Edwin James, American author: b. Camillus, N. Y., 19 July 1821; d. Cambridge 1901. He practised dentistry at Ithaca and Syracuse, N. Y., 1838–44, and in New York 1844–74. In 1877 he lost his eyesight and took up the study of literature. He published: ‹Genesis of Shakespeare's Art: a Study of His Poems and Sonnets› (1897).

Dunning, John, (BARON ASHBURTON), English lawyer: b. Ashburton, Devonshire, 18 Oct. 1731; d. Exmouth, Devonshire, 18 Aug. 1783. He established his reputation in 1762 by drawing up a defense of the East India Company against the claims of the Dutch; and his already large practice was immensely augmented by his arguments on the side of Wilkes in the question of the general warrants. In Parliament he remained a firm opponent to the ministry who conducted the American war; and on the return of Lord Shelburne to power in 1782 he was made chancellor of the duchy of Lancaster, and advanced to the peerage.

Dunning, William Archibald, American educator: b. Plainfield, N. J. He was graduated at Columbia 1881, and became successively fellow 1886–8; prize lecturer in political science 1887–9; instructor in history 1889–91; and professor of history and lecturer on political theory since 1891. In 1894 he became managing editor of the ‹Political Science Quarterly,› to which he has contributed over 60 important articles and reviews. He has published: ‹Essays on the Civil War and Reconstruction, and Related Topics› (1898); ‹History of Political Theories, Ancient and Mediæval› (1902).

Dunnottar, dŭn-nŏt'tar, a parish of Kincardineshire, Scotland, famous for its ancient ruined castle. The older part of the ruins probably belongs to about 1394, when the castle was rebuilt by Sir William Keith, marischal of Scotland. During the Commonwealth the castle was selected as the strongest place in the kingdom for the preservation of the Scottish regalia. Lambert, one of Cromwell's generals, besieged the place, which was starved into capitulation. The regalia had, however, been previously removed by a stratagem, in which Mrs. Granger, the wife of the minister of an adjoining parish, played the chief part. She brought away the crown hid among some clothes in her lap, her servant-maid carrying the sword and sceptre in a bag of flax on her back. In Dunnottar churchyard, near Stonehaven, Sir Walter Scott met Robert Paterson, the original «Old Mortality.»

Dunois, Jean, zhŏṅ dü-nwä, COUNT OF ORLEANS AND OF LONGUEVILLE, French soldier: b. Paris 23 Nov. 1402; d. St. Germain-en-Laye, near Paris, 24 Nov. 1468. He was a natural son of Louis, Duke of Orleans, and made the name «Bastard of Orleans» illustrious by his military exploits in the war for the liberation of France, then completely in the power of England. Being besieged by the English he defended Orleans with the greatest courage until relieved by the Maid of Orleans. To Dunois belongs almost entirely the honor of expelling the enemies of his country from Normandy and Guienne. In 1450 he had completely freed France from the presence of the English, and it may truly be said that Charles VII. was indebted to him for his crown. Dunois received from him the title of «deliverer of his country,» the county of Longueville, and the dignity of high chamberlain of France.

Dunoon, dŭn-oon', Scotland, a celebrated watering-place in the county of Argyle, on the shore of the Firth of Clyde, 25 miles west by north from Glasgow. There is an immense passenger traffic here in the summer season carried on by means of the Clyde steamers. On a hill are the ruins of Castle Dunoon, the ancient residence of the Argyles.

Dunquerque. See DUNKIRK, France.

Dunra'ven, Windham Thomas Wyndham-Quin, 4TH EARL OF: b. Adare, Ireland, 12 Feb. 1841. He was educated at Christ Church, Oxford; was war correspondent for the *Daily Telegraph* in Abyssinia in 1867 and again in the Franco-Prussian war, and succeeded to the title in 1871. He was under-secretary for the Colonies in Lord Salisbury's two administrations, but resigned in 1887. He is a traveler and yachtsman and has published: ‹The Great Divide: the Upper Yellowstone› (1874); ‹The Irish Question› (1880); ‹Self Instruction in the Theory and Practice of Navigation› (1900).

Duns, John, Scottish physicist: b. 11 July 1820. He was educated at Edinburg University and entered the ministry of the Free Church of Scotland in 1843. He was pastor at Torphichen in 1844; editor of ‹North British Review› (1857), and has been professor of natural science in New College, Edinburgh from 1864. Among his published works are: 'Things New and Old' (1857); 'Biblical Natural Science' (1863–6); 'Science and Christian Thought' (1866).

Dunsinane, dŭn-sĭ-nān', one of the Sidlaw Hills in Perthshire, 1,012 feet high, nine miles northeast of Perth. On its top are remains of a fortress "Macbeth's Castle." Here Siward defeated Macbeth in 1054. Shakespeare made use of this battle in his 'Macbeth.'

Dun'stan, Saint, English prelate and statesman: b. Glastonbury about 924; d. Canterbury 19 May 988. His family was a notable one and related to the royal line of the Anglian kings. He was educated in whatever of science and liberal arts existed in that time, by certain Irish monks settled at Glastonbury, and he was proficient in music (including music composition), in painting, and the mechanic arts. His career proves him to have been gifted with administrative talents of the first order. At an early age he entered the service of King Athelstan and continued in that of his successor Edmund, but his superior accomplishments provoked the enmity of his rivals at court, by whom he was set upon with outrageous violence and driven out. He then went to his uncle, Ælphea, bishop of Winchester, and when convalescent from an attack of brain fever brought on by the rough handling to which he had been subjected, took the religious vows and became a monk. He now entered upon a course of asceticism, such as was in that age deemed to be the most perfect way to heaven and an essential part of the life of whoever would walk in Christ's footprints; and hence from the time of the change of religion in the 16th century until lately Dunstan has been rated by those outside of the Roman Catholic Church merely as a fanatical and grossly superstitious monk, and his wisdom as churchman and statesman reputed as "monkish cunning." But modern historic research has begun to do justice to this man, who was without question an enlightened statesman and a wise Church reformer.

At the age of 22 he was made abbot of Glastonbury by King Edmund, who also appointed him principal state treasurer. Under Edmund's successor Edred (946–55), who was of feeble constitution, Dustan was in all but name ruler of the kingdom and a wise and vigorous administrator. Under Edwy, who succeeded Edred, he courageously sought out the king while he was in the company of his destined bride, Elgiva, and to his face denounced the intended union as incestuous. For this action he was outlawed and for a few months was in exile at Ghent; but when Edwy's brother Edgar, a youth, became king of Mercia and Northumberland, he chose Dunstan for his chief minister and at the same time he was appointed bishop of Winchester; in 960 he was promoted to the primatial see of Canterbury. Now it was that Dunstan, as archbishop of Canterbury and principal minister of state, began to execute fully the policy for which his memory has been execrated in modern times. He forcibly expelled from all abbeys, cathedrals and churches to which his power as minister of state extended, all married and concubinary priests, supplanting them with monks where he could; and making the canons of his own cathedral chapter a monastic college. In dispossessing the married clergy he simply enforced the laws of the Church which required her ministers to be celibate; and in reforming his cathedral chapter he appears to have exercised a wise discretion; there were evils rampant in the Church in those times that cried out for stern correction. In that same reign, in which he was all-powerful, he induced the king to visit in person every part of his realm annually, holding courts of justice, hearing appeals, and becoming acquainted with the needs of the people. A strong fleet was maintained off the coast against the Norse pirates; the coinage was reformed; rewards were paid by the Crown for the extermination of beasts of prey. Edgar's successor, Edmund, owed chiefly to Dunstan his elevation to the throne, and the archbishop continued still to be principal minister of state; but when Edmund was murdered, 979, the archbishop's influence under his successor, Ethelred, "the unready," was small, and disasters befell the kingdom thick and fast; the Danes ravaging the coasts and pillaging and slaughtering the people inland. The archbishop passed the closing years of his life in retirement, going back to the favorite studies and pursuits of his youth — music, painting, calligraphy, the making of musical instruments, and bell-founding. Consult: Stubbs, 'Memorials of Saint Dunstan'; Butler, 'Lives of the Saints'; Starr, 'Patron Saints'; Osbern; Eadmer.

Dun'ster, Henry, 1st president of Harvard College: b. Lancashire, England, about 1612; d. Scituate, Mass., 27 Feb. 1659. He was inaugurated president Aug. 27, 1640, and held his office until 1654, when, having become a supporter of the principles of the modern Baptists, he was persuaded to resign his office. He was respected as a modest and pious man, and esteemed an excellent Oriental scholar.

Dunton, John, English bookseller and author: b. Graffham, Huntingdonshire, 4 May 1659; d. 1733. He came to New England in March, 1686, with a cargo of books and remained about eight months. He conducted a weekly called the 'Athenian Mercury,' resolving all the curious questions proposed by the inquiring, of which 20 volumes appeared. A selection from this was made, called the 'Athenian Oracle.' He wrote voluminously on religion, ethics, and politics, filling his works with information which is no less entertaining for being subservient to the author's vanity. Among his writings are: 'Life and Errors of John Dunton'; and 'Letters from New England,' which was published in 1867. In this he relates many curious facts in relation to the bookselling business, describing the ministers, booksellers, and other citizens of Boston and Salem.

Dunwoody, Henry Harrison Chase, American meteorologist: b. Highland County, Ohio, 23 Oct. 1842. He was graduated at the U. S. Military Academy in 1866 and from the Columbia Law School in 1876 and having been detailed in 1872 for duty on the Signal Corps, was appointed in 1891 to the Weather Bureau, then first constituted. His special work has been that of formulating official forecasts of the weather, and he originated the system of cold-wave warnings; in this connection he recommended the organization of State weather services. He is the author of many papers on meteorological subjects published by the Signal Service.

Duodec'imal Scale. See ARITHMETIC; SCALE.

Duodecimal System, in numeration, a system of numbers the scale of which is 12. Duodecimals is a term applied to an arithmetical method of ascertaining the number of square feet, etc., in a rectangular area or surface, whose sides are given in feet, inches, and lines. In recent times it has been proposed to substitute for the present decimal scale of 9 digits and a cipher a duodecimal scale of 11 digits and a cipher, thus making 12 its base. In favor of the system it is urged that 12 admits of a greater number of division into equal parts by 2, 3, 4, and 6; but most mathematicians consider it as not having sufficient superiority over decimals to counterbalance the immense inconvenience of making a change. The great superiority of duodecimals in the practical, everyday affairs of trade, commerce, and ordinary business is so great, that no laws in any manufacturing or commercial country can be made that can compel the use of decimals to the displacing of dozens and grosses.

Duodenitis, dū-ō-dē-nī'tĭs, a term used in pathology, is inflammation of the duodenum, the first portion of the small intestine. It frequently results from an acute gastric irritation and is, in a large number of cases, the affection which causes biliousness. The main symptoms are headache, languor, nausea, loss of appetite, constipation, coated tongue, foul breath, and, at times, a certain amount of jaundice. This latter is due to the fact that the inflammation in the duodenum causes a swelling of the mucous membrane of the common bile duct and leads to partial occlusion of its passage, thus damming back a certain amount of bile, hence the term biliousness. The treatment is by means of careful diet, hot water and hygienic living. See INTESTINE; ENTERITIS.

Duodenum, dū-ō-dē'nŭm, in anatomy. See INTESTINE.

Dupanloup, Félix Antoine Philibert, fā-lēks ăṅ-twăn fē-lē-bĕr dü-păṅ-loo, French prelate and theologian: b. St. Félix, Savoy, 3 Jan. 1802; d. Lacombe, Isère, 11 Oct. 1879. He received a clerical education at Paris and after ordination to the priesthood was appointed chaplain to the Count of Chambord and religious instructor of the young princes of the house of Orleans. In 1837 he was made one of the vicars-general of the archbishop of Paris and head of the Petit Séminaire de St. Nicolas du Chardonnet which, under his direction, ceasing to be merely a preparatory school for aspirants to the clerical state, received as students the sons of the highest nobility. Ernest Renan, who was one of the clerical students, recounts in his 'Recollections of My Youth' a pleasing anecdote illustrating "the noblest trait in Dupanloup's character," his affection for his mother. It was Dupanloup who in 1838 attended Talleyrand on his death bed as minister of religion, and brought about what passed for a reconciliation of the apostate bishop with the Church. Renan reports Talleyrand as having remarked when told that the Abbé Dupanloup was to offer his ministration, "This young man does not know his business"; but in Renan's judgment "never was there priest so well up in his calling." All his life Dupanloup took a lively interest in charitable projects and in measures for extending to the masses the benefits of school education. He combated the endeavors of that party in the Church which sought to displace in institutions of higher education the ancient Greek and Latin classics as being pagan, and to substitute in their room the Fathers of the Church — the Basils, the Chrysostoms, the Augustins and the Jeromes. He was made bishop of Orleans 1849; was elected to the French Academy 1854; but withdrew in 1871 when against his earnest protest Littré, the leader of the Positivists, was chosen to be a member; that same year he was elected to the National Assembly and was several times re-elected; in the Assembly he was the leader of the clerical party, so-called, and ever took an active part in discussions of matters of public education. In the Vatican Council he stood with the minority in opposition to the decree of infallibility, but was one of the first to make an act of submission. Nominated 1871 to be archbishop of Paris, he declined that office. He was a great pulpit orator, worthy of a place beside the great sacred orators of France. His writings are voluminous, dealing almost wholly with questions of education and church interests. Two of his works which are in every good pedagogical library are: 'The Child' and 'The Ministry of the Catechist.' Consult: Pelletier, 'Monseigneur Dupanloup.'

Dupaty, Charles Marguerite Jean Baptiste Mercier, shärl mär-gā-rēt zhŏṅ băp-tēst mär-sē-ā dü-pä-tē, French jurist: b. La Rochelle, France, 9 May 1746; d. Paris 17 Sept. 1788. In 1767 he became advocate-general to the parliament of Bordeaux, and having written in its name against the Duke of Aiguillon, when this nobleman became minister (1770) he was sent to Pierre-en-Cise (a fortress at Lyons, once a state prison), and afterward banished until the accession of Louis XVI. The memorial by which he preserved the lives of three innocent citizens of Chaumont who were condemned to the wheel deserves particular mention. His other works are: 'Reflexions Historiques sur les Loix Criminelles,' a valuable work; various 'Discours Académiques'; and 'Lettres sur l'Italie en 1785,' which appeared in 1788.

Dupaty, Louis Marie Charles Mercier, loo-ē mä-rē shärl mär-sē-ā, French sculptor: b. Bordeaux 29 Sept. 1771; d. Paris 12 Nov. 1825. He was a son of the preceding. He was the restorer of sculpture in France, a member of the Institute, and professor in the École des Beaux Arts; was at first an advocate, served during the Revolution as a dragoon, then as chartographer, and finally went to Rome, where he studied sculpture and made himself known by numerous works. His principal productions are 'Ajax Pursued by Neptune,' his equestrian statue of Louis XIII. (1816), and 'Orestes Pursued by the Furies.'

Duperré, Victor Guy, vēk-tōr gē dü-pĕ-rā, BARON, French naval officer: b. La Rochelle 20 Feb. 1775; d. Paris 2 Nov. 1846. After various gallant naval adventures Duperré in 1811 was raised to the rank of vice-admiral, and commanded in the Mediterranean. In the beginning of 1812 he was naval commander-in-chief in the Adriatic, and during the Hundred

Days guarded Toulon against the attempts of the British and Sicilian troops which landed at Marseilles. In 1823 he commanded the squadron employed in the siege of Cadiz. In 1830 he superintended the landing of the troops on the coast of Algiers, and contributed greatly to the capture of the capital. After the Revolution of July he was raised to the peerage, and held the portfolio of marine, first from 1834 to 1836, and again in the ministry of 1840.

Duperron, Jacques Davy, zhäk dä-vē dü-pě-rôn, French ecclesiastic: b. St. Lô, Normandy, 15 Nov. 1556; d. Paris 6 Sept. 1618. His father, a physician, having embraced the Reformed religion had to flee from France and settled at Bern in Switzerland, where he became a Protestant minister. The son, having received at Bern a superior education, came to Paris at the age of 20, and having been there received into the Roman Catholic Church was appointed reader to the king, Henry III., and afterward adopted the clerical profession. He pronounced the eulogy of Mary Queen of Scots, after her execution, and seized the opportunity to make an attack on Queen Elizabeth; and though the French court disavowed any approval of the discourse and expressed a formal censure of it, the incident marked the beginning of the young ecclesiastic's good fortunes. In the matter of the Cardinal de Bourbon's plot to succeed to the throne after the death of Henry III., he was charged with having joined the Cardinal's faction and betrayed its secrets to Henry of Navarre (Henry IV.). The charge seemed to get confirmation from the fact that after Henry ascended the throne he made Duperron bishop of Evreux. He was the Church's agent in bringing about Henry's conversion to the Roman Catholic faith. In his diocese of Evreux he had great success in checking the advance of Calvinism and bringing seceders back to the Church. He was in Rome on the king's business in 1604 when Clement VIII. died, and was largely instrumental in securing the election first of Leo XI. and then of Paul V., who in less than a month succeeded Leo. He was now made archbishop of Sens and cardinal. Contrary to the principles of Gallicanism he was a zealous advocate of the doctrine of papal infallibility and of the Pope's superiority over a general council of the Church.

Dupetit-Thouars, dü-pē-tē too-är, **Abel Aubert,** French naval captain: b. Boumois, Saumur, 31 Aug. 1760; d. 1 Aug. 1798. When a mere boy he was so smitten with the love of a sea life by reading 'Robinson Crusoe' that he ran off from the military school of Laflèche and attempted to enter himself as a cabin-boy in a vessel at Nantes, but was discovered and sent back. At length, in 1778, he had an opportunity of entering the navy, and distinguished himself on several occasions in the West Indies. On the expedition to Egypt in 1798 he commanded an 80-gun ship. He foresaw the only result which could be anticipated if it was resolved to wait for Nelson's attack in the place selected in the roads of Aboukir, and advised immediately to set sail. But though his advice was disregarded he fought with undaunted valor against the enemy, and fell in the struggle. His MSS. and correspondence were published under the title of 'Lettres, Mémoires et Opuscules d'Aristide Dupetit-Thouars.'

Dupin, André Marie Jean Jacques, äṅ-drā mä-rē zhōṅ zhäk dü-păṅ, French lawyer and advocate: b. Varzy 1 Feb. 1783; d. Paris. He attained first rank at the French bar, defending Marshal Ney and Beranger. He was the eldest of the famous brothers styled "the three Dupins."

Dupin, Jean Henri, zhōṅ ŏṅ-rē, French dramatist: b. Paris 1 Sept. 1791; d. there 5 March 1887. He was a brother of André Dupin (q.v.). His plays were staged with great success.

Dupin, Louis Ellies, French church historian: b. Paris 17 June 1657; d. there 6 June 1719. In 1680 he received the degree B.D. at the Sorbonne, and in 1684 the degree D.D., and then or previously commenced those researches into the history of the Church which resulted in his celebrated 'Universal Library of all the Ecclesiastical Writers' (Vol. I., 1686). The freedom with which in this volume he discussed the teachings of the Fathers of the Church brought upon the work its condemnation by the archbishops of Paris and it was suppressed; but the author having made a retraction and changed "universal" in the title to "new," he was permitted to continue the series, though later he was banished, and restored only after a new retraction. He sought to effect a union between the Anglican and Gallican churches and had a correspondence to that end in 1718 with the Anglican primate, Archbishop Wake. He was now charged with endeavoring to subvert the dogmas of the Roman Catholic Church, and his papers were seized in 1719, in the expectation that they would give proof of the charge; but nothing was found that seriously compromised him. He seems to also have conferred with Peter the Great with a view to union of the Gallican and Russian churches. The 'Library of Ecclesiastical Authors' is a very voluminous work of immense erudition and is a complete history of theological literature within the Roman Catholic Church, both Eastern and Western, to the close of the 17th century; it was soon translated into English. Besides this, his greatest work, he wrote many others, among them: 'Universal Library of Historians'; 'Abridgment of Church History'; 'General History from the Beginning of the World to the Present Time' (1712).

Dupin, Pierre Charles François, pē-ār shärl fräṅ-swä, French engineer: b. Varzy 6 Oct. 1784; d. Paris 18 Jan. 1873. He was a brother of André and Jean Henri Dupin (qq.v.). He performed many notable engineering feats in the government service, and was made a baron and a senator.

Dupleix, Joseph François, zhō-zĕf fräṅ-swä dü-plāks, French colonial governor: b. Landrecies, France, 1 Jan. 1697; d. Paris 10 Nov. 1764. In 1720 he was appointed to a seat in the council at Pondicherry. Ten years later he became superintendent at Chandernagore in Bengal. The remarkable success of his administration here led to his being appointed, in 1741, governor-general of all the French Indies, with the title of Nawab. He now successfully pursued that policy of patient, skilful diplomacy among the native princes which at one time made the Carnatic almost a French province. When war broke out in Europe between France and England (1740), several brilliant engagements planned by Dupleix took place between the French garrison and the troops of the Nawab of the Carnatic, who endeavored to take possession of Madras, but was precipitately forced to raise the siege. An attack on the English at Fort St. David failed, but Dupleix's science and courage were displayed in the defense of Pondicherry, which Admiral Boscawen in vain attacked for five weeks, with an apparently overwhelming force, but was forced to retire discomfited, though the defense was conducted by a civilian, unsupported by a single general of repute. The ambitious mind of Dupleix had long formed the project of founding a French empire in India on the ruins of the Mogul monarchy, but his military designs, able as they were, were frustrated by the energy and military genius of Clive and Lawrence. The struggle continued till 1754, in which year Dupleix was recalled by Louis XV.

Duponceau, dŭ-pŏn'sō, Fr. dü-pôñ-sō, **Peter Stephen,** American lawyer and scholar: b. St. Martin, Isle de Ré, France, 3 June 1760; d. Philadelphia 1 April 1844. For a time he was secretary to Count de Gébelin, and afterward to Baron Steuben, with whom he came to the United States in 1777. Receiving a captain's commission he served with Steuben through the American Revolution and after its close settled in Philadelphia and became noted as a lawyer. For several years he was much interested in an effort to introduce into the United States the production and manufacture of silk. His writings are of a miscellaneous character, among which may be mentioned original treatises on points of law; translations from the Latin, German, and French on similar subjects; various treatises on philology; numerous contributions to American history, including a translation of 'A Description of New Sweden,' by Thomas Campanius Holm. He was a member of more than 40 literary and scientific institutions of Europe and America, including the American Philosophical Society, the Historical Society of Pennsylvania, and the Philadelphia Athenæum, of which three institutions he was the presiding officer at the time of his death.

Dupont, dū-pŏnt', **Henry Algernon,** American military officer: b. Wilmington, Del., 30 July 1838. He is a grandson of E. I. Dupont (q.v.). He was graduated at the United States Military Academy, served through the Civil War, taking part in the battles of Piedmont, Lynchburg, Cedar Creek, Opequan, and Fisher's Hill, and was brevetted major-general for gallantry in the two last-mentioned battles, and lieutenant-colonel for services at Cedar Creek. He became proprietor of the celebrated powder mills bearing his name near Wilmington, Del., and under his direction they became an important factor in the Civil War. He resigned from the army in 1875; became president of the Wilmington & Northwestern Railroad Company in 1879; and was chosen United States senator from Delaware in 1895, but not seated, and again 12 June 1906.

Dupont, Jacques Charles, zhäk shärl dü-pôñ, surnamed *De l'Eure*, French statesman: b Neubourg, Normandy, 27 Feb. 1767; d. Rouge-Pierre, Normandy, 3 March 1855. In 1798 he was a member of the Council of the Five Hundred, which was dispersed by Murat on the 18th Brumaire. In 1811 he was nominated president of the court of justice at Rouen, and in 1813 vice-president of the corps législatif. On the restoration of the Bourbons Dupont signalized himself as a leader of the opposition. In 1830, after the revolution of July, he was made minister of justice, and after the fall of Louis Philippe became a member of the provisional government. On the accession of Napoleon III., in 1852, he ceased to take part in public affairs. Dupont was called by his political friends the "Aristides of French liberalism."

Dupont, Pierre, pē-ãr, surnamed De l' Etang, French soldier: b. Chabanais 14 July 1765; d. Paris 7 March 1840. He served first with the French Legion in the Dutch service, and in 1791 in the French army. By his skilful arrangements as a staff officer, he prevented Denmark from falling into the hands of the Duke of York, and was promoted to the rank of brigadier-general. After the proceedings of the 18th Brumaire, in which he took an active part, he was appointed head of the general état-major of the army of reserve assembled at the foot of the Alps, and distinguished himself in Italy at the battle of Marengo. In 1805 he joined the army in Germany, where he freed Marshal Mortier from Russian troops. He was active in the campaign of 1806 against the Prussians, and in 1807 contributed to the victory of Friedland 14 June but on 22 July 1808 capitulated with 18,000 soldiers at Baylen, Spain. In 1815 he was elected to the Chamber of Deputies from Charente, and retained his seat with some interruptions till the revolution of July.

Dupont, Pierre, French political song writer: b. Lyons 23 April 1821; d. St. Etienne 25 July 1870. After issuing a volume of poems in 1844, he went to Paris and obtained a place in the office of the secretary of the Institute. After the revolution of February 1848 he came forward as the minstrel of socialism, and proved obnoxious to the government which came into power in December 1852. He was condemned to be banished for seven years; but the intercession of his friends soon procured his release. After that event he spent a gay and careless life by the Rhone. His songs did not bring him fortune, and he died comparatively poor. His works (songs and music) appeared in 1854 in four volumes 8vo.

Dupont, dū-pŏnt', **Samuel Francis,** American naval officer: b. Bergen Point, N. J., 27 Sept. 1803; d. Philadelphia 23 June 1865. During the Mexican war, being then a commander, he saw much active and gallant service on the California coast. In 1862 he was put in command of the South Atlantic blockading squadron, and was promoted to rear-admiral in August 1862. He was in command of the ironclad squadron of nine vessels which attacked Charleston, S. C., 7 April 1863, but was repulsed with considerable loss. He greatly contributed to the organization of the Naval School at Annapolis, and was the author of a very remarkable report on the use of floating batteries for coast defense.

Dupont, Victor Marie, American manufacturer: b. Paris, France, 1 Oct. 1767; d. Philadelphia, Pa., 30 Jan. 1827. He was a son of Pierre Samuel Dupont De Nemours (q.v.), and entered the diplomatic service as attaché to the French legation in the United States in 1787; became secretary of legation in 1795 and was appointed French consul in Charleston, S. C., in the same year. In 1798 he was appointed consul-general of France in New York. He returned to France; withdrew from the government service and came to the United States in January 1800. He entered business in New York; removed to Wilmington, Del., in 1809, where he joined his brother and established a cloth manufactory. He was for a time a member of the Delaware Legislature, and a director of the Bank of the United States.

Du Pont de Nemours, Eleuthère Irénée, ā-lū-thār ē-rā-nā dü-pôṅ dė nĕ-moor: b. Paris 24 June 1771; d. Philadelphia 31 Oct. 1834; son of the French political economist Pierre Samuel Du Pont de Nemours. He was a pupil of Lavoisier and entered the royal powder mills at Essonne to familiarize himself with the manufacture of gunpowder with a view to succeed Lavoisier as superintendent of the government powder mills, but subsequently abandoned this in 1791 to take charge of the printing and publishing house established by his father in Paris. Being a supporter of King Louis XVI. he was in the utmost peril after 10 Aug. 1792, and after being three times imprisoned and having his printing house sacked and destroyed he emigrated with his father's family to the United States in 1799, arriving at New London, Conn., 1 Jan. 1800. Not long after his arrival attention was called to the poor quality of gunpowder then made in this country and he determined to enter into powder manufacture here. With this in view he returned to France January 1801 to procure at Essonne, plans and models of improved machinery, returning to the United States in August with some of the machinery. Thomas Jefferson, who was deeply interested in this development, urged that the works be built in Virginia, but owing to his views regarding slavery and its effect on the white race Du Pont was unwilling to make his venture either in Virginia or Maryland. In June 1802 he bought a tract of land with a fine water-power on the Brandywine River, near Wilmington, Del. On 19 July he arrived there with his family and began operations which were so successful that, at the time of his sudden death by cholera, his works were the largest of their kind in the country. Since his death they have been carried on by his sons and grandsons and are still among the largest gunpowder works in this country, while they are the centre of the industrial combination in this industry.

Dupont de Nemours, Pierre Samuel, French economist: b. Paris 14 Dec. 1739; d. near Wilmington 6 Aug. 1817. He lived almost unknown in Paris as a private man of letters till 1773, when his principles of philosophy and political economy set forth in his 'Les Ephémérides du Citoyen' excited the displeasure of the minister, Choiseul, and obliged him to leave France. Several foreign princes offered him a reception and conferred honors on him. He returned, however, to his native country and accepted a small place given him by Turgot, minister of finance. In 1782 and 1783, with Dr. Hutton, the English agent, he negotiated the basis of the treaty by which the independence of the United States of America was acknowledged. As inspector-general of commerce and manufactures, and as a councilor of state, he afterward did much to encourage French industry. After the Directory was abolished he came to the United States in 1798. In 1802 he returned to France, but did not at that time take any office, notwithstanding the offers made him by Napoleon. After Napoleon's return from Elba he settled in the United States where his two sons had already become citizens. Besides various political treatises he is likewise the author of a French translation of the first three cantos of the 'Orlando Furioso.'

Dupont's Smokeless Powder, a hard-grained porous powder, composed of cellulose nitrate of medium nitration which has been formed into grains by suspending the cellulose nitrate in an aqueous solution of barium and potassium nitrates to which amyl acetate is added, stirring the gelatinized material in the fluid until the grains are formed and hardening them by steam until the amyl acetate is expelled. The grains may be separated by sifting into the various desired sizes and colored to meet any taste by the addition of a very small amount of an organic coloring matter. See EXPLOSIVES; POWDER.

Düp'pel, Germany, a fortified village in the province of Schleswig-Holstein, Prussia, on the coast of the Little Belt. The place has been the scene of some severe struggles between the Danes, to whom it formerly belonged, and the Germans. In 1848 the latter were defeated here by the Danes, then the place was retaken by the Prussians, and in 1860 was again in possession of Denmark. After a long siege it was captured by the Prussians in 1864.

Duprat, Antoine, French statesman, archbishop, and cardinal: b. Issoire 17 Jan. 1463; d. Rambouillet 8 July 1535. Under Louis XII. he was president of the parliament of Paris, and in 1515, on the accession of Francis I., became chancellor and prime minister. The chief event of his ministry was the conclusion of the concordat, against great clerical and academic opposition, by which the Church and nobility became subject to the Crown, and by which he nullified the desire of Pope Leo X. to abrogate the Pragmatic Sanction, which in 1438 limited the spiritual power of the Pope in France, and laid the foundation of the so-called Gallican Church. In this direction he was the precursor of Richelieu and Mazarin, in the work of consolidating the power of the state. For his services, he was appointed archbishop of Sens, and later was created a cardinal.

Dupray, Henri Louis, ŏṅ-rē loo-ē dü-prā, French painter: b. Sedan, France, 1841. He was the pupil at Paris of Pils and Cogniet, and early directed his attention to military subjects. His 'Bataille de Waterloo' (1870) is considered his most important work.

Dupré, Giovanni, jō-vän nē dü-pra', Italian sculptor: b. Siena, Italy, 1 March 1817; d. Florence 10 Jan. 1882. Among his works are: 'Abel'; 'Cain'; 'Sappho'; 'Giotto'; and 'Pieta'; the last representing the dead Christ, supported by his mother.

Dupré, Jules, zhül dü-prā, French landscape painter: b. Nantes 5 April 1812; d. L'Isle Adam 6 Oct. 1889. He began his career as a painter of porcelain in his father's factory, but when 18 years old went to Paris where his talent soon became recognized. He sent his first picture to the Salon in 1831; was made a chevalier of the Legion of Honor in 1849, and officer in 1870. He received a second-class medal at the Exposition of 1867 and the same at the Exposition of 1883, and a medal of honor at the Exposition of 1889. His studio for some years was in the Forest of Fontainebleau, and later in L'Isle Adam. A number of his pictures are owned in the United States.

Dupuis, Charles François, shärl frän-swä dü-pwē, French scholar: b. Trie-le-Château, near Gisors, 16 Oct. 1742; d. Is-sur-Tille, France, 29 Sept. 1809. In his 24th year he was made professor of rhetoric at Lisieux. His 'Mémoire sur l'Origine des Constellations et sur l'Explication de la Fable par l'Astronomie' (1781) is erudite, but rather sophistical. Later works of his are: 'Origine de tous les Cultes, ou la Réligion universelle' (1794); two works on the Pelasgi, which attracted great attention; treatises on the zodiac of Denderah, and on the Phœnix; 'Mémoire explicatif du Zodiaque chronologique et mythologique' (1806).

Dupuis, Nathan Fellowes, Canadian scientist: b. Portland, Ontario, 13 April 1836. He was graduated at Queen's University, Kingston, in 1866, and has been a professor there for 28 years, occupying the chair first of chemistry and natural science, then of mathematics, which he still fills. He is a Fellow of the Royal Society of Canada, and editor of the Canadian 'Educational Monthly.' His published works include 'Elements of Geometrical Optics' (1868); 'Geometry of the Point, Line and Circle in the Plane' (1889); 'Elements of Synthetic Solid Geometry' (1893).

Dupuy, dū-pwē', **Eliza Ann,** American novel writer: b. Petersburg, Va., about 1814; d. New Orleans January 1881. 'The Conspirators,' her first novel, has Aaron Burr as the principal character. Most of her stories, some 40 in number, were published in the New York 'Ledger.'

Dupuytren, Guillaume, gē-yōm dü-pwē-trän, Baron, French surgeon and anatomist: b. Pierre-Buffière, Haute-Vienne, 6 Oct. 1777; d. Paris 8 Feb. 1835. In 1801 he obtained the situation of overseer of anatomical labors at Paris; and became in 1815 first surgeon to the Hôtel Dieu. In 1823 he was appointed first physician to the king, Louis XVIII., and retained the same situation under Charles X. He possessed extraordinary acuteness in respect of diagnosis, united with remarkable skill and dexterity in the most dangerous operations, in performing which he had a firmness of nerve which was never shaken. He invented several surgical instruments and modes of operation, and also made some discoveries in pathological anatomy. Some of his pupils united in publishing his 'Oral Lectures on Clinical Surgery' (1830–34); and his 'Theory and Practice as to the Treatment of Wounds by Warlike Weapons,' was published in 1834.

Duquesne, dü-kān, **Abraham,** French admiral: b. Dieppe 1610; d. Paris 2 Feb. 1688. In his 17th year he was in the sea-fight off Rochelle, and distinguished himself during and after the year 1637 in the war against Spain. In 1647 he commanded the expedition against Naples. Bordeaux, which had rebelled, he reduced, notwithstanding the assistance afforded it by Spain. In the Sicilian war he thrice defeated the combined fleets of Holland and Spain, under the renowned De Ruyter, who was mortally wounded in the last engagement. After he had reduced Algiers and Genoa to the necessity of supplicating the mercy of Louis XIV., the king conferred upon him the estate of Bouchet, and made it a marquisate, with the title of Duquesne. More than this he could not do, because Duquesne was a Protestant. He was, also, the only person exempted from the banishment of his sect, occasioned by the repeal of the Edict of Nantes.

Duquesne, dū-kān', Pa., borough, in Allegheny County; on the Monongahela River, and the Pennsylvania Railroad; about 10 miles from Pittsburg. The industries, chiefly the manufacturing of steel, and iron products, are extensive. Pop. 9,300.

Duquesnoy, François, frän-swä dü-kā nwä, or «François Flamand», Flemish sculptor: b. Brussels 1594; d. Leghorn, Italy, 12 July 1646. He was taught by his father and became celebrated at an early age. His best works are child figures. The Baldachino in the Vatican contains examples of his art.

Dura Mater, dū'ra mā'tėr, the outer envelope or covering of the brain. See Brain.

Duram, or **Durão, Jozé de Santa Rita,** hō-sā' dā sän'tä rē'tä doo-rän', Brazilian poet: b. near Mariana, province of Minas Geraes, 1737; d. Lisbon, Portugal, 1783. He qualified himself for the service of the Church by his studies at Rio Janeiro and at Coimbra in Portugal, was graduated doctor of divinity at the university of the latter city, and joined the religious order of St. Augustine. In the course of his travels in Spain and Italy he became acquainted with Alfieri and other eminent men of letters, and subsequently during his residence at Coimbra composed a poem founded upon the story of the Galician adventurer, Diego Alvarez Correa, surnamed Caramuru, the legendary hero of Bahia. This poem was published at Lisbon in 1781, under the title of 'Caramuru, poema epico do descobrimento da Bahia,' and a French version appeared at Paris in 1829. On its first appearance the poem was not highly estimated, but since then has risen to the rank of a national epic in Brazil.

Duramen, dū-rā'mĕn (a Latin word for hardness), the heart-wood, or central wood in the trunk of exogenous trees as found in *dicotyledons* and *conifers*. (See Conifera.) It is hard and dense, and often dark-colored, with its tubes dry and thick. Thus in the ebony the duramen is black, and is the part used for furniture and fine cabinet-making. The alburnum (q.v.), or outer wood, is pale. In the beech the heart-wood is light brown; in the oak deep brown; in the Judas-tree yellow, and in guaiacum greenish. The relative proportion of duramen and alburnum differs in different trees. By ship-carpenters the duramen is known as the «spine.»

Duran, doo-rän', **Augustin,** Spanish scholar: b. Madrid 14 Oct. 1789; d. there 1 Dec. 1862. He paid much attention to the study of foreign, especially to French literature, and edited a very important collection of Moorish, miscellaneous, and historical ballads, and ballads of chivalry (1828–32), a new edition forming part of the extensive 'Biblioteca de autores Españoles' (Madrid 1849–51). He also wrote a history of the Spanish drama from its origin to the middle of the 18th century.

Duran, Carolus, kä-rō-lüs' dü-rän (CHARLES AUGUSTE EMILE DURAND), French painter: b. Lille, 4 July 1837. He received his early art education at the municipal school in his native town, and in 1853 went to Paris and spent much time in copying again and again 'La Joconde,' at the Louvre. He gained the Wicar traveling scholarship, and went to Italy, and at Rome painted 'La Prière du Soir,' exhibited at the Salon in 1865. For 'L'Assassiné' (1866) he was awarded his first medal. This picture and a portrait of M. Ed. Reynart was purchased by the government for the museum at Lille. Duran resided for a year in Spain, and the influence of Velasquez is clearly seen in his 'St. Francis of Assisi,' exhibited at the Paris Salon in 1868. But his fame rests principally on his portraits, which are very numerous, and executed with a power and dash which are undeniable, whatever we may think of their refinement or grace. Among them may be mentioned Emile de Girardin, those of his daughters, the equestrian portrait of Mlle. Croizette, the well-known actress, and a portrait of Pasteur. He is a Chevalier of the Legion of Honor, and of the Order of Leopold. In 1898 he made a lecturing tour to the United States, this being his second visit. In the same year he was elected president of the National Society of Fine Arts.

Durance, dü-räns, a river in France, which rises in Mount Genèvre, on the west slope of the Cottian Alps; flows in a general direction south, and, after a course of 180 miles, empties into the Rhone, 4 miles below Avignon. The stream is so full of debris that it is not navigable. It often commits great ravages by inundation.

Durand, dü-rän, **Alice Mary Céleste Fleury** ("HENRY GRÉVILLE"), French novelist: b. Paris 12 Oct. 1842; d. there 26 May 1902. In early life she went to St. Petersburg with her father, Professor Fleury. She there married M. Durand, a French law professor, returning to France in 1872. She visited the United States in 1886 and several of her novels re-published in America, had a wide circulation here. Her published works, appearing under the pseudonym, "HENRY GRÉVILLE," include: 'A Travers Champs' (1812); 'Dosia' (1876); 'L'Expiation de Savelli' (1876); 'La Princesse Oghéroff' (1876); 'Les Koumiassine' (1877); 'Suzanne Normis' (1877); 'Sonia' (1877); 'La Maison Maurège' (1877); 'Les Epreuves de Raissa' (1877); 'L'Amie' (1878); 'Un violon russe' (1879); 'Lucie Rodey' (1879); 'Le Moulin Frappier' (1880); 'La cité Ménard' (1880); 'Madame de Dreux' (1881); 'Rose Rozier' (1882); 'Manuel d'Instruction Civique et Morale des Jeunes Filles' (1882); 'Un Crime' (1884); 'Idylles' (1885); 'Cléopatre' (1886); 'Frankley' (1880); 'L'avenir d'Aline' (1889); 'Chant de Noces' (1889); 'Le Passe' (1890); 'Un Mystère' (1890); 'Aurette' (1891); 'Péril' (1891); 'L'Héritière' (1891); 'Un vieux menage' (1893); 'Fidelka' (1894); etc.

Durand, dū-rănd', **Asher Brown,** American painter and engraver: b. South Orange, N. J., 21 Aug. 1796; d. there 17 Sept. 1886. For a long time his employment consisted in copying prints from English books, and working on plates for bank-notes. His engraving of Trumbull's 'Declaration of Independence' brought him into general notice, and thenceforth for many years his graver was in constant demand for portraits of various dimensions, and figure pieces. He had always, however, entertained the idea of ultimately becoming a painter, and in 1835, having for the previous 10 years been a regular contributor of portraits, small figure pieces, or landscapes in oil, to the exhibitions of the National Academy of Design, finally abandoned engraving as a profession. He devoted himself thereafter mainly to landscape painting, in which department of art he became eminent. The Corcoran Art Gallery, at Washington, contains his 'Mountain Forest' (1869).

Durand, William Frederick, American engineer: b. Bethany, Conn., 5 March 1859. He was graduated at Annapolis, 1880; served in the United States Naval Engineer Corps (1880–7); was professor of mechanical engineering in the Michigan Agricultural and Mechanical College (1887–91), when he became associate professor of marine engineering at Cornell, and full professor in 1895. He has also been principal of the Graduate School of Marine Engineering and Naval Architecture since 1891. He has published 'Resistance and Propulsion of Ships' (1898); 'Practical Marine Engineering' (1902); and many special articles in engineering journals.

Durand, Wis., city, county-seat of Pepin County; on the Chippewa River, about 20 miles from its junction with the Mississippi, and on the Chicago, M. & St. P. R.R. It is the centre of an agricultural region, and its trade and industries are those that pertain to agriculture and stock-raising. Pop. (1900) 1,458.

Durando, doo-rän'dō, **Giacomo,** Italian general: b. Mondovi, Italy, 1807; d. Rome 26 Aug. 1894. He was minister of war at Turin 1854–5; became a senator in 1860; was minister of foreign affairs in the cabinet of Ratazzi 1862–3, and president of the senate 1884–7. He published in 1847 a brochure in favor of Italian unity under a constitutional government.

Durandus, dū-ran'dus, **Gulielmus,** French prelate and jurist: b. Puimisson, Languedoc 1237; d. Rome 1 Nov. 1296. He became professor of the canon law in the University of Modena, and there acquired so high a reputation for his learning that Pope Clement IV. made him auditor of the Sacred Palace, and took him as his secretary to the General Council of Lyons (1274). He continued to hold high office in the Curia under successive popes till 1277, when he was appointed lieutenant-governor, both in temporal and spiritual affairs, of the patrimony of St. Peter, under Nicholas III.; the following year he successfully asserted the sovereignty of the Pope over the provinces of Bologna and Romagna. These two provinces he then governed from 1283 to 1286, in the meantime carrying on a war against the people of Romagna, who were in revolt. He was appointed bishop of Meude in Languedoc in the latter year, and retired from the governorship. In 1295 he was again in public station, governor of Romagna, and the March of Ancona; but his strength was unequal to the task of resisting the attacks of the Ghibelline faction, and he resigned his office. His greatest work, 'Speculum Juris' (mirror of the law), called by himself ‘Speculum Judiciale,’ was for a long time a work of highest authority in the practice of both departments of the law; between the years 1474 and 1678 it had 38 editions. He wrote an informal history (commentarius) of the General Council of Lyons, the decrees of which were drawn up by him. Many other works he wrote, which have not been printed.

Durango, dü'răn'gō, Colo., town, county-seat of La Plata County; on the Las Animas River, the Denver & R. G., and the Rio Grande S. railroads; about 20 miles north of the boundary line between Colorado and New Mexico. The smelting and reduction works are the chief manufactories of the town. It has also flour-mills and foundries, and it is the trade centre for the agricultural, stock-raising, and mining products of the southwestern part of Colorado. Pop. 3,500.

Durango, doo-rän'gō, Mexico, a state bounded by Chihuahua on the north, Coahuila on the east and southeast, Zacatecas and Tepic on the south, and Sinaloa on the west. It is one of the largest and richest states in the republic. The Sierra Madre range (altitude 8,125 feet to 11,375 feet) traverses the western and southern portions. Less important ranges are the Copolquina, Topia, Cavelas, Amacuti, Tominil, Muinora, Guanaccoi, and San Juan de Camarones; these, as well as the isolated peaks, Cerro del Mercado, Pánuco de Avino, etc., are ore-bearing. The Cerro del Fraile is an extinct volcano. Among the rivers, the Nazas, in the northern part of the state, with its affluents, the Santiago and San Juan; the Tunal, which rises west of the city of Durango, and its affluent, the Suchil; the Rio Chico, or Alaponeta, and the Aguanaval, may be mentioned. There are small lakes, mineral springs, etc. Gold, copper, and silver are the chief mineral products, and the best mining districts are in the partidos of San Dimas, Tamazula, Papasquiaro, San Juan del Rio, Durango, and Nombre de Dios. On 31 Dec. 1897 there were, according to Mexican official figures, 1, 331 mining claims registered in Durango. The Cerro del Mercado, near Durango city, is said to contain an immense deposit of iron. Sulphur and rubies are also found. The climate varies with the altitude of the different localities, being cool or cold in the mountainous western regions, and temperate, or warm, in the valleys extending from the base of the mountains and in the Nazas basin. The pasture lands are extremely hot in summer and cold in winter. There is a moderate rainfall, and frosts occur frequently in the uplands. (See MEXICO — THE STATES OF.)

Durango, Mexico. Capital of the State of Durango. Elevation 6,000 feet above sea level. Average temperature the year round 70 degrees Fahrenheit in the shade. Population 37,000. Founded in 1563 and decreed a city by Philip IV. in 1621. Once the capital of the province of Nueva Vizcaya. Has been an important trade centre since a very early day, of a territory including the Mexican State of Chihuahua, and the southern portion of Texas and New Mexico. Is 540 miles from Eagle Pass, on the Texas border, by the International railway, and 569 miles from Mexico City. Is a city of considerable wealth, the region round about being very rich, both in minerals and agriculture. Many Americans are located here, and are actively engaged in enterprises of various kinds, adding materially to the prosperity of the community. Almost within the city's limits rises a wonderful mountain of very nearly pure iron, 640 feet high, 4,800 feet long and 1,100 feet wide, which has been estimated by mining engineers to contain 7,000,000,000 cubic feet of metal, and to be worth $12,000,000,000. Among the local industries are extensive iron works, cotton and woolen mills, foundries and flour mills. The stores and shops are particularly well stocked and creditable. A local bank,— the Bank of Durango,— with a capita of $2,000,000, and a branch of the National Bank and an agency of the Bank of London and Mexico provide for financial needs. A half million dollar theatre has recently been built. The other notabe buildings are the Cathedral, which was begun in 1695 and completed in 1844, the new City Hospital; the Jesuit College, founded in 1594; the Methodist Episcopal Church; the Catholic Churches of San Francisco, San Juan de Dios and San Agustin; the Government Palace; the Market House and the Mint. An Alameda and several plazas tempt the lover of Nature. Not far distant is an ever-flowing stream which is said to excel the famous one in the grounds of Chapultepec Park, at the national capital, and from which the city receives its drinking water. Two electric light companies supply light. Durango is called the “Denver of Mexico.”

Durant', Henry Fowle, American philanthropist: b. Hanover, N. H., 20 Feb. 1822; d. Wellesley, Mass., 3 Oct. 1881. He was graduated from Harvard in 1842 and became a lawyer, changing his name from Henry Welles Smith to H. T. Durant. He practised with great success at the bar, but on the death of his only son abandoned his profession and devoted his energies to philanthropy. He founded Wellesley College (q.v.), opened in 1875.

Durante, Francesco, frän-chĕs'ko doo-rän'tĕ, Italian musician: b. Naples 15 March 1684; d. there 13 Aug. 1755. He is deemed one of the founders of the “Neapolitan school” of composition, and is especially celebrated as a teacher.

Durazno, doo-räs'nō, Uruguay, a department bounded on the north by Tacuarembo, southeast by Cerro Largo and Treinta y Tres, on the south by Florida and Flores, and on the west by Flores and Rio Negro. It is the most central of the departments, and in size the third Area, 5,527 square miles. A range of hills divides it into two sections or basins, of which one extends northward to the Rio Negro, and the other southward to the Yi River, the department lying between these two rivers. Numerous streams, rising in the central chain of hills, flow toward the south or north; the entire surface is, therefore, well watered, and furnishes grazing for a large number of cattle, sheep, horses, and mules. Pop. about 25,000.

Durazno, Uruguay, capital of the department of Durazno. It is situated near the Yi River, and is one of the principal stations on the Central Uruguay Railroad. As an active centre for the trading of the neighborhood, it has substantial buildings, a church, hotels, and shops. Pop. 2,000.

Durazzo, doo-rät'sō (ancient DYRRHACHIUM or EPIDAMNUS), Turkey, a seaport, in the province of Albania, on the Adriatic, 50 miles south by west of Scutari. It was originally founded by a colony of Greeks from Corcyra, and was long the most important maritime town of Illyria. A few columns and marbles are now almost the only remains of the ancient city; the modern town is a poor place of about 1,200 inhabitants.

Durban, dėr'băn, Natal, town, the only seaport of Natal; situated on the northern shore of the land-locked inlet known as Port Natal. It is well laid out and solidly built, and has a number of fine buildings. There are railroad connections with the capital and other places. On the «Bluff» at the entrance to the port a battery of heavy guns has been placed. Durban was founded in 1834, and named after Sir Benjamin D'Urban, for some time governor of Cape Colony. Pop. 25,512.

Durbar, dėr'bär (Hind. and Pers., *darbar,* door of admittance), in India, Afghanistan, and Persia a state audience at which important public hearings are given, decrees or decisions announced, distinguished foreign visitors received, and treaties, etc., made. These functions are often of great splendor and under British rule there have been several famous durbars in India. The first after the downfall of the Mogul empire and the Mutiny was held 1 Nov. 1858 at Allahabad. Lord Canning then announced the sovereignty of Queen Victoria, and offered amnesty to all but actual murderers of the English. Each viceroy since has held them to impress the Hindus. One of the most magnificent was held by Lord Lytton in 1877, when Queen Victoria took the title of empress of India. The then Prince of Wales had just been visiting India, and been received with enthusiastic demonstrations, and the viceroy summoned the feudatory rulers and their retinues to a great durbar at Delhi, where the proclamation of the new title was made, and festivities, including a grand ball, games, parades, fireworks, convocation of the Indian orders, etc., were held. Another of great splendor was given at the same city on 1 Jan. 1903, to proclaim the accession of Edward VII. The name «durbar» is used also for the audience chamber, as we speak of a church (building).

Durbin, dėr'bĭn, **John Price,** American Methodist clergyman and miscellaneous writer: b. Bourbon County, Ky., 1800; d. New York 17 Oct. 1876. He contributed extensively to current literature, and was the author of 'Observations in Europe, Principally in France and Great Britain' (1844); and 'Observations in Egypt, Palestine, Syria, and Asia Minor' (1845).

Dü'ren (ancient MARCODURUM), Germany, town in Rhenish Prussia, on the Roer and the railroad from Aix-la-Chapelle to Cologne, 16 miles east by north of Aix-la-Chapelle. It is of Roman origin, and is mentioned under its ancient name by Tacitus. In 1543 it was destroyed by the Emperor Charles V., at the head of 50,000 men. Diets were held here by Charlemagne (775 and 779). The modern town has some handsome churches, a gymnasium, important manufactures of woolens, paper, leather, and hardware; several large distilleries, and an extensive trade. Pop. (1900) 27,171.

Dürer, Albrecht, äl'breнt dü'rĕr, German painter: b. Nuremberg, Bavaria, 21 May 1471; d. there 1528. His father was a skilful goldsmith of Hungary, and himself instructed his son. Dürer's talent early developed itself, and although he had made great progress in his father's profession by the time he was 15, his inclination took a decided turn for painting. Michael Wohlgemuth, then the best painter in Nuremberg, became his instructor in 1486. Having finished his studies he entered upon his travels, returning home in 1494. Here he executed his masterpiece, a drawing of Orpheus. To please his father he married the daughter of Hans Frey, a celebrated mechanic; but this connection embittered his life, and perhaps brought him to an early grave. In 1505 he went to Venice to accomplish himself in his art. His abilities excited envy and admiration. He painted the 'Martyrdom of Bartholomew' for St. Mark's Church, which painting was purchased by the Emperor Rodolph, and removed to Prague. He also traveled to Bologna, to improve his knowledge of perspective. At his return, in 1507, begins the proper era of his greatness. His fame spread far and wide. Maximilian I. appointed him his court-painter, and Charles V. confirmed him in this office, bestowing upon him at the same time the painter's coat of arms, namely, three escutcheons argent in a deep azure field. Dürer was in favor with high and low. All the artists and learned men of his time honored and loved him, and his early death was greatly lamented. Profound application, great facility in the mechanical part of his art, and a remarkable talent of imitation, were the characteristics of Dürer, and enabled him to exert a great influence on the character of German art. He was the first in Germany who taught the rules of perspective, and of the proportions of the human body, according to mathematical principles. His treatise on proportions was occasioned, it is said, by his studies on the picture of 'Adam and Eve.' He not only made use of the burin, like his predecessors, but was also the inventor of etching, or, if not the inventor, the first who excelled in the art. He invented the method of printing wood-cuts with two colors. His great mathematical knowledge enabled him to form a regular system of rules for drawing and painting. He wrote the first book on fortification, in Germany, and showed how to cast the letters of the alphabet according to fixed proportions, by geometrical calculations. He was particularly eminent as a portrait painter. He had the power of catching the exact expression of the features, and of delineating all the passions. Among his best engravings in copper are his 'Fortune'; 'Melancholy'; 'Adam and Eve in Paradise'; 'St. Hubert'; 'St. Jerome'; and the 'Smaller Passion' (so-called) in 16 plates. Among his best wood-cuts are the 'Greater Passion' (so-called) in 13 plates; the 'Smaller Passion,' with the frontispiece, 37 pieces; the 'Revelation of St. John,' with the frontispiece, 15 plates; the 'Life of Mary,' two prints, with the frontispiece. Bartsch, however, has made it more than probable that Dürer himself did not engrave in wood. He only made the drawings on wooden tablets, which were then cut by form-cutters, of whom there were many skilful ones at that time. Dürer has also much merit as a writer. His writings, which were afterward translated into Latin, French, etc., were published in a collected form at Arnheim (1603). See Scott, ‘Albert Dürer, His Life and Works’ (1869); Heaton, ‘History of the Life of Albert Dürer’ (1869); Thausing, ‘Dürer, Geschichte seines Lebens und seiner Kunst’; Colvin, ‘Albrecht Dürer, His Teachers, His Rivals, and His Scholars’ (1877); Ephrussi, ‘Albrecht Dürer et son dessein’ (1882); Springer, ‘Albrecht Dürer’ (1892); Cust, ‘Albrecht Dürer’ (1897).

Duress, dū'rĕs or dū-rĕs' (Ital. *durezza,* Lat. *duritia,* deriv. of *durus,* hard), restraint of liberty, or restraint of the person or goods. (1) Of the person. This is exercised either by incarceration or by threats or menaces, *duress per minas;* in either case the overt act must consist in compelling a person to do some act, as to execute a deed or commit an offense; in such cases the act is invalid and excusable. In a broader sense, duress is charged by the law when a person in extreme poverty or distress is induced to seek alleviation by assuming an obligation. Yet the deed signed, or the contract made under duress is not void, though voidable at the will of the party compelled to execute or assume it. (2) Duress of goods refers to the case of one who is compelled to pay money for the release of goods unlawfully detained. Duress may be charged to the collector of a port who charges unauthorized duties.

Duret, Francisque, frän-sēsk dü-rā, French sculptor: b. Paris 19 Oct. 1804; d. there 25 May 1865. He studied sculpture in Paris with intense ardor; in 1823 he won the Roman prize, and gained a gold medal in 1831 by his ‘Mercury, Inventor of the Lyre,’ which recalled somewhat the refined modernity of Canova. Indeed, Canova seems to have been rather the source of inspiration to him than the models of the antique. In 1833 he produced ‘The Neapolitan Fisherman Dancing the Tarantula,’ a work of life-like realism, of perfect elegance and the most refined modeling, which is his masterpiece, and stands in the Louvre. In the same gallery is his ‘Improvisator Singing a Love-Song’ (1836), a replica of which is in the city museum of Leipsic. For the museum at Versailles he executed statues of Molière, Dunois, and Richelieu; for the Madeleine figures of Christ and St. Gabriel. The gallery of seven chimneys in the Louvre is adorned by his ‘Victory,’ and for the foyer of the Théâtre Française he executed statues of ‘Tragedy’ and ‘Comedy’ and a figure of Rachel, the actress. In 1860 he completed the monumental fountain on the Place de St. Michel, in Paris. It is surmounted by a figure of ‘St. Michael the Dragon-Slayer.’ As professor in the École des Beaux Arts, his energies were concentrated on the task of teaching and he produced few original works; those which he has left are good examples of modern French sculpture with its ease, its demonstrative fluidity and dramatic point, which take the place of the serenity and severe but flawless grace of the Greek masters.

Durfee, dėr'fē, **Job,** American jurist: b. Tiverton, R. I., 20 Sept. 1790; d. there 26 July 1847. He was graduated at Brown University in 1813; was elected to Congress in 1820, and became chief justice of Rhode Island in 1835. Among his various writings is ‘What Cheer,’ a poem on the adventures of Roger Williams.

Durfee, Thomas, American jurist: b. Tiverton, R. I., 6 Feb. 1826; d. Providence, R. I., 6 June 1901. He was graduated at Brown University 1846; was admitted to the bar 1848; reporter of the Rhode Island supreme court 1849–53; presiding judge of the court of magistrates 1855–60; speaker of the Rhode Island house of representatives 1863–5; associate justice of the Rhode Island supreme court 1865–75; and chief justice 1875–91, when he retired. He was elected a trustee of Brown University 1875, and its chancellor 1879–88. He published: ‘Reports of Cases in the Supreme Court of Rhode Island’ (1851–3); ‘Treatise on the Law of Highways’ (1857), begun by J. K. Angell; ‘The Village Picnic, and Other Poems’ (1872); ‘Gleanings from the Judicial History of Rhode Island’ (1883); ‘Some Thoughts on the Constitution of Rhode Island’ (1884); and several orations on public occasions.

Durfee, William Franklin, American engineer: b. New Bedford, Mass., 15 Nov. 1833; d. Middletown, N. Y., 14 Nov. 1899. He studied at Lawrence Scientific School, Harvard, and turned his attention to steel manufacture, his establishment turning out in 1865 the ingots from which were made the first steel rails in the United States. After 1875 he practised as a consulting engineer and patent expert.

D'Urfey, dėr'fī, **Thomas,** commonly known as "Tom D'Urfey," English dramatist and poet: b. Exeter, 1653; d. London 26 Feb. 1723. He was a good-natured, simple-hearted, thoroughly vulgar and unliterary writer. His dramas, comedies, operas, tragedies, and songs are like what Sancho Panza would have written if he had taken to letters. Many, like ‘The Siege of Memphis’ (1676), a tragedy, and ‘The Plotting Sisters’ (1691), a comedy, are verbose; others, like the ‘Songs Complete’ (1699), are of virginal simplicity, but not of virginal modesty.

Durga, door'gä, or **Parvati** (Sanskrit, "The Inaccessible One"), a Hindu divinity, one of the names given to the consort of Siva. She is generally represented with 10 arms. In one hand she holds a spear, with which she is piercing Mahisha, the chief of the demons, the killing of whom was her most famous exploit; in another a sword; in a third the hair of the demon chief; and in others, the trident, discus, axe, club, and shield. A great festival in her honor, the *Durgapuja,* is celebrated annually in Bengal with wild orgies about the beginning of October, and lasts for about 10 days in all. See Siva, Devi.

Durgah, The, a famous tomb built for the Sheikh Selim-Chisti, at Futtehpore, near Agra, in Hindustan. It was erected at a cost of 37 lacs of rupees, or $1,750,000. The tomb as well as a canopy, six feet high, which covers it, is made of mother-of-pearl. The floor is of jasper and the walls of white marble inlaid with cornelian. The screens of marble surrounding the building are the most beautiful in India. They are single, thin slabs about eight feet square and wrought into such intricate open patterns that they appear as having been woven in a loom.

Durham, dŭr'am, **John George Lambton,** Earl of, English statesman: b. London 12 April 1792; d. Cowes, Isle of Wight, 28 July 1840. He took an active part in furthering all projects of a reforming tendency, even bringing forward in 1821 a scheme for parliamentary reform much more advanced than that of 1832. In 1828 he was raised to the peerage, with the title of Baron Durham. Under the administration of Lord Grey (1830) he held the office of Lord Privy Seal, and was one of the four persons who drew up the Reform Bill, and supported it in the House of Lords. For a time he was ambassador at St. Petersburg. In 1838 he was appointed governor-general of Canada, where owing to the revolt of the French in Lower Canada, the constitution had been suspended. Lord Durham's measures were statesmanlike, but dictatorial; and the House of Lords voted disapproval of some of his acts. Thereupon he took the extraordinary step of returning to England without either being recalled or obtaining the royal consent. Lord Durham's famous report on Canada anticipated many of the best features in the present Canadian constitution.

Durham, one of the three English counties called counties palatine (see COUNTY PALATINE). There is more coal mined in Durham than in any other county of England; and lead and iron mines are worked. Some of its manufactories are iron works, potteries, linen- and woolen-mills, glass and chemical works. Pop. (1901) 1,187,324.

Durham (ancient DUNHOLME), England, city and parliamentary borough, capital of the county of the same name, on the River Wear; 14 miles south of Newcastle. The principal public buildings are the ancient castle (now appropriated to the uses of the university), the cathedral, and other churches, the town hall, county prison, and the grammar school. The educational institutions comprise the university, the grammar school, training school for school-mistresses, and other schools. There are manufactures of carpeting and mustard. The cathedral is believed to have been founded by William de Carilepho, assisted by Malcolm, king of Scotland, in 1093. Pop. 14,935.

Durham, N. C., city in Durham County, on the Southern Air Line and the Southern railroads; 26 miles northwest of Raleigh. It is a tobacco and cotton-growing centre, and the seat of Trinity College (Methodist Episcopal South). The manufacture of a famous brand of smoking tobacco is the staple industry of the place. It was the scene of the treaty between Gens. Sherman and Johnston at the close of the Civil War. It has a national bank, newspapers, and good schools. Pop. 6,679.

Durham Book, The, or **St. Cuthbert's Book,** a manuscript of the Latin text of the gospels, with an interlinear gloss in Saxon. The book dates from the last of the 7th century, and is supposed by some to have been written by Eadfrith, of Lindisfarne. It is one of the most beautiful of the manuscripts made by the old monks, and is one of the most highly prized treasures of the British Museum.

Durham Cattle. See CATTLE.

Durham, University of, located at Durham and which was originated in 1831 under Bishop Van Mildert, by the appropriation of part of the property belonging to the cathedral chapter. In 1832 an act of Parliament was obtained sanctioning the erection of the proposed university; in 1833 the university was opened, and in 1837 it was incorporated by royal charter. In 1841 the office of warden was permanently annexed to the deanery of Durham, a canonry in the cathedral was annexed to each of the professors of divinity and Greek; a professor of mathematics and astronomy appointed, and 18 fellowships were founded, besides 6 which had previously been founded by the dean and chapter. As at Oxford and Cambridge, the students reside mostly within the university buildings, accommodation being provided for them in University College, and in Bishop Hatfield's Hall. The university awards the degrees of Bachelor and Master of Arts, Bachelor and Doctor of Literature, of Science, and of Divinity; the usual medical degrees, degrees in music, and the degree of Doctor of Civil Law. The academical year is divided into three terms — Michaelmas, Epiphany, and Easter. No religious test is required from any member of the university unless he is a student in the faculty of theology. Science was taught from the first, but not to a satisfactory extent till 1871, when the Durham College of Science was instituted in connection with the university at Newcastle-upon-Tyne. The medical department of the university is constituted by the Durham University College of Medicine, founded in 1851 at Newcastle, an institution which has greatly increased in efficiency in recent years by the establishment of additional chairs. Since 1895 all degrees except those in divinity may be granted to women.

Durian, dū'rī-an, or **Durion** (*Durio zibethinus*), a fruit-tree of the natural order *Malvaceæ*, generally diffused over the southeast of Asia, especially in the Malay peninsula and neighboring islands. It is esteemed for the flavor of its fruit which, however, is an acquired taste, the fruit having a strong, musk-like odor, and a somewhat terebinthine flavor. The tree, which on an average yields 200 fruits annually, is about the size and the form of a pear-tree, but with cherry-shaped leaves, except that they are entire and smooth at the edges. The flowers are large and of a yellowish-white. The fruit, of globular or oval form, from eight to ten inches long, large in some species as a man's head, is not unlike the bread-fruit externally. It has a hard, prickly rind, covered with warts and tubercles. When ripe it becomes of a brownish-yellow, and opens at the top; it must be eaten almost fresh from the tree, as it putrefies in less than 24 hours. The fruit contains five large longitudinal cells, each containing one to four seeds about the size of pigeon's eggs, embedded in a custard-like pulp, which is the delicious part of the fruit. The seeds are roasted and eaten like chestnuts, ground into flour, and also made into vegetable ivory. The pharmaceutical qualities of the fruit are aphrodisiacal.

Dürkheim, dürk'hīm, or **Dürkheim an der Hardt,** Bavaria, town in the Palatinate, 14 miles southwest of Mannheim. Its annual sausage market, founded in 1494, is attended by large numbers of people. Dürkheim has saline springs, in the water of which Bunsen and Kirchhoff, by spectrum analysis, first detected the metals rubidium and cæsium in 1860. Dürkheim was walled and fortified, so was an object of keen contest during the Thirty Years' War. Pop. 6,055.

Durlach, door'läh, Germany, town in the Grand Duchy of Baden, four miles southeast of Carlsruhe, at the foot of the Turmberg. It is of Roman origin. It has manufactures of iron, machinery, organs, sewing-machines, gloves and beer, and is celebrated for its fruit. Pop. 11,425.

Durmast, dėr'mast, a species of oak, *Quercus sessiliflora*, or according to some *Q. pubescens*, a variety of the common oak (*Q. robur*). Its wood is, however, darker, heavier, less easy to split, not so easy to break, yet the least difficult to bend. It is highly valued, therefore, by the builder and cabinet-maker.

Duroc, Michel Gérard Christophe, mē-shěl zhā-rär krēs-tōf dü-rōk, Duke of Friuli, French soldier: b. Pont-à-Mousson, 25 Oct. 1772; d. Bautzen 22 May 1813. He served as aide-de-camp to Napoleon in the Italian and Egyptian campaigns. In 1805 he was made grand marshal of the palace, and was frequently employed in diplomatic missions, though he still took his full share in the wars of France till the time of his death. He was a great favorite of Napoleon, and was killed by his side at the battle of Bautzen.

Durra, dûr-a, a genus of grasses of great economical importance throughout Africa and Asia, especially in India, also called Indian millet, Guinea corn, or Sorgho grass. See SORGHUM.

Dürrenstein, dür'rěn-stīn, Austria, village on the Danube; 41 miles northwest of Vienna. It is celebrated for its feudal castle, in which Richard Cœur-de-Lion was treacherously detained on his return from Palestine (1192) by Duke Leopold of Austria. It was destroyed by the Swedes in 1645. In November, 1805, the French here defeated the Austrians and Russians.

Durugmunan, doo-roog-moo'nän, a race possessing Mongolian characteristics and dwelling in the interior of the island of Mindoro.

Duruy, Georges, zhôrzh dü-rü-ē, French writer on history: b. Paris 1853. He became professor of French literature in the Polytechnic School in 1891. He wrote some novels that became popular favorites, as 'The Life-guard'; 'A Soul's Victory'; 'Dream-End.' His principal historical works are: 'History of Turenne'; 'Short Popular History of France.' His 'Cardinal Carlo Carafa: a Study on the Pontificate of Paul IV.' (1883) was crowned by the Academy.

Duruy, Victor, vēk-tōr, French historian and statesman: b. Paris 11 Sept. 1811; d. there 25 Nov. 1894. He was professor of history in the Collège (afterward Lycée) Henry IV. prior to 1861. In 1862 he was appointed inspector-general of public instruction and professor at the École Polytechnique, and in the following year Napoleon III. made him minister of public instruction. During his six years' tenure of this office he carried out many important reforms in spite of the determined opposition of the clerical party, and on resigning his office in 1869 he was nominated a member of the senate. He was elected a member of the Academy of Inscriptions in 1873, and in 1884 a member of the French Academy. Besides many excellent school manuals, he wrote: 'Histoire des Romains depuis les Temps les plus Reculés jusqu'à L'Invasion des Barbares' (1870–9), his most important work; 'Histoire des Grecs depuis les Temps les plus Reculés jusqu'à la Réduction de la Grèce en Province Romaine' (1862), crowned by the Academy; 'Histoire de France' (1852); 'Introduction Générale à l'Histoire de France' (1865); and other works. He was general editor of Hachette's great 'Histoire Universelle.'

Durward, Quentin. See QUENTIN DURWARD.

Duryée, dûr-yā, **Abram**, American soldier: b. New York 1815; d. there 1890. He was educated in the common schools, and going into business made his fortune in mahogany furniture. He entered the State militia in 1833, was made colonel of the 27th Regiment in 1849 and was conspicuous as a maintainer of order during the riots that prevailed up to 1861. During the Civil War he raised the regiment known as "Duryée's Zouaves," and was promoted to be brigadier-general of volunteers in August 1861, but resigned in January 1863 owing to a disagreement over a question of rank. His gallant services at the battles of Cedar Mountain, Rappahannock Station, Thoroughfare Gap, Groveton, Chantilly, South Mountain, and Antietam gained for him the brevet rank of major-general in 1865. In 1874, as police commissioner of New York, he attacked and dispersed a body of communists seditiously gathered together in Tompkins Square.

Duse, doo'sā, **Eleanora**, Italian actress: b. Vigevano, Italy, 3 Oct. 1859. Her childhood and early youth were filled with sorrow, arising from poverty, hardships, the loss of friends and an unworthily bestowed affection. Hers was a lineage of actors, and her early environment destined her for the stage. Her grandfather founded the Garibaldi Theatre in Padua. She was dragged about the minor theatres of Italy in her father's companies, playing Cosette in 'Les Miserables' at 7, and star of the little troop at 13 in 'Francesca da Rimini.' When she was 14 she played Juliet at Verona, in an open-air theatre, her performance compelling recognition as most extraordinarily brilliant. Still she had to wait for general recognition until 1879, when she played Zola's 'Thérèse Raquin' in Naples in 1887. She appeared in Venice in 1892, and later in all the chief European cities, making her debut at the Fifth Avenue Theatre in New York as Camille in Dumas' play of that name, January 1893. Among the roles which she has triumphantly essayed are Marguerite, Magda, Paula, La Femme de Claude, La Locandiera. She was married to an Italian actor-journalist, Signor Chechi, before she was 20, but they soon separated. Duse has remarkable emotional power and the ability to represent suffering and to make the most of tragic situations, at the same time possessing such versatility that she can play parts of opposite character the same evening. She pays little attention to the meretricious accessories of the stage makeup. Great simplicity and naturalness, coupled with striking intensity, characterize her acting. She has great excellence in diction and in facial expression, the latter being continuous and minute. Her repertory is enormous, her art including the plays of Dumas, Scribe, Verga, Prega, Ibsen, Sudermann, d'Annunzio, and Shakespeare. Her tours in the United States, 1893, 1896, 1902–3, were very successful from the artistic and managerial point of view.

Dusky Duck, or Black Duck, a north American duck (*Anas obscura*), closely related to the mallard, but of a prevailing sooty hue in its plumage. It is peculiar in being confined to the eastern half of North America, breeding abundantly in Labrador, and appearing in the United States in winter, when it becomes one of the principal market ducks. Its nest, eggs, and general habits are like those of the mallard.

Dussaud, düs-sō, **Frantz,** Swiss physicist and inventor: b. Geneva, Switzerland, 1870. He was appointed professor of physics in the university of his native town in 1892 and superintendent of public instruction in 1895, in which year he was elected deputy to the assembly. Besides his services as a scientific writer, he has invented many ingenious and useful appliances such as the phonograph for the deaf, the cinematograph for the blind, the loud-speaking telephone, the registering telephone, etc.

Dussek, Jan Ladislaw, yän lăd'is-lâ doo'-shĕk, Bohemian composer and pianist: b. Czaslau 9 Feb. 1761; d. St. Germain-en-Laye 20 March 1812. He was trained at Iglau, Kuttenberg, and Prague, and afterward was organist at Mechlin and Bergenop-Zoom. At Amsterdam he met with much success, both as a teacher and performer, and here he produced his earliest works for the pianoforte; he afterward resided at The Hague, and in Hamburg, Lithuania, Paris, Milan, and London (1788–1800), where he was very popular. In 1803–6 he lived as instructor and boon companion with Prince Louis Ferdinand of Prussia, whose death called forth the beautiful and pathetic 'Elégie Harmonique' (op. 61); in 1807 he entered the service of Prince Talleyrand, and thenceforward devoted most of his time to composition.

Düsseldorf, düs'sĕl-dŏrf, Germany, city, the capital of the government of the same name, in the Rhenish province; on the Rhine, here crossed by a bridge of boats, and on the railroad from Elberfeld, 22 miles northwest of Cologne. It consists of the old town in the north, Karlstadt, the new town, and Friedrichstadt in the south, with the suburbs of Derendorf, Flingern, Oberbilk, Unterbilk, and other small places. The chief public squares are the Corneliusplatz, with a fountain and a statue of Cornelius; Schadowplatz, with a monument of Schadow; the market-place with an equestrian statue of the Elector Johann Wilhelm; and the Burgplatz, with the tower of the castle which was founded in 1710 and burned down in 1872. In 1896 a bronze equestrian statue of the Emperor William I. was unveiled. The principal churches, of which there are 12 Roman Catholic and 3 Protestant, are St. Lambert's, a 14th century building, near the Rhine, adorned with marble monuments of Wilhelm IV. and Johann Wilhelm, the last two Dukes of Cleves and Berg; and St. Andrew's, completed 1629. Other buildings are the Academy, a modern building in the Renaissance style; the court-house, with Schadow's last oil-paintings; and a building of the 16th century, with fine paintings. The Academy of Art was founded 1767, by the Elector Theodore, remodelled in 1821, and afterwards directed by Cornelius and Schadow. This city has the honor of having founded a school of painting, which takes the name of Düsseldorf. In the Art Hall, opened in 1881, are several modern pictures; and there are some paintings by the old masters, besides drawings, engravings, and water-colors, in the old palace. The Hofgarten is a magnificent public garden extending eastward from the Rhine; and there are also a zoological garden and a Floragarten. Düsseldorf carries on considerable manufacturing, and its trade as a port and railroad centre is large and increasing. After being the capital of the duchy of Juliers and Berg, Düsseldorf passed under the rules of the counts palatine of Neuberg, and then became the residence of the Elector-palatine John William, under whom it enjoyed great prosperity and became a centre of artistic work. It was taken by the French in 1795, restored to Bavaria by the Treaty of Luneville in 1801; in 1806 became the capital of the grand-duchy of Berg, with which it passed to Prussia in 1814. Pop. (1900) 213,767.

Dust, the fine particles of matter which float on currents of air, or settle on surrounding objects. Country air may contain only 200 particles of dust per cubic centimetre, while that of large cities may run up to 150,000, and in tenement houses as high as 1,000,000. These particles consist of sand, soot, cotton fibre, pollen, fine hair, pulverized excreta of animals, parts of seeds, bacteria, molds, etc. This is the ordinary condition of things. Frequently, as was the case after the Krakatoa eruption in 1883, the atmosphere becomes widely and densely charged with volcanic particles of varied minuteness, the smallest and lightest of which must take months, even years in settling. Remarkable color effects were produced in the heavens by the refraction of the sun's rays through these dust clouds. Aitken, a Scotch savant, has shown that no condensation of moisture (as in rain, mist, fog; see FOG) could occur without nuclei such as dust particles. He has also devised an apparatus for counting the number of dust particles in a given sample of air or gas. But one of the most important and serious questions concerning dust-laden air is the danger it brings to human life, as disseminating the bacteria of disease. Nearly one fourth of all deaths are due to consumption. Now the expectoration of a consumptive may contain millions of germs. Falling on the sidewalk or carriage-way of a city, it is soon tracked over a large area and gradually mixed with the dust; especially on asphalt pavements, where each wheel acts as a millstone, grinding everything into the finest powder, to be raised by passing vehicles into the air and sent int thousands of healthy lungs. The number of disease bacteria in the air has been calculated by many analyses. Taking 10 liters of air for a basis: in the Boston City Hospital the number of living bacteria was found to be nearly 450, and of molds 225. In a model New York hospital, where everything is supposed to be clean, 12 living germs settled on the disk, and, after sweeping, 226. In a New York tenement house carpeted living room, 75 living bacteria settled on the disk in an exposure of five minutes; after sweeping, 2,700, and mold settled on a plate or disk three and three quarters inches in diameter. Precautions have recently been taken against the peril of dust-spreading disease by constantly flushing the streets, and sweeping away all superficial dust into the sewers. The dust of such meteorites as undergo complete combustion on contact with atmospheric air, has been traced on the earth's surface; for example, on the inland ice of Greenland in the shape of particles of magnetic iron with cobalt. Dust of the same sort has been found on the snow of various northern regions, and scientific men have given it the name of cosmic dust.

Dust-brand, or **Smut,** a disease of certain plants, as oats, barley, corn, and other cereals. It is caused by a parasite fungi called *Ustilago*, which causes a swelling that at length becomes a powdery sooty mass. The common forms are *Ustilago segetum* and *U. carbo*; that which attacks Indian corn is *Ustilago maydis*.

Dustin, Hannah, American heroine; she was the wife of Thomas Dustin and was captured by the Indians during their attack on Haverhill 16 March 1697. Her youngest child, an infant one week old, was killed, but her husband, with their other seven children was successful in escaping. The mother, with her nurse, Mary Neff, was carried off and put in charge of an Indian family consisting of two men, three women and seven children. The captives on their way to a large Indian village halted at an island six miles above the present Concord, N. H. Here Mrs. Dustin and her nurse, assisted by an English youth, Samuel Leonardson, killed and scalped all the Indians in their sleep, excepting one squaw, and a small boy, and after a difficult journey in which they endured many hardships, reached home in safety.

Dusty-foot. See PIEPOWDER COURT.

Dusty-miller, a common name of some of the plants of the genus *Primula* of the primrose family, from the white flour-like appearance of the leaves. The name is also applied to *Cineraria maritima*, a native of the Mediterranean shore, and much grown in greenhouses.

Dutch is the anglicized form of the word *Dietsch*, *Duitsch*, or *Deutsch*, which in the Middle Ages was applied to the Teutonic people who spoke a language other than the Latin or the Romance languages. *Dietsch* means, "belonging to the common people; vernacular." While the term Dutch was once applied by English speaking peoples to Germany and things German it has long been restricted to the language and poeple of the Netherlands. The people of Holland call themselves *Nederlandsch* and use their forms *Duitsch*, *Nederduitsch*, as the Germans do *Deutsch*, *Niederdeutsch*. For Dutch Language and Literature, see NETHERLANDS.

Dutch Church, the church to which the majority of the people of Holland adhere. In the 16th century the Dutch wavered for a time between the Lutheran Church, whose leader was the great reformer, and the Reformed Church, whose leaders were Calvin and Zwingli. In 1571 they publicly professed their allegiance to the latter by embodying its doctrines in the Belgic Confession of Faith, published in that year. As long as they were under the sway of the Spaniards they, however, abstained from the use of the word Reformed, which had been introduced by the French, and styled themselves "Associates of the Augsburg Confession," the Spaniards considering Lutherans more easy to govern than Calvinists. One of the most notable events in the history of the Dutch Church, after the yoke of Spain was broken, was the Synod of Dort, in 1618. James Arminius, professor of theology at Leyden, having rejected the Calvinistic tenets and adopted those which were destined to be called after himself, Arminian, a synod was convened at Dort to examine and, if need be, condemn his views. This was done, but with little effect, the views of Arminius prevailing to a greater extent after than they had done before their condemnation. The government of the present Dutch Church is Presbyterian. See LUTHER; NETHERLANDS; REFORMATION; ZWINGLI.

Dutch Clover, a common name for the white clover (*Trifolium repens*), a valuable pasture plant, very common throughout the United States, probably naturalized from Europe. It is also a native of Siberia, and is found in all temperate regions. It has a creeping stem, the leaflets are broad, with a horseshoe mark in the centre, and the white or pinkish-white flowers form a roundish head. The plant is so well known that it has a variety of familiar names, the best known English names being sheep's-gowan, honey-stalks, lamb-sucklings, and occasionally shamrock. In America it is called honeysuckle clover. See CLOVER.

Dutch Concert, a so-called concert in which every man sings his own song at the same time that his neighbor is also singing his. There is another form of Dutch concert, in which each person present sings in turn one verse of any song he pleases, some well-known chorus being used as a burden after each verse.

Dutch Courage, false or fictitious courage, usually applied to the bravado inspired by partial intoxication. The phrase probably originated in the 17th century, when England's wars with the Dutch, and especially the naval reverses England suffered at their hands in the reign of Charles II., rendered in England the very name "Dutch" a synonym for all that was bad.

Dutch East India Company. See EAST INDIA COMPANIES.

Dutch East Indies, the islands in the Malay Archipelago owned by the Dutch; situated between 6° N. and 11° S. latitude, and between 95° and 141° E. longitude. The names, area, and population of the divisions are as follows:

Divisions		Area: English sq. m.	Population in 1900
Java and Madura		50,554	28,745,698
Island of Sumatra	Sumatra, West Coast	31,649	1,527,297
	Sumatra, East Coast	35,312	421,088
	Benkulen	9,399	158,767
	Lampongs	11,284	142,246
	Palembang	53,497	692,317
	Atjeh	20,471	110,804
Riau-Lingga Archipelago		16,301	74,483
Banca		4,446	106,305
Billiton		1,863	43,386
Borneo, West Coast		55,825	370,775
Borneo, South and East Districts		156,912	716,822
Island of Celebes	Celebes	49,390	1,448,700
	Menado	22,080	293,947
Molucca Islands		43,864	430,855
Timor Archipelago		17,698	119,239
Bali and Lombok		4,065	431,696
New Guinea to 141° E. lon.		151,789	200,000
Total		736,400	36,000,000

The areas given are accurate; but, except for Java and Madura, the population is estimated. The figures, however, are approximately correct, as the official records give the census every five years. The population of some unexplored sections is not included. The last official returns give the total population, approximately 36,000,000, or about seven times as large as that of Netherlands. The number of Europeans in Dutch East Indies, in 1900, was 75,927; of Chinese, 460,000; of Arabs, 24,000; of people from parts of Asia other than China and Arabia, 27,000; and about all the remainder were natives. The chief occupation of the people is agriculture. The greater part of the land of the island of Java is government property, but in the western part there are a number of private estates. The government or the private owners of estates are entitled by law to one day's gratuitous work each week from each laborer on the estate, or, instead, to the payment of one guilder per head annually. Since the passage of the "agrarian" law in 1870 which granted waste lands on hereditary leases for 75 years, agriculture has increased in Java and the other islands. At first the government raised all the most productive articles as sugar, coffee, rice, etc.; but since 1891 the government has ceased to cultivate sugar, and it is now grown on the lands hired by the natives, or on lands held on emphyteutic tenure from the government. All the usual products are cultivated on private estates. The annual production of sugar has greatly increased from 1896 to 1901; the amount of coffee produced in the same time has decreased; cinchona has increased rapidly; tea, tobacco, and indigo have increased steadily. The yield of the tin mines of Bilton and Riouw, and of the coal mines of Java, Sumatra, and Borneo have increased each year. Buffaloes, oxen, cows, and horses are raised extensively. In India horses are not used for agricultural purposes.

Manufactories are increasing slowly; rice-mills, saw-mills, soap factories, ice and soda water manufactories are in some of the towns. In 1900 there were 3 government and 55 private printing presses. The principal articles of export are sugar, coffee, tea, rice, indigo, cinchona, tobacco, and tin. Nearly all of the exports, except rice, go to the Netherlands. The railroad and the mail and telegraph service is fair and is becoming better each year. The local revenue derived from land, taxes on houses and estates, from licenses, custom duties, personal imposts, some indirect taxes, and from the government monopolies of salt, opium, and railroads, and the sale of government products. About one-third of the annual expenditure is for the army and navy, another third for the general administration, and the balance for the local government administration. The "Java Bank" is controlled by the government. There are two other Dutch banks, several branches of banks in Great Britain, and a number of savings banks. The legal coins and the weights and measures are the same as for Netherlands. The local weights and measures are as follows:

The Amsterdamsch Pound	= 1.09 lb. avoirdupois.
" Pikol	= 133⅓ lbs. "
" Catty	= 1⅓ lb. "
" Tjengkal	= 4 yards.

In the administration of justice the principle observed is that Europeans and those assimilated with them, are subject to laws nearly similar to those in vogue in the Netherlands; and the natives are subject to their own customs and institutions. The administration of justice for Europeans is in charge of European judges, while that for the natives is almost wholly in charge of native chiefs.

Schools are provided for all Europeans and natives. In 1900, there were five normal schools, four schools for sons of native chiefs, and the government and private elementary schools in Java and Madura numbered about 600, and for the outposts for the same year, 900.

Entire liberty of worship is granted to the members of all religious denominations. Christianity is increasing among the natives. In Java and the outposts, in 1873, there were 154,345 Christians, and in 1896, there were 309,258 Christians.

Dutch Gold. See COPPER.

Dutch Guiana. See GUIANA.

Dutch Harbor, Alaska, a port in the northeastern part of the island of Unalaska, situated on Bering Sea. It is a port of call for steamers passing through the Unimak Pass. See ALASKA.

Dutch Language and Literature. See NETHERLANDS.

Dutch Liquid, an oily liquid, known to the chemist as ethylene dichlorid ($C_2H_4Cl_2$), which is obtained by the action of chlorine gas upon ethylene, and also as a by-product in the manufacture of chloral. It has anæsthetic properties, and is reputed to be quite safe; but it is irritating to the throat, and is therefore not used. The name relates to its early preparation by the Dutch chemists.

Dutch Metal. See COPPER.

Dutch Oven, a spider, skillet, or camp-oven used by those who cook by hot coals on the hearth, a mode yet common in the western States of the Union, and unsurpassed in its results with skillful housewives. The pot stands in hot embers, and more of the same are piled on the dish-shaped lid. The phrase is also applied to a cooking-chamber suspended in front of a fire so as to cook by radiation.

Dutch Pink, a yellow lake, prepared from bark of the quercitron (the dyer's oak), used in distemper, for staining paper-hangings, and for other ordinary purposes.

Dutch Reformed Church in America. The history of the Dutch Reformed, or Reformed Dutch Church, had its beginning in Switzerland in 1516 under the leadership of the heroic and devout Zwingli. Holland early felt the impulse of the Reformed faith as it came to her by way of the Palatinate, and through Swiss and French influences received it modified as to doctrine and polity. That Calvin had much to do in giving shape to the government of the Church in its Swiss home may account for that robustness of character by which in the early days the Reformed faith had so wide and powerful an influence and that heroic endurance to withstand the persecutions which befell it. These persecutions under the direction of Charles V. of Spain (1519–55) and his son Philip (1555–81) while disturbing in a greater or less degree the peace of those countries holding the Reformed faith, it was sturdy little Holland which received the full fury of the sword and under the leadership of William of Orange achieved those victories that gave her civil and religious liberty. In six years from 1567–73, over 100,000 men gave up their lives to purchase such liberty. Great enthusiasm was aroused by holy and learned men, who while preaching the Gospel in the open fields, also urged resistance to every power opposed to the progress of the Reformed faith. Added to this, the devotion of the people was expressed in song. The hymns of Beza and Marot became an inspiration. Men everywhere sang them as they stood in the thickest of that fight whose outcome they determined should be religious liberty for themselves and their children. But while the Prince of Orange was able in time (1576) to carry his negotiations so far as to bring about "the Pacification of Ghent," it was not uninterrupted peace. Out of those troublous times, in 1579, came the "Union of Utrecht." Seven northern provinces of Holland bound together by a common faith making this the motto of their convenart, *Eendracht maakt macht* ("Union makes strength") — a sentiment used to-day by the American Reformed Church on its seal. The independence of the northern provinces, however, was yet to give place to something broader and grander. It was the founding of the Dutch republic with a history too resplendent to be given in detail, excepting to say that her career in everything that ennobles a people — her universities, her diplomacy, her constitution, her arts, sciences, and her maritime and commercial power became, and are yet, the admiration of the world.

It was, however, in the darkest days of her history that Holland was busy in formulating the doctrinal standards of the Reformed Church, its liturgy and polity. It was in 1566 that some Walloon and Dutch pastors met at Antwerp, and, joined by a few nobles, proceeded to form the first regular Church organization. The Belgic Confession, written by De Beers, with some slight alterations, was put among its doctrinal standards. The Heidelberg Catechism, written by Ursinus and Olivianus of the Palatinate, was also accepted, but not fully endorsed until a later period. This Antwerp organization might properly be called the first synod of the Church of Holland. Doctrinal standards were endorsed and adopted, although declaring at the time that the Word of God was their only rule of faith, and much of this work was afterward confirmed by the greater synods that followed.

The Synod of Wesel was held in 1568. This synod did more toward shaping the policy of the Church. Calvin's Presbyterian polity was modified as suited their circumstances and adopted. A learned and godly ministry loyally endorsing their faith was made a necessity and the duties of church officers were carefully defined. Three years having passed with their land yet under the ominous cloud of Charles V., the Synod of Emden was called in 1571. The acts and proceedings of the Synod of Wesel were re-endorsed, with new features of church government formulated and arranged. The first Synod of Dort — the first of the national synods — was called in 1576 at Dortrecht, Holland. The government of the Church was farther perfected in defining the four grades of ecclesiastical bodies, namely: The general synod — the highest council, synod classes and consistories. It also declared what thereafter should be the conditions of church membership. Following this was the important Synod of Middleburg, held in 1581. Its chief work was to complete the organization of the Church, arranging all matters relating to schoolmasters, professors of theology, liturgy, and creed, with which in the deposition of Philip II., a month later, the Reformed Church became the established Church of the Netherlands. The great Arminian controversy that was agitating the young Church in the early part of the 17th century was the immediate cause of the calling of the second Synod of Dort in 1618. All of the Reformed churches of Europe were invited to send delegates and most of them responded. James I. of England sent the Bishop of Llandoff, Samuel Ward, professor at Cambridge, and Joseph Hall, who afterward became Bishop of Salisbury. The doctrines of grace respecting fore-ordination, the perseverance of the saints, sin, and the conversion of man, the atonement, upon which Arminius was believed to hold unsound views, became subjects of earnest discussion. The Remonstrants who, headed by Episcopius, supported Arminius, were excluded from office in the Reformed Church and in a learned formula called the 'Canons of the Synod of Dort,' the synod's views upon these great doctrines were accurately defined. When the foreign delegates had withdrawn from the synod at the close of the 144th session, the Dutch delegates remained and acted as a third National Synod. These proceedings were called "post-acta," and much was done to develop much farther the working power of the young Church. The call to the ministerial office, festival days, hymns to be used in worship, baptism of adults and the sick, professors of theology and their relation to the Church, a new translation of the Bible into Dutch, foreign missions, profanity, the liturgy, and also ministers' salaries, were matters provided for. Yet again the Heidelberg Catechism came up for discussion and was re-adopted with enthusiasm, ordered to be taught in the schools, in the home, and explained in the churches every Sabbath. A 'Compendium' of its teachings was prepared and put among its standards of doctrine.

It was about this time that Holland immigration to America began. For 20 years before the Dutch East India Company had been pushing its commercial enterprises in the Indian Ocean. To find a shorter route to India it sent Hendrik Hudson on his voyage of discovery. The result was he explored in 1609 the river which bears his name. Five years later the country betwen Virginia and New France, or, measured on the coast line, from the 40th to the 45th parallel of latitude was taken possession of, made a province of in 1623 and was called the New Netherlands. In 1621 a West India Company, an armed corporation, with unlimited powers of colonization, and with great power on the sea was formed and with it Dutch immigration was more widely extended. Settlements began to form about New York Bay and in the vicinity, while Manhattan Island was at once occupied and held by the West India Company. In 1626 Peter Minuet, born of Huguenot parentage, an elder in the French Reformed Church at Wesel, came to America commissioned as director of the now powerful West India Company. To strengthen the company's hold upon Manhattan Island he bought it of the Indians for the sum of $24. With the coming of Minuet began the first religious services in the

New Netherlands. He brought over with him two *Krankenbesoeckers* or comforters of the sick — devout men who in a commodious room over a horse-mill held religious services. These were held until the arrival of the first minister, Rev. Jonas Michaelius, early in 1628, when the first Church of the Reformed faith was organized in 1628. Fifty communicants were present at the first Lord's Supper, among them some Walloons. The Walloons were of the Reformed Church in Belgium, bordering on Holland, and who spoke the old French language, hence called by the Dutch *Waalche*, corrupted to Walloon. Many of them settled on Long Island in the vicinity of Wallabout, or Walloons bay or cove. The ecclesiastical connection of the new Church was with the Classis of Amsterdam in Holland. The Rev. Everardus Bogardus took the place of Michaelius in 1633. With him also came the first schoolmaster of the colony. The loft over the horse-mill was now replaced by a plain wooden church at what is now 100 Broad Street, between Pearl and Bridge streets, New York. The "dominie," as the minister was called, had a house and stable near. The Church now began to grow slowly, and accessions were made from other countries. Up to the time of the English conquest in 1664, and after various vicissitudes, there were 13 organized churches doing their work on American soil. Dutch immigration continued, and settlements were made in New Jersey, along the Hudson River as far as Fort Orange (Albany) and on Long Island, with good work done in adjacent settlements.

In the early part of the 18th century, the young Church began to feel the necessity of new pastors for their many vacant churches. It was getting to be inconvenient to look to Holland for men ordained by the Classis of Amsterdam. The necessity of managing their own Church affairs themselves, and of educating and ordaining their own ministry was now becoming imperative. How this could be done at first was not clear either to the Church in Holland or America. A Coetus, or an association, was finally proposed that might be given authority as a high judicatory in the New Netherlands and have the power of ordination. After much opposition both in Holland and in the colony permission was granted which existed for six years until 1754. In that year began the great disruption, when the young Church became divided into the Coetus and the anti-Coetus parties, but they came together again upon a basis of union of 1772. The Colonial Period, 1771–92, was now passing away and it was also a period of transition to the Church. Changed conditions made it necessary to broaden the 84 articles of the Synod of Dort by adding 73 explanatory articles adapting the whole ecclesiastical machinery to the entire freedom the Church was now enjoying. Minor changes were afterward made in the constitution of the Church at two different times and in 1867 the Dutch Reformed Church after a warm discussion became the Reformed Church in America.

The Church never had a widely scattered constituency — its growth has uniformly followed the lines of Dutch immigration — it is chiefly found to-day doing its quiet work throughout the States of New Jersey, Pennsylvania, New York, and in many of the Western States. The constitution of the Church consists of its standards of doctrine, its liturgy, and its rules of government. Its liturgy has come down from the Church of Holland, but its use is optional, excepting the forms for the Lord's Supper, baptismal forms, and forms for ordination. In doctrine the Church is moderately Calvinistic. The fundamental thought is Divine Sovereignty, and in all its standards, what are called the doctrines of grace are given emphasis. Its standards of doctrine are the Belgic Confession, the Heidelberg Catechism, and the Canons of the Synod of Dort, together with a 'Compendium' explanatory of the Catechism. All ministers and teachers of theology are obliged to subscribe to these standards. The form of government is Presbyterian, having four church courts, the consistory consisting of the pastor and the elders and deacons, which are chosen from the congregation every two years, the Classis, a semi-annual convention of adjacent churches represented by pastors and elders, the Particular Synod, meeting annually, composed of ministers and elders delegated by each Classis, the General Synod, delegates appointed by each Classis, and elected by the Particular Synod. There is 1 General Synod, 5 Particular Synods, and 35 Classes representing 652 churches, and 700 ministers.

The Dutch Reformed Church has always insisted upon an educated ministry. Next to being the oldest body of Presbyterians in America, it may also claim to have established the first School of Theology (1784). Before that the ministers of the Church came from Holland, while a few went there for their education. The Theological Seminary at New Brunswick, N. J., with its six professors, is the result of the modest beginning. A second Theological Seminary is at Holland, Mich., and a third is connected with the Church's missionary work in India. This Church is also believed to have antedated any other body in founding the first college. A charter for a college was granted by Gov. Franklin of New Jersey in 1766, but a second and amended charter under which it organized was granted 20 March 1770, called Queens College, afterward changed to Rutgers College, and permanently located at New Brunswick, N. J. The New Jersey State Scientific School is also a part of the institution. The great immigration from Holland to Michigan and the neighboring States in 1847 and their prosperity made it soon appear that their high school which had passed under the control of the General Synod as Holland Academy, must soon expand to the proportions of a college. This it did in 1866 and Hope College took its place among the flourishing institutions of the West. A "board of education" to assist indigent and godly young men in pursuing their studies for the ministry was one of the early conceptions of the Church, and put in practical form in 1828. Later in 1865 the board was empowered by the Synod to co-operate with the Classes in the establishment of academies and classical schools.

The Dutch Reformed Church early imbibed the missionary spirit. Its home work was coincident with its history. As early as 1790, much work was done in scattered fields — in Canada, and later, in the Middle States and the West. "The Missionary Society of the Dutch Reformed Church," organized in 1822, had all the missionary work of the Church under its care. In 1844 it took the name of "The Board of Domestic Missions," and much of the increase in the number of churches is due to its work. The Church did its Foreign Mission work through the American Board, beginning in 1832 and continuing until 1857, when it began its independent work. As the Board of Foreign Missions of the Church, it has had since that time in its several fields 200 missionaries. It has fields in India, China, Japan and Arabia, employing 80 missionaries, 350 native helpers, 27 native ministers, with 40 churches and nearly 5,000 communicants. One of the most invaluable helpers in this work was the organization of the Woman's Board of Missions in 1875, since which time it has contributed toward the general work more than $600,000. Its contributions in 1900–1 were more than $34,000. The young people of the Church are also organized in Christian Endeavor societies, co-operating with such societies everywhere in their work in the world. See CHURCH; PRESBYTERIAN.

REV. EVERT VAN SLYKE.

Dutch Rush, a common name for the scouring rush or shave grass (*Equisetum hyemale*), a plant of the horsetail family, used for scrubbing floors in country places, and imported from Holland as an article of commerce, to be used in polishing hard woods and alabaster. The stems are filled with silica deposited in a regular manner, forming an integral part of the plant. It is native throughout Europe, Asia, and nearly the whole of North America, where it is found in wet places, and along the banks of streams. See *Equisetum*.

Dutch School. See PAINTING.

Dutch in the United States. Holland's one effort at colonizing the northern New World was along the coast strip between the Hudson and Delaware (then known as North and South Rivers). Thence they penetrated inland, striking first of all up the Hudson to Albany, to establish fur-trade with the Indians, and thence westward to Schenectady; spreading east and west from New Amsterdam (New York), to the Connecticut settlements and on Long Island, and into New Jersey. They made a grasp at the Connecticut River, but were soon driven off it. The Delaware was fiercely contested with them by the Swedes, who left a strong impress there (see DELAWARE, *History*), but in vain; and the western side of New Jersey has considerable Dutch blood and settlement as well as the east, with not a little in Pennsylvania and Delaware. The English took all their possessions from them in 1664 (see NEW YORK, *History*), but of course did not root out their blood or traditions. The contribution of the Dutch to American institutions has been the subject of keen debate. Enthusiastic writers have credited them with pretty much everything distinctive of American institutions; partly and largely through the residence of the Pilgrims in Holland, it being assumed that the Pilgrims were unable to originate even such primitive ideas as that of confederations for protection except by imitating Holland; partly through the study of their institutions by the statesmen of the Constitution period. Democracy and religious freedom, written constitutions and the ballot, free religion and free schools, equal inheritances and state recording of deeds, have all been traced to their example. Some influence on the Pilgrims is more than probable, especially in technicalities like the recording of deeds; and in the form of some few others there are significant similarities. But the wholesale character of their advocates' claims injures their cause. Democracy and equal inheritances were the result of the nature of the settlements; free schools existed among the Huguenots as well as the Dutch, and the people colonized on the basis of religious exposition of a book must train children to understand that book; the ballot is centuries older than Holland, and a written federal agreement was needed as security for its being kept. The extreme view is taken by Douglas Campbell, 'The Puritan in Holland, England, and America' (1892); a more moderate one by John Fiske, 'The Dutch and Quaker Colonies in America' (1899).

Dutch West India Company, The, an association of merchants of Amsterdam, Zealand, the Meuse, North Holland, and Friesland, incorporated 1621, with a capital of 6,000,000 florins (about $2,500,000). Unlike the East India Company, which was primarily a trading association, and in its conquests and colonies had no other purpose than to protect its commerce, the West India Company never had an extensive trade, but strove to injure the Spaniards, to conquer their establishments, to capture their ships, and to break the intercourse between Spain and its American gold and silver mines. The design was conceived in the interest of the Belgians, when Spanish persecutions had driven more than 100,000 Protestant families from Belgium to the north. It was thought that the Spaniards would be compelled to evacuate Belgium when their resources had been thus destroyed. Large fleets were sent out, the company possessing sometimes as many as 70 armed vessels. The prizes captured were of such value that during several years shareholders received 25 to 75 per cent interest. Twelve millions were added to the original capital. Spain and Portugal being united at this time (the union lasting from 1580 to 1640), the company not only captured the Spanish silver fleet in 1628, securing a booty of more than 14 million florins, but took Bahia (1624) and Pernambuco (1630) in the Portuguese colony of Brazil. The history of Dutch Brazil had a brilliant period (1636–1642) under the administration of Count John Maurice of Nassau. Curaçao was taken about this time, and the company's North American colony of New Netherlands grew more and more prosperous. But the fatal defect of the company's plan now became apparent. Not being supported by extensive trade, the military and naval triumphs cost much more money than they produced. The financial condition of the company showed, after 1630, a terribly constant downward tendency; the government of Holland, moreover, was very slack in fulfilling its pledges of assistance. The beginning of the end was reached in 1641, when Portugal, having shaken off the Spanish yoke, devised means to regain Brazil. In 1654 the Dutch troops withdrew from that part of South America. The death-blow was struck when New Netherlands, the last valuable possession of the practically bankrupt company, was conquered by the English (1664). Consult: Asher's 'Bibliography of New Netherland and the Dutch West India Company,' Amsterdam, 1856–67.

Dutch West Indies, The, islands of the Caribbean Sea belonging to Holland. They are: Curaçao (area 210 sq. miles, pop. 28,-187), the capital of which, Willemstad, is the residence of the governor of all these small Dutch possessions; Buen Ayre (area 95 sq. miles, pop. 4,399); Oruba; one half of St. Martin (total area 38 sq. miles, total pop. 3,724); Saba (area 5 sq. miles, pop, 2,065); and St. Eustatius (area 8 sq. miles, pop, 1,613). The last three are members of the outer and inner Caribbean chains, and lie 300 miles northeast of the Curaçao group, which is near the Venezuelan coast.

Dutchman, The Flying, a phantom ship which sailors believed could often be seen about the Cape of Good Hope. The story is that a Dutch captain, Vanderdecken by name, being tossed about by adverse winds while trying to double the Cape, swore with many oaths that he would accomplish his purpose if he beat to and fro till the judgment day, and as a punishment his ship never touched land. Another version of the legend is that the Flying Dutchman is condemned to wander the seas forever because a murder was committed on board his ship.

Dutchman's Breeches. See DICENTRA.

Dutchman's Pipe, a common name for *Aristolochia macrophylla*, a plant of the birthwort family (*Aristolochiaceæ*). It has a twining stem, with very slender branches, the leaves broad and thin. The calyx tube is bent in such a manner that the flower suggests a pipe with a long stem. It grows in woods from southern Pennsylvania to Minnesota, Kansas, and Georgia. See ARISTOLOCHIA.

Dutra E Mello, Antonio Francisco, än-tō'-nē-ō frän-thēs'ko doo'trē ā mĕl'lō, Brazilian poet: b. Rio Janeiro 8 Aug. 1823; d. 22 Feb. 1843. His verses are considered among the best of South American poetry. Among his choicest works are: 'A'noite Inspiracão Poetica'; 'A'noite de S. Toão'; and 'Historia Critica da Lingua Latina.'

Dutt, doot, **Romesh Chunder,** East Indian scholar and civil servant: b. Calcutta 13 Aug. 1848. He was educated at Presidency College, Calcutta, and University College, London, at which latter institution he is lecturer on Indian History. He joined the Indian civil service in 1871, becoming a divisional commissioner in 1894, the first native of India to attain that position. In 1892 he was decorated for ability as an administrator, and his literary researches. Beside a series of novels in Bengali, and translations of the 'Rig Veda,' etc., into Bengali, he has published in English: 'Civilization in Ancient India'; 'Lays of Ancient India'; 'Mahabharata,' condensed into English verse; 'Ramayana,' condensed into English verse; 'England and India, 1875–85); 'Famines in India'; 'Economic History of British India'; 'Lake of Palms: a story of Indian domestic Life.'

Dutt, Toru, Hindu poet: b. 1856; d. 1877. She received a good European education, and translated into English many French poems — from Béranger, Gautier, Coppée, etc. A collection of these was published as 'A Sheaf Gleaned in French Fields' (1876). She also rendered into English some of the 'Ancient Ballads of Hindustan.' She wrote in French a story: 'Miss d'Arvers' Diary.'

Dutteeah, doot'tē-ä, **Dattiya,** or **Datia,** India, city, capital of a State of the same name, in the Bundelkhand Agency, on the route from Agra to Saugor, 110 miles southeast of Agra. The rajah's palace is situated within a pleasure ground of about 10 acres, inclosed by a lofty wall, with embattled towers at each of its four corners. A few miles distant are Jainas temples. (See JAINAS.) Pop. 27,566.

Dutton, Clarence Edward, American soldier and geologist: b. Wallingford, Conn., 15 May 1841. He was graduated at Yale in 1860, and two years afterward became captain of the 21st Connecticut Volunteers. He received a commission as second lieutenant in the United States army in 1863, and was promoted to the rank of major in 1890. In 1875 he joined Maj. J. W. Powell in the United States survey of the Rocky Mountain region; in 1879–80 was secretary of the United States land system committee, and from 1880 to 1891 was a member of the United States Geological Survey. He was elected a member of the National Academy of Sciences in 1884. His writings embrace the subjects of metallurgy, gunnery, and geology, to which last he has devoted his main literary attention. His most important geologic works are: 'Geology of the High Plateaus of Utah' (1880); 'Tertiary History of the Grand Cañon District' (1882); 'Hawaiian Volcanoes' (1884); 'Mount Taylor and the Zuni Plateau' (1886); 'Earthquakes' (1904).

Dutton, Edward Payson, American publisher: b. Keene, N. H., 1 Jan. 1831. He was educated at the Boston Latin School, entered the book business, and was a member of the Boston firm of Ide & Dutton, 1852–8. Having acquired the publishing interests of Ticknor & Fields, and of the General Protestant Episcopal Sunday-School Union & Church Book Society of New York, he consolidated the enterprises and founded the New York firm of E. P. Dutton & Co.

Dutton, Henry, American jurist: b. Plymouth, Conn., 12 Feb. 1796; d. New Haven, Conn., 12 April 1869. He was graduated at Yale in 1818, and became professor of law in the same university in 1847, occupying this position for 8 years, and in 1854 was elected governor of Connecticut. He was judge of the superior court, and court of errors 1861–6, and prepared many digests and compilations of State statutes, which are of permanent value to his profession.

Dutton, Samuel Train, American educator: b. Hillsboro, N. H., 16 Oct. 1849. He was graduated at Yale, 1873, and was superintendent of schools in Brookline, Mass., 1890–1900. He was a lecturer on pedagogy at Harvard, 1895–7; Chicago University, 1897; Vassar College, 1897–8; and Boston University, 1898. In 1900 he was appointed professor of school administration, and superintendent of Teachers' College School, in connection with the Teachers' College of Columbia University. He has written: 'Social Phases of Education,' and several school text-books.

Duty, a tax or impost levied upon imports and frequently upon exports. In the United States duty payment is in the nature of a tariff levy, and is determined largely by the appraised value of the dutiable article itself. The list of dutiable articles is very large in the United States, France, Germany, and Russia. It is small in England. Merchants who have occasion to pay duty usually enlist the services of a custom-house broker, who is charged with the protection of his client's interests. Duty payments to the United States may in certain cases be deferred, the imported articles being held in bonded warehouses by the government. The stamp duty is a well-known tax in Great Britain. At the close of the Civil War and for a short time after the Spanish-American war, the United States levied a duty to meet war indebtedness by taxing medicines, matches, and other proprietary articles. See CUSTOMS DUTIES; STAMP TAX; TARIFF; etc.

Duumvirs, dū-ŭm'vėrs, among the ancient Romans, two magistrates, or officers, appointed for a particular purpose. They were therefore of various sorts, and were specially named from the nature of their functions. The *duumviri iure dicundo* were the highest magistrates of colonies, and towns, where they had the rank of consuls at Rome. The *duumviri navales* had charge of the construction and equipping, and sometimes of the command of fleets. The *duumviri quinquennales* were the censors of municipal towns.

Duval, dü-väl, **Alexandre,** French dramatist: b. Rennes 6 April 1767; d. Paris 10 Jan. 1842. He served in the French fleet during the American Revolutionary War, and on his return to France was an engineer and architect; but finally devoted himself to writing plays, which won great favor from their skilful construction, interesting situations, and fine dialogue. The best are: 'Edward in Scotland' (1802); 'The Domestic Tyrant' (1805); 'The Youth of Henry Fourth' (1806); 'The Chevalier of Industry' (1809). He wrote the text of the very successful opera, 'Joseph in Egypt' (1807).

Duval, Claude, English highwayman: b. Domfront, Normandy, 1643; d. London 21 Jan. 1670. He went to England at the Restoration, in the train of the Duke of Richmond. Taking soon to the road, he robbed many gentlemen of their purses, and ladies of their hearts, till, having been captured while drunk, he was hanged at Tyburn, and was buried in the central aisle of Covent Garden Church.

Duveneck, dū'vĕn-ĕk, **Frank,** American artist: b. Covington, Ky., 1848. He began his artistic education as pupil in the studio of Dietz, at Munich, making a specialty of portraits and genre. Many of his pictures are in this country, although he has lived much abroad, and since 1881 has taught and painted at Florence, Italy. He was awarded a medal at the Columbian Exposition of 1893.

Duvergier de Hauranne, Jean, zhŏṅ doo-vĕr-zhē-ā dė ō-rän, French theologian: b. Bayonne 1581; d. Paris 11 Oct. 1643. At the University of Louvain, where he studied theology, one of his fellow students, and his most intimate friend, was Cornelius Jansen (q.v.), after whom a certain system of theological views is named — «Jansenism.» The two friends, after both had left the university, continued their intimate relations, first at Paris, then at Bayonne, where Duvergier had been appointed to a prebend. When Jansen left Bayonne Duvergier resigned his prebend, and went back to Paris. All this time the two men had diligently been studying the ancient fathers of the Church, and in particular St. Augustin, from whom Jansen claimed to have drawn his doctrine of Divine Grace. In Paris Duvergier's winning personality and his reputation for austere views of religious and moral obligations, commended him to the favor of the bishop of Poictiers, who gave up to him the monastery, or abbey, of St. Cyran, and there Duvergier, having brought together a number of devout men, formed them into a convent of monks, under the ancient, unamended rule of St. Benedict. But his zeal for reform of the monastic life was suspected of being inspired by a secret hostility to the Church and the Church's rulers, and Duvergier was compelled to retire from St. Cyran, whence he returned to Paris. There he was received with great favor by the highest society, especially the feminine element, and in particular he became the trusted counsellor of Angelique Arnauld, abbess of Port Royal, and all the members of the remarkable Arnauld family, those staunch defenders of Jansenism (see ARNAULD). A sect was formed and Cardinal Richelieu had strong suspicions that the Abbé of St. Cyran was leader in a conspiracy against Church and state; so he was arrested by order of the cardinal, and committed to the Castle of Vincennes 14 March 1638, where he was held in close confinement as long as Richelieu lived, or till December 1642; and he survived his liberation only a few months.

Duvergier de Hauranne, dü-vĕr-zhē-ā dė ō-rän, **Prosper,** French publicist: b. Rouen 3 Aug. 1798; d. Paris 22 May 1881. He went to London, and became in 1824 a constant contributor to the *Globe*. He was elected deputy from Sancerre, and in the national assembly he supported Casimir-Perier, and Thiers, while opposing Guizot, who had been his friend and associate on the *Globe*. After the *coup d' etat* of Napoleon III. he was imprisoned for a while, and eventually sentenced to banishment, but was subsequently allowed to return to Paris. He became a member of the Academy in 1870 and among the works which won him reputation is to be mentioned 'Histoire du gouvernement parlementaire en France' (10 vols., 1857–70).

Duvernoy, Georges Louis, zhŏrzh loo-ē dü-ver-nwä, French naturalist: b. Montbéliard 6 Aug. 1777; d. Paris 1 March 1855. In 1802 he was invited by Cuvier, to whom he was related, to assist in editing his treatise on comparative anatomy. With the aid of the notes and counsels of his master, he prepared the last three volumes of this work, embracing the organs of digestion, respiration, circulation, generation, and the secretions. In 1827 he was elected professor of the faculty of sciences at Strasbourg, where, during 10 years, he published a variety of papers on anatomical subjects; and after the death of Cuvier was engaged in arranging his papers for publication. In 1837 he was elected professor of natural history in the College of France. He published numerous works, which have furnished important materials to anatomists and zoologists.

Duyckinck, dī'kĭnk, **Evert Augustus,** American author: b. New York 23 Nov. 1816; d. there 13 Aug. 1878. Graduating from Columbia College, he studied law, was admitted to the bar in 1837, and went to Europe for a year, after which he devoted himself to literature, in which he was fertile and successful. With his brother, George, he prepared the 'Cyclopædia of American Literature' (1855; enlarged eds. 1865 and 1875). He was a voluminous and successful writer, and added much to the literature of his time. His last work was the preparation, with William Cullen Bryant, of an edition of Shakespeare.

Duyckinck, George Long, American author: b. New York 17 Oct. 1823; d. there 30 March 1863. He was a brother of E. A. Duyckinck (q.v.), and with him prepared the 'Cyclopædia of American Literature.' He was also the author of 'George Herbert of Bemerton' (1858); and 'Life of Bishop Thomas Ken' (1859).

Duzine (derived from the Dutch «dozijn»), or THE TWELVE MEN, the twelve patentees in 1677 of the Huguenot settlement on the Walkill, now in Ulster County, N. Y., and known as New Paltz (New Palatinate) from their German refuge after escaping from France. The «duzine» and their successors were the executive and legislative body of the settlement during a century.

Dvorák, Antonin, än'tōn-ĭn dvōr'zhäk, Bohemian composer: b. Mühlhausen, Bohemia, 8 Sept. 1841; d. Prague, Bohemia, 1 May 1904. At first intended for his father's trade of butcher, he showed such musical ability that he was allowed to study the organ. For a time he played the tenor violin in a theatre orchestra in Prague, and was also organist for several churches. In 1873 he first made himself known as a composer by a patriotic hymn for chorus and orchestra, and not long afterward an opera of his was successfully produced. His first great success was his setting of the 'Stabat Mater,' first performed in England in 1883, which at once raised him to the rank of a popular and widely-known composer. Among his subsequent works are songs, operas, dances, symphonies, a wonderful cantata, 'The Spectre's Bride,' first performed at Birmingham in 1885, the composer himself acting as conductor, and an oratoria, 'St. Ludmilla,' first performed at Leeds in 1886 under his own direction. Dvorák is characterized by a brilliant imagination, great originality, and a rare inventive power. His 'Stabat Mater,' which betrays less of the Bohemian nationality than many of his other works, is regarded as one of the greatest works of its kind in modern music. In 1892 he was called to New York as director of the National Conservatory of Music.

Dwarf, a human being much below the ordinary size of man. Dwarfs are described by several ancient classical writers. Herodotus gives an account of a race of dwarfs living in Libya and the Syrtes, to which Aristotle and Pliny also refer. Henry M. Stanley, in his journey across Africa in 1888, came on a dwarfish race which he thought might be descended from that mentioned by Herodotus. Philetas of Cos, distinguished about 330 B.C. as a poet and grammarian, was jocularly said to have carried weights to prevent his being blown away. He was preceptor to Ptolemy Philadelphus. Julia, niece of Augustus, had a dwarf named Coropas, two feet and a hand's breadth high; and Andromeda, a freemaid of Julia's, was of the same height. The best known of modern dwarfs was Charles S. Stratton, or, as he was popularly called, «Tom Thumb,» who was 31 inches high at the age of 25. He was born in Bridgeport, Conn., and traveled extensively abroad and at home under the management of P. T. Barnum. Wherever he went he attracted great attention, even from such personages as Queen Victoria and Napoleon III. Another modern dwarf was Francis Flynn, «Gen. Mite,» who was 21 inches in height at 16 years.

In Scandinavian mythology dwarfs (*Dvergar*) are inhabitants of the interior of the earth, and especially of large isolated rocks. They were imagined to be dark in aspect like the caverns in which they dwelt, and were often styled «dark elves.» A dwarf was set by the gods at the corner of each of the four quarters of the earth to bear up the sky; and they were named East, West, North, and South. All the dwarfs were esteemed great artists in working metals, and weapons of marvelous properties were said to be produced from their subterranean workshops. Like the Jotuns, they could not endure the sunlight, and if its rays touched them they were turned into stone. If a man met a dwarf away from his rock, and could throw steel between him and it, it was believed that thereby his habitation was closed up, and that any thing in his power could be extorted from him. In the old Norse, echo is called the «dwarf language,» probably because it was thought to be produced by the dwarfs within mountains imitating the sounds which they heard without.

Dwarf Snake, a common name for small snakes of many genera, given in the United States to species of the genus *Carphiophiops*, which are found in the South in old logs. They are brown above and yellow or salmon below. The name is also applied to a pretty little snake of the genus *Haldea*, small and slender with coloring similar to the dwarf snakes of the first genus, but with a dark brown band across the head. It destroys insects and is harmless.

Dwarfed Trees, a favorite ornament for dwellings among the Japanese and Chinese, who adopt a peculiar method of dwarfing. They choose some fruit- or flower-bearing branch of any tree of which they wish to produce a dwarf specimen, and cutting off a ring of the bark, surround the stripped part with clay, which they keep moist by means of a covering of moss, which is watered when it becomes dry. After a period, varying in different trees from about 3 months to 2 years, roots are sent out by the branch into the clay. The branch is then cut off below these artificial roots, and planted in a poor soil, where it is kept scantily supplied with water. In this state the tree will remain for years, with vitality enough to produce leaves and even flowers annually, but never producing any but abortive shoots. Another method is to plant trees in flower-pots with a shallow covering of soil, supplying them, as in the former case, very sparingly with water, and pinching off all the strongest shoots. Still another method, which is said to give good results when tried by amateurs, is to enclose a seed in a small pellet of earth which is placed in the centre of a ball of absorbent moss, then is crowded into the interior of an orange from which the pulp has been removed. The moss is liberally supplied with water until the roots appear on the outside of the orange, when they are cut off and the orange-skin covered with varnish, and placed in a flower-pot. Thereafter only enough moisture is applied to support the life of the plant.

Dwarka, dwär'kä, India, a maritime town of the district of Guzerat, on the west side of the peninsula of Kathiawar, in the dominion of Baroda, 235 miles southwest of Ahmedabad. On an eminence overhanging the seashore stands a great temple of Krishna, visited annually by 10,000 pilgrims. Dwarka is claimed as the birthplace of Krishna. Pop. 5,121.

Dwight, Benjamin Woodbridge, American educator and author: b. New Haven, Conn., 5 April 1816; d. in 1889. He was graduated at Hamilton College, New York, in 1835, and became a teacher, being engaged, during a large part of his life, as principal and proprietor of a school in Brooklyn and New York, in preparing boys for college. Among his works are: 'The Higher Christian Education' (1859); 'Modern Philology' (1864); and 'The True Doctrine of Divine Providence.'

Dwight, Edmund, American merchant: b. Springfield, Mass., 1780; d. 1849. He was graduated at Yale in 1799, and became the head of a flourishing business at Chicopee, and Holyoke. He was one of the main agents in establishing the Massachusetts State Board of Education, and the normal school system of the State.

Dwight, Francis, American educator: b. Massachusetts 14 March 1808; d. 15 Dec. 1845. He was graduated at Harvard College in 1827 and at the Law School in 1830; traveled extensively in Europe, and afterward practised law (1834–8), but in 1838 turned his whole attention to the promotion of common school education in our country, and established at Albany, N. Y., in 1840, 'The District School Journal,' under State patronage.

Dwight, Harrison Gray Otis, American missionary: b. Conway, Mass., 22 Nov. 1803; d. Shaftesbury, Vt., 25 Jan. 1862. He was graduated at Hamilton College, Clinton, N. Y., 1825, and became a missionary of the American Board of Commissioners for Foreign Missions in 1830, to the Armenians, making Constantinople the centre of his field of operations. He was abundant in his labors, and met with great success in his work. He wrote 'Researches of Smith and Dwight in Armenia,' and 'Christianity Revived in the East' (1850).

Dwight, John Sullivan, American musical critic: b. Boston 13 May 1813; d. Boston 5 Sept. 1893. After two years in the Unitarian ministry he became one of the founders of Brook Farm and was editor of its organ, the 'Harbinger.' In 1852 he established 'Dwight's Journal of Music,' in which appeared most of his scholarly musical criticisms. His best-known poem is 'God Save the State.' See Cooke, 'Biography of John S. Dwight' (1898).

Dwight, Joseph, American soldier: b. Hatfield, Mass., 16 Oct. 1703; d. Great Barrington 19 June 1765. He graduated at Harvard University in 1722; became judge of the court of common pleas of Hampshire County, Mass., and afterward of Berkshire County, and judge of probate. He was eminent both as a judge and a soldier. He commanded the Massachusetts artillery at the reduction of Louisburg in 1745 with distinction, and led a brigade at Lake Champlain in the second French War in 1756. He was also for 11 years a member of the general council of Massachusetts.

Dwight, Nathaniel, American educator: b. Northampton, Mass., 31 Jan. 1770; d. 11 June 1831. He was a brother of Timothy Dwight the elder (q.v.) He prepared and published the first school geography ever issued in the United States, and was also the author of 'The Great Question Answered,' and 'A Compendious History of the Signers of the Declaration of Independence.'

Dwight, Sereno Edwards, American Congregational clergyman: b. Greenfield Hill, Conn., 18 May 1786; d. Philadelphia, Pa., 30 Nov. 1850. He was a son of Timothy Dwight (1752–1817). He was graduated at Yale 1803, and practised law in New Haven until 1816, when he entered upon a clerical career. He preached in Park Street Church, Boston 1817–26, and was president of Hamilton College, Clinton, N. Y., 1833–5. Among other works he published: 'The complete writings of Jonathan Edwards with a Memoir' (10 volumes 1830).

Dwight, Theodore, American journalist: b. Northampton, Mass., 15 Dec. 1764; d. New York 12 June 1846. He was a brother of Timothy Dwight, the elder. He was a well-known Federalist, a member of Congress, and wrote 'History of the Hartford Convention' (of 1814), and 'Character of Thomas Jefferson.'

Dwight, Theodore, American writer: b. Hartford, Conn., 3 March 1796; d. Brooklyn, N. Y., 16 Oct. 1866. He was a son of the preceding. He wrote: 'Tour of Italy' (1824); 'Summer Tour in New England'; 'The Northern Traveler'; 'The Kansas War' (1859); 'Life of Garibaldi' (1859); besides gazetteers, histories, and school books.

Dwight, Theodore William, American educator, jurist, and editor: b. Catskill, N. Y., 18 July 1822; d. Clinton, N. Y., 28 June 1892. He was educated at Hamilton College, and was professor of law there and subsequently in Columbia College, in each of which he founded a law school. He was elected (non-resident) professor of constitutional law in Cornell University in 1868. He was interested in philanthropic work, and served as president of the New York Prison Association, vice-president of the New York Board of State Commissioners of Public Charities, and as a member of the "Committee of Seventy," of New York. In collaboration with E. C. Wines he published 'Prisons and Reformatories in the United States,' and was associate editor of the 'American Law Register.'

Dwight, Timothy, American Congregational clergyman: b. Northampton, Mass., 14 May 1752; d. New Haven, Conn., 11 Jan. 1817. In 1769 he was graduated at Yale College, and in 1771 became a tutor there. In 1783 he was ordained as minister at Fairfield, Conn., where he opened an academy. In 1795 he was elected president of Yale College, and he also held the professorship of theology. His chief works are: 'The Conquest of Canaan,' and epic poem (1785); 'Theology Explained and Defended, in a Series of Sermons' (1818); 'Travels in New England and New York' (1821). Consult: Sprague, 'Life of Timothy Dwight,' in Spark's 'American Biography.'

Dwight, Timothy, American Congregational clergyman: b. Norwich, Conn., 16 Nov. 1828. He is a grandson of Timothy Dwight (1752–1817). He became professor of sacred literature at Yale Divinity School in 1858, and was president of Yale University from 1886 till 1898, when he resigned. He was one of the members of the New Testament Revision Committee. He published 'The True Ideal of an American University.'

Dwight, William Buck, American geologist: b. Constantinople, Turkey, 22 May 1833; d. Cottage City, Mass., 29 Aug. 1906. He was graduated at Yale in 1854, at the Union Theological Seminary, New York, in 1857, and at the Yale Scientific School in 1859. He filled several educational posts in a scientific capacity, and from 1878 till his death has been professor of natural history and curator of the museum at Vassar College. In 1891 he invented and patented a rock-slicing machine for the scientific section of minerals, for which he was awarded a bronze medal at the Paris Exposition of 1900.

Dwina, dwē'nä, **Dvina,** or **Northern Dwina,** a river of Northern Russia, formed by the union of the Sukhona and Witchegda Rivers, in the government of Vologda. It flows northwest and enters Dwina Bay, an arm of the White Sea, about 25 miles below Archangel. The whole course, from the source of the Witchegda, is over 1,000 miles. Canals connect the Dwina with the Volga and the Neva.

Dyaks, dī'äks, or **Dayaks,** the name of the natives of Borneo. They are divided into innumerable tribes differing pretty widely in language, customs, and degrees of savageness. Physically they closely resemble the Malays, to whom they are doubtless akin, but are somewhat taller; they are intelligent, hospitable, and unsuspicious, and greatly excel the Malays in truthfulness and honesty. Many of the dialects spoken by them are little known. The coast tribes have adopted many Malay words, and some have completely adopted the Malay speech. Even the most uncivilized tribes have many ingenious arts and industries, weave cloth, make excellent steel weapons, and erect most serviceable suspension bridges with bamboo poles and withes. Their chief weapon is the blowpipe, not the bow. The barbarous custom of systematic head-hunting is dying out, though the heads of enemies are still cherished trophies of the warrior. See BORNEO.

Dyce, Alexander, English Shakespearian scholar: b. Edinburgh 30 June 1798; d. London 15 May 1869. He was educated at Exeter College, Oxford; and, taking orders, held several curacies prior to 1827, when he settled in London, where the most of his life was passed. He was first brought to notice by his 'Specimens of the British Poetesses' (1825), which was followed by editions of Collins (1827), George Peele (1828), Webster (1830), Robert Greene (1831), Middleton (1840), Beaumont and Fletcher (1843–46), Marlowe (1850), Shirley (1833), Skelton (1843), Wotton, and Drayton, all of which were accompanied by notes and biographies of the authors. In 1840 he founded, in conjunction with Collier, Halliwell, and Wright, the Percy Society, for the publication of ancient comedies and ballads. His chief labors, however, were devoted to Shakespeare, an edition of whose works he published in 1857; second edition, greatly improved, nine volumes (1864–67). In his 'Remarks on Collier's and Knight's Editions of Shakespeare' (1844); he pointed out several errors into which the modern commentators on Shakespeare had fallen; and in another work, entitled 'A Few Notes on Shakespeare' (1853), he pronounced very strongly against the emendations of the text of Shakespeare published by Collier, and maintained by him to belong to the first half of the 17th century.

Dyce, William, Scottish painter: b. Aberdeen 19 Sept. 1806; d. Streatham 14 Feb. 1864. In 1830 he settled at Edinburgh, where he soon became known as a portrait-painter and as a distinguished contributor to the exhibition of the Royal Scottish Academy. In 1827 he had exhibited at the Royal Academy his 'Bacchus nursed by the Nymphs.' About 1837 he settled in London. In 1836 he exhibited 'The Descent of Venus,' the subject of which was taken from Ben Jonson's 'Triumph of Love'; and in 1839 'St. Dunstan separating Edwy and Elgiva.' When the decoration of the interior of the new houses of Parliament was made a subject of competition Dyce exhibited his talents in a new light, namely, as a painter in fresco. His first fresco, 'The Consecration of Archbishop Parker,' was executed in Lambeth Palace, and was followed by 'The Baptism of Ethelbert,' in the House of Lords (1846). In 1848 he was commissioned to paint a series of seven frescoes in the House of Lords, but he only lived to complete five. Among his other pictures are: 'Joash Shooting the Arrow of Deliverance' (1844); 'Virgin and Child' (1846); 'Omnia Vanitas' (1849); 'Meeting of Jacob and Rachel' (1850); 'King Lear and the Fool in the Storm' (1851); and 'John Leading Home the Virgin' (1860).

Dyea, dī'ā, Alaska, an unimportant village, which was, however, important during the gold-rush, as being the starting-point of the Chilkoot Trail, a much traveled pathway to the valley of the Yukon, and the Klondike fields. The building of a railroad from Skagway (q.v.) reduced Dyea to its present insignificance. The census of 1900 gives the place less than 300 population.

Dyeing. Dyeing is the art of staining or coloring yarn or cloth. It has been practised among the eastern nations from time immemorial, and in the sacred writings, we read of the vestments of the high priest being dyed purple, and of linen cloths being dyed blue, purple, and scarlet. The famous Tyrian purple is supposed to have been discovered by the inhabitants of Tyre 1500 B.C., and immediately afterward Tyrian purple became the badge of royalty, and cloth dyed with it commanded a very high price. The Egyptians, Grecians, and Romans practised the art of dyeing, and it gradually became more widespread as civilization advanced. In earlier times dyeing was much more extensively followed as a domestic art than at present.

If the various coloring matters used in dyeing had an affinity for the fibre in its natural state, the process would be very simple. It would only be necessary to make a solution of the dye drug and immerse the goods to insure their being dyed. But so far from this being the case, if we except indigo and safflower, there is scarcely a dyestuff that imparts its color to goods. The greater part of the dye drugs have so weak an affinity, for cotton goods especially, that they impart no color sufficiently permanent to deserve the name of a dye. The cause of this is obvious. If, for example, we take a decoction of logwood, the color matter is held in solution by the water. By putting a quantity of cotton into this solution, the fibre becomes filled with the colored solution, and if the cotton has no power to render that coloring matter insoluble within its fibres, it is plain that by taking out the cotton and putting it into water, the coloring matter within it will be diffused in the water. In other words, the dye having no attraction for the fibre, is washed out. This primary want of affinity makes dyeing sufficiently intricate and renders it more dependent upon science. Indeed, it is only by the careful arrangement of a few chemical laws, that the dyer is enabled to turn to advantage the various coloring matters of which he is in possession. When the dyer finds there is no affinity between the goods and any coloring substance which is put into his possession, he endeavors to find a third substance, which has a mutual attraction for the cloth and coloring matter, so that by combining these substances with the cloth and then passing the cloth through the dyeing solution, the coloring matter combines with the substance which is upon the goods and constitutes a dye. This third substance used, which acts as a mediator, combining two inimical bodies, is termed a mordant, from the French *mordre*, to bite, from an idea which the old dyers had that these substances bit or opened a passage into the fibres of the cloth, giving access to the color. Although the theory of their action is now changed, the term is still continued, and perhaps farther investigation will prove the term applicable.

All the mordants with one or two exceptions are found among the metallic oxides. In order that a substance may act as a mordant, it must possess certain properties. It must have an attraction for the coloring matter so as to form with it an insoluble colored compound and it must be held easily in solution. It may also have an affinity for the fibre and a tendency to unite with it, but this property is not essentially necessary; only the first two properties are so, and they limit the mordants almost entirely to what are termed the insoluble bases, that is substances which are not by themselves soluble in water. The bases or oxides, which are in general use as mordants, and which appear to succeed best are alumina and the oxides of tin and iron. The first two are colorless and the peroxide of the latter is a light brown and imparts to white goods the buff or nankeen color which in many cases affects to a considerable extent the color of the cloth, a circumstance which must also be attended to by the dyer. Indeed, the principal part of all dyeing operations is the proper choice and application of mordants; there being a chemical union between them and the coloring matter, a new substance is formed, not only differing in properties, but differing in color from any of the originals. Consequently, a very little alteration in the strength or quality of a mordant causes a decided alteration in the shade of color. However, it gives the dyer a much wider field for variety of shades, and, at the same time, a less number of color substances are required. As, for example, logwood alone gives no color to cotton worthy the name of a dye, yet by judicious application of a few different kinds of mordants, all the shades from a French white to a violet, from a lavender to a purple, from a blue to a lilac, and from a slate to a black, are obtained from this substance. Before any chemical union takes place between bodies, they must not only be in contact, but they must be reduced to their ultimate molecules. Mordants that are insoluble of themselves, must be dissolved in some appropriate menstrua before their particles can enter the fibres of the goods or combine with the coloring matter. In doing this the dyer must attend to the degree of affinity between the solvent and the mordant to determine what force it will exert against the mordant combining with the fibres of the cloth should there exist an affinity between them. Otherwise, a powerful mordant may be weakened by the attraction of the solvent, as for example, common alum even though much concentrated, is but a weak mordant for cotton goods owing to the great attraction between the sulphuric acid and the alumina, but if the acetic acid, which has comparatively a weak affinity for the alumina, be substituted for sulphuric acid, it becomes a very powerful mordant.

It is with the vegetable coloring matters, however, that the greatest attention must be paid to the many conditions and properties of mordants. Bi-chromate of potash is largely used as a mordant for logwood and fustic for blues, blacks, browns, and a variety of shades of color. Bi-chromate of potash, alum, and oxalic acid as mordant on wool produce with logwood a very fine navy blue, but one that is not very fast to light. Sulphate of copper is used largely as a mordant with logwood for making black on cotton. These mordants are used almost exclusively for the wool dyes. In dyeing wool either raw, woven, or as yarn, care has to be taken that the wool is thoroughly free from grease before being mordanted. This is done by passing it through either soap, sal soda, or soda ash, and then thoroughly rinsing to free it from the alkali solution. If this is not done, unevenness in the dyeing is caused as well as a rubbing off of the color. When the dyer is given a shade to match he has to take into consideration the amount of fastness required, as where goods have to be heavily fulled, unless the colors are sufficiently fast, they will full out and be spoiled. In this case only such dyes can be used as will stand this process. The quantity of dye to be used depends on the class of wool to be dyed, as the finer the quality of the wool, the more dyestuff it takes to produce the same shade. The dyer also has to study to produce the result at the lowest possible cost, both for labor and dyestuff. Machines are now manufactured which economize in the labor and a large quantity of the goods are dyed at one time. It would be generally supposed that where the dyer carefully proportioned out his dyestuff to the weight of the material to be dyed, and observed every care in reference to the mordant and heat, that the shades would come out alike. However, this is not the case, and with the greatest amount of care the shades will vary and it is necessary to use extra skill after the shades get off the pattern to bring them again to the shade required. The dyer, knowing full well that owing to difference in the water and the stock in the goods, besides conditions that are not always understood, that the shade is apt to vary, goes light on the dyestuff and when he finds that he is not up to the shade required, he adds such dyestuff as is necessary to give the desired result. In fact, making the shade right when it is once off the pattern requires the very best efforts and skill on the part of the dyer. The dyeing of wool is a chemical combination. On the other hand, the dyeing of cotton is a fixation of the color in the pores of the cotton. Cotton is dyed in the raw state, pieces, and yarns, and the amount of dye used to produce a given shade also varies somewhat according to the quality of the staple. In using colors requiring a mordant, sumac and antimony are used, and the amount employed is governed by the depth of the shade required.

Dyeing of Mixed Fabrics.— The coloration of textile fabrics composed of more than one kind of material generally requires two or more processes, as the plan pursued in dyeing wool is seldom capable of fixing the color upon cotton. The customary plan followed is to immerse the fabric in the requisite baths to dye the wool and then to treat the partially dyed material in the manner found suitable for cotton. Occasionally the woolen thread of the cloth is dyed of one color, and thereafter the cotton is treated so as to acquire a different shade or color. With the coal tar colors recently brought out, mixed fabrics can be dyed in one bath, thus saving much time. The dyer is now able to produce, by combination of the different colors, a great variety of rich shades on mixed fabrics, and even to dye two shades in the same fabric, by first dyeing the wool with an acid dye, then cooling down his bath and adding his cotton dye, and dyeing the cotton another shade from what was produced on the wool. In dyeing silk, care has to be taken to free the silk from all gums, and this is done by boiling off in a soap bath. Most of the dyeing is done direct and under the boil.

In communicating the deep indigo blue to woolen cloth and yarn a vat is taken about six or seven feet in diameter, and eight to nine feet in depth, and nearly filled with water, along with from 18 to 22 pounds of indigo, finely ground in water, 10 to 20 pounds of madder, 7 to 9 pounds of bran, and 9 pounds woad. After the requisite boiling, and the addition of seven or eight pounds lime to form an alkaline liquid, in which the indigo can be held in solution, the whole is well closed over with tightly fitting wooden covers. Within 24 hours the putrid fermentation of the woad and bran proceeds the result of which is to abstract the oxygen from the blue indigo, the color of which is greatly reduced, until it assumes a yellowish color, and the solution then contains indigo white. If woolen cloth or yarn, is now dipped in this liquid, it comes out of a yellow tint from the attachment of the white indigo solution. But when exposed to the air, the oxygen immediately begins to act on the white indigo, combining with it so as to form oxidized or blue indigo, and as the process of oxidation proceeds, the yarn or cloth becomes first of a greenish and then of a blue color. If the cloth be again soaked in the yellowish solution, and subsequently exposed to the air, the depth of the blue color may be increased, step by step, till it arrives at that deep shade of blue so well known.

In the dyeing of cotton with indigo the vat is prepared differently. The indigo is first ground into a thin paste with water, and afterward placed in a vat with protosulphate of iron and milk of lime. The lime (CaO) takes the sulphuric acid (SO_3) from the sulphate of iron ($FeOSO_3$) forming sulphate of lime ($CaOSO_3$), and liberating the protoxide of iron (FEO), which immediately abstracts the oxygen from the blue indigo, reducing it to white indigo and the latter dissolves in the excess of lime present in the vat, yielding a colorless solution. When cotton cloth or yarn is dipped in this it comes out of the vat almost colorless, but on exposure to the air, the indigo becomes reoxidized and the cloth passes to a green and ultimately to a deep blue shade. The cloth or yarn is then washed in water and afterward soaked in a very dilute sulphuric acid to remove any oxide of iron remaining attached and rewashed in water, when the blue color becomes more bright and clear. Fast fulling colors dyed either in the wool yarns or pieces, are usually dyed with the alizarine colors on account of their being fast to fulling and light. These are usually mordanted with bi-chromate of potash and cream tartar for one and a half hours at a boil. Then they are thoroughly rinsed in cold water and finished in another bath with the alizarine colors. Owing to the great affinity existing between the alizarine colors and the mordanted wool, great care has to be taken to enter the bath at a low temperature and very gradually bring to the boil to insure the goods being dyed even. Extra care must also be taken that only the amount of the alizarine necessary is added to produce the shade. Cotton is now largely dyed direct. Formerly dyers were obliged to give a number of baths and even then were not able in a great many cases, to secure the brilliant shades that are now dyed in one operation. The color simply being fixed in the pores of the cotton, it is more difficult to secure a fast color on this fibre than on wool. As in the case of wool, dyeing machines are now manufactured by which the cotton is dyed both in the raw state, yarns, and pieces, which economize in the labor and enable the dyer to produce better results both as to shade and fastness. During the last few years, there has been a large addition to the coal tar dyes, thus giving cotton dyers a much better opportunity to produce brighter and faster colors. Some of these are dyed direct, and thus making a great saving of labor, besides some are very fast both to light and washing.

The yarns for carpets are dyed almost exclusively with the coal tar dyes. This is done mostly in the yarn, and are dyed direct by entering them in the dye bath, which has previously had added the color, with the proper proportion of sulphuric acid and glaubersalt, and gradually brought to the boil, being turned by hand. The bath is generally exhausted in about three quarters of an hour. The yarns furnished the dyer are frequently of a mixed material which is dark in color and in this case, he must choose the very brightest of dyes to give the required brightness of shade. For the finer grades of carpets, the color must thoroughly penetrate and in matching shades the dyer usually cuts his yarn and matches from the centre. F. H. Prescott.

Expert in Dyes and Dyeing, Philadelphia.

Dyer, dī'ėr, **Alexander Brydie,** American soldier: b. Richmond, Va., 1817; d. 1874. He was graduated at West Point, and joined the Third United States Artillery in 1837. He served in the Florida War of 1846, and was brevetted captain for gallant conduct. During the Civil War he was appointed chief of ordnance at Washington with the rank of brigadier general. In 1865 he was brevetted major general in the regular army.

Dyer, Sir **Edward,** English poet and courtier: b. Sharpham Park, Somersetshire; d. in London May 1607. An elegant courtier, he advanced himself in royal favor by court verse and was knighted in 1596. He will be longest remembered by his poem, 'My Mind to Me a Kingdom Is.' His works, 'The Shepherd's Conceit of Prometheus' and other poems, were not collected until 1872.

Dyer, Eliph'alet, American jurist: b. Windham, Conn., 28 Sept. 1721; d. there 13 May 1807. He was graduated at Yale College in 1840 and began law practice in 1745. During the French War of 1755 he commanded a Connecticut regiment; was elected a member of council in 1762; chosen delegate to the Stamp Act Congress in 1765, and served as a member of Congress during the War of Independence.

Dyer, George, English antiquary and scholar: b. London 15 March 1755; d. there 2 March 1841. He was educated at Cambridge, and from 1792 till his death lived by literary work in London. He edited 'Valpy's Classics' and among other writings, published a 'History of the University and Colleges of Cambridge' (1814). Talfourd refers to his "simplicity of nature, not only unspotted by the world, but almost abstracted from it," and speaks of him as "breathing out at the age of 85 the most blameless of lives, which began in a struggle to end in a learned dream."

Dyer, John, English poet: b. Aberglasney, Carmarthenshire, Wales, 1700; d. 24 July 1758. He was originally a painter and his sense of beauty in scenery is shown in his 'Grongar Hill,' a poem published in 1727. He took holy orders in 1740, and received the living of Calthorpe, Leicestershire, in 1841, but eventually settled in Lincolnshire. He published 'Ruins of Rome' (1840); and 'The Fleece' (1857), by which latter poem he is best known.

Dyer, Louis, American writer and lecturer: b. Chicago 30 Sept. 1851. He was educated in early years in Chicago, Switzerland and France, was graduated from Harvard in 1874; and afterward studied at Balliol College, Oxford. He was assistant professor of Greek at Harvard (1881–87), and settled at Oxford in 1890, where he was lecturer at Balliol College (1893–96). He has lectured before the principal colleges of this country and published among other works 'Studies of the Gods in Greece at Certain Sanctuaries Recently Excavated' (1891).

Dyer, or **Dyar, Mary,** American martyr: d. Boston 1 June 1660. She was a victim to the persecution which befell the Quakers in the early history of Massachusetts. The government of Massachusetts by a statute excluded Quakers from the bounds of that colony, and sentenced to death any one of that sect who should be guilty of a second visit there. The statute was little regarded, or rather was construed as an invitation instead of a menace, by the enthusiastic and devoted believers against whom it was directed. Mary Dyer had departed from the jurisdiction of the magistrates upon the enactment of the law, but soon after returned on purpose to offer up her life. She was arrested and sent to prison full of joy, wrote from the gaol a remonstrance in which she pronounced her persecutors disobedient and deceived, was reprieved after being led forth to execution and after the rope had been put around her neck, and was against her will conveyed out of the colony. She speedily returned, and suffered as a willing martyr, being hanged on Boston Common.

Dyer, Nehemiah Mayo, American naval officer: b. Provincetown, Mass., 1839. He enlisted in the navy in 1861 and was promoted for gallantry in the Civil War, having attained the rank of volunteer lieutenant by 1865. He rose steadily through the grades to that of captain in 1897, and took part in the battle of Manila Bay the following year; was promoted rear-admiral in 1901 and retired the same year.

Dyer, Oliver, American journalist and author: b. Porter, Niagara County, N. Y., 26 April 1824. He was educated at Genesee Wesleyan Seminary, Lima, N. Y. In 1848 he was appointed stenographic reporter to the United States Senate, afterward became a reporter on the New York *Tribune,* and an editorial writer on the New York *Sun.* In 1871 he engaged to write exclusively for the New York 'Ledger.' He was ordained minister of the New Church (Swedenborgian), in 1876, but resigned from his charge at Mount Vernon, N. Y., owing to ill health. He is the author of: 'The Wickedest Man in New York' (1868); 'Great Senators of the United States Forty Years Ago' (1889); etc.

Dyer, Sidney, American poet and prose writer: b. Cambridge, N. Y., 11 Feb. 1814. He published a volume of poems entitled 'Voices of Nature' (1850); 'Songs and Ballads' (1857); 'Great Wonders in Little Things' (1871); 'Ocean Gardens and Palaces' (1877); 'Elmdale Lyceum' (1879); etc.; also 'Psalmist for the Use of Baptist Churches.'

Dyer, Thomas Henry, English historian: b. London 4 May 1804; d. Bath 30 Jan. 1888. He traveled and studied for years to prepare a 'History of Modern Europe' (1861); 'History of the City of Rome' (1865); and 'Ancient Athens' (1873); all monuments of learning and critical insight.

Dyer, Sir **William Turner Thistleton,** English botanist: b. Westminster, London, 28 July 1843. He was educated at Oxford, and beside holding other professional posts has been director of the Royal Botanic Gardens at Kew from 1885. He has edited: 'Flora Capensis'; and 'The Flora of Central Africa'; and is joint author of 'The Flora of Middlesex' (1869).

Dyersburg, Tenn., city, county-seat of Dyer County; on the north fork of the Deer River, navigable as far as Dyersburg; on the

Illinois C. R.R., and about 80 miles northeast of Memphis. The city owns its own electric light and waterworks plants; it contains a number of manufactories, chief of which are for flour, lumber, iron products, tobacco, and cotton and woolen goods. Pop. 3,800.

Dyer's Broom; Greenweed Woadwaxen. See DYE WEED.

Dyer's-moss, a lichen, called also archil or orchil. See ARCHIL.

Dyer's Rocket, Dyer's Weed, or **Weld,** a plant (*Reseda luteola*), of the mignonette family (*Capparidaceæ*). The plant is an erect herb, sparingly branched with long, narrow spikes of greenish-yellow flowers. The plant is extensively cultivated in Europe for the beautiful yellow dye it yields, and was originally grown in American gardens for the same purpose. It now grows wild in waste places, on Long Island, and in various spots near the eastern seaboard. It is known also as weld and woad.

Dyer's Weed. See DYER'S ROCKET.

Dyes, are employed in the various processes of dyeing, and when two or more are associated together, many different shades and colors are produced. The dyeing materials are procured from the mineral, animal, and vegetable kingdoms. Logwood is brought from Jamaica and from the eastern shores of the Bay of Campeachy, and on this account it is called Jamaica and Campeachy logwood. The former is much superior to the latter, owing to its having a larger percentage of coloring matter, and being of better quality, it brings a higher price. Fustic, or yellow wood, grows spontaneously in Brazil and in several of the West India Islands, where it attains to a great height and is used for producing yellow and in combination with logwood for producing various colors both on cotton and wool. There are two kinds of fustic, and to distinguish them, one is called young fustic. It is a shrub which grows principally in Italy and the south of France, where it is cultivated for the purpose of dyeing. When cut down it is stripped of its bark and broken into small pieces in which state it is met with in commerce. Quercitron is the inner bark of a tree which grows spontaneously in North America. Its dyeing properties were first made known to the public by Bancroft 1784. This gives a bright yellow orange color. Persian berries are the root of a plant growing in the Levant and south of France. They yield a bright yellow color, but are not largely used owing to the color being fugitive. Turmeric is principally brought from the East Indies. It is the root of a plant which is reduced to powder of a bright color although very fugitive, and is used for yellow, exclusively for cotton goods. Madder is a vegetable dye and rivals indigo as a dye drug not only for the beauty of the colors obtained from it, but also for the various shades it produces by combination of coloring matters. From this is made the fast turkey reds so well known. It is the root of a shrub and is cultivated in the Levant and several of the countries of Europe, including France and Holland. The East Indies also furnish a quantity. The madder not only furnishes a red but also a madder purple, orange, and brown. Archil coloring matter is procured from lichens growing on seaside rocks. The most esteemed is that which comes from the Canary and Cape Verd Islands, but it is also found abundantly on the coasts of Sweden, Scotland, Ireland, and Wales. Camwood is another species of red-wood, imported from Sierra Leone. It produces a bright red color, which is permanent and for this reason has been largely used in the dyeing of wool, where especially fast colors were required. Barwood chemically the same as camwood, is brought also from Sierra Leone.

Indigo comes from plants growing in India, Africa, and America, called *Indigofera*, of which genus there are some 60 species. The coloring matter is found in the cellular tissue of the leaves as a secretion or juice, not however blue as we are accustomed to see indigo, but as a white substance, and is procured from the plant by fermentation. After the plant is fermented, the liquor is drawn and is agitated with paddles by the natives, until the indigo crystallizes out, when the clear liquor is drawn and indigo is taken out and pressed into blocks and dried. Latterly this has been done largely by machinery, which gives an indigo that is much purer than that made in the crude way by the natives. This indigo gives one of the most permanent dyes for standing light and for this purpose is greatly valued.

Sumac is diligently cultivated in Spain, Portugal, and some parts of Italy and Sicily. Sicily sumac is the best quality. This shrub grows to a height of about eight or ten feet. The shoots or shrubs are cut down every year close to the roots, and being dried are reduced to powder. Fine stems are often cut into small pieces and put in the powder. This is generally used when the metallic base or mordant is iron or tin and is therefore the bottom for blacks, reds, etc., for cotton dyeing. Sumac also grows largely in Virginia, and although having a very large proportion of tannin, owing to its leaving the cotton more or less stained, is not valued as highly as the Sicily and for this reason does not bring as high a price. See SUMAC.

Galls are certain species of oak excrescences, which originate in punctures made by insects for the purpose of depositing their eggs. Juice excretes from these punctures and gradually grows around the openings, varying in size from about a fourth of an inch to one inch in diameter. This substance from its resemblance to nuts and from its bitter taste is called gall-nuts. The best galls contain 26 per cent of tannin, and as they practically leave the cotton without being stained, are notwithstanding their much higher price, used where very light and bright shades are required.

Cochineal belongs to the animal kingdom, and is a small insect, largely found in Mexico, which gives a very bright crimson and scarlet. They feed on a cactus plant, which the natives cultivate around their buildings for that purpose. The insect attaches itself to the leaves of the plant and increases rapidly in number. During a season of seven months the insects are gathered three times, by brushing them off the leaves by the feather end of a quill into boiling hot water, in which they are kept for a few seconds. This not only kills them instantly but causes them to swell to twice their natural size. When taken out of the hot water, they are spread out and dried, and then packed for market. Some cultivators instead of hot water use steam and others again place them in an oven or upon a hot plate. The difference in the cochineal is caused by these different means of killing the insects and heating them. The best sorts seem as if dusted with a white powder and are of a slate gray color. Carmine is made from cochineal.

Weld or wold is a vegetable extensively cultivated in France and many other parts of Europe, for the purpose of dyeing yellow and is found in commerce in small dried bundles; the more slender the stem the better is it considered for dyeing. Both seeds and stems are used. The coloring matter approaches very near to quercitron in chemical properties. Owing to the color being extremely fugitive, it has been largely abandoned as a dye.

The most recent discovery of importance is the extraction of color substances of great beauty from coal tar. The discovery dates back to 1826, but it was not until 1861 that they commenced to be extensively employed. Those first placed upon the market were aniline purple, violine, rosine, fuchsine or magenta, solferina, *bleu de Paris,* aniline green or emeraldine, etc. The tar consists of numerous classes of bodies of which aniline and benzole are two. Aniline is present in minute quantity, and for manufacturing purposes, means are generally resorted to for the conversion of the benzole of the tar into aniline. The coal tar colors in many instances are not only more brilliant in shade but easier of application. These are now so largely used that they are almost entirely displacing the dyes formerly employed. When first brought out, it was found that they were not able to resist the sunlight like many of the old dyes, but in recent years, great improvements have been made in this respect, and many of the coal tar dyes, as improved, are not only noted for beauty of shade but for fastness to light as well as being economical to use, and more certain in results. Some of the coal tar dyes are made in the United States, but at the present time, Germany is far ahead of all other countries in the manufacturing of these colors, and it has grown to an immense proportion; some of the German works employing as high as 5,000 people. Among the coal tar colors are the alizarines; alizarine red, blue, and yellow, which now almost entirely take the place of madder.

The so-called aniline reds are the salts of rosaniline from which we derive most aniline colors. Aniline red, under the name of fuchsine or magenta, is prepared by adding anhydrous bichloride of tin by degrees to aniline. The materials are constantly stirred during the operation to keep down the intensity of the action, and the result is that much heat is evolved. The mixture becomes pasty, then liquid and brown and as the temperature approaches the boiling point it becomes a dark, almost black liquid, which in very thin layers presents a rich, crimson color. This liquid is boiled for some time. Much water is added and the whole is reboiled so as to volatilize any free aniline and chloride of sodium (common salt) added until saturation, when fuchsine or magenta is precipitated as a golden green, semi-solid pitchy substance. Any resinous matter still remaining may be separated by digestion in benzole. This dye may also be obtained by acting upon aniline with nitrate of mercury. Fuchsine or magenta is sparingly soluble in water and dissolves to some extent in alcohol and is insoluble in ether and naphtha. Roseine is most readily prepared on the commercial scale by adding two equivalents of bin-oxid of lead to a boiling solution of one equivalent of sulphate of aniline, and boiling the whole for a short time. On filtration, a rose-colored solution is obtained, then evaporated down to small bulk when some resin separates and the roseine is precipitated by soda or potash, and being collected on the filter can be washed and dried. This dye is readily soluble in alcohol and yields a very intense crimson color, which on being evaporated to dryness leaves a dark, metallic looking and brittle residue of roseine. It is soluble in water, but not in naphtha.

Aniline violet was the first aniline color manufactured. It was discovered by Perkin 1857. It is a sulphate of mauveine, known under the name of mauve, indisine, etc., and produced by oxidizing sulphate of aniline by bi-chromate of potassa. Tarry substances are formed at the same time, which are removed by dissolving them in hydrocarbons such as naphtha. This violet or purple is hardly soluble in water, but easily so in alcohol and sulphuric acid. The imperial purple of Girard and de Laire is obtained by heating together salt of rosaniline, magenta, for instance, with its own weight of aniline at a temperature of 350° F., for several hours. All the unaffected aniline is removed by weak acids and the purple remains. The regina purple of Nicholson is magenta heated to a temperature of from 390 to 420° F. The substance melts, evolves ammonia and a new color is produced. Blues can be obtained from these violets by washing them several times with diluted hydrochloric acid in order to dissolve all the aniline and magenta undecomposed and also a violet color. Aniline blues generally contain some violet and the violets some red shades in them. We find in the trade, blues with violet shades and violets with red or blue shades. Repeated washings will remove the violet, which is more soluble than the blue. But we must not consider the violets as simply mixtures of blue and red. The different shades are salts of rosaniline, in which hydrogen has been replaced by the radical phenyl. By varying the proportions of magenta and aniline and also the temperature various shades of violet are obtained. A true blue is prepared by adding to the mixture of magenta and aniline an organic acid or salt such as benzoic, acetic acid, or acetates. A blue thus obtained is called night blue, on account of its remaining blue under artificial light. Aniline greens are obtained by treating four parts of magenta by six of oil of vitriol, and two of water. Then 16 parts of aldehyd are added and the whole is kept at a temperature of boiling water until a few drops of the liquid give a blue color to a weak solution of sulphuric acid. The liquid is then poured into a solution of hyposulphite of soda and the green is "fixed." This green bath can be used directly for dyeing. It does not keep very long, but the color may be precipitated by tannin or acetate of soda. The insoluble compound is employed for calico printing and forming new dye baths. An iodide of ethyl green is produced by boiling Hoffman's violet with water and carbonate of soda. The liquor is treated by picric acid, a green precipitate is formed, which is washed, dried, and sold in powder. It is soluble in alcohol, and, we believe, in water after trituration of the powder with two or three times of its weight of sal ammoniac. Aniline blacks and grays are developed on the cotton fibre itself. Lightfoot, who discovered aniline black, if black is a color, used a paste composed of chlorate of potassa, hydrochlorate of aniline, sulphate or chlorate of copper and starch enough to thicken. By the mutual oxidizing reaction of chlorate of potassa and chlorate of copper the aniline is oxidized to the degree of black. This paste was open to the objection of destroying metals. Further experiments made by Cordillot, Koechlin, and Lauth, led to these important facts, namely, that the hydrochlorate or nitrate of aniline are the only aniline salts which can produce a black, that the best aniline should be a mixture of aniline and toludine, that the presence of copper is indispensable, and that a sulphide of copper, prepared by precipitation, will not corrode metals, and will gradually absorb the quantity of oxygen for its transformation into sulphate. If a tartrate or acetate of aniline is used, it is necessary to add to the mixture a certain quantity of sal ammoniac which will furnish the muriatic acid necessary for the transformation of the tartrate or acetate of aniline into a hydrochlorate. Aniline grays are obtained by diminishing the proportion of black producing substances of the above receipts by keeping as much free acid as in the primitive mixture for black. The maroon of M. de Laire was made by melting four parts of anhydrous hydrochlorate of aniline with one of dry aniline oil, the temperature slowly rises to 465° F. The operation is over when yellow vapors begin to appear and the mass is constantly transformed into brown. The color is soluble in water. Leucaniline brown is obtained by Koechlin in the following way: A salt of rosaniline is transformed into leucaniline by zinc powder. The leucaniline is separated from the zinc by alcohol, and this being evaporated, a tartrate of leucaniline may be formed, which is afterward transformed into brown by the oxidizing action of a mixture of sulphide of copper and chlorate of potassa.

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Dyeweed, Dyer's Broom, Greenweed, or **Woadwaxen,** a plant, *Genista tinctoria*, the only American representative of the genus *Genista* of the pea family. The genus comprises about 80 species, natives of Europe, northern Asia, and Africa. The dyeweed is a low-branching shrubby weed, with a few yellow nearly sessile flowers. It was originally cultivated in New England gardens because of the green dye it produced, and escaping is found from Maine to eastern New York. Its medicinal value is small, although it is used in Russia as a specific for hydrophobia.

Dygasiúski, dī-gäs-ēn'skē, **Adolf,** Polish story writer: b. Russo-Polish government of Kjebzy 1839. His stories are remarkable for charming descriptions of scenery; among them are: 'On the Manor'; 'From Village, Field, and Forest' (1887); 'From City and Country' (1889). He has translated works by Max Müller, Tyndall, Mill, Lewes, and others.

Dyherrn, dī'hārn, **Baron George von,** German poet and novelist: b. Glogau 1 Jan. 1848; d. Rothenburg, Silesia, 27 Dec. 1878. He wrote many poems and tales of great merit; 'In the Still Hour' (1870) being a collection of his best verse; and 'From Society' (1880), and 'Heights and Depths' (1881), his ablest fictions.

Dying Declaration, a deposition made by one who is near to death. Such declarations are admitted as evidence both in England and Scotland.

Dying Gladiator, a famous work of ancient sculpture, representing the scene of a dying Gaul, and supposed to be one of a series of figures illustrating the incursion of the Gauls into Greece. The work is now preserved in the museum at Rome. It is not known whether the statue is an original or a copy, the work of Cresilas, a Grecian sculptor and contemporary of Phidias. The right arm of the statue has been restored, and it is not postively known by whom this restoration was made. The work has been credited to Michael Angelo.

Dyke. See Dike.

Dykes, James Oswald, Scottish clergyman: b. Port Glasgow 14 May 1835. He entered the Presbyterian ministry in 1859, and in 1869 became minister of the Regent Square Church in London. Since 1888 he has been principal and Barbour professor in the Theological College of the Presbyterian Church of England. He is the author of: 'Beatitudes of the Kingdom' (1872); 'Laws of the Kingdom' (1873); 'Relations of the Kingdom' (1874); 'From Jerusalem to Antioch' (1874); 'Abraham, the Friend of God' (1877); 'Daily Prayers for the Household' (1881); 'Sermons' (1882); 'The Law of the Ten Words' (1884); 'The Gospel According to St. Paul' (1888); 'Plain Words on Great Themes' (1892).

Dykes, John Bacchus, English composer: b. Hull 10 March 1823; d. 22 Jan. 1876. He was graduated at Cambridge; ordained in 1847, and was appointed precentor of Durham Cathedral in 1849. In 1862 was presented to the vicarage of St. Oswald's in Durham. He was a joint-editor of 'Hymns Ancient and Modern,' and composed, besides many services and anthems, a number of hymn tunes, most of which are to be found in all English collections. Among these are: 'Nearer, My God, to Thee'; and 'Jesus, Lover of My Soul.'

Dynam'eter, an instrument for measuring the magnifying power of a telescope. This power is the ratio of the solar focal distance of the object glass to the focal distance of the eyepiece considered as a single lens: this being the same as the ratio of the diameter of the aperture of the telescope to the diameter of its image or disk formed beyond the eye piece, the object of the instrument is to measure the exact diameter of this image, which can be either projected on mother-of-pearl or measured by optical means.

Dynam'ic Theory, an hypothesis broached by Kant that all matter originated from the action of two mutually antagonistic forces — attraction and repulsion. All the predicates of these two forces are attributed by Kant to motion. As applied to heat, it is a theory or hypothesis — that now generally accepted as the correct one — which represents a heated body as being simply a body the particles of which are in a state of vibration. This vibratory movement increases as the body is still more heated, and diminishes proportionately as it more or less rapidly cools. It is called also the mechanical theory of heat.

Dynamic Units. See UNITS.

Dynam'ics (Gr. "power"), that branch of theoretical mechanics which treats of forces. It is to be distinguished from "kinematics," which treats of the various kinds of motion that are possible in a given system, without discussing the forces to which these motions are due. See MECHANICS; HYDRO-DYNAMICS.

Dynamite (from Greek *dynamis*, power), an explosive invented by Nobel in 1866 and originally consisting of infusorial silica or diatomaceous silica, called "kieselguhr," and nitroglycerin. The kieselguhr, being composed of the siliceous skeletons of micro-organisms, is a very fine, dry powder with a great capacity for absorbing and holding liquids, and it will absorb and retain three times its own weight of nitroglycerin, so that the product contains 75 per cent by weight of the nitroglycerin, and is known as dynamite No. 1. Other grades are made by adding less nitroglycerin to the absorbent or dope. The name has now been extended to cover a great variety of pulverulent or plastic solid mixtures of which nitroglycerin is a component.

Dynamite is fired by means of a detonator or blasting cap. As the percentage of nitroglycerin in dynamites with inert bases is reduced, they become more difficult to detonate until when the nitroglycerin is below 30 per cent they can not, according to Howe, be detonated at all. This does not hold true for dynamites with active bases. Dynamite is usually put up in cylindrical brown paper wrappers, closed at each end and coated with paraffin. These cartridges or "sticks," as they are called, are usually from one to two inches in diameter and eight inches long, and they are packed for transportation in sawdust in wooden cases, there being 50 pounds in each case. The sticks are paraffined to prevent water reaching the dynamite, as this drives the nitroglycerin out of the kieselguhr dynamites and dissolves the nitrate of soda in the nitro-lignin dynamites, thereby diminishing their efficiency. Good dynamite is of about the consistency of fresh mold. It varies greatly in color according to the absorbent used, magnesia powder being snow white, kieselguhr dynamite No. 1 pearl gray to red, carbo-dynamite black, the lignin dynamites about the color of coarse brown sugar. There is usually a little sodium, calcium, or magnesium carbonate, mixed with the dope. Dynamite keeps as well as the nitroglycerin, from which it is made. It is safer than the latter, because it avoids the liquid state, while from its softness it will bear blows better. Its sensitiveness to blows increases very rapidly with the temperature, so that, according to Eissler, "at 350° F., the fall upon it of a dime will explode it." At ordinary temperatures it may be exploded by firing musket balls into the mass. The firing point of dynamite is about 180° C. (356° F.), and at this temperature it either burns or explodes. If free from all pressure, jar, vibration, or force of any kind, it burns; otherwise, it explodes. If a thin layer be placed on a plate of tin and heated over a burner the nitroglycerin volatilizes or takes fire. If the layer is of any considerable depth, say over a quarter of an inch, it explodes. This is a dangerous experiment. When heated to any temperature less than this, it is exploded by a detonator, blow, jar, or vibration with an ease dependent on the temperature and time of exposure. When ignited in comparatively small quantities dynamite simply burns away fiercely, but with moderate and larger amounts ignition causes explosion. To safely destroy dynamite it should be treated with a solution or emulsion of an alkaline sulphide such as the spent lime from gas works. High temperatures, much below the ignition or explosion temperature, cause the nitroglycerin to exude, or in technical terms, "they will make the powder leak," hence a dynamite should be made to resist exudation at the highest temperature to which it may be exposed.

Dynamite freezes at about 40° F., and remains frozen at temperatures considerably exceeding this. If solidly frozen it cannot be detonated except with great difficulty and uncertainty, but if loose and pulverulent it may be detonated, though the efficiency is much diminished, hence when frozen it is practically useless as a blasting agent, and must be thawed or "tempered" for use. This operation requires great care and the instructions issued with each case should be closely followed. Many persons suppose that since cartridges of unfrozen dynamite may sometimes be set on fire and burned without exploding, it is safe to warm it upon a shovel, or in an oven, or to boil it over a stove, or in various other ways which usually lead to a verdict of "accidental death." It cannot be too strongly impressed upon the minds of those handling it that if dynamite or other nitroglycerin preparations are gradually warmed up to a temperature approaching their explosion temperatures they become extremely sensitive to the least shock or blow, and once that point is reached they do not simply ignite, but they explode with great violence, and further that, owing to the poor conductivity of the mass, a portion of it may become raised to this temperature and explode the whole.

Dynamite has a specific gravity of 1.5 to 1.6. In his earlier experiments with absorbents Nobel in 1863 placed gunpowder in a zinc case and filled the interstitial spaces with nitroglycerin. This might be called a dynamite with an active base, but that the nitroglycerin was greatly in excess of that existing in dynamites. See EXPLOSIVES; NITROGLYCERIN; POWDER.

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Dynamo Electric Machinery, machinery which transforms mechanical energy into electrical energy, or which converts electrical energy into mechanical energy. A dynamo electric machine consists of two distinct parts, one of which is stationary, the other part being rotative. When the rotary element is driven by an external force and the machine develops electrical energy, it is termed a generator or a dynamo. If electrical energy be supplied to the machine and the revolving element develops mechanical energy, the machine is termed a motor. Special types of machines in which both dynamo and motor action are present are treated later.

The operation of dynamos is due to the principle of electro-magnetic induction discovered by Michael Faraday in the year 1831. He noticed that when a loop of wire of several turns was revolved between the poles of an electro-magnet a flow of electric current took place in the wires of the loop. The rotation of the loop was about an axis perpendicular to the lines of force emanating from the pole.

The term electromotive force represents the pressure which forces an electric current through a circuit. In a dynamo its magnitude depends upon the rate of cutting of magnetic lines of force. These lines of force are imaginary and indicate the magnitude and direction of the force of a magnetic field. To continuously produce an electromotive force, continued cutting of lines of force is essential. The magnitude of the electromotive force induced in a loop which is revolving in a magnetic field is directly proportional to the rapidity with which the loop is revolved, to the number of turns of wire in the loop, and to the strength of the magnetic field. The direction of the E. M. F. induced in a loop depends upon the position of the loop relative to the poles. When one of the wires of a loop passes one pole, an E. M. F. is induced in the wire which tends to send a current in one direction; this direction changing as the wire cuts the flux at the other pole. Opposite sides of the loop pass poles of opposite polarity simultaneously, a current therefore tends to flow in one direction around the loop. The direction of the E. M. F. in the loop changes as the wires pass from a north to a south pole. When the loop is connected to two slip rings, as illustrated in Fig. 1,

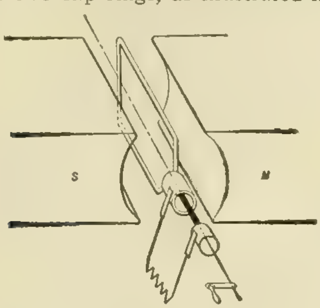


FIG. 1.

and revolved, an alternating current may be obtained by attaching to the slip rings suitable collecting devices. The substitution of a two-part commutator, Fig. 2, for the slip rings will rectify the current and produce a direct current, or a current which flows continuously in one direction.

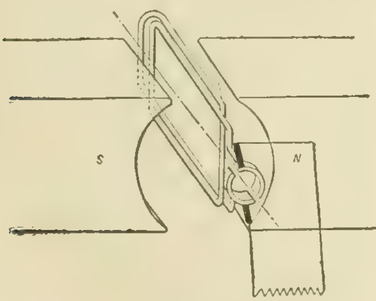


FIG. 2.

Dynamo electric machines are divided into two distinct classes, those which generate a direct current and those which generate an alternating current. It is customary, with a few exceptions, to term the part of a machine in whose coils the E. M. F. is generated the armature, and the parts that produce the flux, the field magnets. Dynamo electric machines are further classified as to their mechanical operation into machines in which: (a) The armature revolves and the field magnets are stationary; (b) The field magnets revolve and the armature is stationary; and (c) The field and armature coils are stationary and iron core revolves. It is obvious from previous mention that a dynamo electric machine may generate either a direct or an alternating current depending upon whether it is supplied with a commutator or with slip rings. Machines termed rotary converters possess both a commutator and slip rings, their function being to convert alternating into direct current or *vice versa.* If the machine be driven by an external force, either direct or alternating current may be obtained by making the proper brush connections. The rotary converter when operated in this manner is termed a double-current generator. As the construction of the armatures of direct current machines, rotary converters, and a large number of alternating current machines is similar with the exception of their commutators or slip rings, the construction of the armature of a direct current machine will be given in detail.

Direct Current Armatures.—A direct current rotative armature consists essentially of three parts, an iron core mounted upon a shaft, a number of conductors wound upon the surface of the core or embedded in slots near the surface, and a commutator.

Core.— The object of the core is to facilitate the passage of lines of force from one pole of the field magnet to another. If this core were not present fewer lines of force would pass through the armature, and this would tend to decrease the E. M. F. generated by the machine. For equal magnetizing forces a sample of iron may carry 2,500 times the number of lines of force that would be carried if air were substituted for it.

The periphery of the armature core of large machines is usually slotted longitudinally, the purpose of which is to contain the conductors. This also tends to decrease the air space, termed the air gap, between the core and the pole faces, a thing which is very desirable.

The core is composed of iron disks punched from sheets. These disks are punched out whole for small machines, or are made in segments, the junctions of which are staggered in large machines. The disks in machines of large capacity are mounted upon a form of proper dimensions, which in turn is fastened to a spider and keyed to the shaft. The punchings are assembled with their planes perpendicular to the axis of rotation. The reason for using disks instead of a solid casting is that the iron core is equivalent to a conductor revolving in a field. Currents, termed Foucault currents, flow through the iron in the direction of the axis if the disks are not properly insulated. This current unduly heats the armature and is therefore undesirable.

Armature Windings.— The wires distributed over the periphery of the core of an armature constitute the generating part of a direct current machine. Armatures in which the windings are only upon the periphery are termed drum armatures. When the core of the armature is in the form of a ring and the wires are wound in and out around the ring the armature is called a ring armature. Drum armatures are in use commercially to a greater extent than ring armatures particularly in the case of large machines. In the drum armature a greater portion of the winding is active in producing an electromotive force than in the ring armature. The ring armature has considerable wire upon the inner face of the ring in which very little electromotive force is induced.

The length of active conductor connected in series on an armature determines the magnitude of the electromotive force generated by a given magnetic field. In machines of large magnitude two volts or more are generated per foot of active conductor.

Many forms of armature winding are in vogue. The designing engineer is often called upon to design a machine of given capacity which will generate a certain pressure at a definite speed. To do this he must place sufficient wire in series to produce the required E. M. F. and this wire must be of sufficient cross-section to carry the current it will be called upon to deliver. To meet these conditions and still have an armature which is not abnormal in size often results in a very complicated series multiple winding. Machines of large capacity usually have more than one pair of poles and have brushes between successive poles around the commutator. These serve to conduct the current to the main circuit.

An economical method of winding drum armatures consists in the employment of formed coils. These coils are wound upon a collapsible form of proper dimensions and after being thoroughly insulated and shellacked are removed from the form. They are then inserted in the slots of the armature core. The distance between the two halves of the loop is nearly equal to the distance between the centres of two poles of opposite polarity. The terminals of the loop are connected to two adjacent commutator segments. The next loop is placed in slots and similarly connected, care being taken to connect the two coils in series to a common commutator segment. By this method the current tends to flow in one continuous direction. Many modifications are made to this form of winding but the principle of connecting the coils so that their E. M. F.'s will be cumulative is common for all machines. Some machines have two or more separate windings upon the same core.

Commutators.—A commutator consists of an assemblage of drop forgings, or castings of copper called segments, Fig. 3, which are thoroughly insulated from each other. These segments are assembled around a tube. The tube is threaded at both ends to receive nuts to hold the segments together. Mica is usually employed to insulate the segments from each other, from the nuts, and from the tube. In addition to its high insulating properties, mica possesses the advantage that it wears under the brushes at about the same rate that copper does. This maintains a smooth surface at all times upon the surface of the commutator. The maximum voltage between adjoining segments is seldom allowed to exceed 20 volts. Assuming that the voltage is uniformly distributed, a 240-volt machine with a closed winding would therefore have 12 bars between adjoining brushes, or for a 2-pole machine 24 commutator segments. In Fig. 3 the perpendicular projection, "P," of the commutator segment protects the coils on the armature, and is made to receive the extremities of the coils of the armature windings. The wires in some cases are fastened to the lugs, "P," with set-screws and then soldered. The commutator complete is keyed to the armature shaft.

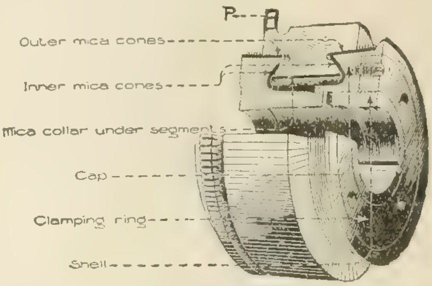


FIG. 3.

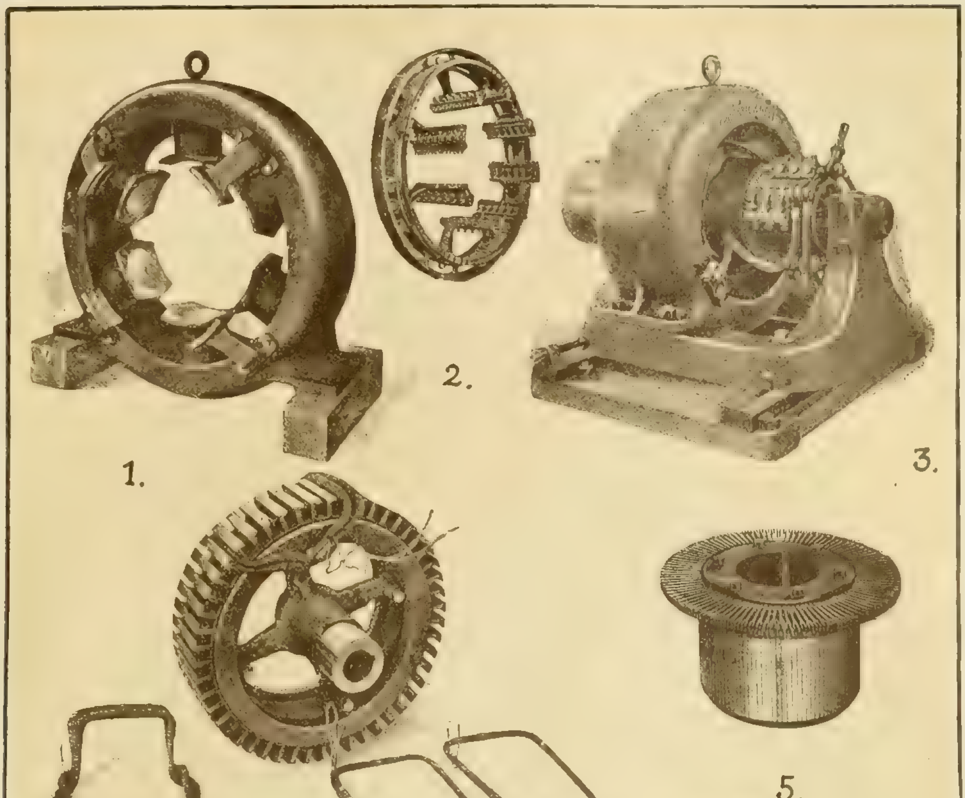
Brushes.— Carbon and copper are the two materials usually selected for brushes; carbon for high potential machines and copper for low potential machines. When a coil is entering commutation it has a current of electricity flowing in it. The direction of this current changes when the coil is commutated. The current flowing in the coil before commutation tends to keep up because of its self-induction. In the time it takes a strip of insulation to pass under the brush, the current flow in the coil must be stopped, and a current of equal value started in the opposite direction. Both operations may be done by counter E. M. F., or the current flow may be stopped by a high resistance and started by fringe flux. The transition resistance of brush to commutator usually causes a fall in the potential of about one volt for every brush. The pressure of the brushes against the commutator varies, the average value is about $1\frac{1}{4}$ pounds to the square inch. The necessary area of rubbing surface of carbon brushes is one square inch for 40 amperes, and copper brushes permit of 200 amperes for the same cross-section.

Field Magnets and Field Frame.—The field magnets produce the magnetic flux in which the armature rotates. The flux is created by a current of electricity traversing many turns of wire which are wound upon iron cores. A north or a south pole is produced, depending upon the direction in which the current flows through the coil. The coils on the field magnets are connected in series and so arranged that the polarity changes consecutively from pole to pole. Modifications are sometimes made to this form of winding when it is desirable to produce a machine which will supply a three-wire circuit. The machine is then designed as a four-pole machine having two adjoining north poles and two south poles similarly placed.

The laws governing the flux of magnetic lines are similar to the laws of current flow. The flux which will flow in a magnetic circuit is equal to the magnetizing force (termed the magnetomotive force) divided by the reluctance of the circuit.

$$\text{Flux} = \frac{\text{Magnetomotive Force}}{\text{Reluctance}}$$

The reluctance of a magnetic circuit is a property analogous to the resistance of an electric circuit. To obtain a maximum flux through

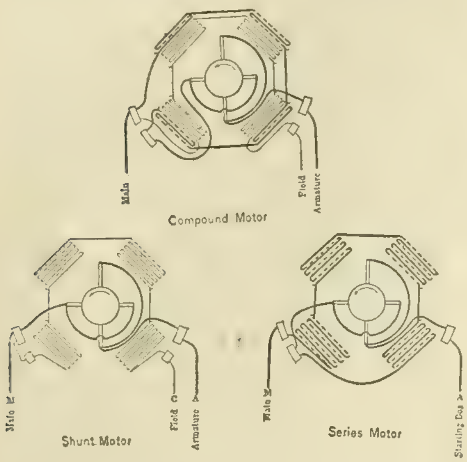


1. Multipolar Field Frame.
2. Rocker Arm and Brush Holder.
3. Direct Current Dynamo, Complete.
4. Direct Current Armature Core, showing Method of Winding and Applying Formed Coils.
5. Commutator.
6. Dissected Direct Current Dynamo: 1. Armature (includes 2 and 3); 2. Commutator; 3. Shaft; 4. Base; 5. Bearing Cap; 6. Bearing Cap Screws; 7. Oil Cock; 8. Oil Hole Cover; 9. Journal Box; 10. Oil Ring; 11. Lower Magnet Frame (includes 13 and 14); 12. Upper Magnet Frame (includes 13 and 14); 13. Pole; 14. Pole Shoe; 15. Eye Bolt; 16. Magnet Frame Bolts; 17. Terminal Board; 18. Terminal Block; 19. Compounding Rectifier; 20. Field Coil; 21. Field Cable; 22. Rocker Seat with Screws; 23. Brush Rigging (includes 24, 25, 26, 27, 28, 29, 30, 31, 32 and 33); 24. Rocker (includes 25); 25. Rocker Handle; 26. Brush Stud; 27. Brush Stud Nut; 28. Brush Stud Insulating Washer (Round Hole); 29. Brush Stud Insulating Washer (Oval Hole); 30. Brush Stud Insulating Sleeve; 31. Brush Stud Cable; 32. Armature Cable; 33. Brush Holder; 34. Brush; 35. Pulley; 36. Pulley Key.

an armature with a given magnetomotive force it is necessary to reduce the reluctance of the magnetic circuit to a minimum.

In the design of a generator it is often convenient to first design the armature and then obtain the magnitude of the flux which must be generated by the field magnets. Having selected a given material for a field frame, a given air gap, a given length and cross-section of magnetic circuit, the total reluctance of the circuit is determined. The reluctance varies directly as the length of the circuit, directly as the reluctivity of the material and inversely as the cross-section. Knowing the total flux and the reluctance of the circuit, the magnetomotive force is determined, and this quantity divided by 1.257 gives the number of ampere turns necessary to produce the magnetic field.

Field Coil Connections.— Dynamos and motors may be shunt wound, series wound or compound wound. In the series dynamo the armature circuit, the field circuit, and the external circuit are all in series.



Series motors are used for traction purposes as they give a large starting torque. Series dynamos are used for arc lighting, as they gènerate a constant current. Shunt wound machines have their field circuit, their armature circuit, and their external circuit connected in multiple. A shunt machine is designed to generate a constant potential, or when operated as a motor to run on constant potential. The field coils of a generator may be separately excited, in which case an external source furnishes the current for exciting the coils. Separately excited machines are usually employed in large power houses where it is desirable to have a flexible system, which means the ability to vary the pressure sent out on the line at any instant of time. In the United States where 8,000 horsepower generators are now in successful operation, each machine is taken as a unit and the control of the exciting current for the fields is a very important factor. The machines are separately excited; the exciting dynamo being supplemented by a bank of storage batteries as an emergency. A compound winding consists of an additional winding upon the field, this winding being connected in series with the line. It may be placed in series with the armature and the field connected in multiple, or it may be connected in series with the armature alone, its connection depending upon the percentage of compounding required. By compounding a machine the strength of the magnetic field is increased in proportion to the current generated by the machine, the percentage depending upon the number of turns in the compound coil and as to the way in which it is introduced in the circuit. If a shunt machine be not compounded, the potential falls with an increase above normal of the generator output.

Methods of Excitation.—A dynamo electric machine may be separately excited or self-excited. When self-excited, the machine builds up slowly to its normal potential, and when disconnected from the main circuit the field magnets gradually discharge themselves as the speed of the machine decreases. The polarity of a self-excited machine may become reversed or the machine may fail to generate sufficient pressure to magnetize the field magnets. Both of these conditions are serious. When the field coils of the separately excited machine are connected to an external circuit they definitely assume their proper polarity and there is no possibility of this polarity becoming reversed.

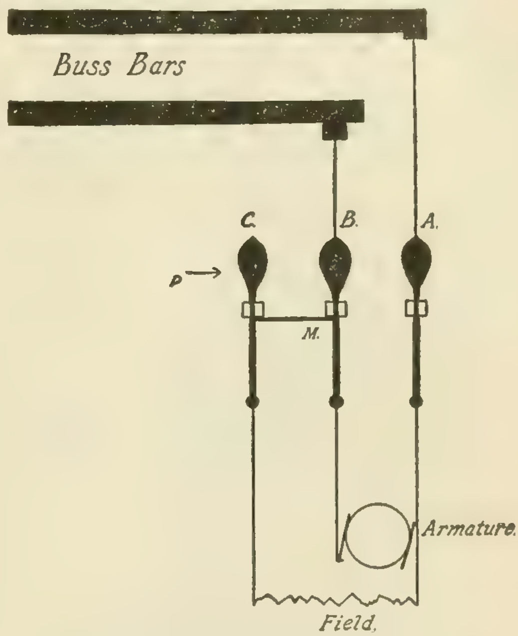
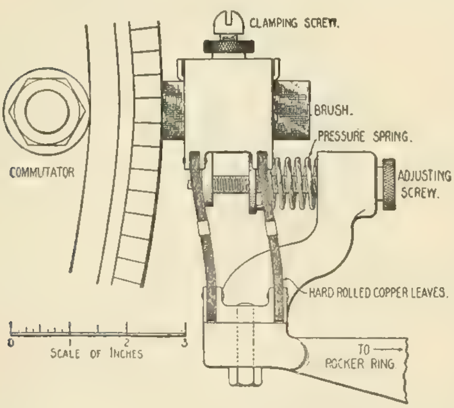


Fig. 4.

In addition to this the field magnets of the separately excited machine rapidly build up to the point where the machine generates its normal potential. The disadvantage of this machine is that when disconnected from its external exciting source its fields must be instantly discharged through a bank of lamps or some other consuming device, as there is danger of the fields discharging through the insulation of the machine. A method devised by Mr. Donshea embodies the advantages of both the separately excited machine and the self-excited machine and lacks their disadvantages. The method consists of the operation of a specially devised three-part switch. Fig. 4. The single switches A and B are closed, connecting the field magnets of the generator to the source of separate excitation. The field magnets quickly and definitely assume their proper polarity. The switch C is closed when the machine is generating the proper potential. The machine then returns power to the circuit which may be the buss bars of the switchboard. When the switch C is closed a catch on the handle engages the switch B at the point P. When it is desired to disconnect the machine from the circuit, the handle M is engaged which carries switches B and C out together. The machine is then equivalent to a self-exciting machine and the fields gradually disappear as the machine slows down.

Speed Conditions.— Consider a motor operating under normal conditions from an external supply of E. M. F. The armature of this motor is rotating in a magnetic field and therefore has an E. M. F. induced in its armature windings. The direction of this E. M. F. is such as to tend to send a current of electricity in the opposite direction to that passing through the armature under the influence of the external supply. This E. M. F. is termed the counter electromotive force. The pressure of the external source remains approximately constant, and the counter E. M. F. varies with the armature speed. As the motor is loaded its speed tends to decrease. This decrease diminishes the counter E. M. F., and a larger current is permitted to pass through the machine. The difference between the impressed and the counter E. M. F.'s divided by the resistance of the armature gives the magnitude of the armature current. It is obvious that a very large current would flow through a stationary armature of low resistance, if the armature



PARALLEL MOVEMENT BRUSH HOLDER.

were connected directly to an ordinary commercial lighting or power circuit. To prevent this large current flow, devices called starting boxes are employed for starting motors. The function of a starting box is to first complete the exciting circuit of the field magnets and then to gradually cause a rise of the impressed potential upon the armature terminals, from zero to that of the supply circuit. The latter is accomplished by gradually diminishing resistance which is in series with the armature until the speed of the machine is almost normal, when all the resistance is entirely removed.

Induction Motors.— In the year 1888, Mr. Nikola Tesla, of New York, introduced a dynamo electric machine, which is now termed an induction motor, and which made possible the economic long-distance transmission of power. This motor had two great advantages over the direct current motor, in that it possessed no commutator or brushes to be cared for, and it could be operated by alternating currents. It possessed the disadvantage that there was no ready means of regulating its speed. There is considerable difference between the construction of an induction motor and that of a direct current motor. Induction motors have a revolving element whose laminations are somewhat similar to those of the armature of a direct current motor, as they fulfil the same function. The movable part of an induction motor is called the rotor, and the stationary element surrounding the rotor is called the stator. In a common form of rotor, called the squirrel cage, the inductors are insulated and embedded diagonally in slots around the periphery, and at each end of the rotor these inductors are connected together to a common ring. The coils of the stator which create the magnetic field are so wound that several out-of-phase alternating currents have their magnetic actions superimposed upon each other and thus produce a field which continually shifts. This field is termed a rotating field. The stator field induces currents in the rotor which react upon the field and cause the rotor to revolve. The motion of the rotor is not synchronous with respect to the field of the stator, but slower. The ratio of the deficit of the rotor speed to the speed of the stator field is termed the slip of the induction motor.

Safety Devices.— There are many large power houses in the United States continuously generating 40,000 horsepower and over. The units employed in these power houses range as high as 8,000 horsepower. Since the introduction of the steam turbine there has developed a tendency to increase the size of these units to 12,000 horsepower. One of these units would generate sufficient power to replace all of the electrical power developed in Switzerland. New York has under course of development and in operation power houses whose output will aggregate 750,000 electrical horsepower when completed. When the new power houses at Niagara are in operation, almost 500,000 E.H.P. will be developed. The management of many of these power houses claim to have given continuous service since first installed. They have been able to give this service to the public by having duplicate pieces of apparatus in many cases and by protecting their entire system from excessive overload and strain, and from the elements by suitable protecting devices.

Fuses.— The simplest protecting device consists of a fuse. Fuses are made in many forms. The link fuse is made in strips, or as wire of an alloy possessing a low melting point. When the current strength exceeds a certain limit, the heat developed in the fuse by the pressure overcoming the resistance of the fuse is sufficient to melt it and interrupt the service.

Circuit Breakers.—Where heavy currents have to be interrupted an electromagnetic device termed a circuit breaker is employed. This device consists of an electromagnet of low resistance placed in series with the circuit. When the current in the circuit exceeds the normal amount, the magnet attracts an armature which releases a catch, and allows a spring to open the switch governing the circuit.

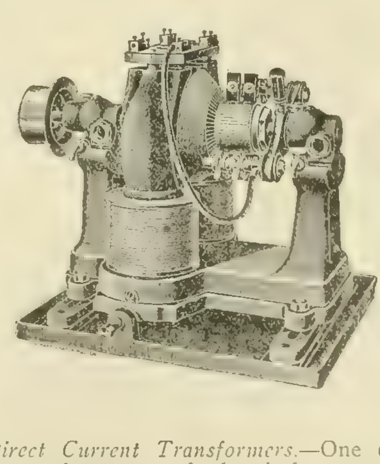
Time Limit Relays.—Generators are liable to be subjected to an excessive overload for a short period of time. This sudden variation in load often occurs in the operation of railroad trains, mining machinery, mills, and machines of a similar nature. It would be very inconvenient to have breakers open the circuit whenever these sudden variations in load occur, especially as the generators are usually designed to stand an overload of 25 per cent for half an hour, and an overload of 50 per cent for one minute. The time limit relay performs the same function that a circuit breaker does, namely, opens the circuit whenever an excessive overload occurs. There is this difference, however, between the two devices: the operation of a circuit breaker is practically instantaneous, whereas a time limit relay has a time element associated with it. This time element is adjustable and may be arranged so that the circuit will be opened after a definite interval of time following the overload. In one form the magnetic action of the relay is opposed by a bellows, or a dash-pot, which contains air. When the relay begins to operate a solenoid draws a plunger down, which in turn compresses air in a receiver. The force exerted by the compressed air is lessened by leakage. When the limit is reached, say five seconds, the circuit is automatically opened.

Reverse Current Relay.— If a generator become disabled and is unable to develop a pressure equivalent to that generated by machines linked in with it, there is a possibility of a large cross-current flow into the disabled generator from the other machines. To prevent power returning into such a machine a device termed a reverse current relay is employed which automatically cuts out the machine from the service.

Lightning Arresters.—While there is nothing that will protect electrical apparatus from a direct stroke of lightning, still means have been provided to protect apparatus from discharges occurring in its vicinity. It is customary to protect transmission lines by installing ground wires at repeated intervals along their course. One method much in use is to run a wire from the top of the transmission pole to the ground. Such wires are installed every few poles. Charges, due to lightning occurring in the vicinity of the pole line, discharge themselves over these wires into the ground in preference to traveling along the transmission line, entering the station, and destroying the generating or the receiving apparatus. As lightning frequently oscillates with a very high frequency, a few turns in the transmission wire is sufficient to impede the discharge of the lightning and make it tend to seek another path. An auxiliary path to the ground is often provided, this path being composed of a number of spark gaps in series. These gaps are traversed very easily by the high potential of the lightning and are sufficiently far apart to prevent the line potential from discharging to ground. A device of this character is termed a lightning arrester. When the lightning has broken down the gaps of a lightning arrester, there is a tendency for the line potential to continue the discharge through this path. To prevent this, one half of the gaps are shunted by a reactive coil. The induction of this coil is so adjusted that the lightning will jump the gaps, shunting the coil in preference to flowing through the coil. The line potential, however, of much lower frequency and lower potential than the lightning, passes through the coil in preference to jumping the gaps. The result of this current flowing through the coil is to produce a magnetic field of sufficient intensity to extinguish the arc across the gaps and to restore the line to normal conditions of operation.

Central Station Economics.— It is desirable to reduce the initial cost of the production of electric power to a minimum wherever fuel is expensive and natural sources of energy, such as water-power, are absent. Such conditions are met with in many of our large cities. This reduction is accomplished by installing engines and generators of the highest efficiency, and by employing all methods which will tend to increase the efficiency of the plant. One of these methods is to directly connect the armature of the generator to the shaft of the engine. This eliminates the friction losses which would occur if belting were employed, but necessitates good speed regulation, as the pressure of a generator is directly proportional to the speed with which it rotates. It is essential for good service that the speed be regulated to within 1 per cent, otherwise lights will flicker and their use will be objectionable. Sometimes in large electric lighting systems the voltage of a given part of the system may vary as much as 5 per cent, but this variation is not continuous, and is due more to the local loading of the mains and not to the generator at the central station.

Throughout the western part of the United States much use is made of water-power for generating purposes. Power houses are situated in the bottom of ravines and are operating under heads of water as great as 2,000 feet. The famous Colgate plant on the Yuba River has transmitted power 253 miles, the longest electric power transmission in the world. Although the cost of water is small compared with the cost of coal, still the cost of electric power generated from water is not much cheaper than when generated from coal. This is due to the fact that the initial investment in a water-power plant is much greater than in a steam plant of the same magnitude. Much capital must be spent in the construction of expensive dams, waterways, and pipe lines.



Direct Current Transformers.—One of the greatest advantages of electrical energy over other forms of energy is its flexibility. It may be generated in one place, and its pressure may be transformed from a low voltage to a high voltage. The electrical energy in this form may be transmitted to a distant place where the reverse transforming process occurs. The higher the voltage under which power is transmitted, the smaller need be the cross-section of the transmission line. A stationary static transformer operating upon the principle of induction, is all that is essential to transform alternating currents, but with direct current transformation, it is necessary to employ rotating apparatus. It is not considered good engineering practice in the United States to use direct current for transmission purposes. Alternating current is used for this purpose and direct current is employed for distribution. Several machines have been designed which will transform direct current from one voltage to another voltage. They are termed motor-generators, dynamotors, and boosters. A motor-generator consists of a motor and a generator coupled together upon one shaft. The speed of the motor may be varied, which will correspondingly alter the voltage generated by the dynamo. A dynamotor consists of two armature windings upon the same core, rotating in one field. The armature has two commutators, one at each end of the shaft. This type of machine has practically no armature reaction and therefore has a small tendency toward sparking. The main disadvantage of this machine is that it is impossible to vary the field strength for purposes of regulation without correspondingly altering the voltage of the dynamo. A booster is a machine used extensively to raise the potential of railway feeders. Its armature is usually placed in series with the feeder and driven by some external source of energy. When its field coils are in series with the line, it is termed a series booster, and when the field coils are connected in multiple it is called a shunt booster. The capacity in watts of a booster is determined by the product of the feeder current into the maximum change of voltage which it causes. See also ELECTRICITY and kindred articles.

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Dynamom'eter (Gr. «power-measurer»), an appliance for determining the force required to overcome a given resistance. It is constructed in the most varied forms, according to the nature of the problem to be solved. A tension-dynamometer, such as might be used for measuring the force required to tow a vessel, is usually constructed on the principle of the steel balance, the tension that it is to measure being caused to compress (or elongate) a steel spring, whose deformation is observed by means of an index and scale, or continuously recorded by means of a pencil upon a drum that is revolved by clockwork. Dynamometers for measuring the torsional force transmitted by a shaft are commonly made by cutting the shaft in two, and uniting the separate but adjacent ends by means of a coupling which permits one of the ends of the shaft to rotate somewhat, relatively to the other end, the relative motion being opposed by a spring in the coupling, whose extension measures the twist that is communicated through the coupling. The commoner forms of dynamometer measure force, and not power. To determine the horsepower that a given apparatus is transmitting, it is necessary to know the velocity with which the resistance is overcome, as well as the magnitude of the resistance itself. In ordinary work the velocity is observed separately, and the horsepower inferred by computation; but instruments known as «integrating dynamometers» are used to a limited extent, the computation being performed by these instruments automatically, somewhat as the area of a curve is computed by the planimeter.

Dynamotor. See MOTORS AND DYNAMOS.

Dyne, dīn (Gr. «power»), the unit of force in the centimetre-gram-second system of units. It is defined as the force that must be exerted upon a gram of matter for one second, in order to give it a velocity of one centimetre per second. The attractive force that the earth exerts upon a milligram of matter is somewhat different in different latitudes, but it may be said, for the sake of illustrating the order of magnitude of the dyne, to be about 1.02 dynes. For many purposes this is too small a unit for convenience, and a larger unit, called a «megadyne» and defined as equal to 1,000,000 dynes, is often used in its place. To the same degree of approximation as before, the attraction that the earth exerts upon a kilogram of matter may be said to be equal to 1.02 megadynes. See UNITS.

Dy'nograph, an apparatus used in modern railroading for testing the inequalities in the road-bed or track. It consists of a recording instrument mounted in a car and geared to the wheels thereof. An automatic pencil records the slightest roughness or inequalities, and locates them. The dynograph is in use on all the great railroads.

Dy'renforth, Robert St. George, American patent lawyer: b. Chicago 17 Oct. 1844. His early education was in the public school, but he finished it in Prussia where he began studying in 1857, and was graduated at Breslau in 1861. He took a degree in the Carlsruhe Polytechnic School after a course in mechanical engineering; he also was graduated at Heidelberg in mathematics, physics, and chemistry (1866–9). During the Civil War he served on the staffs of Gens. Rosecrans, Copeland, and Dodge. He entered the United States Patent Office 1871, resigned on Cleveland's election in 1885, and has since practised as a patent and corporation lawyer.

Dyrrhachium, dĭr-rā'kĭ-um. See DURAZZO.

Dysart, dī'zärt, Scotland, a seaport in the county of Fife, on the Firth of Forth; 12 miles northeast of Edinburgh. Dysart possessed great importance in the 15th century, and was famous for collieries and salt-works. The trade is still of importance. Pop. 3,022.

Dyscrasia, dĭs-krā'sĭ-a, **or Dyscrasy,** in pathology, a generally faulty condition of the body; an unequal mixture of elements in the blood or nervous juice; a distemperature, when some humor or quality abounds in the human system.

Dys'entery, a general term connoting a series of diseased conditions of the large intestine or colon (q.v.) These may be of an infectious, nervous, or chronic inflammatory origin. At the present time, it is becoming recognized that most cases of dysentery are due to some form of micro-organism, and, within recent years, a bacillus has been described by a Japanese observer, Shiga, which is thought to be responsible for a number of the cases of dysentery, both in adults and in children. Certain mild cases of dysentery have been shown to be dependent upon the pernicious activities of certain bacteria belonging to the genus *Proteus*. And it has now been known for a long time that a certain lowly organized animal form, the *Amœba*, can induce a peculiar type of dysentery known as amœbic dysentery.

The general mode of onset of dysentery of the non-amœbic form, that is particularly epidemic dysentery, is rapid, with diarrhœa following perhaps a mild constipation or alternating constipation and diarrhoea with a mucous or serous discharge. Symptoms of indigestion frequently precede the attack, and it is characteristic that diarrhœa is accompanied with much wind. The fæcal movements are large, loose, very fetid and usually mixed with blood and mucus. The movements are accompanied with great pain of a colicky or gripy nature. Tenesmus, or straining, is a very frequent symptom. There is usually much general pain, some rise in temperature, loss of appetite, nausea, restlessness, and irritability. In favorable cases formed fæces commence to reappear in the stools and there is disappearance of the griping and straining. In the patients in whom the disease becomes more acute, the passages become looser, watery, slimy, and of a dark red color. The odor is mawkish, and in later stages may even become putrid. The fluid that is passed consists largely of an albuminous serum with epithelium blood cells, pus cells, tissue fibres, and small sloughs, and if the disease becomes even more pronounced the stools become dark brown in color, with sloughs and blood clots, and have a distinctly gangrenous odor. These sloughs from the intestine usually indicate an extremely severe form of the disease and ofttimes the patient dies with completely relaxed anus, with subnormal temperature, shrunken features, and in complete collapse.

Amœbic dysentery is, as a rule, a more gradual form of disease. It is extremely intermittent in its course and much protracted, running on sometimes months and even years. It very frequently begins with painless diarrhœa, alternating with constipation; the stools being loose and yellowish, containing much mucus and a little blood. The patient commences to lose flesh, becomes weak and anæmic, and the complication of abscess of the liver is extremely common. Chronic dysentery is a form of chronic colitis and can be found under that head. The treatment of dysentery consists in rigid hygiene and skilled medical attendance. See Amœba; Cholera; Colitis; Enteritis; Enteroclysis; Intestines; Parasites.

Dys'lysin (Gr. «hard to dissolve»), an amorphous, resinous substance, having the formula $C_{24}H_{36}O_3$, and obtained from cholic acid by heating to about 600° F., or by prolonged boiling with dilute hydrochloric or sulphuric acid. It is soluble in ether, slightly soluble in boiling alcohol, and insoluble in water; and it is reconverted into cholic acid by boiling with an alcoholic solution of caustic potash. It is occasionally found in fæces.

Dysmenorrhœa, dĭs-mĕn-ō-rē'a, painful menstruation. To constitute dysmenorrhœa, the pain accompanying menstruation should be very distinct and persistent. Inasmuch as dysmenorrhœa is found accompanying a vast variety of abnormal conditions of the uterus and ovaries, it seems not improbable that this affection has no settled pathology, but may be associated with almost any abnormal condition within the generative apparatus of women. A vast variety of forms of dysmenorrhœa have been described, the most important of which seems to be that of obstructive dysmenorrhœa, or a mechanical form supposed to be due to some interference in the escape of the menstrual fluid. Those who suffer from dysmenorrhœa are apt to be anæmic, which anæmia in itself may be a sufficient cause for the disease. They are apt to be extremely nervous and run down. Treatment, therefore, should be directed to the supplying of the deficiency of the iron in the blood to overcome the anæmia, and the use of cod liver oil and other reconstructives. Of the various drugs that have been used for the treatment of dysmenorrhœa those that relax muscular fibres and arterial walls seem to give the best results. This is true of a number of the newer synthetic drugs that have been employed very widely of late. As no two cases of dysmenorrhœa are due to precisely the same cause, general directions for treatment would be out of place in a work of this character, but rest in bed, free movements of the bowels, and hot water in the form of hot-water bags, or hot-water enemata, are very useful household remedies. See Menstruation; Ovary; Womb.

Dyspep'sia is that combination of symptoms that result from interference with the proper digestion of food in the stomach. Because of the taking of too much food, or unsuitable food, the mucous membrane of the stomach becomes irritated and there is set up an acute or subacute gastric catarrhal condition which prevents the proper digestion of the food. This food is apt to ferment and to decompose, and as a result, the familiar picture of acute dyspepsia may arise. In mild cases there may be nothing more than an uncomfortable feeling in the stomach, with a certain amount of depression, headache, loss of appetite and perhaps belching of wind and occasionally vomiting. There may also be accompanying intestinal symptoms, such as diarrhœa and colic, particularly in children. There may be only the familiar heartburn, due to the over-dilatation of the stomach, from the excessive gases of fermentation or putrefaction. In the more severe cases, those that last over a day or two, the symptoms enumerated may be much more intense. The distress may be marked, and the general constitutional symptoms more evident. Vomiting, loss of appetite and mental depression are much more pronounced. This is particularly true of acute gastritis, due to the excessive use of alcohol.

Very frequently, from continued errors in diet, the acute or subacute condition may become chronic so that there is a continual indigestion. Here the symptoms persist for an indefinite period, the appetite is very apt to be variable, although at times very good. Oppression after eating, which may amount to actual pain, is one of the most constant symptoms. Occasionally the pain may be pronounced when the stomach is empty. Heartburn is frequent, if not constant, the stomach is painful on pressure, the tongue is coated, there is bad taste in the mouth, there are changes in the amount of salivary secretion. Frequent belching of gas is a very common accompaniment of chronic dyspepsia, particularly of the flatulent variety. Here also the intestines suffer from distention. Nausea is more pronounced, particularly in the morning hours, and vomiting is common in the morning. Constipation is usually present, although diarrhœa may alternate with constipation, and mental depression is almost characteristic. The treatment of acute and chronic dyspepsias constitutes one of the most difficult problems in modern medicine, particularly as few patients are willing to undergo the ordeals of a rigid dietary regimen. Most cases of dyspepsia can be cured if the diet is looked after, although each case needs careful consideration from the standpoint of causation. Proper eating and proper amounts of food are the two most important features in the treatment. Most people eat too fast, and eat too much. If the food is taken slowly, observing the old-fashioned rules of counting between mouthfuls and small amounts are taken, many patients suffering from indigestion can treat themselves with success. As to the details of the dietary and as to the medicinal treatment of the condition, medical advice is absolutely necessary. One of the most pernicious of all practices in the treatment of dyspepsia is the taking of many of the patent medicines which are so blatantly advertised in the religious and lay press. As most of these so-called tonics are hardly more than alcoholic beverages, it is evident that their use is not unattended with a great deal of danger. The treatment of the constipation that is so frequent an accompaniment of chronic dyspepsia by means of the many patent pills, powders, teas, and liquids is positively suicidal. See CONSTIPATION; ENTERITIS; GASTRITIS.

Dyspha'gia. See SWALLOWING.

Dyspho'nia, roughness of sound; in pathology, a difficulty in speaking. The disorder known as «clergyman's sore throat» is a common example. Rest of the vocal organs, tonics, muscular exercise, change of scene, are generally needed to aid recovery.

Dyspnea, disp-nē'ạ. See RESPIRATION.

Dys'trophies. See MUSCLES.

Dysuria, dĭs-ū'rĭ-ạ, difficult or painful urination, a symptom of temporary disorder, a deep-seated disease. When dysuria is merely the result of a slight cold it can often be relieved by a dose of sweet spirits of nitre, or linseed tea. Sometimes this symptom is the result of a stricture, or it may be caused by gravel, or stone, in which case the services of a physician should be obtained, and that without delay.

Dyveke, dü'vĕ-kĕ, mistress of Christian II. of Denmark: b. Amsterdam 1491; d. by poison 1517. She was the daughter of an innkeeper at Bergen, and Christian met her for the first time in the inn of her father. She accompanied the king to Denmark in 1507 and was constantly with him for the 10 years following. She is one of the most romantic figures in Danish history, and has frequently been celebrated in poetry and fiction as the victim of royal passion, and the insane jealousy of the nobility, who resented her exaltation.

Dzeren, dzē'rĕn, the «goitred» yellow antelope of China (*Gazella* or *Procapra gutturosa*), with unusually pale horns, and a protruding, goitre-like crop. It is indigenous to the deserts of central Asia, China, and Tibet, and is noted for its fleetness. The name "dzeren" is Mongolian.

Dzhol, the Arabian Saturn.

Dzierzkovski, tsērts'kōf-skē, **Joseph,** Polish novelist: b. Xaverov, Galicia, 1807; d. Lemberg 13 Jan. 1865. Among his works are: 'Salon and Street' (1847); 'The Twins' (1854); 'The Jugglers' (1855); 'The Crown of Thorns' (1856); 'Polish Chivalry' (1858), a historical novel; a drama, 'The Spark of Poesy' (1860).

Dziggetai, dzig'ge-tī, the native name for the Mongolian wild horse or wild ass (*Asinus* or *Equus hemionus*), also known as the Kiang (q.v.), and sometimes confounded with the Kulan (*Equus* or *Asinus onager*).

Dzoha'ra, the Arabian Venus.

Dzungaria, dzoon-gä'rē-ä, **Ili Proper,** or **Thian-Shan-Pe-Loo,** an extensive territory in central Asia, the boundaries of which are not very well defined. Dzungaria was originally the independent empire of the Dzungars, a branch of the Mongols, but about 1754 the territory was subjugated by the Chinese, under whom it remained till about 1864, when a rebellion broke out, and the Chinese settlements in Dzungaria were completely destroyed. A period of anarchy followed, which was not put an end to till July 1871, when Kuldja was occupied without opposition by the Russians. Since then the greater portion of Dzungaria has remained in the hands of the Russians, the rest being again under Chinese rule.

E

E the fifth letter of the English alphabet, as also of the alphabets of Greek and Latin, and of all the European languages except those which, as the Russian, use the Cyrillian alphabet, where the E has sixth place. The character corresponding to E in Hebrew and other Semitic languages, as Phœnician, Samaritan, Chaldæan, holds the same relative place in the alphabets of those languages. The form of the letter *he* in early Hebrew and early Phœnician was ꟻ and from that is derived the Greek **E** (epsilon), which is the Phœnician character reversed, with stem shortened and made perpendicular: this character represented in the Hebrew and other languages of western Asia, not the vowel sound E but the soft breathing. Taken into the Greek alphabet it was at first used to represent the vowel sound *e* whether short or long; but afterward the character **H** was employed in Greek for the long *e* and was called *eta*, while the **E** received the name *epsilon*. The Latins used the E for both the long and short vowel and adopted the **H** of the Greek alphabet to denote the aspirate. The name and sound of this letter in all European languages except English is *eh*, as in our interjection of inquiry: long *e* in those languages is invariably equal to *a* in *mate*, and short *e* equal to *e* in *met:* the long E of English is in those other languages expressed by the third vowel, I: thus, English *he, me, lee,* would in those languages be written phonetically *hi, mi, li*. In the standard alphabet employed in linguistic science the vowels *a, e, i, o, u,* are taken to represent the sounds *ah, eh, ee, oh,* and *oo,* and are named accordingly. The letter E occurs in English words far more frequently than any other letter of the alphabet: compared with A, I, O, U, its frequency of occurrence is as 1,000 to 728, 704, 672, 296 respectively; compared with various other letters it is as 1,000 to 770 (*t*), 670 (*n*), 392 (*d*), 280 (*c*), 236 (*f*), 120 (*b*), 22 (*z*). In frequency of occurrence as an initial letter it ranks only as eleventh and is to T as 340 to 1,194. One reason of the greater frequency of E in general use is that it often takes the place, in modern English words, of the vowels *a, o,* and *u* of Anglo-Saxon words; another reason is that final *e* is largely employed to lengthen the vowel of a preceding syllable, as in *there, here, cape, pane:* it is employed even where it serves no purpose of pronunciation at all, as in *gone, live, give.*

E as an abbreviation is used for East, *editio, emeritus,* and *ergo;* e. g. and e. c. for *exempli gratiâ,* and *exempli causâ.*

In music E is the third tone in the key of C, and the fifth semitone in the chromatic scale.

E. C. Sporting Powder is a superficially hardened, soft-grained, smokeless sporting powder, consisting, according to an analysis by C. E. Munroe, of 53.57 per cent of soluble cellulose nitrate, 1.86 per cent of insoluble cellulose nitrate, 3.12 per cent of unconverted cellulose, 34.26 per cent of barium nitrate, 4.55 per cent of potassium and sodium nitrates, 1.17 per cent of volatile matter, and 0.55 per cent of aurine, the latter being an organic coloring matter, used to impart an orange color to the grains. The manufacture, as carried out by the Explosives Company, after the method invented by Reid and Johnson, consisted in placing the moistened, pulped cellulose nitrates and metallic nitrates in "barrels" where, by rotation, the ingredients were mixed and then broken up into rounded grains, which were dried and then sprayed with ether-alcohol which at first gelatinized the surfaces of the grains, and then by evaporation left a hard skin about the grains. The coloring matter was added in the solvent.

E Pluribus Unum, ē ploo'rĭ-bus ū'nŭm ("one from many"), the motto of the United States; chosen for its Great Seal 10 Aug. 1776, by Franklin, Adams, and Jefferson, as a committee. It has been part of the motto of the 'Gentleman's Magazine,' founded 1731; apparently taken by it from a sentence in Virgil's (?) 'Moretum,' "color est e pluribus unus."

Eachard, John, D.D., English clergyman: b. Suffolk, England, 1636; d. Oxford 7 July 1697. He became a Fellow of Catherine Hall, Cambridge, in 1658, and master in 1675. His writings include: 'The Ground and Occasions of the Contempt of the Clergy and Religion Inquired Into' (1670), and a 'Dialogue on Hobbes's State of Nature' (1672). He was a writer of considerable humor, but of no great ability.

Eadie, ē'dĭ, **John,** Scottish religious writer: b. Alva, Stirlingshire, 9 May 1810; d. Glasgow 3 June 1876. He wrote on theology with great vogue among the unlearned; his books including: 'The Divine Love' (1855); 'Paul the Preacher' (1859); etc.; in addition to scholarly treatises and commentaries.

Ead'mer, or **Ed'ner,** a mediæval churchman, historian of his own times and biographer: he flourished in the 11th and 12th centuries, dying at Canterbury about 1124. He was a Benedictine monk and was the companion, counselor, and friend of St. Anselm, Archbishop of Canterbury, whose life he wrote. He held a like relation to St. Anselm's successor, Radulphus, or Ralph, till 1120 when, invited to Scotland by King Alexander I., he was nominated bishop of St. Andrews; but went back to his monastery because of a controversy having arisen over the king's right to nominate and the pretensions of the archbishops of Canterbury to primatial jurisdiction over the bishops of Scotland, which pretensions Eadmer upheld. He was even wont to say that he would refuse the highest see in Scotland if he must divest himself of his character as a monk of Canterbury. He wrote 'Historia Novorum,' that is, history of recent occurrences of his own times. Besides the life of St. Anselm he wrote the lives of three of Anselm's predecessors in the primatial see — St. Odo, St. Dunstan, and St. Bregwyn; also the lives of St. Wilfrid, and of St. Oswald of York; all of which writings have been printed.

Eads, ēdz, **James Buchanan,** American engineer: b. Lawrenceburg, Ind., 23 May 1820; d. Nassau, New Providence, 8 March 1887. He early designed some useful boats for raising sunken steamers, and in 1861, when called to advise the Federal government, constructed within 100 days eight ironclad steamers for use on the Mississippi and its tributaries. He afterward built a number of other ironclads and mortar-boats, which were of considerable service to the North. He built an arch bridge across the Mississippi at St. Louis. (See Eads Bridge.) His works for improving the South Pass of the Mississippi delta were successfully completed in 1875–9; and his great plan for deepening the river as far as the mouth of the Ohio by means of jetties has been demonstrated to be entirely practicable. A later suggestion, for the construction of a ship-railway across the Isthmus of Tehuantepec, attracted much attention. In 1884 he received the Albert Medal of the Society of Arts, being the first American citizen to whom this honor had been awarded.

Eads Bridge, The, so named after its chief engineer, Capt. Jas. B. Eads (q.v.), is the great steel arched bridge over the Mississippi River at St. Louis, Mo. It has three spans, the central being 520 feet in the clear, and the side spans 502 feet. The rise of the central arch is 47½ feet. Each span consists of four steel ribs carrying two railways and a broad highway for teams, street-cars and pedestrians.

The bridge is remarkable chiefly in four respects: (1) The depth and size of the foundations and piers. (2) The method employed in sinking the piers. (3) The novel construction of the arched ribs. (4) The method of erection.

1. All four of the great piers stand upon the bed-rock far below the ordinary bottom of the river. The eastern river-pier extends 126½ feet below extreme high water, with a total height to the upper roadway of 199¼ feet. Its base is an elongated hexagon, 82 feet long by 60 feet wide. The east abutment pier has a larger base and a depth below high water of 134½ feet. These depths were beyond all precedent.

2. The deep piers were built upon hollow iron caissons which at first floated upon the water, and which later during the sinking were supported by the friction of the loose sand which formed the river bed, and by the compressed air in the chambers of the caissons. All the masonry was laid in the open air at or near the level of the water. The sand below the caissons was removed by an ingenious device known as the sand pump (q.v.), invented by Capt. Eads. The difficulties encountered and overcome in sinking the piers to the rock, and in working men under several atmospheres of compressed air — form most valuable chapters in the history of bridge engineering. The air chambers were finally filled with concrete so that the piers now stand solid masses of masonry.

3. Each of the arched ribs consists of two parallel series of steel tubes, one above the other, and 12 feet apart. The tubes are 18 inches in diameter and about 12 feet long, with their ends slightly beveled so that they follow circular arcs. A tube is formed of six bars of steel inserted in a steel envelope one fourth of an inch in thickness, like staves in a barrel. Sleeve couplings and heavy braces give every rib the strength and rigidity of a continuous mass of steel. The first or springing tubes, which are very thick, are screwed into wrought-iron "skew-backs" which are fixed to the masonry by three or four steel (or wrought-iron) bolts 6¼ inches in diameter, and from 24 to 34 feet in length. Under moving loads and changes of temperature the tubes are alternately subjected to tension and compression. These arched ribs with tubular members are unique in engineering history and were the result of a vast amount of study and experiment. In construction they were very expensive.

4. The bridge was erected over a deep and rapid stream without centring and without interfering with the river traffic. The fixed end of a rib made it self-supporting while it was built out from above to about 100 feet; it was then supported by cables passing over the pier and over a temporary tower standing on the pier and by a secondary cable until the centre of the span was reached.

Recent investigations have found the bridge sufficiently strong for the heaviest locomotives and trains. When tested publicly 14 locomotives stood upon each span. Capt. Eads designed the piers, the arched ribs and the method finally adopted for closing them. Charles Pfeifer developed the mathematical theory of the arch, which was finely elaborated by Prof. William Chauvenet. The method of erection was devised by Col. Henry Flad, who gave to the whole work continued study and supervision.

Work on the bridge was begun in 1867 and finished in 1874. The cost of the bridge was about $6,500,000. The difficulties, financial and physical, were many and great. Over 600 men were prostrated by the compressed-air work, and 13 died. The complete story with the "Theory of the Ribbed Arch" is told in 'The History of the St. Louis Bridge,' published in 1881 by the writer of this sketch. See Bridge.

Calvin M. Woodward,
School of Engineering and Architecture, Washington University.

Eagan, Charles Patrick, American military officer: b. Ireland January 1841. In 1862 he entered the Union army as first lieutenant; in 1874 was promoted captain and commissary of subsistence; in 1892, major; in 1897, lieutenant-colonel; on 11 March 1898, colonel, and on 3 May, following, brigadier-general and commissary-general. In January 1899, he made remarks concerning Gen. Miles, in his testimony before the War Investigation Commission, for

EAGLES.

1. The Golden Eagle (Aquila chrysaetus).
2. The Black Eagle (Aquila melanaetus).
3. The Pomarine Eagle (Aquila pomarina).
4. The Oriental Eagle (Aquila orientalis).
5. The Dwarf Eagle (Aquila pennata).
6. The Wedge-tailed Eagle (Aquila audax).
7. The Striped Eagle (Aquila fasciata).
8. The Crested Eagle (Spizaetus occipitalis).
9. The War Eagle (Spizaetus bellicosus).
10. The Harpy Eagle (Harpyia destructor).
11. The Screech Eagle (Haliaetus vocifer).
12. The White-tailed Eagle (Haliaetus albicilla).
13. The Baldheaded Eagle (Haliaetus leucocephalus).
14. The Osprey (Pandion Haliaetus).

which he was tried by court-martial and sentenced to dismissal from the army. His sentence was commuted by the President to suspension from duty and honors for six years. On 6 Dec. 1900, he was restored to duty and immediately afterward retired.

Eagle, James Phillips, American Baptist clergyman: b. Maury County, Tenn., 10 Aug. 1837. He was educated at Mississippi College (1870). He served through the Civil War as a Confederate in all grades from private to colonel. In the close of the War he became a Baptist minister and cotton planter in Arkansas; has been elected four times to the Arkansas legislature, served one term as governor of the State, and for years has presided over the Baptist State Convention.

Eagle, as a popular name includes several raptorial birds which vary in some respects from the strictly defined group in which science has been wont to place it. The order *Accipitres,* to which it belongs, is broad enough in definition to include all the vultures, the typical eagles, and the buzzards. Recent osteological demonstrations, however, have led to the separation of American vultures from the Old World vultures, including the latter in the family *Falconidæ*, to which eagles and vultures belong. This family, which embraces 300 species of diurnal raptores, is characterized by imperforate nostrils, legs of medium length, and, except in the Old World vultures, a feathered head, a bill decidedly hooked, the hind toe inserted on a level with the three front ones, and the claws roundly curved and sharp. The subfamily *Aquilinæ* makes prominent the cutting edge of the upper mandible, the bony shield over the eye, the feet heavy and short, either scutellate or feathered. The Lämmergeier (*Gypaetus barbatus*), lamb-killer, or bearded vulture of the Alps, the Pyrenees, and the Himalayas, finds its nearest affinity here. The *Aquilinæ* are naturally divided into two genera: *Aquila,* land eagles, and *Haliaetus,* sea-fishing eagles. The former is feathered to the toes, the latter half way to the toes.

The leading specimen of *Aquila* is the golden eagle (*A. chrysaetus*) one of the largest and most magnificent of its kind, dark brown with purple gloss; head and neck brownish-yellow; tail rounded and dark brown, ending in light and dark tints. The length is about three feet, the extent of wing seven feet. In North America its range is from Mexico north. It is very scarce in the United States but more abundant in Canada, where it is distinguished as *canadensis.* It is regarded as a variety of the European species, which seldom occurs in England, though more prevalent in Scotland, where the demand for its eggs has favored its increase. The nest is usually placed on some inaccessible cliff, the eggs are spotted and do not exceed three. Closely allied to the golden eagle are the imperial eagle (*A. mogilnik*) of southwestern Europe and of Asia, and the king eagle (*A. hiliaca*) of the same range. The smallest of the kind is the dwarf eagle (*A. pennata*) which measures less than two feet and is native in Southern Europe, North Africa and in India.

First in interest among the sea-eagles stands the bald-headed eagle (*Haliaetus leucocephalus*), selected as the national emblem. Its markings are familiar, though the term "bald" is to be referred not to the absence of feathers, but to the effect produced by the white feathers on the head. In size, it corresponds nearly to the golden eagle, but it differs in its habits, living mainly upon the fish which it seizes along the sea-shore and around lakes and rivers. The nest is built on a high tree top or upon a rocky cliff. A finer specimen than this is the northern sea-eagle (*Haliaetus pelagicus*) of northeastern Asia. It is conspicuous by its large form and bill, and by the contrast of its main color, brown, with the white of its shoulders, rump and tail. The African sea-eagle (*H. vocifer*) is a fish-eater, about half the size of the "bald-head," remarkable for its color-markings, being white on the head, neck, and breast, while the under parts and wing coverts are chestnut, and the upper parts are black or brown. Nearly related to the *Haliaetus* is the fishing-eagle (*Polioaetus ichthyaetus*) of India and the East Indies, with extremely curved talons, and living entirely on fish. In countries bordering on the Mediterranean and ranging into India and Central Europe, is the serpent-eagle (*Circaetus gallicus*) with short toes, white, brown-spotted under parts, and dark brown upper parts. It feeds upon reptiles, which it kills and carries away, not eating the game on the spot, as do other eagles. A buzzardlike genus, *Helotarsus,* is represented in Southern Africa by *H. ecaudatus,* the short-tailed eagle, ornamented with maroon and black plumage, and bright red, very short legs.

The buzzard-eagles include some species which command notice from their great size and powerful action which fairly entitle them to their name. South America, in the dense forests of the Amazon, is the habitat of the Guiana eagle (*Morphnus guianiensis*) relatively small, but with a tail longer than that of almost any other species. The wings are short and rounded, adapting it to swooping down with great force upon its prey, rather than for lofty or prolonged flight. From southern Mexico through the forests of Brazil, the harpy-eagle (*Thrasaetus harpyia*) has its home, and for muscular power is scarcely surpassed by any bird of prey in the world. It is larger than the golden eagle, gray in color, with long crest feathers, a stout, vicious bill, and talons of extraordinary force and sharpness. Though rapacious and apparently destructive, the eagles are useful in killing many other birds which venture nearer to farms and human habitations, in reducing the number of injurious reptiles and small mammals, and in helping to preserve the balance of the animal world.

Eagle, a gold coin in the United States of the value of 10 dollars, or £2 1*s.* 8*d.* sterling, and weighing 258 grains troy, 900 fine. It was first coined in 1795, in accordance with an act of Congress, dated 2 Jan. 1792. There are also half eagles (first coined in 1795), quarter eagles (first coined in 1796), and double eagles (first coined in 1849), of proportionate values.

Eagle, in astronomy, name given to a northern constellation, from the bird supposed to have carried the thunderbolts of Jove. The constellation is usually called by its Latin name, *Aquila.* The most important star in the constellation is Altair, whose brightness is nearly that of a typical star of the first magnitude.

The name is also given to the standard carried by the ancient Roman legions. This standard consisted of a staff, with an eagle perched upon its extremity. A special band of men was appointed to precede and guard these eagles, which always led the army into battle. The French battle standard, in imitation of the Roman, is also surmounted by an eagle.

In heraldry a bearing of frequent occurrence, and often assumed by sovereigns as the emblem of empire from having been borne on the legionary standard of the ancient Romans. The United States, in 1785, adopted the bald eagle, its wings displayed, proper, as the national emblem. The eagle of Russia is *or,* with two heads, displayed, sable, each ducally crowned of the field; the whole imperially crowned, beaked, and membered gules. The eagle of Austria is also displayed with two heads. The Prussian eagle has only one head.

Eagle, Black, a term applied to the golden eagle, *Aquila chysaetus,* also to the young of the bald-eagle. See EAGLE.

Eagle, Black, Order of, a Prussian order, founded by Frederick II. in 1701. The number of knights in the order is limited to 30, exclusive of the princes of the blood royal, and all members must be of unquestioned nobility. The badge is a cross of eight points having in the centre a circle with the monogram F.R. (for *Fredericus Rex); * the four arms are enameled red with the eagle of Prussia in black enamel between each two arms.

Eagle Hawk, or **Hawk Eagle** is the name for a group of some rather small and some large raptorial birds, closely related to *Aquila,* and chiefly represented by the genus *Spizaetus.* They are beautifully crested and range in South Africa, Central and South America. A notable specimen is the crowned eagle (*S. coronatus*) of South Africa, of medium size, its under parts buff, banded with black, the head furnished with a crest of long, brown feathers. Of the same geographical range is a species of *S.* (*Lophoaetus*) *occipitalis,* a small bird with a crest four inches long. In Central and South America are crested members of the group, *S.* (*Lophotriorchis*) *isidori* and *S. ornatus.*

Eagle Owl, an owl of the genus *Bubo* (family *Strigidæ,* horned owls, order *Accipitres,* represented in nearly all parts of the world except Australia. Of rare occurrence in Great Britain, it is common in the foot-hills of the Ural Mountains, and throughout Siberia as far as China. In the northern Old World *B. ignavus* is one of the largest owls, of unsurpassed strength and daring. The colors are black, brown and white, mottled. A grown specimen weighs about eight pounds and measures 26 inches from bill to end of tail; the wing is 18 inches long, and the plume feathers, constituting the horns, are nearly 4 inches in length. It is the boldest and most ravenous owl, and is a match for the eagle. To the superstitious people of the north, its weird call-note sounded at night in the depths of the forest announces the presence of evil spirits. The great horned-owl of America (*B. virginianus*) bears a general likeness to its European congener, though smaller in length of body and wing. The colors are the same but differently arranged. The lower parts are barred rather than spotted, the breast and throat are marked with a large white patch, and a black ring is stamped on the disk of the face. Like the European species, it preys upon hares, large ground birds, rats, mice, reptiles, and fish, and besides on the young of the American turkey.

Eagle Pass, Texas, town, county-seat of Maverick County; on the Rio Grande River; the Mexican I. and the S. P. R.R.'s; about 155 miles southwest of San Antonio. It is a trade centre for a coal mining and cattle section, and the shipping of cattle, hides, and wool is steadily increasing. It contains large brick and lumber yards. Pop. 3,200.

Eagle Ray, a fish of the order *Raiæ, of* which the torpedo and the sting-ray are familiar members, and associated with the sea-devil in the family *Myliobatidæ.* It is a flat fish with a very broad disk distinguished by pectoral fins which continue to the snout and then reappear at the extreme end of the head. The tail is long and slender like a whiplash. The teeth are flat for crushing crabs and for grinding shells. Though much smaller than the sea-devil, which is sometimes immense, the eagle ray often attains a considerable size. It brings forth its young alive, and inhabits tropical or subtropical waters.

Eagle, Red, Order of, originally called Order of the Red Eagle of Baireuth, and also called Order of Sincerity; founded by the Margrave of Baireuth in 1705. The badge is an eight-pointed cross, having in the centre a medallion with a red eagle bearing the arms of the Hohenzollern family.

Eagre, a Norse word signifying a formidable influx and surging of the tide, the same as *bore* in a river, as in the Severn and Hooghly rivers and the Bay of Fundy. See BORE.

Eakins, ēk'ĭnz, **Thomas,** American artist: b. Philadelphia 25 July 1844. He was a pupil of Gérome. He has been professor in several art schools, lecturing there on anatomy and painting. Among his works are many pictures of American domestic scenes, out-of-door sports, portraits and several large canvases, such as Dr. Gross and Dr. Agnew at their clinics. The colossal figures of the prophets, Witherspoon building, Philadelphia, were molded by him and his pupil Samuel Murray.

Ealing, ēl'ĭng, England, town, and also a parliamentary division of Middlesex, the former a few miles west of London. The town has a free library, science and art schools, and a training college for teachers of the deaf. Pop. of town 23,979; of the parliamentary division 70,748.

Eames, ēmz, **Charles,** American lawyer and journalist: b. New Braintree, Mass., 20 March 1812; d. Washington, D. C., 16 March 1867. He was graduated at Harvard in 1831, and began the study of law. After accepting a position in the navy department at Washington in 1845, he took editorial charge of the Washington *Union.* He was sent by President Polk as U. S. Commissioner to the Sandwich Islands, and afterward became United States minister to Venezuela, under President Pierce. Returning in 1858 he gained a great reputation as a lawyer in admiralty cases.

Eames, Emma, American operatic prima donna: b. Shanghai, China, 13 Aug. 1867. She studied music in Boston and Paris, singing in churches and concerts in the former city, and making her début in grand opera, Paris, 13 March 1889, in 'Juliette,' appearing in grand opera at the Covent Garden, London, 1891, and in New York the same year, since which time she has been a popular member of grand opera companies in Europe and America. She married the well-known artist, Julian Story, 1891, but was divorced in 1907.

Eames, Wilberforce, American bibliographer: b. Newark, N. J., 12 Oct. 1855. He has long been prominent in bibliographical matters, having been assistant at the Lenox Library, New York, 1885; assistant librarian 1892; librarian 1893–5, when upon the consolidation of the Astor Library and Tilden Trust as the New York Public Library, Astor, Lenox and Tilden Foundations, he became librarian of the Lenox branch. He edited volumes 15–20 of 'Sabin's Dictionary of Books relating to America' (1885–92). Among his works are: 'Bibliographies of the Bay Psalm Book' (1885); of 'Ptolemy's Geography' (1886), and of 'Sir Walter Raleigh'; bibliographic notes on 'Eliot's Indian Bible' (1890), reprinted from 'Pilling's Indian Biographies,' and a bibliographic account of the early catechisms of New England (1898).

Ear, Anatomy, Physiology, and Disorders of the. In most of the animal creation the vibrations which we term sound have special portions of the body for their recognition, more or less precise; although in the lower forms every part of the simple organism can respond to them in some degree. The earliest separation of a distinct hearing-organ is seen in the Medusæ, of which the common nettle of the salt waters is a well-known example. Here we find certain of the tentacles covered with delicate cells having hair-like projections and enclosing a chalky concretion, the otolith (Fig. 1). This structure of a tiny vesicle with single or mul-

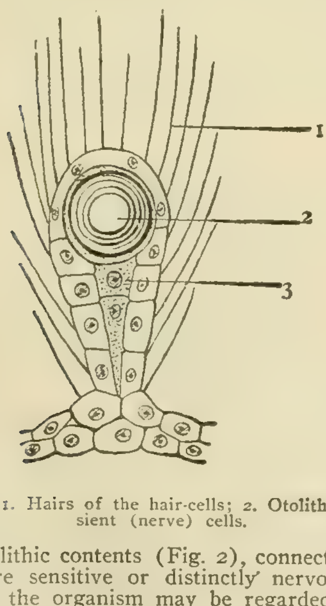

FIG. 1.— 1. Hairs of the hair-cells; 2. Otolith; 3. Sensient (nerve) cells.

tiple otolithic contents (Fig. 2), connected with the more sensitive or distinctly nervous portions of the organism may be regarded as the fundamental form of the ear; as it develops, it takes on more and more complicated forms of fluid-containing sacs deserving the name of "labyrinth," in which chalky particles (often of special crystalline form) lie in close relation to "hair-cells," — as we term these structures with their delicate prolongations. A nerve, more or less defined, passes to the sac (Fig. 3) and connects it with the sensory centres, which in the vertebrates and some of the higher invertebrates may be called brain-centres. This apparatus is in the vertebrates imbedded in the cartilage or bone on either side of the head; and in those creatures which do not live in the water, accessory apparatus

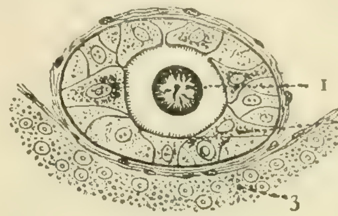

FIG. 2.— 1. Otolith; 2. Hair-cells directed toward cavity; 3. Nerve-cells.

is present to help transmit the air-vibrations to the fluid ("endolymph") of the labyrinth. As we pass up the scale of animal life the organ of equilibrium is found in relation to that of hearing; and thus in the lowest fishes we find that the sac assumes a ring-form (Fig. 4) by reason of the formation of a semicircular canal with a pear-shaped widening or ampulla at either end. In these the nerve terminates in hair-cells without otoliths, while between these a larger portion of the sac receives the main nerve-supply at a prominent "macula" supplied with hair-cells and otoliths. A second and a third semicircular canal, each with its own ampulla and nerve, is found in the higher forms, and the main sac divides into two increasingly separate portions with separate nerve-supply. One of these portions communicates with the semicircular canals, while the other is connected with a tubular outgrowth, which in the highest forms coils into a spiral and is encased in a snail-shell covering, which gives it the name of "cochlea." The nerve passing to this becomes highly developed and the end-organ is greatly elaborated into an apparatus generally called after its discoverer, "Corti's organ." Around this essential apparatus more and more complex protective envelopes and spaces filled with "perilymph" have been developed, while accessory apparatus, called middle and external ear, have been formed to aid in the conduction of sound-waves to the percipient contents of the labyrinth.

The development thus roughly traced in the ascending scale of animals can be still more perfectly seen in the development from the ovum of the embryo of the higher forms. Here we see a portion of the external surface dip inward as a pit, become separated as a closed sac beneath the surface, undergo the elaboration described, secure nerve-connection with the brain and at such points of communication develop its hair-cells and otoliths. Originally a spherical sac, its complexity soon merits its name of labyrinth and this membranous labyrinth gives form to a surrounding labyrinth of cartilage or bone, which has been longer known and studied.

Taking the human ear as representing that of all the higher vertebrates and as an elaboration of that of lower animals, we find an acoustic nerve emerging from each side of the pons or lower back part of the brain, to pass, in close association with the nerve giving motion to the face, into the stony-hard, innermost part of the temporal bone which encloses the ear, but may be paralyzed by involvement in tympanic disease. The facial nerve passes on through, and practically has but accidental relation to the ear. The acoustic nerve, containing nerves for the organ of equilibrium, divides and

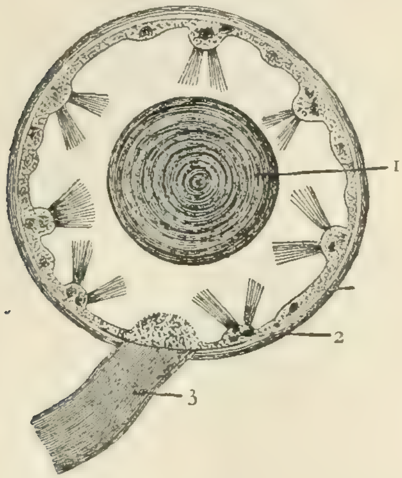

FIG. 3.— 1. Otolith; 2. Hair-cells; 3. Nerve-trunk.

is distributed to the various parts of the labyrinth. At each point of its distribution cells with hair-like projections form end-organs through which impressions are received to be conveyed to the brain. Three of these points are in the three pear-shaped swellings of the semicircular canals, two are in the two vestibular sacs and the most elaborate enters the base of the snail-shell (Fig. 8), and is distributed to the highly elaborated organ of Corti, here located. This consists of a fairly orderly arrangement of hair-cells without otoliths, supported by curiously modified cells of like origin (Fig. 7), all resting upon a delicate "basilar membrane" narrowest below and broadest above, which winds spirally from the bottom to the top of the shell-like cochlea, and is formed of parallel transversely stretched fibres. Here we have an apparatus comparable to the strings of a harp or piano; and just as each string of a musical instrument can vibrate in accord with those attuned to it in another and can even repeat the tones of an inaudibly distant instrument with which it is connected by a wire; so there is much to support Helmholtz's claim that each fibre of the basilar membrane is a cord tuned to a certain pitch and vibrating responsive to any tone of that exact pitch which reaches it. This serves to excite a special hair-cell resting upon it and send a nerve-impulse along the ultimate nerve-fibril of which this forms the terminus. Certainly the apparatus in form and elaboration meets most of the requirements of such a theory and its partial destruction by disease has caused loss of hearing for certain tones — low if the apex, high if the base, be injured.

Outside of the labyrinth or *percipient* apparatus we find a *conducting* apparatus of external and middle ear (Fig. 9). The outer ear is formed by the in-growth of a pit of the skin-surface to constitute an external auditory canal, around the edge of which gristly projections raise the skin-covering into the prominent but unimportant features to which the name "ears" is commonly applied. The inward growth of the canal brings its bottom into close relation with the middle ear, so that only a thin partition, the drumhead, intervenes. The middle-ear is an outward development of the mouth-cavity, which hollows out the tissues between the external and internal ears — forming the Eustachian tube as its inner portion, the drum-cavity or tympanum just within the drumhead at the bottom of the external canal, and other air-spaces, "mastoid cells," of less constant presence and form and of doubtful value, but notable because of serious disease-conditions to which they are subject. Two "windows" make communication between the internal and middle ear, both closed by membranes shutting in the fluids of the labyrinth — that closing the lower "round window" being called the secondary tympanic-membrane. The upper or "oval window" is occupied by the foot-plate of the stirrup-bone, which with the little hammer and anvil forms (Fig. 11) a compound lever between the drumhead and the labyrinth-fluids. This serves to increase the force while lessening the amplitude of the vibrations of the drumhead and thus aids the transmission of waves of sound, especially of low tones, from the air to the internal fluids. The lower animals move the external ears as an aid in locating sounds, but the muscles effecting this are rudimentary in man and the external ear can be lost with little recognizable impairment of hearing. More important, although of ill-determined working, are the muscles moving the little bones of the drum-cavity; one, the drumhead tensor, drawing in the hammer-handle and thus tightening

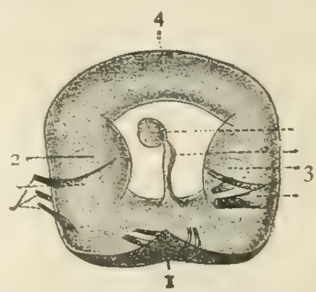

FIG. 4.— 1. Acoustic nerve and macula in vestibular sac which communicates with (2) the anterior and (3) posterior ampulla of (4) the semicircular canal.

the drum-membrane to which it is attached, and one acting on the stirrup. Even the drumhead and chain of little ear-bones can be actually or virtually destroyed with preservation of a large part of the hearing: but their presence in damaged condition may be a serious obstacle to useful function by impeding sound conduction.

The upper and lower limits of human hearing are somewhat in dispute, but it is fairly safe to say that tones of 32 double vibrations per second and up through 10 octaves, should be audible to a healthy ear. If a cog-wheel touching a card or other elastic plate be turned with increasing speed the individual strokes or vibrations can be distinguished up to 16 per second;

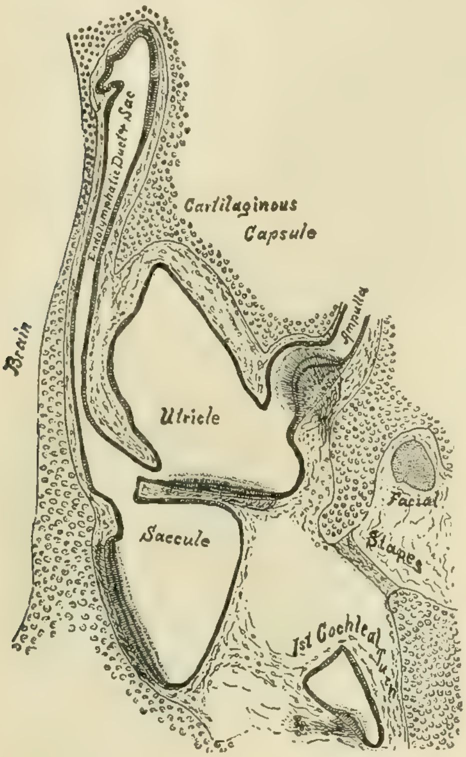

FIG. 5.—Developing labyrinth dividing into two sacs with separate areas of hair-cells.

then they blend and a continuous tone is produced; but the tone heard may be an overtone and not that of 16 per second as is often claimed. Through the thin young drumhead or one having an opening in it still higher tones can be heard, probably up to 55,000 vibrations; but age and disease easily effect changes which bar out these high and relatively weak tones; yet it is striking to note how well they may be heard by those deaf to ordinary speech. Those unable to enter general conversation by reason of impairment of the conducting apparatus may often hear the same voice readily over the telephone, which transposes it to a higher key; and some much-advertised hearing-helps have their value as portable telephone lines. Human speech, the hearing of which is in civilized life the most important use of the ear, has a range from near the lowest limit of perception in the sound of R to some 4,000 vibrations per second in the sibilants S and X. We have in speech, therefore, with its easy gradations of intensity from faint whispers to loud shouts, a ready means of testing the hearing and measuring its defects. Variable as are voices or even the same voice within its range, it constitutes our best practical test of the degree of deafness. Generally the faintest articulate whisper should be heard at arm's length and a loud "stage whisper" 50 feet or more. The numbers up to 100 make good tests if rightly selected and should be spoken clearly with the "reserve-air" which can be expelled from the lungs after an ordinary "tidal expiration"; and they should be repeated by the person examined in evidence that they have been correctly heard. The watch is a very variable, limited, and imperfect test, which may be ill-heard by ears otherwise perfect, well-heard by some with little useful hearing and imagined or falsely claimed to be audible when it is not, in a way not always easy of detection. All measurements of hearing for sounds or speech should be made with the eyes screened from seeing the approach of a sounding body or "reading the lips" as many deaf persons do most successfully, at times unconsciously. Medically, the best tests of hearing are by speech and by tuning-forks — the latter serving not only to measure the hearing or loss of it, but to locate the seat of trouble as a prime requisite to successful effort for recovery. A "continuous tone-series" of tuning-forks or other instruments may be used by the expert to test the entire ten or more octaves; and the aurist should always have several forks, although much may be learned with a single one. A fork of 200 to 500 double vibrations per second is the most useful and should be seven or more inches in length and weigh as many ounces; the latter is important as the loudness and duration of tone depend upon it. One of 30 to 50, and one of 2,000 double vibrations should also be used, while intermediate tones have value. The lower forks should have thickened ends or clamps or pieces of rubber-tubing on the tips

FIG. 6.— Diagram of the cochlea in section with the channels for its nerves and the perilymph spaces which surround the cochleal canal in its windings.

to damp the "over-tones," which may be heard by ears to which the fundamental note is inaudible. The fork should be struck by falling of its own weight through its own height upon a rather dead surface such as the top of the knee, and will thus give a tone of fairly constant strength; and testing a number of normal ears will show for each fork at what distance or for how many seconds it should be heard after a standard blow. Thus if a fork which a normal ear hears at 15 inches or for 100 seconds is heard by a deaf ear only 5 inches or for 30 seconds, 5/15 or 30/100 fairly represents the fraction of hearing remaining. Ears with impairment of the percipient apparatus of the internal-ear hear high sounds relatively less as a rule; those with the more usual conduction-defect hear low tones worse. A case of "nerve-deafness" may hear no sound from the 2,000 fork — a case of tympanic catarrh none from the 50 fork; although all other tones are fairly or even perfectly heard. A whistle de-

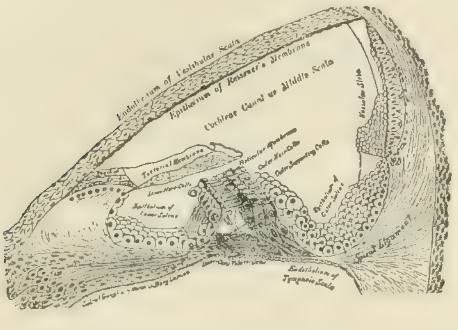

FIG. 7.— Scheme of human cochleal canal in section showing Cortis organ and its nerve connections.

vised by Galton giving tones from 4,000 up to 40,000 double vibrations is a practical and useful aid in studying the upper limits of hearing, as are the steel rods suspended by threads introduced by Koenig, since tuning-forks of such a pitch are unusual and costly. All of these tests should be made at the side of the head, but not so near that they may be *felt* instead of heard. The other ear may need to be closed with a down cushion or other adequate cover and we must avoid several "deaf-spots" nearly opposite the opening of the canal where the sound-waves by interference are weakened or lost.

Thus far we have considered tests of the hearing for sounds coming through the air in the usual way; but if the handle of a vibrating tuning-fork or other sounding instrument be rested upon the head it will be heard through the bone, and the sound will generally be much louder if the fingers are stuck into the ears. If only one ear be stopped, it will be heard louder in this ear — so much so that the other generally fails to recognize its vibration, even though the fork is resting close behind or above it. Normally this "bone-conduction" is only half as loud as "air-conduction" — the fork which should be heard for 100 seconds through the air in front of the ear is heard but 45 when resting behind it. It can usually be heard from the bridge of the nose or the teeth after it has become inaudible back of the ear; but when unheard here it should be audible for a further period if held close outside of the canal-opening. Yet disease-conditions can affect the matter like stuffing the fingers in the ears; the obstructions in the conducting apparatus which bar out in greater or less degree the outside air-vibrations shut in and echo back upon the percipient apparatus sounds produced or conducted within the head. The deafer ear may hear the sound by bone-conduction better than its fellow. More than this — it can often hear better than a normal ear, perceiving through the bone for 50 seconds, perhaps, the vibrations which ought to be heard for only 45. With this generally goes a marked loss of hearing through the air, which may be reduced from 100 seconds to 40, 20, or less. Under such conditions bone-conduction will be better than air-conduction and the sound will be louder as well as longer when resting on the head. This constitutes Rinne's or Schwabach's test and is simplified by resting the handle of the lightly vibrating fork back of the ear and then placing it outside the opening with the question "louder back or front, front or back?" The perception through the bone, especially at the bridge of the nose, ought to be nearly the same in duration as the *feeling* of the vibrations by the examiner's fingers; and Gardiner Brown saved time and confusion by noting how many seconds before or after his fingers lost the vibration, it ceased to be heard in the ear. Bone-conduction may greatly preponderate, in evidence of the conductive defect in an ear with marked loss of air-conduction, and yet this test or Schwabach's timing will show that the perceptive apparatus is also defective and loses the sound sooner than normal, instead of having it exaggerated. So we must test the actual, as well as the relative, perception through the bone.

Another delicate and important test may be here mentioned. The drum-cavity communicates with the throat back of the nose by a trumpet-shaped tube called after its describer Eustachius. This serves as a drain for the removal of any mucus from the drum-cavity and as a ventilating passage for maintaining equal air-pressure on each side of the drumhead. It is really a slit habitually closed, but opens in the act of swallowing or yawning, from the action of the muscles lifting the palate. If a sounding tuning-fork, then, is held before the

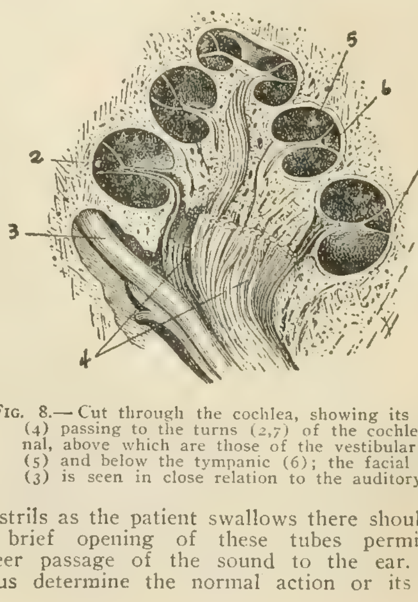

FIG. 8.— Cut through the cochlea, showing its nerve (4) passing to the turns (2,7) of the cochleal canal, above which are those of the vestibular scala (5) and below the tympanic (6); the facial nerve (3) is seen in close relation to the auditory.

nostrils as the patient swallows there should be a brief opening of these tubes permitting freer passage of the sound to the ear. We thus determine the normal action or its lack in these very essential parts of the apparatus.

This proper ventilation of the drum-cavity is needful for perfect function. It is said that the head of the military drum will split if there is no opening in the side; and certainly a stuffed Eustachian tube makes all concussions painful if not damaging to the drum-membrane. Any excess of pressure within interferes with the freedom of the windows, while any lack of air makes pressure on the outside preponderant, forcing in the drumhead and through the chain of bones pressing upon the labyrinth. More than this, if the partial vacuum in the drum-cavity is increased through absorption of the unrenewed air by the moist lining, the drumhead becomes stretched until it collapses into contact with the inner wall, or the walls congest and swell to fill the space or else fluid is poured out to occupy the cavity. Generally all of these results are present in varying degree and from this comes the large majority of ear-diseases. So, too, interference with the freedom of the breathing through the nose unfavorably affects the ears. If one holds the nose and blows, air will be forced up the tubes into the drum-cavities, and swallowing motions have to be made

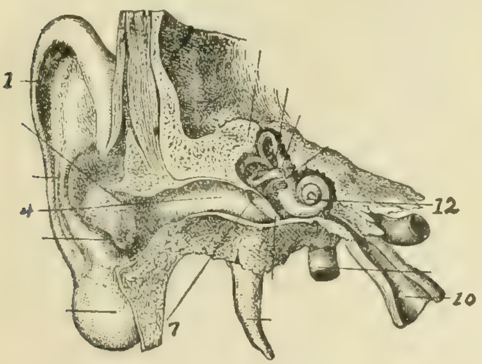

FIG. 9.—Section through external ear with its pinna (1) and (4) canal and the middle ear with its drumhead (7) and Eustachian tube (10), showing the labyrinth with its cochlea (12) and semicircular canals.

to relieve the distention. If this swallowing is done while the nose is held closed, strong suction is exercised, making partial vacuum in the drum-cavity, and this occurs when cold-taking stuffs up the nose or tonsillar enlargement narrows the upper throat just behind it. It is not surprising then, to find that two thirds of ear-patients have middle-ear trouble, only one fourth external-ear affections and in hardly one tenth is the percipient nervous apparatus at fault. This explains why much of the treatment of ear-diseases must be directed to or through the nose and throat in the effort to restore free ventilation and repair the injury due to the lack of it. The unfavorable influences are often slow and insidious in action; deafness may be advanced in one ear without attracting the notice which any defect of the second ear quickly forces upon the attention; and treatment must be long-continued if it is to retrace much of the course by which the affection has passed to its later stages. Discouragements are frequent, and the conscientious aurist has to tell his patient that only the recent losses can probably be recovered, and that ill-health or recurrent cold-takings may offset his best efforts. Yet many of these cases tend to grow steadily worse unless judiciously treated and a gain, however slight, is better than a loss. Mere inflation of air up the Eustachian tube by the Politzer bag or the catheter can aid the earlier stages; but in chronic conditions intratympanic medication must be used to stimulate the lining of the drum-cavity and retrace the steps by which it has become thickened and stiffened.

Accompanying the defect of hearing for outside sounds there may be greatly increased hearing of noises within the head. Every one hears a singing in the ear when a shell or other resonator is held against it, and similar results often follow any thickening and stiffening of the conducting apparatus. Tinnitus, as the subjective sound is called, may be due to many causes, however, and its relief is often difficult. Generally a perception of the sounds of the blood-circulation, it may be caused by changes in the blood itself in anæmia, by overaction of the heart, by brain-pressure due occasionally to stuffiness of the upper nasal passages, as well as to more local affections. It is usually worse when lying down and in a silent place, since outside noises and occupations of mind and body make it less noticeable; but it is in some cases unceasing and intrusive, seeming to bar out other hearing, and may be almost maddening. In its milder forms it is annoying and excites apprehension of deafness or of brain-disease, with which it is known to be sometimes associated; but its many causes, often wholly trivial, must be remembered and rational measures employed for its relief. As stuffing of the Eustachian tubes or tension of the drumhead and chain of bones are its common causes, much relief can often be gained by simple hot gargling to

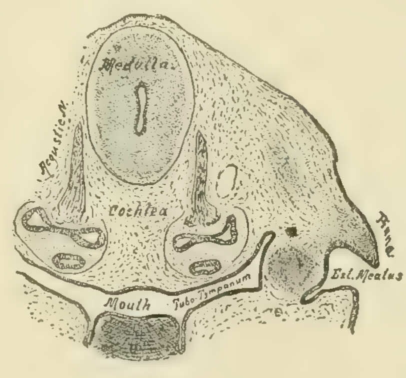

FIG. 10.—Developing ear with cartilage in the partition between external and middle ear, which are beginning to form.

free the former, or gentle massage of the drum-structures, as may be well done with the hands.

A curious characteristic of conduction-defects is the ability to *hear better in a noise*, often better than normal ears. A person deaf to ordinary speech in a quiet place will hear on a train much that is inaudible to persons nearer the speaker. One with nerve-deafness will be unduly disturbed by other noises, although perhaps unconscious of defect in a still place.

Only less important than freedom of the Eustachian tube is a healthy free condition of the external canal. This is lined with skin and supplied with glands like the sweat-glands elsewhere, but furnishing the ear-wax or cerumen which consists of the dead skin-scales and oily material. The purpose of this seems to be to arrest by its stickiness the entrance of dust, small insects, etc., from outside; but it serves a more useful purpose in cleansing the ear. The growth of new skin is most active at the centre of the drumhead and is there rapid enough to spread out over the membrane, moving the older cells before it by a glacier-progress which carries them beyond the margin and out upon the

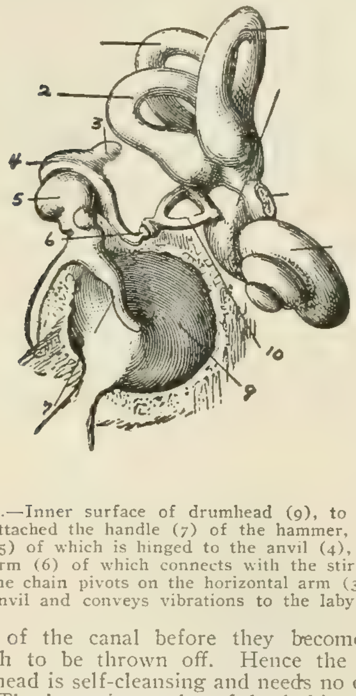

FIG. 11.—Inner surface of drumhead (9), to which is attached the handle (7) of the hammer, the head (5) of which is hinged to the anvil (4), the long arm (6) of which connects with the stirrup (10) the chain pivots on the horizontal arm (3) of the anvil and conveys vibrations to the labyrinth.

walls of the canal before they become effete enough to be thrown off. Hence the normal drumhead is self-cleansing and needs no officious aid. The loosening scales of dead skin pass out along the walls of the canal and about its middle become a pasty mixture with the secretion of the cerumen-glands. This clings to the fine hairs of the canal, but is gradually worked outward by the motions of the jaw-joint, which presses upon the canal, and drying into unnoticed scales it escapes from the exit. Under diseased conditions, including those of the throat and middle-ear, the wax tends to diminish in quantity and grow harder, escaping less readily or collecting in firm plugs. So long as any crack remains for the sound-waves to pass between it and the wall, hearing may be unaffected by an almost total filling of the canal; but jarring may force it down upon the drumhead and moisture may swell it into complete closure. Marked and sudden deafness results, often with dizziness, tinnitus or coughing. The plug may dry or crack away from the wall, quickly relieving the trouble, but only for the time; and it becomes so moulded to the irregular curves of the canal as to make it difficult to remove. Most of the sponges and spoons offered in the drug-stores are good only for ramming in the wax more firmly and pressing it down upon the drumhead. They should never be used. The best solvent for ear-wax is hot water, and it should be syringed in with gentle force until the last particle of the plug has been removed. Dropping in of oil or other fluids rarely does much to loosen the collection, they can often increase the distress caused by its presence — they certainly cannot remove it, although some hope that they will do so seems present to many that use them. Any violence in digging out the plug or too vigorously working even with the syringe is to be condemned. Underneath it skin-flakes have been forming which are often partly incorporated in its mass, partly still fast to the walls — ready like "hang-nails" to tear down into the quick and leave open wounds, very easy of infection. One seventh of the work of the aural surgeon consists in removing ear-wax, rather especially for those of his private patients who *seek to be too clean.* It is easy to do it skilfully and promptly, yet it is often not so removed. If spoon-like instruments be used at all they should be *sharp* — they will thus be more efficient, while no mistaken idea of harmlessness will make them doubly dangerous. There is many a thing besides a firearm that a man "did not know it was loaded."

Seeds, beads and other foreign bodies are sometimes put into the ears. If they are let alone they may remain for many years without doing the least harm; but forcible removal has often done great or fatal injury. If the ear is directed downward they will often fall out, especially with a little rotary rubbing in front of the ear. The syringe will almost invariably bring them away promptly and safely. If they have been rammed in and fixed, it is really gentler to remove them by laying forward the soft parts under ether and operating in the bony canal.

Two other affections of the external ear make up much of the 25 per cent of disease involving this part — the diffused and the circumscribed inflammations of the canal. The first may be broadly called eczema — the latter furuncle or boil. Gout and many general conditions can predispose to the eczematous inflammation, which by its heat and moisture makes the ear a hot-bed for the growth of the moulds and bacteria which maintain or increase the trouble, and it may have an intensity verging into erysipelas. The milder, chronic forms are generally responsible for furuncles, for they furnish the itching which leads to scratching and the germs which punish this. "What did you scratch it with?" will generally bring confession of a hairpin or a match-stick according to the sex, and boils are more common on the right-hand side. The suffering caused by a boil may be extreme; sometimes keeping the patient walking the floor all night. They are rarely serious matters, but each tends to cause others, so they cannot be made light of. They consist of an infective inflammation of the glands of the skin lining the canal and are apt to be trivial when the superficial sebaceous glands are involved, but more severe if a deeper cerumen-gland is the seat. These glands extend into the subcutaneous tissue, possibly into the periosteum, so their inflammation can excite a periostitis pressing the ear out of place and perhaps strongly suggesting mastoid inflammation. Pressure or motion of the parts, as in chewing, is acutely painful; but firm pressure on the bone can be comfortably borne if all motion of the canal be avoided. Hot douching (110° F.) is usually comforting and if fully used has an excellent tonic effect; warmth and moisture often increase and renew the trouble. The infection should be fought by mercurial oxide ointment and, if bearable, a firm plug covered with it should be passed into the swollen canal where it will exercise pressure, secure a useful massage from each jaw-motion and continue throughout the day the rubbing in of the salve.

Bony outgrowths of the walls sometimes narrow or close the external canal and less often cancerous growths involve it and the external ear. The bony growths are curiously common in the ears of ancient Peruvian and Moundbuilders' skulls and in modern times in Hawaii and in England. The London surgeons among their private patients see and remove more of these bony outgrowths than are reported from all the hospitals of the world. Their causes are not clear, and bathing has been suggested as influencing their formation. As seen in other than Englishmen, the great majority seem due to long-continued discharge from the ear; and this suppuration must be cured or the growth removed, lest the confinement of pus may lead to serious or fatal complications.

The suppurative inflammations of the middle-ear form the most important phase of our subject, not only because of their malign effect in producing deafness and deaf-mutism, but from their serious menace to the life. Thousands are known to die annually from ear-diseases, and the records of large numbers of post-mortem examinations show that a larger proportion usually escape recognition during life. The prevalence of influenza for ten years past has hugely increased the frequency of serious outcomes, as well as served to bring them to notice; but even before that the record was long and grim. All the eruptive fevers, especially scarlatina, measles and typhoid, are apt to bring involvement of the ears. These should, therefore, be closely watched and generally guarded in some measure by coverings, especially in children, who may never call attention to their ears and yet if they lose hearing are prone to become deaf-mutes.

It is well known that discharge from the ear is apt to lessen or cease at the onset of serious extension and that bottling up of the flow may give rise to such results; but the somewhat prevalent view that such suppuration should be "let alone and it will be outgrown" is as mistaken as is the idea that it is dangerous to bring it to an end. To "stop it up" is wholly different from stopping it by cure: and the chronic cases of slight discharge, often hardly noticeable, are those from which fatal diseases such as brain-abscess, pyæmia, and sinus-clotting are generally recruited. Few good insurance companies will have anything to do with a man having a long-standing running ear — the risk for the individual may not be very noticeable, but it is enough in any large aggregate to consume all the profit of insuring lives.

Suppuration of the middle-ear is ushered in by pain, and the severity of this "ear-ache" is at times some measure of the seriousness of the attack. The onset may be insidious or misleading, however, and relief may be sought of the dentist; while in children the fever, delirium or convulsions may draw attention away from the ears. Stains upon the pillow or visible moisture in the canal may be the first indications that the ears are involved. But every such case, however stormy or mild its beginning, may go on immediately or remotely to the worst of issues; and it is our duty to take reasonable precautions from the start, lest we have reason later to reproach ourselves. Mere external protection as by ear-tabs or a night-cap may conserve the recuperative powers; gentle hot douching with clean water may relieve the pain by reducing the inflammatory congestion; and spray and gargling may strike at the root of the trouble in nose and throat. However ill the patient may be in other respects it is mistaken kindness to withhold these simple yet often effective measures of treatment. The tendency is to a "gathering in the ear," which may be watery or mucous or may be purulent and infective. If the simple measures named, with dry heat from a salt-bag or hot water-bottle fail, there is need for surgical aid. Drainage by the natural Eustachian channel can only sometimes be gained; but after good cleansing of the nose and upper throat, it should be gently attempted by the Politzer method or the catheter. Abuse of these means is rightly condemned; so only the expert can maintain his right to use them if ill results follow—in spite rather than because of them. If they fail and the drumhead is seen to be bulging, especially with yellowish fluid, it should be delicately cut along its back margin to furnish a free escape for the collected fluid. If the swelling is marked at its upper portion, the knife should be carried up into this region, coming out in a sweep to the bone along the upper back wall. Free bleeding may be encouraged by warm douching, and is more effective from such a cut than from external leeching; yet since much of the blood-exit from the drum-cavity is along the front wall of the canal, leeching in front of the ear may be almost as good, but should remove not less than four to eight ounces. A wick of gauze or absorbent cotton, dry or moistened with carbolic or boric glycerine, should be inserted deep into the canal and the protective covering replaced. "But if you cut the drumhead you destroy the hearing!" is a fallacy which is still repeated. The opening of the drumhead is a delicate operation, often very painful so as to require ether or other anesthæsia and capable of doing injury to the structures beyond it; but it only forestalls the opening which would occur spontaneously, makes a free and well-placed opening and really saves the drumhead from ulcerating through. Far more important is its influence for good in relieving the injurious pressure in the drum-cavity and it may be really life-saving in preventing fatal extension of the suppuration.

It is impossible to foresee how mild or serious any case is going to prove; and without panicky fighting of shadows, it is only reasonable to press home all due precautions. The patient is best in bed, especially if feverish, and all exposure and stimulating diet avoided. Constipation must be relieved, for straining of every sort is not only painful but increases the congestion.

With the opening, artificial or spontaneous, of the drum-membrane, there is generally relief of the pain; yet this is almost sure to recur, especially at night, but with lessening severity, duration and frequency. The fever, which is commonly marked in children, declines and some of the lost sleep is made up. The tension within the drum-cavity is lessened by the escape of the "gathering" and obtains continued relief by the persistence of the discharge. This is thin and bloody at first, then thicker and probably stringy. Its amount is often surprising, so that hourly cleansing is needful, and it may excoriate the skin in and about the canal, calling for protective ointments. The ideal treatment is thoroughly to cleanse before cutting the drumhead and thereafter as frequently as the flow demands to change the sterile wicks of cotton in the canal. If these are prepared by the hundred, each wrapped in a waxed paper and the package of them baked, the patient can readily remove the moist plug and substitute a clean one without contaminating it. Practically, frequent syringing with boiled water at 110° F. or more and a clean soft-rubber bulb better relieves the pain and cleanses the deeper parts of the canal. The heat can penetrate where the water cannot and is the best astringent and stimulant. After two or three weeks the discharge should cease, and another week or two should bring cure; but the cardinal fact in these cases is the infected character of the inflammation, which endangers serious destruction in the drum-cavity and adjacent more vital regions. Often worse than the destruction is the scarring which results from nature's effort at repair. An opening in the drumhead generally heals and may leave no visible scar; in an important minority of cases the edges are skinned over, preventing its closure and grafting skin upon the mucous surfaces within. Nature is prepared to sweep away fluid waste material in the drum-cavity, but skin-flakes forming there are difficult of removal; they tend to collect and by their presence excite more exaggerated scaling. Onion-like masses may thus form, constituting "cholesteatoma" or pearly tumor, and these can do much damage by their pressure as well as maintain or renew the suppuration. The bony walls and the little ear-bones may be destroyed by pressure or decay; and while an exit may thus be made for the cholesteatoma-mass, it too often works inward instead of outward, damaging the labyrinth and may carry the infective process into the brain-case. Just under the thin floor of the drum-cavity is the head of the jugular vein, its intracranial part is equally vulnerable just behind, and an even thinner roof alone protects the brain-membranes above. It is not surprising, then, that symptoms of brain-inflammation are not unusual in ear-diseases; and while these may be merely irritative and transitory, they are at times of deadly meaning. Where the bone suppurates and decays the mastoid-projection just behind the ear is apt to be involved, forming a "mastoid abscess," and may need to be chiseled open to give exit to the matter and dead bone. Even without this, the inner wall of bone can decay and an abscess-collection form on the outer surface of the brain-membrane. Yet this is strong and firm and may thicken to better protect all within; so such "extra-dural abscesses" have but a fraction of the danger of a collection upon or in the brain itself. Even this can now be often recognized in time by its subnormal pulse and temperature, and located sufficiently by its symptoms to permit of surgical relief; and nearly 80 per cent of the reported operations have been followed by cure. The infection can penetrate the adjacent great blood-vessels and cause clotting within them, with general blood-poisoning and formation of abscesses in the lungs or other parts of the body; but the septic clot can be recognized and safely removed in many cases even when extending down almost to the heart.

Disease of the nervous apparatus of the internal ear is met in hardly 10 per cent of ear-patients. Some of these are due to injury and fracture at the base of the skull, others to cerebro-spinal meningitis or other severe fevers, more still to the extension inward of the catarrhal or the suppurative middle-ear inflammations. Mumps, too, or diphtheria may be followed by sudden total deafness. Inherited syphilis is one of the insidious and slowly acting causes, generally also giving rise to clouding of the cornea of the eye and marked by typical malformation of the second teeth. In any of these conditions the main hope of relief is through the absorption by mercury and iodine of the exuded material, which in the meningitis cases may be in the brain itself and not in the labyrinth. Of notable interest are the cases of "boiler-makers' deafness," as we sometimes call a group of occupation-disorders, usually located in the internal ear, and affecting those subject to persistent clangor — a condition which may compel change of work, if freeing the Eustachian tubes and good plugging of the external canals fails to relieve the advance of deafness. Important too are the cases of vertigo, due to ear-disease. Menière called attention to some of these as caused by labyrinthine apoplexy and they are often called by his name; but the recognizable disease may be of different nature and often is located in the drum-cavity, indirectly affecting the organ of equilibrium in the semicircular canals. Influenza has caused a number of these cases in which the hearing for more or less of the scale has been suddenly lost and the patient made incapable for days or weeks of lifting the head from the pillow. Absorption is here also the best hope; but in some extreme cases advantage has been taken of the damaging effect upon the ear of large doses of quinia, and the irritative condition has been by it changed to a destruction with cessation of the vertigo.

Finally we may mention the brain-affections in which the hearing-centres, especially that for speech, are involved, when we may have "word-deafness," which prevents recognition of the spoken word, although the hearing is perfect for tones of every pitch; for while the ear itself is uninvolved, it is only through ear-examination that one can by exclusion reach a correct diagnosis and perhaps point the way for the surgical removal of a brain-tumor.

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B. Alex. Randall, M.A., M.D.

Ear Cockle, a disease peculiar to wheat caused by the presence in the grain of worms belonging to the family *Vibria.* In some parts of Europe the disease is known as purples.

Ear-ring, a ring or other ornament for the ear, a hook passing through the lobe, with a pendant of diamonds, pearls, or other jewels, frequently attached. It seems to be in repute among all nations, the most savage as well as the most civilized, and it dates from the most remote antiquity. In Gen. xxiv. 22 we read that Abraham's servant presented Rebekah with an ear-ring, and the same ornament is mentioned in several other passages of Scripture. In the statue of Aphrodite by Praxiteles the goddess was represented with rings in her ears. Among the fine specimens of antique art now extant there are several heads bearing only a single ear-ring on the left ear; and it appears that the Greek children only wore them on the right ear. Ear-rings were not so commonly worn by men as by women, yet, that men did sometimes do so is evident from the fact that the Emperor Alexander Severus thought it necessary to interdict this ornament to men. The ear-rings worn by the ancients sometimes consisted of simple rings, but pendants were frequently attached to them, and these sometimes very heavy. The form of the pendants was various. The Roman ladies used ear-rings of great value. European women, as well as some of the men, wear ear-rings at the present day, although the custom has become almost obsolete in the United States and children's ears are no longer pierced as formerly.

Ear-shell, Sea-ear, Oreille de Mer, names given to any one of the several species of Haliotis.

Ear-trumpet, an instrument used by persons partially deaf to strengthen the sensation of sound. The purpose of the external ear, both in men and beasts, is to collect, by its funnel form, the waves of sound, and conduct them to the internal organs, the seat of the sense of hearing. All the artificial instruments, then, ought to resemble in form the natural ear. They are sometimes made like a trumpet of moderate size, the smaller aperture enters the ear, and the wider is directed to the quarter from which the sound proceeds. But these instruments are inconvenient, both on account of their size and the necessity of continually holding to the ear. Ear-cornets (so called from the French, *cornet acoustique*) are applied to the outside of the ear, and kept in their place by a slender steel spring. A small instrument in the form of a scroll, called an auricle is worn inside the ear, the mouth only being visible. Flexible india-rubber tubes, kept open by a spiral wire spring, are among the most convenient forms of ear-trumpet.

Ear-worm. See Corn Insect-pests.

Ear of Dionysius, a famous quarry near Syracuse, in which the slightest whisper was audible at a great distance. It was connected by a secret passage to the palace of Dionysius, the Elder, who died 367 B.C.; also an acoustic instrument with a large mouthpiece to collect the sound, which a flexible tube conducts to the ear. The cave was afterward used as a prison.

Eard'ley-wil'mot, Sydney Marrow, English rear admiral: b. East Sheen, Surrey, 3 Oct. 1847. He entered the navy in 1861, retiring in 1893. He has published 'Life of Vice Admiral Lord Lyons'; 'Our Navy for a Thousand Years'; 'Our Fleet To-day and its Development during the Last Half Century'; 'Our Flags: Their Origin, Use and Traditions.'

Earl, Robert, American jurist: b. Herkimer, N. Y., 10 Sept. 1824; d. there 2 Dec. 1902. He was graduated from Union College 1845, and was admitted to the bar 1848. Elected county judge in 1855 he served two terms and in 1869 was elected to the court of appeals, retiring in 1894. He founded the Herkimer Free Library in his native town.

Earl, a degree of the British nobility between marquis and viscount. The title was made hereditary by William the Conqueror, and for a time was used interchangeably with that of count, the corresponding title on the Continent. The wife of an earl is still called a countess. An earl's coronet is composed of eight pearls raised upon points, with small leaves between, above the rim. Though not of the highest rank earl is the title of highest antiquity in Great Britain. See Heraldry.

Earl Marshal, the eighth great officer of state in Great Britain, who had, anciently, several courts under his jurisdiction, as the court of chivalry and the court of honor. He is the head of the College of Arms (Herald's College), grants armorial bearings, and determines all claims in connection with them. The office is hereditary in the family of the Howards.

Earle, ėrl, **Alice Morse,** American writer: b. Worcester, Mass., 27 April 1853. She was married to Henry Earle in 1874. She has written extensively upon the manners and customs of the colonial period in New England and New York. Her published works are: 'The Sabbath in Puritan New England' (1891); 'Customs and Fashions in Old New England' (1893); 'Life of Margaret Winthrop' (1894); 'Diary of a Boston School Girl' (1894); 'Costumes of Colonial Times' (1895); 'Colonial Dames and Goodwives' (1895); 'Old Narragansett' (1896); 'Curious Punishments of Bygone Days' (1897); 'Colonial Days in Old New York' (1897); 'Home Life in Colonial Days' (1898); 'Child Life in Colonial Days' (1899); 'Stage Coach and Tavern Days' (1900); 'Old Time

Gardens; Sundials and Roses of Yesterday' (1903).

Earle, Ferdinand Pinney, American soldier: b. Hartford, Conn., 11 Sept. 1839; d. 2 Jan. 1903. He served as a private soldier in the Federal army during the Civil War. In 1889 he was appointed on the staff of Gov. Hill of New York to represent the artillery branch of the State service with the rank of brigadier-general. In 1884 he was decorated by the Venezuelan government with the Order of the Bust of the Liberator as a recognition of services rendered that country.

Earle, John, English ecclesiastic: b. York, England, 1601; d. Oxford 17 Nov. 1665. He was educated at Oxford and after graduation became tutor to Prince Charles and accompanied him in his exile. After the Restoration he was advanced in succession to the offices of dean of Westminster, bishop of Worcester, and bishop of Salisbury. He was the author of several works, the best known being 'Microcosmographie,' one of the "character" books popular in the 17th century.

Earle, John, English philologist: b. Elston, England, 29 Jan. 1824. He was educated at the Plymouth New Grammar School and at Kingsbridge Grammar School in early life, entering Oxford in 1842. He took his B. A. degree in 1845 and was elected fellow of Oriel. Taking the degree of M. A. in 1849, he became professor of Anglo-Saxon, being later ordained deacon. He was presented by Oriel to the rectory of Swanswick 1857; appointed to the prebend of Wanstrow 1871, and became professor of Anglo-Saxon in the University of Oxford 1876. His chief publications are 'Gloucester Fragments' (1861); 'A Book for the Beginner in Anglo-Saxon' (1877); 'English Plant Names from the Tenth to the Fifteenth Century' (1880); 'Anglo-Saxon Literature' (1884); 'English Prose: its Elements, History and Usage' (1890); 'The Psalter of 1539: a Landmark in English Literature' (1894); 'A Simple Grammar of English Now in Use' (1897).

Earle, Mary Tracy, American fiction writer: b. near Cobden, Ill., 21 Oct. 1864. She was educated at the University of Illinois and since 1893 has devoted herself to literary pursuits. She is the author of 'Through Old-Rose Glasses and Other Stories' (1900); 'The Man Who Worked for Collister'; 'The Wonderful Wheel'; 'The Flag on the Hill Top' (1902).

Earle, Mortimer Lamson, American classical scholar: b. New York 14 Oct. 1864: d. New York City 26 Sept. 1905. He was educated at Columbia College; was instructor in Greek at Barnard College for six years beginning 1889, and was then appointed associate professor of Greek and Latin in Bryn Mawr College; 1898 to 1900 was lecturer in Greek at Columbia; and in 1900 was appointed professor of classical philology in Barnard College. Among other literary work he edited Euripides' 'Alcestis' (1895), and Sophocles' 'Œdipus Tyrannus' (1900).

Earle, Parker, American horticulturist: b. Mount Holly, Vt., 8 Aug. 1831. He took up his residence for some years in Illinois and became a trustee of the State University; thence he removed to Mississippi. At the World's Exposition at New Orleans, in 1884, he superintended the horticultural department, and since 1885 has been president of the American Horticultural Society.

Earle, Pliny, American inventor: b. Leicester, Mass., 17 Dec. 1762: d. there 10 Nov. 1832. In 1785 he became engaged in the manufacture by hand of machine and hand cards for carding cotto nand wool, and invented in 1790 a machine for the manufacture of such cards by which the labor of one man for 15 hours could be performed in as few minutes.

Earle, Pliny, son of the preceding, American physician: b. Leicester, Mass., 31 Dec. 1800; d. Northampton, Mass., 18 May 1892. He was educated at the Friends' School, Providence, R. I., and was graduated as M.D. at the University of Pennsylvania in 1837. He was resident physician of the Asylum for the Insane at Frankford, near Philadelphia, 1840–2; physician to Bloomingdale Asylum N. Y., 1844–9; elected professor of materia medica and psychology in the Berkshire Medical Institution at Pittsfield, Mass., in 1863, and was superintendent of the Massachusetts State Hospital for the Insane 1864–1885. In the years 1837–39, 1849 and 1871, he traveled in Europe visiting the most important insane asylums. He is the author of 'Marathon and other Poems' (1841); 'Institutions for the Insane in Prussia, Germany, and Austria' (1853); 'An Examination of the Practice of Blood-letting in Mental Disorders' (1854).

Earl'ham College, a coeducational institution in Richmond, Ind., founded in 1847, under the auspices of the Order of Friends. In 1902 the school had in attendance 300 students and 21 instructors.

Early, Jubal Anderson, American soldier: b. Franklin County, Va., 3 Nov. 1816; d. Lynchburg, Va., 2 March 1894. He was graduated from the United States military Academy in 1837, fought in the Seminole war (1837–8), and having resigned from the service, entered legal practice at Rocky Mount, Franklin County, Va., in 1838. A member of the Virginia House of Delegates in 1841–2, he was also attorney to the commonwealth in 1842–7 and 1848–52. During the Mexican War he was major (1847–8) of volunteers; and at the outbreak of the Civil War, although strongly opposed to secession, he received the appointment of colonel in the Confederate forces. Promoted brigadier-general for services as a brigade commander in the first Bull Run, he fought with distinction at Williamsburg, the second Bull Run, and Antietam. He was in command of a Confederate division at Gettysburg, and in 1864 of an army for the invasion of Maryland. He crossed the Potomac, defeated Lew Wallace at Monocacy Junction (9 July), threatened an attack on Washington, D. C., but at the arrival of a considerable Union reinforcement, withdrew to the Shenandoah, possession of which he contested with Sheridan, then commanding the Federal army in the valley. On 19 September he was defeated at Opequon Creek, with the loss of 3,000 prisoners and 5 guns, and on 22 September at

Fisher's Hill, where he lost heavily, and from which point he was driven to the mountains. On 19 October he surprised the Federals in the morning at Cedar Creek, but the tide of victory was turned by Sheridan's arrival from Winchester, and he was completely routed. After his defeat by Custer at Waynesborough (March 1865), he was removed from his command. He attained lieutenant-general's rank. Subsequent to the war he practised law in Virginia, and was, with General Beauregard, a director of the Louisiana lottery. He never took the oath of allegiance. He is ranked high in the list of Confederate officers, and by some authorities was considered not inferior to "Stonewall Jackson." His chief publication is a 'Memoir of the Last Year of the War for Independence in the Confederate States of America' (1867). Consult 'Battles and Leaders of the Civil War,' edited by Johnson and Buell (1887).

Early English Architecture, the name generally given to the first pointed Gothic used in England. This style of architecture began to be used in England about the end of the 12th century, and lasted for about 100 years. It immediately succeeded the Norman, and finally merged in the Decorated style. It is characterized by long lance-shaped windows, which are often gathered into clusters and enclosed by a large arch, the space between which and the tops of the windows is often pierced with circular, trefoil or quatrefoil ornaments. The molding consist of alternate rounds and deeply cut hollows, separated by small fillets. The doorways are often divided into two by a single shaft.

Earth, The. The earth is at once the subject and the object of many sciences. Of these the most elementary are geography and physiography, which deal primarily with the salient surface features of our planet. Next in order of difficulty are geodesy and geology, which deal more minutely with the shape, the size, the constitution, the mechanical properties, and the material history of the earth. The science of meteorology is concerned with the phenomena of the atmosphere; and our theories of the tides and terrestrial magnetism must be added to the list of purely physical sciences of the globe. All of these sciences are intimately related, and they are sometimes grouped under the single term geophysics. In a broad sense, also, these sciences may be regarded as branches of astronomy, for astronomy is founded on, and hence includes, geophysics. This article is written from the point of view of geophysics and deals especially with the physical and mechanical properties of the earth.

THE SHAPE AND THE SIZE OF THE EARTH.

First Approximation.—The form and the dimensions of the earth have presented a problem of the greatest interest and difficulty to men of science for more than twenty centuries, and they promise to tax the resources of the ablest physicists for some centuries to come. The first approximation to a solution of this problem, of which we have definite record, was made by Eratosthenes of the Alexandrian school of astronomers. Assuming the surface of the earth to be spherical, he measured the length and the angular amplitude of an arc of a great circle extending from Alexandria to Syene. He observed that at Syene, which is about 500 miles south of Alexandria, the sun shone vertically downwards into deep wells at noon on the day of the summer solstice, proving thus that at that place and time the sun was in the zenith. On the same day at Alexandria he observed, by means of the gnomon, that the sun at noon was south of the zenith by one fiftieth of a circle, or 7.2°. The principles involved in these measurements and in the calculation of the size of the earth are very simple, but they are so fundamental as to justify a full explanation. They assume, first, that the earth is spherical in shape; secondly, that the plumb bob at any

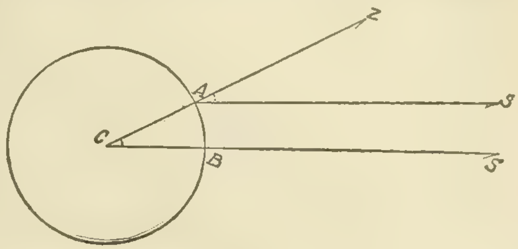


FIG. 1.

point of the earth's surface is directed towards the earth's center; and, thirdly, that the sun is so distant that lines drawn to it from different parts of the earth are sensibly parallel. Thus, in Fig. 1, if A and B indicate the relative positions of Alexandria and Syene and C the center of the earth, lines from A and C to the sun will be parallel; and hence the angle ZAS, or the meridian zenith distance of the sun at Alexandria, will be equal to the angle ACB. Knowing this angle and the distance AB, the rule of three gives the entire circumference.

Second Approximation.— No substantial advance beyond this first approximation was made until Newton showed that the gravitation and the rotation of the earth ought to make it somewhat flattened at the poles, or that the surface of the earth should have the shape of an oblate spheroid of revolution. The proof of this theoretical conclusion of Newton constitutes the second approximation to the figure and the size of the earth. Such a figure, however, is much more difficult of measurement than a spherical

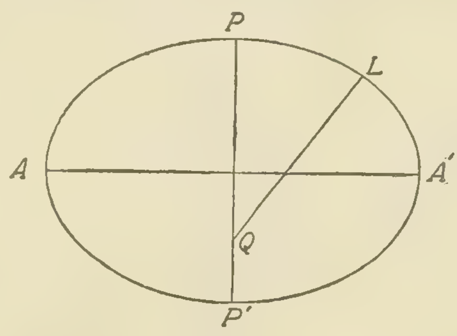


FIG. 2.

figure. This is seen by a glance at Fig. 2, representing an ellipse, which, if revolved about its shorter axis PP', will generate an oblate spheroidal surface. The principles of mechanics show that when such a surface is due to the attraction and the rotation of a fluid mass, the plumb line at any place will not in general point towards the centre of the mass, but will pass somewhat to one side of it, as shown by the line LQ in the figure.

Newton's conception, therefore, involved the difficulties of the more complex spheroidal figure and of the hypothesis that the earth was primitively a fluid mass. Two ways of testing Newton's views were proposed. One was to measure the meridional lengths of a degree of latitude at different places on the earth's surface. If the earth is an oblate spheroid, it is seen from Fig. 3 that the meridional distance along the surface intercepted by two plumb lines which make an angle of one degree (or any constant angle) with each other is greater at the poles than at the equator, or in general, greater in high than in low latitudes. The other method proposed to measure by means of the pendulum the varying acceleration to which a body is subject in different latitudes on the earth's surface. If the Newtonian view is correct, that acceleration, which is the resultant of the effects of attraction and rotation of the earth, and hence the weight of a body, must increase in passing from the equator to the poles.

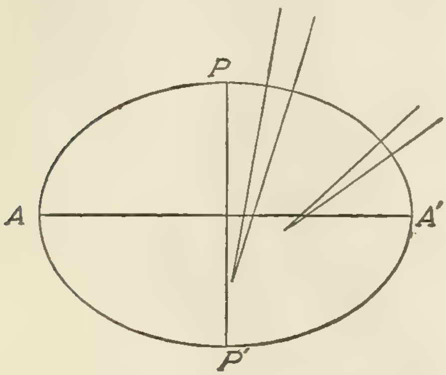


FIG. 3.

But the Newtonian theory was neither readily accepted nor easily verified. In the early part of the 18th century, in fact, the theory was hotly opposed by the justly distinguished Cassinian school of French astronomers, whose erroneous interpretation of a carefully measured arc of a meridian in France indicated that the earth is an oblong rather than an oblate spheroid. The question was permanently settled by the famous Lapland expedition sent out by the Academy of Sciences of Paris, in 1735, under the auspices of Maupertuis and Clairaut. They proved beyond doubt that the earth's surface is very closely that of an oblate spheroid, thus "flattening the poles and the Cassinis," as Voltaire remarked at the time.

A vast amount of labor has since been devoted to the determination of the dimensions of the spheroid which best fits the earth's surface. This is, indeed, the principal problem of the precise geodesy of to-day. The dimensions of the earth which have been provisionally very generally adopted are those of General A. R. Clarke published in 1866. The theory of a spheroidal surface requires a knowledge of the lengths of the longer and the shorter axes of the generating ellipse, or equivalent data. Generally the half axes, or the equatorial and the polar radii are given. The values of these are as follows:

Equatorial semi axis $= a$, polar semi axis $= b$.

$a = 20{,}926{,}062$ feet $= 3{,}963.3$ miles $= 6{,}378{,}259$ meters.
$b = 20{,}855{,}121$ feet $= 3{,}949.8$ miles $= 6{,}356{,}635$ meters.

It should not be inferred from these figures that the semi axes are known to the nearest foot or meter. The values given above are those derived from computations carried out to the nearest foot. More approximate values will be determined from computations now in progress, and they may possibly show Clarke's values to be in error by a few hundred feet.

The following derived values appertaining to the earth's spheroid are often referred to:

Equatorial diameter of the earth	= 7,926.6 miles
Polar diameter of the earth	= 7,899.6 miles
Difference of diameters	= 27.0 miles
Circumference of equator of earth	= 24,902.0 miles
Meridian perimeter of earth	= 24,859.8 miles

Area of the surface of the earth
= 196,940,000 square miles
= 510,071,000 square kilometers
= 197×10^6 square miles (about)
= 51×10^7 square kilometers (about)

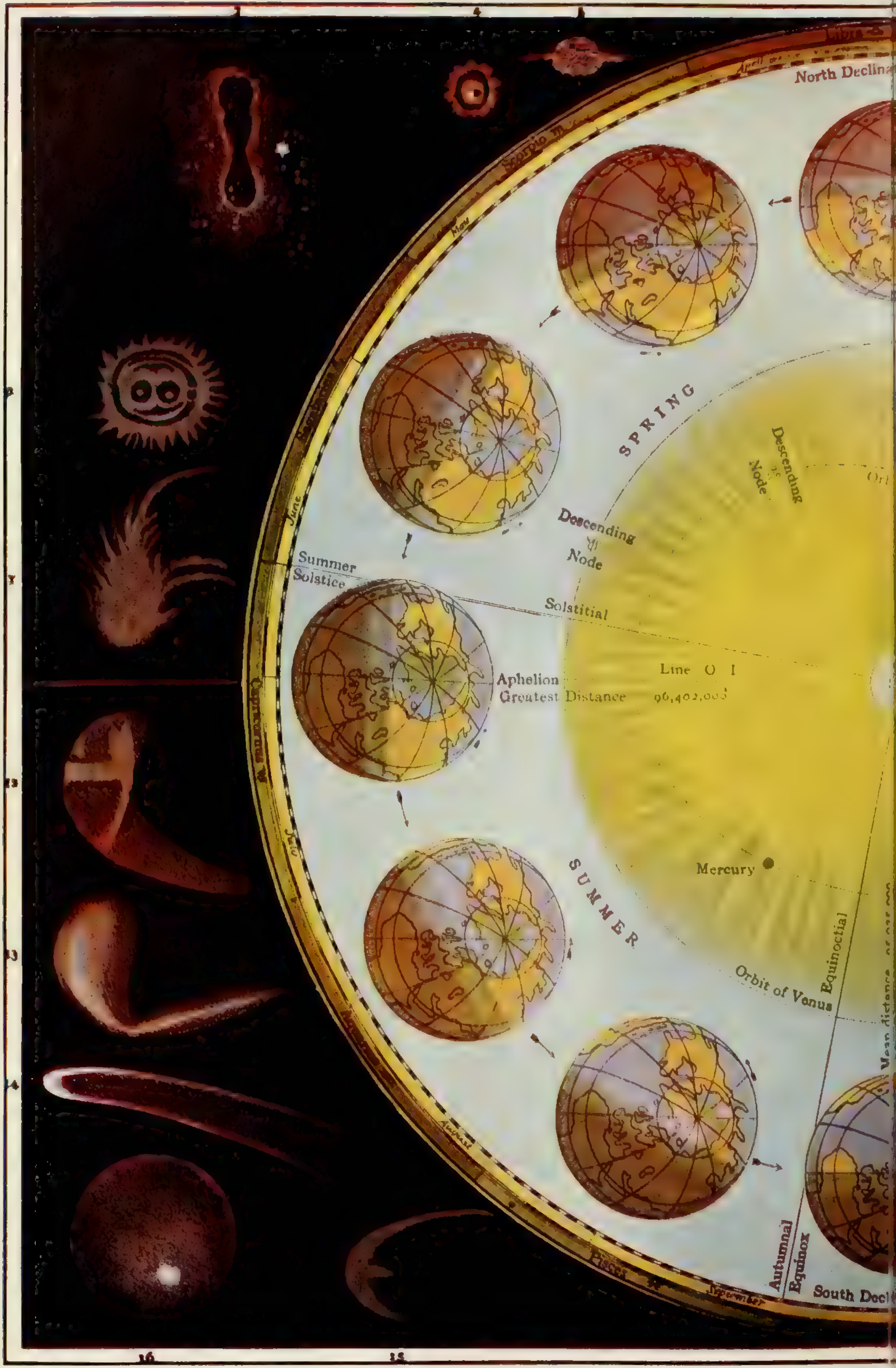
Volume of earth
= 259,880,000,000 cubic miles
= 1,083,200,000,000 cubic kilometers
= 260×10^9 cubic miles (about)
= 108×10^{10} cubic kilometers (about)

The following table gives the length of a degree of a meridian in different latitudes; the length of a degree in longitude measured along a parallel of latitude; and the areas of quadrilaterals of the earth's surface of one degree extent in latitude and in longitude. The latitude in the first column of the table is that of the middle point of the corresponding meridional arc or quadrilateral.

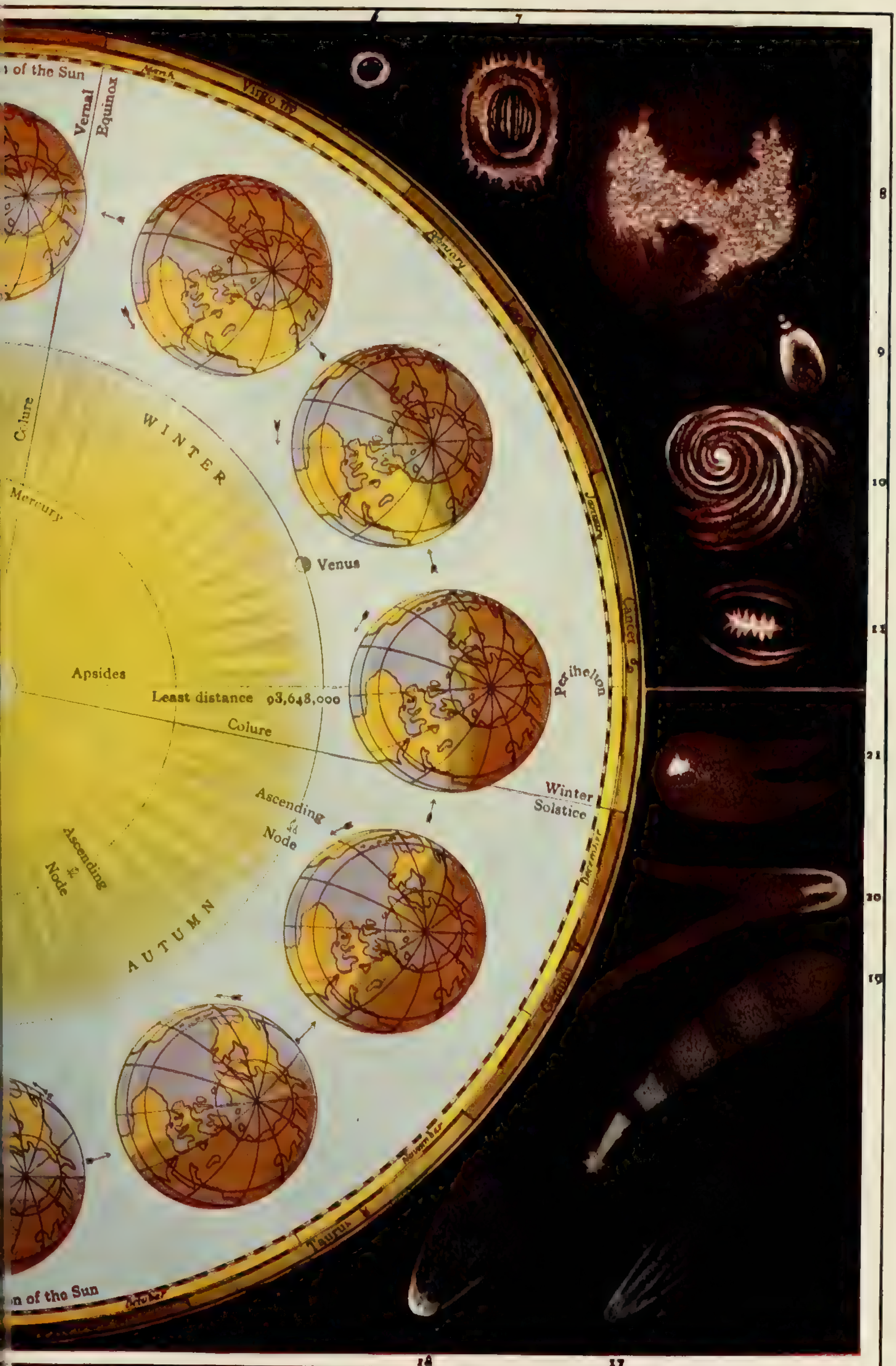
Latitude	Length of 1° of meridian	Length of 1° of parallel	Area of quadrilateral 1°×1° in latitude and longitude
	Statute miles	Statute miles	Square miles
0°	68.703	69.171	4752.3
10	68.725	68.128	4682.0
20	68.786	65.026	4472.8
30	68.879	59.956	4129.6
40	68.993	53.063	3661.0
50	69.115	44.552	3079.2
60	69.230	34.674	2400.5
70	69.324	23.729	1645.0
80	69.386	12.051	836.2
90	69.407	00.000	

From the second column of this table it is seen that the length of a degree of a meridian is about seven tenths of a mile greater at the poles of the earth than at the equator.

Third Approximation.—A third approximation to the figure of the earth may be briefly referred to here. Imagine the mean sea level, or the surface of the sea freed from the undulations due to winds and to tides. This mean sea surface, which may be conceived to extend through the continents, is called the geoid. It does not coincide exactly with the earth's spheroid, but is a slightly wavy surface lying partly above and partly below the spheroidal surface, by small but as yet not definitely known



NEBULÆ. 1. The Crab Nebula. 2. Round Nebula. 3. Great Nebula in Argo. 4, 5, 6, 7. Nebulæ as shown Rosse's Telescope. COMETS. 12. 13, 14. Halley's Comet as seen in 1835 at different periods. 15. Halley's Co parting from the sun. 19. Comet of 1680. 20. Com



rd Rosse's Telescope. 8. The Dumb-bell Nebula. 10. The Spiral Nebula. 9, 11. Nebulæ as shown by Lord departing from the sun, 1836. 16. Encke's Comet as seen in 1828. 17. Great Comet of 1811. 18. As seen de- 807 as seen by Bessel. 21. As seen by Schroeber.

amounts. The determination of the geoid is now one of the most important problems of geophysics. Its solution will be accomplished by means of gravimetric surveys, or by measuring the acceleration of gravity at a great number of points on the earth's surface.

PHYSICAL PROPERTIES OF THE EARTH.

The Atmosphere.—Adopting the convenient terminology of geologists, the earth may be divided into four parts, namely: the atmosphere; the hydrosphere, or oceans; the lithosphere, or crust; and the centrosphere, or nucleus. These are considered in turn without encroaching on the fields of the meteorologist or of the geologist.

The atmosphere is a gaseous envelope covering the earth to an extent not yet fully determined. The pressure it exerts at the surface of the earth is easily measured and is definitely known to be about 14.7 pounds per square inch, or about 1,033 grammes per square centimeter.

The pressure, density, and temperature of the atmosphere are observed to decrease rapidly with increase of height above the earth's surface, but the exact laws of decrease are not yet known. Hence it is impossible in the present state of science to assign a height to the atmosphere. It appears certain, however, that it is more than two hundred miles high, since it is dense enough to set meteorites on fire at that height.

Many investigations of the properties of the atmosphere have been made during the past century. These are all too technical for presentation, even in abstract, here. But their results may be summarized as follows:

(a) If the earth did not rotate and if the atmosphere were of the same density throughout as at the earth's surface, its height would be 26,200 feet, or about 5 miles.

(b) If the earth did not rotate, and if the adiabatic law (pressure proportional to the 1.4 power of the density) held in the atmosphere, it would be about 17 miles high.

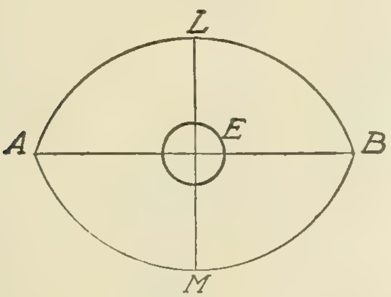


FIG. 4.

(c) But the earth rotates and the atmosphere must be supposed to rotate with the same angular velocity. From this fact, and from the assumption that the atmosphere behaves like a fluid, Laplace concluded that it must be limited by a lenticular-shaped envelope as indicated in Fig. 4. The revolution of this figure about the axis LM, which is supposed to be coincident with the axis of rotation of the earth, E, will generate the envelope and the earth in their true relative dimensions. The polar and equatorial axes LM and AB are, respectively, 4.4 and 6.6 times the diameter of the earth. According to this theory, therefore, the atmosphere may be about 17,000 miles high above the poles of the earth and about 26,000 miles high above the equator. The latter limiting height is that at which the centrifugal force due to rotation is just balanced by the attraction of the earth. The volume of the envelope is 156 times the volume of the earth. Whether the atmosphere actually extends to the limits thus defined has not been determined either by Laplace or by subsequent investigators.

A question of great interest is that of the quantity of the asmosphere, since the oxygen thereof is essential to the existence of all higher forms of life on our planet. By quantity is meant the amount of mass of the atmosphere. If the law of distribution of this mass within the Laplacian envelope were known the total quantity could be computed. But that law is not known, and hence it is only possible to attain an approximation, or to set limits, to the actual amount. A lower limit may be found from the adiabatic distribution of (b), above, for a non-rotating earth. This distribution does not differ widely from the actual distribution near the earth's surface; but since it is limited to a height of 17 miles it will give too small an amount. A computation on this basis makes the mass of the atmosphere 1–1170000th part of the total mass of the earth; or, in round numbers, one millionth part of the mass of the earth. This result is also reached, substantially, if it is assumed that the mass of the atmosphere is the same as the mass of a uniform layer of water, or mercury, which would produce the same pressure at the earth's surface. On the other hand, if the adiabatic distribution is supposed to hold within the Laplacian envelope, of (c), above, an upper limit of about 1-1200th of the mass of the earth is obtained. The actual value of the mass of the atmosphere is undoubtedly much closer to the lower than to the upper limit; but how much closer is still a matter for investigation.

The Hydrosphere.— It is well known that about three fourths of the earth's surface is covered by oceans and seas. Precise measures of the relative areas of land and sea are difficult to obtain, and the present state of knowledge does not justify the use of more than three significant figures in defining these areas. The values given below are derived from H. Wagner's 'Lehrbuch der Geographie.' They do not differ widely from the values given recently by other German authorities, though they make the total ocean area about one per cent greater than the earlier estimates of the distinguished British geographer, Sir John Murray. The table below gives the continental areas along with their average heights and the total oceanic area along with its average depth:

CONTINENT	Area in square miles	Average height or depth, in feet
Europe	3,860,000	980
Asia	17,100,000	3,120
Africa	11,500,000	2,130
North America	9,260,000	2,300
South America	6,840,000	1,070
Australia	3,440,000	1,310
Total continental area	52,000,000	2,300
Total oceanic area	145,000,000	11,480

The total area of the continents is, therefore, 26.3 per cent of the total surface of the earth; leaving, with the same degree of precision, for the total area of the sea surface 73.7 per cent of the surface of the earth.

The average depth of the oceans according to Wagner is 3,500 meters or 11,480 feet, or, in round numbers, 2.2 miles.

The data thus given show that the volume of the oceans is 315,000,000 cubic miles, or, in round numbers, 1-800th of the entire volume of the earth. Assuming the density of sea water to be 1.03 times that of pure water, and the density of the latter to be 62.3 pounds per cubic foot, the mass in the oceans is found to be 1.49×10^{18} tons of 2,000 pounds, or one and one half million million million tons.

It is interesting to contrast this mass of the oceans with the mass of the continents which lies above sea level. The average heights of the continents given in the above table require an average height for the entire land area of about 2,300 feet. This combined with the area of the continents gives for the volume of the continents above sea-level 22,500,000 cubic miles. If to this mass a density of 2.75 times that of water be attributed, the resulting mass of the continents above sea-level is 284×10^{15} tons. This is about one fifth the mass of the hydrosphere, or oceans.

The Lithosphere.—The lithosphere is the special province of the geologist, and is treated in detail under GEOLOGY. It is here considered, therefore, only in its broader physical aspects.

No precise value to the thickness of the shell which is called the crust can be assigned. The estimates of geologists make it 5 to 10 miles thick. It is the shell to which are confined the great rock movements and transformations with the attendant phenomena of crust crumpling, folding and faulting. For the present purposes it may be assumed to be 10 miles thick.

In its mechanical aspects the most important fact presented by the crust is that it rests on the centrosphere, or nucleus, in substantially the same manner as a fluid crust would. In other words, the crust is essentially, in view of the forces to which it is subject, a viscous mass, which may be likened in its behavior to sealing wax. This conclusion is reached when one compares the compression to which the crust would be subjected if it were self supporting, like a dome, with the crushing strength of rocks. That compression is about thirty times the crushing strength of the finest steel and five hundred to one thousand times that of the best building stones. Hence we must infer that at a depth of a few miles there can be no such thing as a cavity in the crust. Another conclusion of great importance, also, is that the surface shape of the earth must conform very closely to the shape it would have if it had been originally fluid, as assumed by nearly all geodesists and geologists, many of whom adduce that shape as a proof of primitive fluidity. Given time enough, and the amount of time available is ample, as seen below, the viscous earth will assume the same shape, essentially, as a fluid earth.

Since the lithosphere, the hydrosphere, and the atmosphere are the theatre of the principal activities, physical and biological, of our planet, it is of interest to know their volume, mass, and chemical constitution. The volume of the shell 10 miles thick below sea level is 1,969,400,000 cubic miles. Adding to this the volume of the crust above sea level, namely, 22,500,000 cubic miles, there results for the volume of crust and hydrosphere down to a depth of 10 miles below sea level, 1,992,000,000 cubic miles. Of this, as stated above, 315,000,000 cubic miles are sea water, leaving for the solid matter of the crust to the depth in question 1,677,000,000 cubic miles. Attributing to this volume a density 2.75 times that of water, the mass of this solid part of the shell is 21×10^{18} tons of 2,000 pounds. This is about 14 times the mass of the oceans. These two masses and that of the atmosphere give, in round numbers, a total of 23×10^{18} tons, the contribution from the atmosphere being taken as 7×10^{15} tons.

CHEMICAL COMPOSITION OF THE LITHOSPHERE, HYDROSPHERE, AND ATMOSPHERE.

ELEMENT	Solid crust	Oceans	Mean, including atmosphere
Oxygen	47.29	85.79	49.98
Silicon	27.21	....	25.30
Aluminum	7.81	....	7.26
Iron	5.46	....	5.08
Calcium	3.77	0.05	3.51
Magnesium	2.68	0.14	2.50
Sodium	2.36	1.14	2.28
Potassium	2.40	0.04	2.23
Hydrogen	0.21	10.67	0.94
Titanium	0.33	....	0.30
Carbon	0.22	0.002	0.21
Chlorine	0.01	2.07	0.15
Bromine	....	0.008	....
Phosphorus	0.10	....	0.09
Manganese	0.08	....	0.07
Sulphur	0.03+	0.09	0.04+
Barium	0.03	....	0.03
Nitrogen	....	....	0.02
Chromium	0.01	....	0.01
	100.00	100.00	100.00

Professor F. W. Clarke, making use of the above data, has worked out the relative abundance of the chemical elements in the combined mass of the atmosphere, the hydrosphere and the lithosphere. His results are given in the preceding table. (See Bulletin of the United States Geological Survey, No. 78.) It is interesting to note that nearly one half of that part of the mass of the earth visible to us is oxygen, the next most abundant contributions being in order, silicon, aluminum, iron and calcium.

The Centrosphere.— Since the crust of the earth, as seen above, rests like a viscous fluid on the centrosphere, the latter, whatever its temperature and other properties, must be subject to great internal stress. Indeed, the mechanics of celestial bodies of large mass leads inevitably to the conclusion that pressure is the dominant factor in the earth at no great depth below the surface. Given time enough, therefore, the distribution of pressure will be essentially the same as if the mass of the earth were fluid. This justifies the application of the laws of hydrostatics to the earth as a whole, whether it was originally fluid or not. With this concept, and with the law of gravitation, several facts enable us to determine within narrow limits what must be the constitution of the earth as regards distribution of density, gravity and pressure. The principal of these facts are (1) the surface density, (2) the mean density, and (3) the surface value of the acceleration of gravity. In addition to these facts, there are some others of less importance depending on the attraction of external bodies on the earth. Laplace correlated all these facts by means of an hypothesis with regard to the compressibility of matter. This asserts that the pressure in the earth increases as the square of the increase in density.

Adopting the indications of Laplace the following table showing the variation of density, acceleration of gravity, and pressure with depth below the surface of the earth has been computed. The relatively unimportant effect of the rotation of the earth is ignored in the calculation. The assumed values of the surface density and the mean density are 2.75 and 5.5, respectively, times that of water. In the third column of the table g represents the average surface value of the acceleration.

DISTRIBUTION OF DENSITY, ACCELERATION, AND PRESSURE IN THE EARTH.

Depth in fractions of earth's radius	Density relative to water	Acceleration of gravity	Pressure in millions of pounds per square inch
0.0	2.75	1.00g	
0.1	3.9	1.04	3.09
0.2	5.0	1.04	7.24
0.3	6.2	1.00	12.42
0.4	7.2	0.94	18.37
0.5	8.2	0.84	24.53
0.6	9.1	0.72	30.61
0.7	9.8	0.55	35.99
0.8	10.3	0.38	40.30
0.9	10.7	0.20	43.04
1.0	10.8	0.00	43.96

It is seen from this table that the acceleration attains a maximum value. This value is 1.05 times the surface value and it is attained at a depth of about 610 miles. At this depth a given mass would have a greater weight than at any other distance from the earth's center. A more extended table, computed by the author from slightly different data, is given in the article on GEOLOGY.

The variation of the density, acceleration and pressure are shown graphically in the following diagram, Fig. 5, in which these quantities are all measured horizontally from the line AO, representing the earth's radius, to the right. The curves have different horizontal scales and are designated, respectively, D.C. (density curve), A.C., (acceleration curve), and P.C. (pressure curve). The pressure curve intersects the axis OQ at right angles at Q.

Another interesting question in this connection is what total radial compressibility is compatible with this Laplacian distribution of density, acceleration and pressure. The answer may be stated in convenient form thus: If the pressure of the atmosphere were to be doubled the radius of the earth would be shortened everywhere by about 2 meters, or 6.5 feet. This explains how mere inequalities in surface loading of the earth may account for some of the great observed movements of the earth's crust.

Acceleration at Surface of Earth.— What is commonly called the acceleration of gravity at the surface of the earth is the resultant of the accelerations due to the attraction and to the rotation of the earth. This quantity has been measured with considerable precision at various points of the earth's surface by means of the pendulum, and the results have been combined in the following formula, g being the accelera-

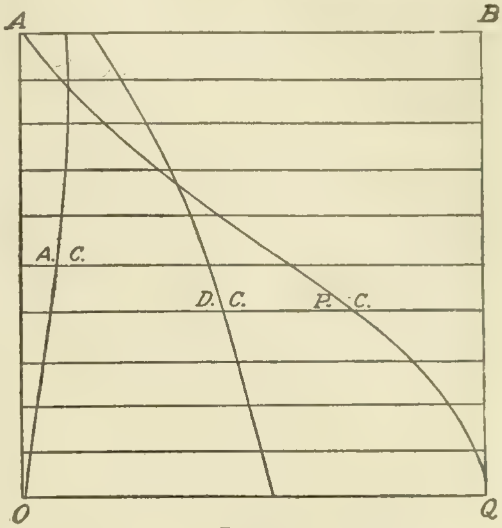


FIG. 5.

tion at any point of the sea level whose latitude is ϕ:

$$g = 978.00 + 5.22 \sin^2 \text{ centimeters / (seconds)}^2$$
$$= 32.087 + 0.171 \sin^2 \text{ feet / (second)}^2.$$

Mean Density and Mass of the Earth.— Since the volume of the earth is known accurately, the mass can be computed if its density can be ascertained. The author has recently shown (The Astronomical Journal, No. 424), that the product of this mean density and the gravitation constant may be derived with a precision comparable to that of the value of the acceleration just given above. The gravitation constant is the quantity essential to convert the proportionality of Newton's law of gravity into an equality. That is, if m and m' are two masses, D their distance asunder, F the force of attraction they exert on one another, and k the gravitation constant, then

$$F = k\frac{mm'}{D^2}.$$

It is thus seen that k is not a mere number, but a quantity such that the second member of the equation is force as well as the first member. k is, in fact, the cube of a length divided by the product of a mass and the square of a time.

Denoting the mean density of the earth by ρ, it is found in the paper referred to that

$$k\rho = 36797 \times 10^{-11} \text{ / (second)}^2.$$

this quantity being the reciprocal of the square of a time. In a more interesting, as well as a more intelligible, form this relation may be written

$$k\rho = \frac{3\pi}{T^2}$$

where π is the number 3.1415+ and T is the time it would take an infinitesimal satellite to pass around the earth, under the law of gravitation, just grazing the equator, if there were no atmosphere to impede its progress. This time is seen to be 1 hour, 24 minutes, 20.9 seconds.

It is clear then that ρ will be given by the above equation if k is known. This quantity has been measured directly by several observers. A mean of the most recent and most trustworthy determinations is, in C.G.S. units. (See 'The Century's Progress in Applied Mathematics,' Science, N. S., Vol. XI.)

$$k = 6673 \times 10^{-11}.$$

Thus ρ is found to be 5.514 times the density of pure water. The uncertainty of this value as shown by the computation is about four units in the last place of decimals. In view of this fact, and of the great difficulties in measuring the quantity k, we shall use the round number 5.5 as hitherto.

From the volume of the earth given above the following results are derived for its mass:

$$\text{Mass of Earth} \begin{cases} = 1{,}311 \times 10^{21} \text{ pounds} \\ = 6{,}552 \times 10^{18} \text{ tons (of 2,000 pounds)} \\ = 5{,}945 \times 10^{20} \text{ kilogrammes} \end{cases}$$

For convenience of reference the masses that have been given above are here collected and expressed in tons of 2000 pounds.

Mass of Earth	$= 6{,}550 \times 10^{18}$
Mass of Centrosphere	$= 6{,}529 \times 10^{18}$
Mass of Lithosphere	$= 21 \times 10^{18}$
Mass of Hydrosphere	$= 1.49 \times 10^{18}$
Mass of Atmosphere	$= 7 \times 10^{15}$

The Internal Heat of the Earth.— That the earth has a great store of heat a few miles below the surface is amply proved by a variety of geological phenomena. Wherever deep wells, or bore holes, have been sunk the temperature is observed to increase with depth at a rate of about a degree F. for 60 feet. This shows that heat is being conducted from the interior to the surface of the earth and is thence radiated into surrounding space. The amount of this heat is sufficient to melt a layer of ice 6 to 8 millimeters (or ¼ inch, say) thick, covering the globe, per annum, or more than 800 cubic miles of ice. It seems most probable (though it is by no means certain) that the temperature of the centrosphere is high enough to melt all known rocks, although the lower strata of the crust do not assume the molten or viscid form of lavas except on relief from the great pressure to which they are subject. This was, essentially, the view of Fourier, the earliest physicist to investigate this question, and it is still regarded as the most plausible hypothesis with respect to the actual state of the earth.

Whether this hypothesis is exact or not, however, the theory of heat conduction founded by Fourier enables us to draw with certainty two important conclusions with respect to the earth, namely: (a) that the heat conducted from the interior to the surface escapes as if there were neither atmosphere nor oceans; and (b), that a million years is the smallest unit of time convenient for measuring the historical succession of thermal events.

With less certainty it may be affirmed that the earth is shrinking in bulk as it cools, and that this is one of the principal causes of the grand crust crumplings and volcanic activities to which geologists pay special attention. This cubical contraction goes on exceedingly slowly, however; requiring, so far as one can infer from present indications, nothing short of thousands of millions of years for its completion.

The Earth as a Time Keeper.— The time of rotation of the earth is the most trustworthy unit of time man has discovered. The present value of this unit is 86164.1 mean solar seconds. That the earth must rotate with great steadiness is at once apparent when the immense amount of its energy of rotation is considered. This energy is about 156×10^{27} foot-pounds, or 2×10^{30} ergs. It is more than will be developed at Niagara (at the present rate of 5 million horse-power, say) in a million million years. Nevertheless, the period of rotation of the earth is subject to variation from four obvious causes. These are (1), secular contraction of the earth's mass; (2), the influx of meteorites, or meteoric dust; (3), tidal friction; and, (4), shiftings in position of the surface load of the earth, as in the processes of sedimentation, glaciation, etc.

The effects of the first two causes have been investigated. ('The Astronomical Journal,' No 502.) Contraction tends to shorten the day, and may possibly cause a diminution of as much as six per cent of the present length. The change goes on very slowly, however, and will not be perceptible in any such interval as that of human history (20 centuries, say). Meteoric dust tends to lengthen the day; but at the present rate of influx (about 20 millions of meteorites daily) the effect will not amount to so much as a quarter of a second in less than a million million years. During this interval of time the total effect, substantially, from secular contraction will have accrued.

The effects of the other causes named have not been evaluated, though the last one is probably the most important of all of them; since it may be easily shown that such shiftings of the surface load as are now taking place on the earth may modify the length of the day by an amount which, if cumulative, might in a few centuries seriously disturb astronomical reckonings.

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Earth Currents, a term used in electricity. Telegraph lines and particularly long submarine lines, are constantly troubled by violent electrical disturbances of the nature of transient currents which rush in one direction or the other through the line. The name earth currents is given to these movements of electricity. They are frequently so powerful and so changeable as to render the use of the telegraphic instruments for the time impossible, the earth currents passing so rapidly as to confuse the speaking signals completely. The nature of these disturbances is not thoroughly understood. They are found, however, to be very intimately connected with the perturbations of terrestrial magnetism called magnetic storms, and these, it is well known, are closely connected both with the appearance of the *aurora borealis*, and with the occurrence of the sun's spots. It seems probable that earth currents and the aurora are due to secondary discharges taking place in consequence of alterations in terrestrial magnetism, and that these alterations in terrestrial magnetism are caused by violent solar disturbances.

Earth, Estimated Race Population of the. The total population of the earth is estimated at 1,440,650,000, divided among the following races: Mongolian, 630,000,000; Indo-Germanic, 545,500,000; negro, 150,000,000; Semitic, 65,000,000; Malay, 35,000,000; Indian, 15,000,000; Hottentot, 150,000. In the world's religions the peoples generally termed heathen have a far larger space, numerically, than all other religions combined. They are as follows: Confucians, 250,000,000; Hindus, 200,000,000; Buddhists, 150,000,000; Mohammedans, 175,000,000; Polytheists, 120,000,000; others, 65,000,000; total, 960,000,000. Christians are as follows: Catholics, 230,000,000; Protestants, 145,000,000; Greeks, 90,000,000; Jews, 9,000,000; and all others 6,000,000; total, 480,000,000. The human family is subject to 48 principal governments. The average duration of human life is estimated at 33 years. The deaths are calculated at 67 per minute, 97,970 per day, and 35,639,835 per year; the births at 70 per minute, 100,800 per day, and 36,792,000 per year. One quarter of the people of the earth die before age 6, one half before age 16, and only one in 100 attains to the age of 65.

Earth-houses, a name generally given throughout Scotland to underground buildings, also known as "Picts' houses" or "Picts' dwellings." The earth-house in its simplest form consists of a single irregular-shaped chamber, formed of unhewn stones, the side walls gradually converging toward the top until they can be roofed by stones of four or five feet in width, all covered in by a mound of earth rising slightly above the level of the surrounding district. In the more advanced form of these structures two or three chambers are found. Earth-houses are frequent in the northeast of Scotland, occasionally 30 or 40 being found in the same locality. Very similar structures, known as bee-hive houses, occur in Ireland. In the United States modern earth-houses are to be found in Nebraska, Kansas, and other Western States, and are commonly called "dug-outs." In Arizona and California certain dwellings of adobe may be designated as earth-houses. See ADOBE.

Earth, Internal Heat of. There is abundant evidence that the interior of the earth is warmer than the surface. All deep mines, tunnels, and borings show a temperature considerably in excess of that which prevails in the shallower strata. At Rosebridge Colliery, near Wigan, England, a temperature of 94° F. was found at the depth of 2,445 feet, although the mean temperature of the surface is only about 49°. We have thus an increase of 45°, which is at the rate of about 1° for every 54 feet of depth. In the Mont Cenis tunnel, at one part where there is a thickness of a mile of rock overhead, the temperature was 85°. The temperature at the depth of 400 metres in the well of Grenelle at Paris is 75°, the temperature of the superficial strata being about 52°. In a bore through rock-salt at Sperenberg, near Berlin, the temperature at the depth of 3,490 feet was found to be 116°, the mean temperature of the air at the surface being only about 48°. At Yakutsk, in Siberia, where the mean temperature of the air is 13½°, it was found, in sinking a well to the depth of 540 feet, that the soil (which was frozen for the entire depth) increased in temperature by about 1° for every 52 feet of descent.

There is usually a considerable amount of irregularity in the rate of increase at different depths. In a deep boring at Wheeling, W. Va., the increase in the 1,000 feet from 2,375 feet to 3,375 feet is about 13°, while the increase in the next 1,000 feet is more than 16°, the temperature at that depth being 108°. Also, the mean rate of increase is by no means the same at all places, being sometimes as rapid as a degree for every 40 feet, and sometimes as slow as a degree for every 80 feet. Its average value appears to be about a degree (F.) for 50 or 55 feet.

The simplest theory to account for the increase of temperature in descending is that which supposes that the earth has formerly been at a high temperature throughout and is gradually cooling. This theory has been fully developed by Lord Kelvin. Solid rock has greater specific gravity than melted rock, even at the same temperature. Hence, if the earth were originally melted, and were then subjected to loss of heat from its surface, the solid crust which would form would from time to time fall in and allow fresh portions of liquid to come to the surface, until a solid interior had thus been formed, containing perhaps numerous cavities filled with liquid, but having on the whole the characteristics of a solid globe. After this stage a few hundred years would suffice to make the surface nearly as cool as it is at present, although a temperature nearly as high as the melting-point of rock would still exist at the depth of a few feet. The cooling would gradually penetrate deeper, and the rate of increase of temperature with depth would become slower, until, after about 100,000,000 years, this rate would be reduced to the value which it has at present. If we suppose the earth not to have been originally melted, but to have had a temperature considerably below the melting-point, a still shorter period of time would suffice to bring about the present condition of things. Hence Lord Kelvin argued that the age of the earth, as a globe cool enough for habitation cannot be greater than about 100,000,000 years. Professor Tait, on revising the physical data on which this calculation was based, came to the conclusion that the limit must be drawn still closer, namely, at about 10,000,000 years.

It was, until quite recently, maintained by geologists that the solid part of the earth consisted only of a thin crust enclosing a molten interior. This has been disproved by Lord Kelvin, both by the line of argument above sketched, and also by another argument based on the phenomena of the tides. A thin crust enclosing a liquid or pastry interior would yield and change its shape under the action of those forces (emanating from the moon and sun) which produce the tides. Evidently if the surface and bottom of the sea at a given place rise together and fall together, the depth of water may remain unaltered. The observed effect is the difference between the tide at the surface and the tide at the bottom. Hence the observed effect will be greater with a rigid than with a yielding earth. Now the observed effect agrees with what calculation gives on the supposition that the earth taken as a whole is highly rigid, and is completely at variance with calculation on the supposition that the earth is highly flexible.

Volcanic eruptions have an obvious connection with the question of the condition of the earth's interior. According to one theory they are due to local generation of heat by friction. The outermost layers of the earth have long since attained a nearly permanent temperature. The layers below them are cooling more rapidly, and have therefore a tendency to shrink faster. This tendency finds its relief from time to time in dislocations, which are the source of earthquakes, and which frequently involve the rubbing of one part against another under the enormous pressure of the superincumbent weight. Such friction would certainly involve an enormous local development of heat. See EARTHQUAKE; VOLCANO.

Earthenware, vessels or objects of clay, as distinguished from porcelain, is opaque; as distinguished from stoneware the body is dull and earthy. The clay is baked or fired in a kiln, or more rarely sun-dried. The glaze depends on the quality of the ware; generally it is of a readily fusible character and contains lead; but a simple salt glaze is employed for common articles. Occasionally the unglazed body is employed, as for water-bottles, cream-jugs, vases, and ornaments; these have generally a reddish-brown color, due to iron. The finer kinds of earthenware, such as Majolica, Delft ware, Faience, and Palissy ware, are not only glazed, but are besides elaborately colored and enamelled and ornamented with raised figures of various kinds. See FAIENCE; POTTERY.

Earthnut, a common name for many unrelated plants. The most common are probably the following: *Bunium flexuosum*, and *B. bulbocastanum*, both members of the natural order *Umbelliferæ*, the latter referred by some botanists to the genus *Carum* (caraway). Certain species of *Carum*, *Oenanthe*, and *Chærophyllum* of the same natural order, also bear this common name. All these species are natives of Europe and all bear tubers which have been used to some extent for human food, but are more valued as food for swine, since the animals can be turned loose to root them out of the ground. They are also known as earth chestnuts, pig-nuts, etc. Certain species of *Cyperus* of the order *Cyperaceæ* are also called earthnut (see NUT-GRASS), and so are various species of the natural order *Leguminosæ*, especially *Arachis hypogæa* (see PEANUT), *Apois apios*, or *tuberosa* (see GROUND-NUT), known also as wild bean.

Earthquake. Earthquake denotes a shaking of the rocks of the earth's crust, due to the passage of elastic waves, depending on some internal cause. These waves are principally of two classes: longitudinal, in which the particles vibrate as in sound; and transverse, in which they vibrate as in light; but near the origin of disturbance both classes of vibrations coexist, and the movement of the earth particle is a combination of the two oscillations. A cubical element of the earth's crust has its volume compressed and its form distorted, with the passage of each successive wave, and the rapid recurrence of this movement constitutes the trembling called an earthquake. The velocity of this wave propagation varies according to the elasticity and average density of the rock, the observed values lying between a few hundred feet and about five miles per second, as in the recent San Francisco earthquake, which was propagated across the continent with great speed. Powerful earthquakes are now recorded all over the world by means of long-distance Seismographs, and it is found that the greater the distance of propagation the more the waves are separated, the compressional waves outpacing the distortional ones.

The record of a South American earthquake, like that of Valparaiso, 16 Aug. 1906, occupies from two to three hours when registered upon seismographs in the United States and Europe; and moreover the further the disturbance is propagated the slower the earth movement becomes, so that from a violent agitation near the origin it becomes a gentle swaying of very slow character in the distance, and may not be felt by men nor animals, though faithfully recorded on delicate long-distance seismographs. As more than 60 world-shaking earthquakes occur each year, one of these disturbances on the average is due each week; and by the investigation of the propagation of these waves through the earth seismologists have drawn important conclusions regarding the constitution of the globe. In this way Mr. R. D. Oldham shows (*Quarterly Journal of Geological Society, 1906*) that the earth is fairly homogeneous throughout until we reach a distance of about 0.4 of the radius from the centre, when a change takes place, the cause of which is not yet understood.

Moreover, it is possible for a seismologist to calculate from his record of an earthquake how far off the disturbance was. Here is the empirical formula given by Professor Omori of the Imperial University at Tokio, for very distant earthquakes (*Publications Astron. Soc. Pacific*, 10 June 1906):

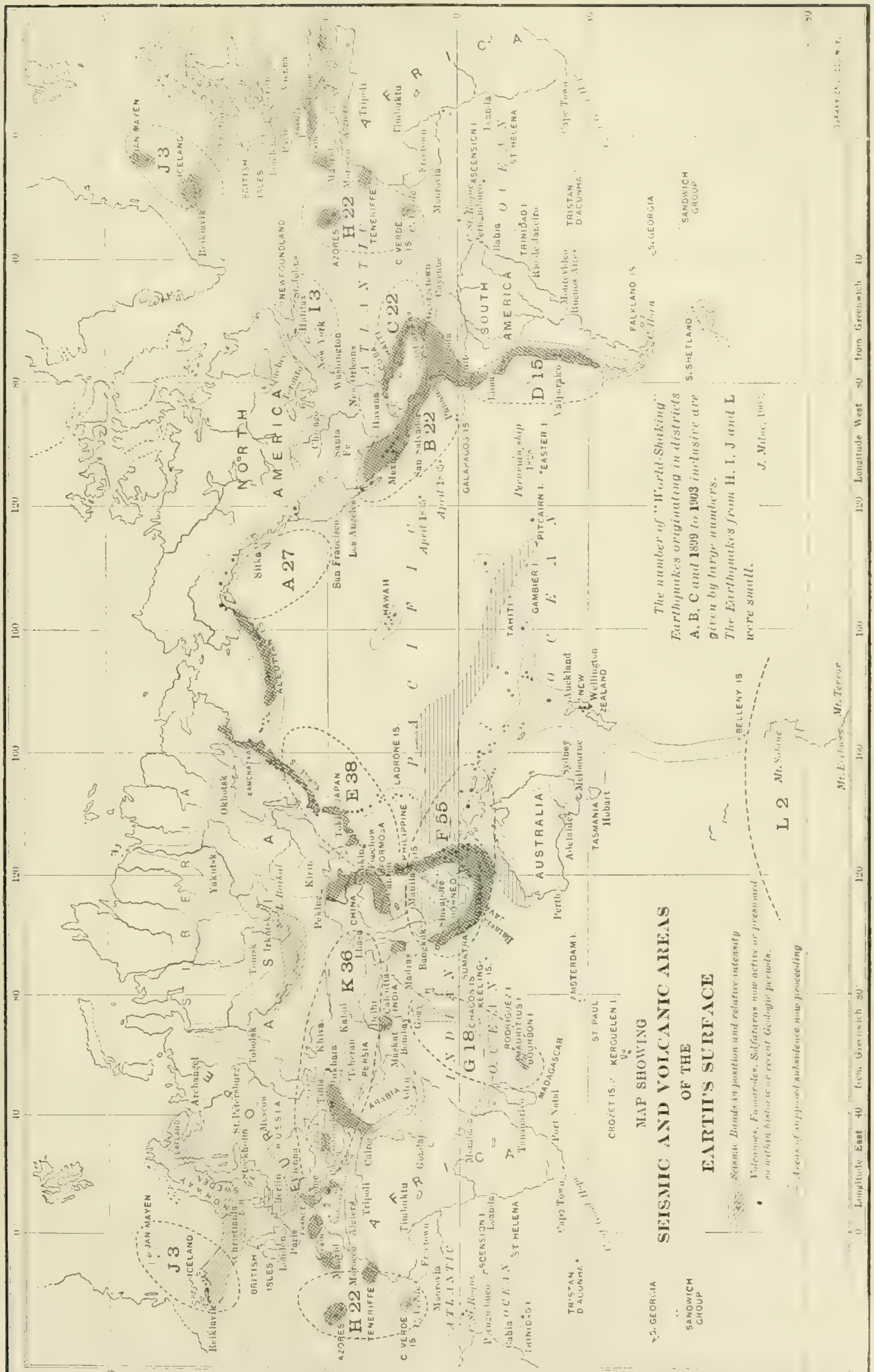
$$X^{\text{Km.}} = 6.54Y^{\text{Sec.}} - 720\text{km.};$$

where X, in kilometres, denotes the actual distance between the centre of disturbance and the place of observation; and Y, in seconds, the total duration of the first and second preliminary tremors. When the distance is small the formula becomes

$$X^{\text{Km.}} = 7.27Y^{\text{Sec.}} - 38\text{km.}$$

From the records obtained at the Lick Observatory Professor Omori calculates that the most central part of the San Francisco earthquake was 80 or 90 miles to the west of Mt. Hamilton, which places the origin under the margin of the Pacific Ocean.

The motion of the earth particle usually is only a small fraction of an inch, and houses resting on solid ground do not suffer greatly;


MAP SHOWING
SEISMIC AND VOLCANIC AREAS
OF THE
EARTH'S SURFACE
Seismic Bands in position and relative intensity
Volcanoes, Fumaroles, Solfataras now active or presumed so within historic or recent Geologic periods.
Areas of supposed subsidence now proceeding
The number of "World-Shaking" Earthquakes originating in districts A, B, C and 1899 to 1903 inclusive are given by large numbers.
The Earthquakes from H, I, J and L were small.
J. Milne, 1903.
A 27
B 22
C 22
D 15
E 38
F 55
G 18
H 22
I 3
J 3
K 36
L 2
Longitude East
Longitude West
from Greenwich

but where the land is made by the filling in of soft earth it remains loose and by the passage of the earthquake waves is thrown into billows like the sea, so that all structures on such foundations are frequently destroyed. This was observed to be the effect at Lisbon as long ago as 1755, and illustrated again very clearly at San Francisco and at Valparaiso in 1906. Even the steel frames of brick buildings were destroyed on the made land at Valparaiso, though houses standing on rock foundation suffered but little. Observations by Professor Omori and the writer at San Francisco show that on the made land the oscillations did not exceed about 3 inches. Owing to the rapidity of vibrations of this amplitude, however, few structures are able to withstand them. But on hard ground, where the vibrations were about a quarter of an inch, the worst that would result would be a cracking of the plastering and perhaps of the walls.

There are many modern investigators of earthquake phenomena. The names of Milne, Omori, Dutton, Oldham, Wiechert and many others are familiar; and in Europe and Japan many earthquake observatories are in active operation. Several such observatories have been established in the United States, and now that the Seismological Society of America has been founded at San Francisco, no doubt the study of earthquakes will become an important object of attention. The Seismological Society of Japan has done much for the investigation of earthquakes in the Orient and elsewhere.

We give below some references to the literature of the new science, which is growing rapidly. On the whole it must be said that the *phenomena* attending earthquakes have received much more study than the *physical cause* of these disturbances, which has remained quite obscure. We shall therefore devote the rest of this article to the cause of earthquakes; investigation shows that they are clearly related to the most important phenomena of the physics of the globe, and we must therefore treat briefly of the whole subject.

(1) *Earthquakes and* (2) *Volcanoes.*—The relation of these phenomena has been recognized since the days of Aristotle, Strabo, and Pliny, but most investigators have been unable to discover the underlying cause; and of late years earthquakes have been classed as volcanic and tectonic or structural. We believe this classification to be erroneous, and shall show that a single cause underlies all earthquakes and volcanoes; and that cause is nothing less than common steam formed within or just beneath the earth's crust, principally by the leakage of the oceans.

The accompanying map illustrates the distribution of volcanoes and earthquakes as plotted by Professor Milne in his work on 'Earthquakes' (edition, 1903). The distribution of earthquakes in the interior of the great oceans is imperfectly known, and hence the known earthquakes appear mainly as belts around the oceans, especially the Pacific, which includes in its boundary ⅞ths of the active volcanoes. The total absence of active volcanoes in the interior of continents is recognized, and the rarity of earthquakes within these inland regions is also conspicuous. When we examine the volcanoes in the earthquake belts along the shores of the continents, we notice that they are scattered in disconnected groups, while the earthquakes are more evenly distributed in somewhat continuous belts. The four leading facts about volcanoes may be stated thus:

(a) The distribution of some 400 active volcanoes in and about the margins of the oceans, and the numerous eruptions which take place in the sea, while none at all occur inland at distances exceeding about 100 miles from the oceans or equivalent large bodies of water.

(b) The fact that, according to Sir A. Geikie, 999 in 1,000 parts of all the vapors emitted by volcanoes is steam, as if produced by the leakage of the oceans, near which the volcanoes always are burning.

(c) Volcanoes are particular mountains, and all mountains when first elevated follow the sea shore, as if formed in some way by the action of the sea upon the adjacent land, which can only be through the injection of the land with steam saturated lava expelled from under the bed of the sea.

(d) The close geographical relation existing between volcanoes and earthquakes throughout the world, and the part played by earthquakes in mountain formation and the eruption of volcanoes. When a volcano breaks into eruption the earthquakes cease. In regions where there is no active volcano earthquakes are due to pent up steam seeking relief, which usually is accomplished by the expulsion of lava from under the sea towards the land, or some movement of a fault which relieves the internal strain.

These four fundamental facts admit of easy and natural explanation on the hypothesis that the penetration of sea water develops steam just under the crust of the earth, and the result is the upheaval of mountains and the eruption of volcanoes. Charles Darwin held, as the result of extensive observations, that volcanoes usually break out in regions of elevation, where the crust is cracked, and an outlet can be developed; and, as Major Dutton remarks, this seems to be confirmed even for those volcanoes which are heaved up in the depths of the sea. Therefore volcanoes usually break out in mountain ranges which are still rising by injection of lava from beneath the sea, but sometimes they develop from a mere crevice, where the rocks are broken; and always under the throes of earthquakes which cease when eruption has given outlet to the pent up vapors.

Now since volcanoes occur only in the sea, on islands, and along the shores of continents, but always die out inland, while all the vapor they emit is steam, except one part in a thousand, which is of secondary character, made up of by-products due to moisture and high temperature, it follows that steam is the sole original cause of volcanic activity. It has long been observed that earthquakes in a region near an active volcano cease when the steam escapes, and therefore imprisoned steam was the sole cause of the previous shocks. A true cause established for certain particular cases must be held to be the general cause of all similar phenomena whatsoever, according to Newton's Rule of philosophy. The observed distribution of volcanoes in the midst of the earthquake belts, confirms this inference from the principle of continuity; and we may therefore affirm that all important earthquakes are due to steam pressure accumulating within or just under the earth's crust, which must have relief; whether by volcanic eruption, uplifting of mountain chains parallel to the sea, or the formation and movements of faults in the earth's crust.

The earth has a temperature of some 2,000° F. at a depth of less than 20 miles, and the leakage of the earth's crust is well known. But in connection with the penetration of water we may recall the porosity of all rocks and even metals. Under sufficient pressure water has been forced through solid layers of gold, silver, lead, iron, and steel, and under a pressure of 4,000 atmospheres Amagat forced Mercury through three inches of solid steel. The oceans are deep enough to give a pressure of about 1,000 atmospheres on their bottoms, and as the water penetrates downward, the pressure steadily increases.

As Sir Archibald Geikie justly remarks Daubrée's experiments showed that owing to capillarity water may permeate rocks against a high counter pressure of steam on the further side, and that so long as water is supplied, whether by minute fissures or through pores of the rocks, it may, under pressure of its own superincumbent column, make its way to highly heated regions. It may thus increase the steam pressure within, until it is sufficient to raise lava in the vent of a volcano, or produce earthquakes by the movement of the crust along an adjacent fault.

It has been found by experiment that gases are rapidly absorbed in hot steel and other metals, and the rapid absorption of water in molten rock is proved by the vast clouds of steam arising from lava as it pours from a volcano. The vapors which are thus freely emitted are as readily absorbed. Hence it follows that as water permeates downward into the earth it finally gets hot enough to become steam in spite of the pressure, and tends to diffuse among the molten rocks below. But it cannot descend to great depths without becoming superheated and having its explosive power enormously increased; and the result is that it is spread in a layer just under the crust, and finally brings on an earthquake. As the melting point of silicates (the lavas are mainly silicates) is lowered by moisture, the heated rocks the more easily become molten, and hence the development of fluid lavas, some of which are expelled from volcanoes. The lava which is expelled may be heated above that which remains quiescent below, because it is often forced out by superheated steam, and by churning still further heated in the process of expulsion.

(3) *Formation of Mountains.*—In 1829 Elie de Beaumont, a noted French Geologist, proposed the theory that the mountains are wrinkles in the crust due to the shrinkage of the globe. Laplace's nebular hypothesis presupposed the shrinkage of the sun and planets, and this was therefore an extension of the astronomical view. Prior to de Beaumont's time no definite theory of mountain formation was universally recognized. The contraction theory has been generally held by Geologists, and is still the basis of current thought, but we believe it to be thoroughly unsound. It has been shown by the Rev. O. Fisher ('Physics of the Earth's Crust,' second edition) that on the contraction theory the average height of mountains would be only about 40 feet, even when the radius of the globe had shrunk 12 miles. If the average theoretical height be so small we may be very sure that the maximum height of mountains would not exceed a few hundred feet, whereas in reality we find the height to be between five and six miles, or about 100 times the theoretical height. It is impossible to reconcile this enormous discrepancy.

But besides the difficulty of accounting for the great height of the mountains, we meet with another almost as insuperable, in the way the existing mountains are bunched and congested into great systems, while large areas of the globe are quite flat and devoid of any mountains whatever. If the mountains were due to shrinkage this great inequality of distribution should not occur.

Vertical Section perpendicular to the Andes and Andean Trough, Trough drawn to natural scale, and showing the mode of operation of the Trough in the formation of Mountains and Cordilleras.

Outline map of South America, showing the great Ocean Trough parallel to the Andes. The Andes were formed by matter expelled from beneath the ocean bed, as shown in the upper part of the figure, the crust being supposed 10 miles thick.

Moreover, why should the mountains run parallel to the sea? In the memoir cited below I have shown by mathematical methods that the probabilities are more than 100 billion to 1 that a range like the Andes would not run so great a distance (4,400 miles) exactly parallel to the sea without a true physical cause depending on the ocean. This cause can be nothing else than the injection of lava under the coast by explosions of steam under the bed of the sea. For the elevation of the coast after earthquakes has been repeatedly observed in South America, particularly in 1822, and by Darwin and Fitzroy at the time Conception was destroyed, 20 Feb. 1835,

1. Ruins along the Sea-front at Messina, the American Consulate in foreground.
2. Soldiers searching the Ruins for Bodies.

when the coast was elevated 4 or 5 feet for 300 or 400 miles, which would correspond to the expulsion of a vast quantity of lava from under the sea, sufficient, according to Lyell, to make a mountain as large as Mt. Ætna. Moreover, Darwin observed the volcanoes in Chile to break out into violent eruption immediately after this earthquake. Ætna and Vesuvius had their foundations laid in the sea, and elevations of the land at Pozzuoli and near Vesuvius have been repeatedly observed; and the temple of Jupiter Serapis shows that subsidences may also take place. Evidence of elevation is furnished by beaches throughout the world. At Valparaiso Darwin found that the elevation had been 1,300 feet within recent Geological time. In the same way all the small islands in the sea have been upheaved—none of them existed at the time of the consolidation of the globe.

In the great earthquake of Sept. 10-15, 1899, the coast of Yakutat Bay, Alaska, was elevated 47 feet 4 inches, and the elevation extended for more than a hundred miles, with small depressions in a few places (see memoir by Tarr and Martin, 'Bulletin of the Geological Society of America,' vol. 17, May 1906). Moreover, Professor H. D. Curtis of the D. O. Mills Expedition of Lick Observatory, at Santiago, Chile, reports that the recent Valparaiso earthquake raised the coast ten feet and that the displacement was mainly vertical.

We therefore reach the conclusion that the mountains have all been formed by the explosion of steam beneath the earth's crust, which pushes up a ridge parallel to the shore, giving rise to faults, and occasional outbreaks of volcanoes. They are in no way connected with the shrinkage of the globe, which has been wholly insensible ever since the consolidation of the earth's crust; nor are there any lines of weakness except those produced by the sea. Under the land the amount of water seeping down is very small, while under a deep sea it is very great; and hence relief is afforded only by lava being expelled towards the land, which breaks the crust and pushes up the mountain range parallel to the seashore. Off the west coast of South America the bottom of the sea is sunk down, so as to be actually convex to the centre of the earth, and explosive forces arising beneath this downward arch can only find relief at the sides. In the same way just east of Japan there is another deep depression beneath which the earthquakes originate, and the whole island of Nippon has been raised from the sea by this expulsion of lava from beneath the Tuscarora Deep. This process is still going on and causes the terrible earthquakes felt on the east coast, which is also proved to be rising from the sea.

It is a remarkable fact that the two slopes of a mountain chain are generally unequal, the gentler slope being turned toward the sea, from which the lateral thrusts have been exerted to give the range its characteristic unsymmetrical features. In the case of the Sierra Nevada range in California the eastern slope is about ten times steeper than the western; and the range has been pushed from the direction of the San Joaquin and Sacramento valleys, which were originally deep valleys in the sea, and have since been elevated. By this tangential movement and subsequent elevation of the sea valley it got far away from the Sierras, and the relief was therefore difficult in the old way; it finally became easier to force the crust upward, and in this way the coast range was formed parallel to the Sierras, and the sea eventually withdrew to the outside and assumed its present limits. The injections from the sea are now chiefly effective in raising the coast range, and it was one of these expulsions of lava from beneath the sea which produced the great earthquake of 18 April 1906, and the accompanying movement of the faults.

If we examine the Andes and the Himalayas we shall find the slopes towards the continent from three to five times steeper than that towards the sea. The Alps have been raised largely by expulsions of lava from the ancient sea valley now occupied by the valley of the Po, into which the Adriatic formerly extended. The limits of this article do not permit an account of all the principal mountain ranges of the world, but we may say that the operation of lateral thrusts from the direction of the sea is generally recognized by geologists, though on the contraction theory heretofore in use they have not been able to account for these forces.

(4) *Elevation of Plateaus and Islands.*— Most plateaus have been formed by the injection of steam-saturated lava from the adjacent seas. Thibet, Caxamarca, Cuzco, Titicaca, Mexico, and the western plateaus of the United States were elevated in this way. American geologists have long claimed that vertical forces have been exerted in the elevation of our western plateaus. After the Rocky Mountains were formed the Pacific Ocean was deep and kept receding and raising the great plateau, which accounts for the marine fossils as well as the numerous parallel ranges of mountains in Utah, Nevada, California, and other states.

The Plateau of Thibet is now about three miles above the sea level, and fossil bones of elephants and rhinoceroses, animals which could not live at that altitude, show that the elevation occurred within comparatively recent geological time. In fact the valleys of the Ganges and Brahmaputra were originally sea valleys, and expulsions of lava from beneath these valleys were the main forces in raising the Himalayas. In his great work on the 'Face of the Earth' Professor Suess remarks with astonishment on the opposite directions shown by the tangential movement on the two sides of the Brahmaputra, that in Assam being southward, and that of the Himalayas northward—but this is perfectly accounted for by the old sea valleys where these great rivers now flow; and this also explains why earthquakes are still so powerful in this region. The valleys have indeed risen from the sea, but the great rain fall and enormous rivers furnish the water necessary for the continuation of the earthquake process. The side spurs thrown off by mountain ranges generally show the direction from which injection has proceeded.

In regard to islands the injection usually proceeds from both sides, and hence the mountains run along the principal axes as veritable backbones. In no other way could the symmetry of the lay of the mountain chains be accounted for. Let the reader examine the maps of such islands as Crete, Sumatra, Java, Saghalien, etc., and of peninsulas like those in

Greece, and Italy, also Kamschatka, the Malay Peninsula, etc., and the evidence of this injection process will be found sufficient to convince even the most skeptical.

(5) *The Feeble Attraction of Mountains.*—It has been recognized by Geodesists for nearly 200 years that mountains exert an unusually feeble attraction in proportion to their apparent mass, as if they were hollow. They are not hollow, but filled with pumice, which is lava inflated with steam into a froth of bubbles and then dried, giving maximum strength to minimum weight. If such material fills the mountains their attraction ought to be feeble, because the mass of the internal portion of a mountain is very small. That such matter actually does fill the mountains and plateaus seems proved by the vast quantities of pumice blown out of volcanoes, which are simply ordinary mountains broken through, so as to give vent to the imprisoned steam. The escaping vapor blows out whatever lies in its path, and thus we have vast masses of pumice, and ashes, which are made chiefly through the disintegration of dry pumice by the violence of the explosions to which it is subjected. The lava expelled from a volcano is simply the molten rock pushed out by the escaping steam, and neither the inflation of liquid lava, nor the shattering of solid rock will account for the clouds of volcanic ashes observed to pour forth frequently in such vast quantities as to obscure the sun and spread over the earth for hundreds and even thousands of miles. This fine material is nothing else than pulverized pumice.

(6) *Seismic Sea Waves.*—One of the most frequent phenomena noticed to accompany severe earthquakes along the ocean shores is the violent disturbances of the sea, giving rise to enormous waves which sometimes prove more disastrous than the earthquakes themselves. These seismic sea waves have been observed from the earliest ages, but no satisfactory explanation of their origin has heretofore been given. Since the earth particle only moves a few inches at most, they could not be accounted for by the vibrations of the earth's crust during an earthquake, but must be explained in some other way. We shall see that they are easily understood, and confirm the present theory in every respect; so that they become one of the most significant and interesting phenomena in all nature. Seismic Sea waves are divided into two classes. First, those in which the water is noticed to slowly withdraw from the shore sometime after the earthquake, and later return as a great wave carrying everything before it. Second, those in which the water rises suddenly and overflows the coast, without any previous recession from the shore. Major Dutton and perhaps others have concluded that in the first class the sea bottom sinks, and the water withdraws to fill up the depression; but so long as this could not be shown to be a part of the usual order of nature the acceptance of this hypothesis presented great difficulty. It was not easy to explain the supposed cavities under the sea. We shall now show that the sea bottom does really subside after lava has been expelled from under it by the throes of the earthquake, so that the support is weakened.

To make the class of waves here considered more specific we may say that it includes the waves which inundated Lisbon after the great earthquake of 1 Nov. 1755; Callao, 28 Oct. 1746; Conception, 20 Feb. 1835; Arica, 13 Aug. 1868; and Iquique, 9 May 1877. In all such cases the water retired some little time after the earthquake, say from a quarter to half an hour, and sometimes after longer intervals; and moreover the withdrawal is gradual, so that ships at anchor simply settle down upon the sea bottom laid bare by the slow withdrawal of the water. Then after an interval of 20 minutes, or half an hour, the sea returns as a great wave, which is said to have been 80 feet high at the overflow of Callao in 1746, and from 50 to 60 feet high at the inundations of Arica and Iquique. The wave is naturally made higher with a more vertical front as it approaches the shore, owing to the resistance to propagation in shallow water.

The slow draining away of the water sometime after the earthquake shows that the sea bottom has sunk, and the water rushes in from all sides to fill up the depression; the currents meet at the centre, and raise a ridge where there was formerly a depression, and the ridge then collapses and sends ashore the first great wave. After this has swept the shore the sea slowly withdraws to again fill up the depression, leaving bare the land as before, and after the same interval again returns and sweeps the coast. This movement has been observed again and again, always in this order; and at Arica in 1868 and at Iquique in 1877 it is said that the sea continued to oscillate for nearly two days before it finally quieted down, and meanwhile the waves were propagated around the world.

These seismic sea waves are therefore produced by subsidences of the ocean bottom after the expulsion of lava has thinned out the underlying molten rock and rendered the support of the crust unstable. This phenomenon has often been observed in South America, and in 1812 it occurred at Santa Barbara, California, after a long series of earthquake shocks. But as it does not happen every time an earthquake occurs, it is evident that a considerable undermining of the sea bottom is required to produce a subsidence, so that a seismic sea wave may ordinarily be expected only after several earthquakes have occurred at a place situated on the shores of a deep ocean. But every place on the sea coast visited by severe earthquakes will sooner or later be devastated by a seismic sea wave, because the undermining of the sea bottom will finally cause it to sink after some earthquake has shaken the region. The great subsidence in the sea bed parallel to the Andes was gradually produced in this way, and hence within historical times we have simply witnessed the ordinary phenomena of nature, which have been going on throughout all Geological time.

In seismic sea waves of the second class, where the water rises suddenly without recession from the shore, the cause is an upheaval of the ocean bed, which also lifts the water resting upon it. The result is the sudden appearance of a great wave. This class of waves appears to be less frequent than the preceding class, and therefore are not so famous as those in which the water first withdraws from the shore. At great distances from the origin waves of the first class, in being propagated round the world, resemble those of the second class; so that to classify sea waves intelligently a careful investigation must be made of the place of origin of the disturbance.

It will be seen that all the principal phenomena of the earth's surface are explained in a simple and natural way by the above theory. And the way in which the phenomena are interrelated and mutually confirmatory one of the other gives the theory such a degree of consistency and strength that it seems impossible to doubt its essential truth. The indications of nature are plain enough, and all we need to do is to follow her teachings, and not be misled by antiquated theories merely because they have been held by someone else. A theory which unites and harmonizes all these phenomena must be considered to embrace the true laws of nature.

It should be remarked that the Roman poet Lucretius believed that the sea water penetrated under Ætna, and thus produced the escaping vapors; and he also held that earthquakes are due to vapors even when they do not escape to the surface. Similar views appear to have been held by Aristotle; and Strabo distinctly states the doctrine of the upheaval and subsidence of the land. In the 10th century of our Era the Arabian astronomer and physician Avicenna correctly ascribed the formation of mountains to violent earthquakes. But while traces of the present theory may be found as far back as the classic period, yet the precise forces involved were never fully understood nor worked out. It is easy to propose or suggest a theory, but rigorous proof derived from the phenomena of nature is the only thing which justifies its universal acceptance by the scientific world.

In conclusion it follows that as the penetration of water into our globe is the cause of its tremors, mountain formation and seismic sea waves, and only a part of this water is again restored to the surface by the exhalations of volcanic vents, more and more water must be gradually sinking into our globe, and consequently there is a slow secular desiccation of the waters of the oceans. The lowering of the sea level due to this cause does not appear to be sensible during the historical period, but it helps to account for the lowering of the strand line, noticed to have occurred in recent Geological ages. See MOUNTAIN FORMATION.

Bibliography.—Dutton, 'Earthquakes in the Light of the New Seismology' and numerous memoirs in the 'Transactions' of various learned Societies and Government Surveys; Humboldt, 'Cosmos'; Judd, 'Volcanoes'; Lyell, 'Principles of Geology' (12th edition); Milne, 'Earthquakes' (1903), and 'Seismology'; Russell, 'Volcanoes of North America' and numerous other works on Geology and related subjects; See, 'Cause of Earthquakes, Mountain Formation, and Kindred Phenomena Connected with the Physics of the Earth'; Suess, 'Face of the Earth.' Papers by Milne and others in the Philosophical Transactions and Proceedings of the Royal Society, and in the Reports of the British Association; Publications of the Seismology Society of Japan; Beiträge zur Geophysik.

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Earthquakes. Several thousand earthquakes have been recorded by seismologists and fairly complete lists of those occurring from 1606 B.C. up to 1842 A.D. are given in Mallet's 'Catalogue Raisonné,' (1854-8), etc. The most disastrous earthquakes of modern times are as follows: Callao 28 Oct. 1746; Lisbon 1 Nov. 1755; Calabria 1783; the New Madrid earthquakes in the Mississippi Valley 1811-12; Caracas 1812; Aleppo 1822; Concepcion, Chile, 1730, 1751, and 20 Feb. 1835; Mount Ararat 1840; Brusa, Asia Minor, 1855; Naples 1857; Quito 1859; Mendoza, Argentina, 1860; Manila 1863; Arica, Chile, 13 Aug. 1868; Iquique, Chile, 1868, and 9 May 1877; Cachar, India, 10 Jan. 1869; Manila 1880; Agram, Hungary, 1880; Valparaiso 1880; Yokohama, Japan, 23 Feb. 1880; Ischia 1883; Colchester, England, 1884; Malaga and Granada 1884 and 1885; Charleston, S. C., 31 Aug. 1886; Central Japan 26 Oct. 1891; Chilpancingo, Mexico, 1892; San Francisco, Cal., 18 April 1906; Valparaiso 16 Aug. 1906; Kingston, Jamaica, 14 Jan. 1907.

Earthquakes, Instruments for Recording. The first record of an earthquake really worthy of being regarded as accurate and complete was obtained by Professor James Ewing at the University of Tokio, on 3 Nov. 1880, by the aid of a new seismograph of his own invention. This great epoch-making result was dimly foreshadowed, no doubt, by earlier crude attainments, yet Ewing's work was far in advance of that of the times, and his records were the first and only ones from which the approximate amplitudes, periods, and accelerations of the motions of the ground could be deduced.

In order that a seismograph may faithfully record the motion of the ground during an earthquake it is in general a necessity that some portion of the instrument must remain relatively at rest throughout the disturbance. It seems to the writer that to Ewing more than any other is due the credit of having formulated the kinetic basis of all modern seismometry. He was the first to show how to realize and utilize the principle of the steady mass in the measurement of earthquake motion. There is scarcely any type of seismograph now in use that does not find its prototype among the large number of devices and arrangements either described or actually constructed and employed by Ewing at the University of Tokio from 1880 to 1883. We cannot attempt to describe in this brief account any of his early work,[1] or the equally important contributions to seismology by Milne, Gray and others[2] of that period.

Within the past 10 or 15 years seismographs have multiplied very greatly throughout the civilized world, and by their records it is found that any considerable earthquake literally sets the entire crust of the globe vibrating and its tremors are measurable at almost any point on the surface by the aid of the sensitive instruments now employed.

Nature of Earthquake Motion.—A short statement explaining the motions of the ground will aid in understanding the instruments and their records. The commonly current conception that earthquake motion is a comparatively simple

[1] Memoirs of the Science Department, University of Tokio, No. 9.—1883

[2] Publications of the Seismological Society of Japan, since 1880.

vibratory displacement of the ground in some particular direction is shown to be decidedly erroneous by the actual records. The motion, in fact is exceedingly complex; the vibrations in a horizontal plane take place in all conceivable directions and are compounded with motion in the vertical. With this complex sort of vibratory displacements there may also coexist certain twisting and tilting rotations. No single instrument can possibly produce the record of such highly intricate motions. They must be separated or resolved into elementary components for satisfactory registration. It is generally recognized that no less than six distinct and separate components require to be measured, namely, three displacements in directions at right angles to each other, that is, one North and South, one East and West and one vertical; also, three components of rotation about the same three axes. The turning on the vertical axis may be called a twisting component. The turnings on the horizontal axis are tilting effects. Seismologists have not yet succeeded in recording all of these elementary components. Unfortunately most of the instruments thus far employed are influenced by more than one component of motion, and the records cannot therefore be entirely interpreted.

Seismographs — The seismographs chiefly employed up to the present time are those designed to register the horizontal vibratory displacements of the ground. In a limited number of cases efforts have been made to register the vertical component of motion. In still fewer cases the tilting motions of the ground have been the subject of special measurements. The writer is not aware that the twisting component has thus far ever been recorded, although forms of apparatus for the purpose have been proposed.

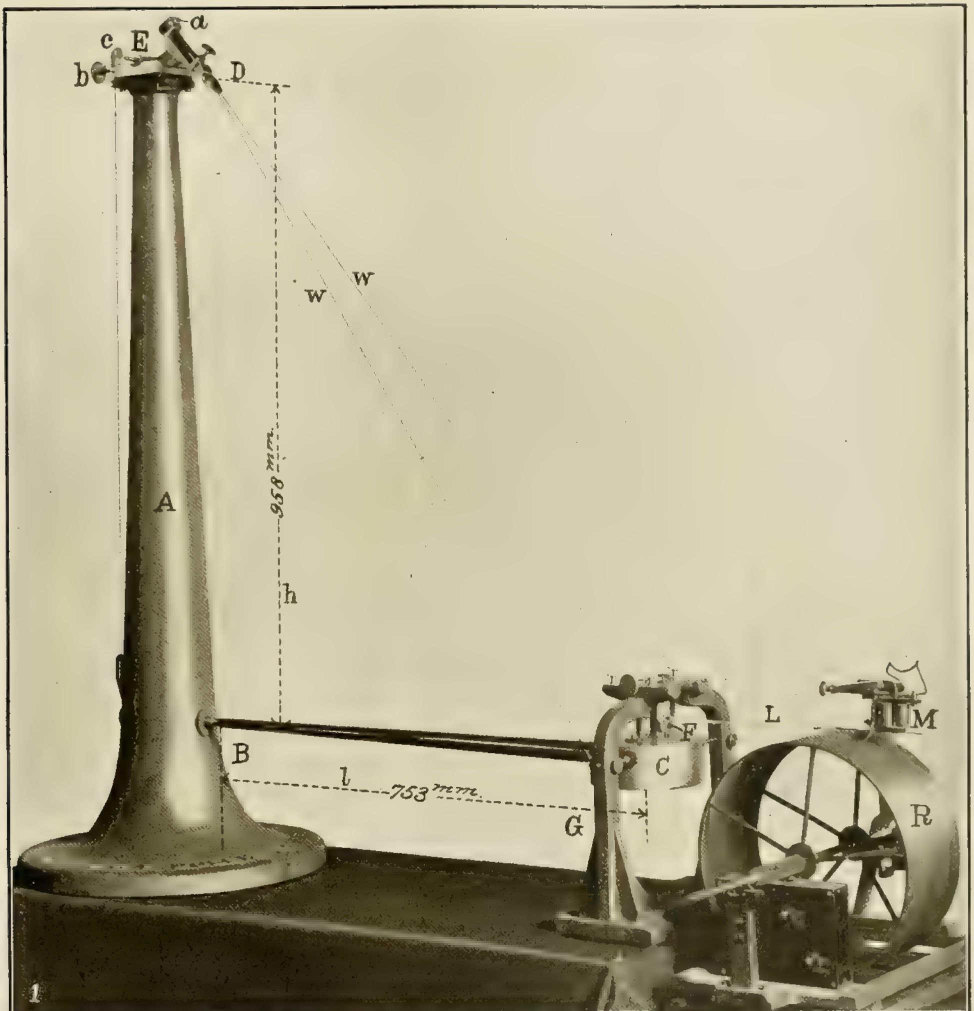
Vertical Component.— Instruments for vertical motion are not so easy to design, and the results obtained by their use have been less satisfactory than with other types either because the vertical motion of the ground is relatively very small, or because it may be absent altogether. In seismographs for vertical motion the so-called steady-mass must, in general, be suspended by means of very flexible springs, or their equivalents, in order that it may remain at rest in the vertical sense while the ground may rise and fall beneath it. If the springs are too stiff the steady-mass fails to remain at rest but is made to rise and fall with the movement of the ground. On the other hand, if the springs are too weak, very slight variations of strength, due to temperature and prolonged excessive stress, cause the steady-mass to wander slight amounts from its normal position of rest. As the motions are generally greatly magnified, these slight progressive displacements often carry the tracing entirely off the sheet designed to receive it, or otherwise prove fatal to the desired result. These characteristics of ordinary springs constitute serious limitations in the construction of seismographs for vertical motion. What is needed in this connection is some sort of available material for springs that, under very great extension does not exhibit with the lapse of time any minute slow, progressive, after deformations and is unaffected by variations of temperature.

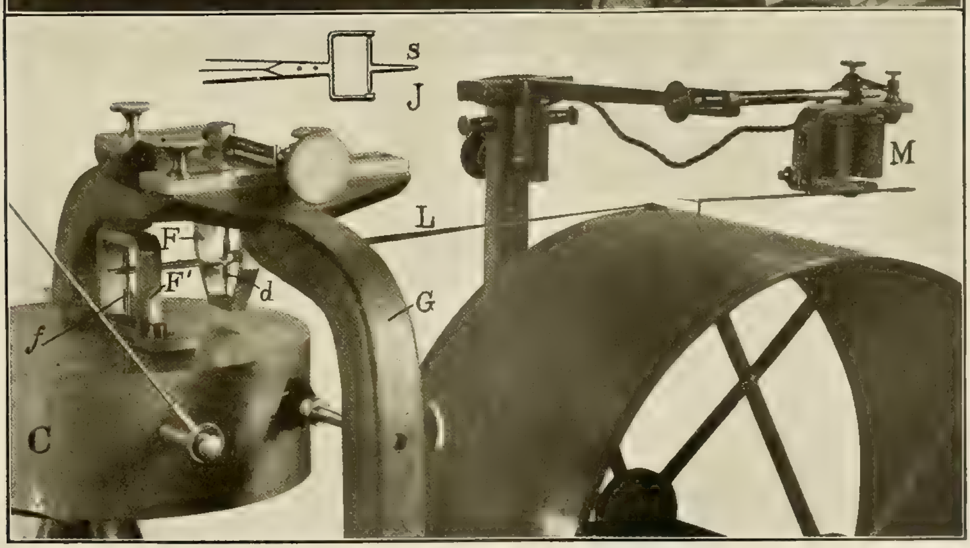
Horizontal Motion. —A simple pendulum consisting of a massive bob, weighing several hundred pounds in some cases, suspended by a steel wire from a massive support has been extensively employed especially in Italy and Spain as the "steady mass" for a seismograph. The motions of the ground with respect to such a mass must be magnified from 10 to 100 or more times if we are to produce satisfactory records of small distant earthquakes. The means of doing this will be shown later.

A simple pendulum of this character fails to provide a reliable steady mass for two or three reasons. If the length is short, 10 or 20 feet, the mass very quickly responds to the earthquake movements and presently the pendulum is itself swinging in a more or less violent manner. A long pendulum (several hundred feet) cannot be supported with sufficient rigidity. The top of a lofty tower, even during the absence of an earthquake, wanders all about a fixed point within it, due to the influence of temperature, wind, etc., on the tower, and the effects of moisture, temperature, rainfall, etc., upon its foundation and the adjacent earth. During an earthquake the motions of the top of such a tower cannot be the same as those of the ground and are doubtless much greater, thereby seriously influencing the steady mass, notwithstanding the great length of its support.

The Horizontal Pendulum.— The type of pendulum employed first by Ewing for the measurement of earthquake motion in the horizontal plane, is commonly called the horizontal or conical pendulum. A modern design of this form of seismograph is shown in Figs. 1 and 2. The steady mass, C, (about 40 lbs.) is supported upon the massive column A by a horizontal strut and the diagonal wires W. W. so that it is exceedingly free to swing about a pivot point at D and another at B. The two points D and B are not quite in a vertical line, hence the steady mass is in slightly stable equilibrium and if disturbed oscillates like a very long pendulum. As ordinarily adjusted at the Weather Bureau the pendulum illustrated, makes a complete oscillation in about 35 seconds. This is equivalent to a simple pendulum about 4.000 feet long. The record is made upon the clock-driven drum R by means of the lever L, carried in the heavy yoke piece G. For this purpose the surface of the drum is closely covered with a piece of smooth white paper which is uniformly coated with soot from a wide-flame, smoky, kerosene lamp. The drum makes one revolution an hour, and each minute of time is electrically marked on the record sheet by the time-ticker magnet M. The distant end of the drum-shaft is cut with a coarse thread which causes the drum to move endwise about 3-16 of an inch with each revolution, thus separating the lines traced by the stylus.

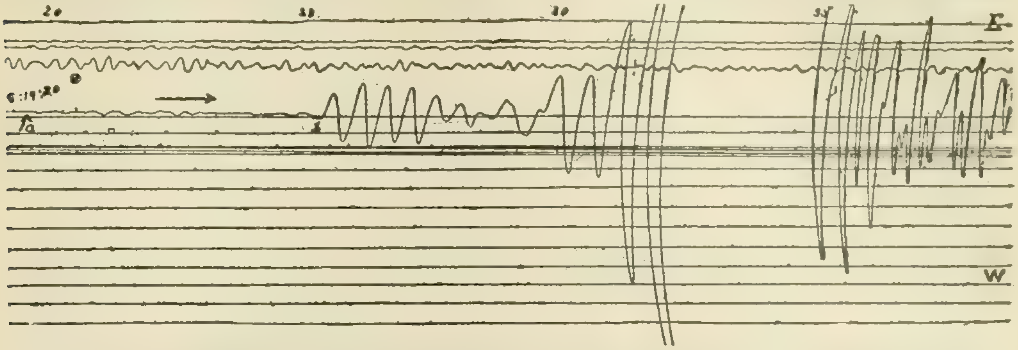
The manner in which the registration of the earth motion is effected is more clearly seen in Fig. 2. The lever L is pivoted very freely in the stirrup F. The short end of the lever is forked and engages the slender steel staff *f*, which is pivoted in the most delicate manner in the frame F, rising from the steady mass C. Observing now that the steady mass is free to remain at rest with respect to the lateral motions of its pier and the yoke piece G, it is plain





No. 1. Horizontal Pendulum Seismograph with Mechanical Registration.
No. 2. Details of Horizontal Pendulum Seismograph.

that the stylus at the long end of the lever will trace a magnified record of all lateral displacements of the pivot *d*, because the point of the fork which engages the steady mass at *f* must cations are likely to enter into the records of seismographs especially of the horizontal pendulum. This instrument is more and more sensitive to minute tilting motions the greater



Record of San Francisco Earthquake as made by the Seismograph at the U. S. Weather Bureau, Washington, D. C.

remain at rest with the mass. The amount of magnification depends upon the ratio of the lever arms. In instruments of the kind illustrated a 10 or 15-fold magnification is usual. Owing to the fractional resistance offered by the soot and at the pivot points greater magnifications require proportionately greater mass in the pendulum, if the same period is retained.

Very similar devices to those shown are quite generally employed in all instruments with mechanical registration.

Two separate pendulums installed at right angles to each other are required to register both components of horizontal motion.

Photographic Registration.—Much less massive horizontal pendulums can be employed to register photographically by the aid of light reflected from a mirror in the usual manner. The Milne seismograph used in the English work records photographically without the use of mirrors. A small steady mass is suspended on a horizontal strut only an inch or two long, but the strut is prolonged beyond by a very light boom to a length of nearly three feet or more. This long boom at the outer end carries a light aluminum vane pierced with a narrow radial slit. The photographic paper, in the shape of a long ribbon is placed in a box just under the vane. The box has a slit in its top at right angles to that in the vane. Light from a lamp is thrown upon the aluminum vane and passes into the box at the point where the two slits intersect, thus making the photographic record.

Magnetographs.— It has been found that the delicately suspended magnetic needles employed for the purpose of recording continuously the small diurnal and other changes going on in the earth's magnetism are nearly always disturbed by even very small earthquakes. These are not seismographs at all, in the ordinary meaning of the word, and the records give very little information except the time at which the needles were disturbed. The needles act like any other small, light pendulum and simply suffer certain mechanical agitation during the earthquake. In some less frequent cases there appear to be certain distinct magnetic effects that occur with the earthquake, but these are only imperfectly understood at the present time.

Interpretation of Records.— Serious complications are likely to enter into the records of seismographs especially of the horizontal pendulum. This instrument is more and more sensitive to minute tilting motions the greater its period of oscillation. If the ground at the Weather Bureau instrument tilts as little as only one inch in a mile the stylus of the seismograph will be thrown out of line nearly one-quarter of an inch. Furthermore, the instrument is sensitive to the twisting component of motion and finally we cannot feel entirely sure the steady mass has remained quite at rest. If the earth quake motion synchronizes with the free motion of the pendulum, the latter is quite certain to be set swinging. In the face of these complications it is hardly possible, as yet, to exactly interpret the records obtained. Great improvements in the instruments are constantly being made and it appears as if the horizontal pendulums are likely to be displaced in the future by better types of apparatus.

Records.— The interesting features of the Weather Bureau record of the San Francisco earthquake appear in Fig. 3. The small preliminary tremors begin at "a", at 8 h.— 19 m.— 20 s., A. M., that is 6 mins. 42 sec. after the strong motion recorded at the University of California. The stronger motion begins at "b", on the record at Washington and at 8:32 to 8:35 the pen was deflected off the sheet by the very strong motion, producing a gap in the record which, however, was resumed when the motion subsided a little. The original record sheet is 36 inches long and vibratory motion is perceptible for fully four hours. The complete period of the larger waves was from 20 to 30 seconds. Such vibrations are very slow and appear to be entirely imperceptible to human beings, nor do they affect buildings or other structures injuriously, so far as can be ascertained.

C. F. Marvin,
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Earths, a term applied by alchemists to substances which were considered elementary bodies, but since the researches of Lavoisier and Sir Humphry Davy, defined as metallic oxides, or compounds of oxygen with metals similar to potassium and sodium. Earths are seldom found in a state of natural purity, but constitute chiefly the component parts of gravel, soil, or strata. The more important earths are divided into two classes; alkaline earths, lime, baryta, strontia, and magnesia; and proper earths, alumina, zircoma, glucina, yttria, and thorina; most of these are treated under separate titles, to which refer. The alkaline earths resemble the alkalies. They are soluble in water; baryta and strontia readily, lime sparingly, and magnesia very slightly. Their solutions affect vegetable colors similarly to the alkalies. They combine with acids, forming neutral salts, some of which are readily soluble in water, and others insoluble. The proper earths are insoluble and infusible, and by exposure to heat lose the property of easy solubility in acids.

Earthworks, in military parlance, are permanent or temporary defenses chiefly of earth forming a shield against the enemy's fire. For the various forms of military earthworks see FORTIFICATION; TRENCH.

Earthworm, annelid of the order *Oligochæta* (q.v.). Although certain families of *Oligochæta* are strictly aquatic and others exclusively terrestrial, still others contain both aquatic and terrestrial species, and aside from peculiarities which are obviously adaptations to the mode of life no sharp distinctions can be drawn between these two classes. The earthworms generally are larger and more robust, with shorter setæ than the waterworms, and have dorsal pores. Within recent years the earthworms have attracted much attention from systematic writers and no less than 800 species, of which upwards of 90 inhabit North America, are now known. Externally they look much alike, but in their internal anatomy exhibit an astonishing variety. The common earthworms of Europe and America, of which a dozen or more species may be found in almost any suitable locality, belong chiefly to the genera *Lumbricus* and *Allolobophora* which have the setæ arranged in four pairs on each somite, a well-developed girdle or clitellum occupying a variable number of segments toward the anterior end, the female and male genital pores on the 14th to 15th segments respectively, and various complex internal peculiarities of the reproductive organs. While our species rarely equal a foot in length, several South African and Australian species reach five feet. Earthworms inhabit nearly all parts of the earth except the frozen regions of high latitudes and altitudes, dry sandy soils, and some portions of the North American prairies. Their habits are everywhere much alike. They burrow in damp earth, which the common kinds penetrate to the depth of about two feet. They swallow the soil, and after digesting its nourishing elements reject the rest in the form of castings from the mouths of their burrows. At night they partly leave their burrows and draw to them the petioles of leaves, etc., on which they feed and with which they close the openings in cold weather. In this way they also seek one another's company and copulate, as hermaphrodites mutually fertilizing each other. A cocoon is formed by secretions of the clitellum and receives the eggs and spermatozoa in a quantity of albumen as it slips past the openings of the genital ducts toward the head, from which it passes and remains in the earth. During the winter they burrow to a depth beyond the reach of frost, but some species at least will survive actual freezing. The importance of earthworms as cultivators of the soil can scarcely be overestimated. By their burrowing they render it porous and permeable to the rain and air; they continually turn the earth by bringing up soil from beneath the surface, and they add to its fertility by burying vegetable matter and by their secretions. Darwin has estimated that earthworms bring to the surface in rich meadow lands not less than one fifth inch of soil per annum, and recent laboratory experiments demonstrate most emphatically the beneficial influence on plants of the presence of earthworms. Consult: Beddard, 'Monograph of the Oligochaeta,' and Darwin, 'Formation of Vegetable Mould.'

Earwig, an orthopterous insect, forming type of a family, *Forficulidæ,* and an order *Dermaptera.* This insect has generally a habit of concealing itself in cavities, endeavoring to reach their innermost recesses, and in some rare cases may have sought a hiding place in the ear, but its passage into the internal ear would be stopped either by the waxy secretions or by the tympanic membrane. The common earwig (*F. auricularia*) is found throughout Europe, in north Africa, Asia Minor, and North America. It has a length of from two fifths to two thirds of an inch; the antennæ are thread-like, and the number of joints is 15. The fore wings are short, horny, and somewhat rectangular, but the larger hind wings are thin and mainly membranous, and fold up somewhat like a fan under the fore wings. The last segment of the abdomen carries a pair of curved, horny, pincher-like appendages, which in the male are toothed at the base. The eggs are laid in spring, about 20 at a time, and are carefully protected by the female. The young earwigs differ little except in size from the mature insects; they are guarded by the mother during the first period of their existence. Earwigs shun light as far as possible and this habit is taken advantage of by gardeners to catch them and destroy them. In the daytime they may be found in various situations, such as beneath the bark of trees, under stones, in the soil, or in any suitable hole. They feed on fruits, seeds, leaves, and flowers, and at times on animal refuse. Eight other species of this genus are found in Europe. In the genus *Chelidura,* represented in Europe by nine species, the wings are altogether wanting. *Labia* is another genus with only one European species (*L. minor*), which is common in Great Britain about manure heaps and similar habitats.

Easement, a legal term, denoting a privilege comprising a permanent public or personal right as legal owner of one parcel of land, to use, or forbid its use, for some special purpose, with regard to a parcel of land belonging to another owner. This definition includes easements strictly so called, which are always appurtenant to land, public easements, and easements in gross or such as are attached to the person. In more general terms it is said that the right of making use of the land of others, whether it be that of the public or individuals, for a precise and definite purpose, not inconsistent with a general right of property in the owner, especially where it is for the public use, is in legal contemplation an easement or franchise, and not a grant of the soil or general property. In the civil law the land against which the privilege exists is called the servient tenement; its proprietor the servient owner; he in whose favor it exists, the dominant owner; his land the dominant tenement. And, as these rights are not personal and do not change with the persons who may own the respective estates, it is very common to personify the estates as themselves owning or enjoying the easements. Easements have these essential qualities. There must be two tenements owned by several proprietors: the dominant, to which the privilege is attached; the servient, upon which it is imposed. Considered strictly, easements exist only in favor of, and are imposed only on, corporeal property. They confer no right to any profits arising from the servient tenement. They are incorporeal. At common law they may be temporary; by the civil law, the cause must be perpetual. They impose no duty on the servient owner, except not to change his tenement to the prejudice or destruction of the privilege. Easements are of various kinds. They are as various as the exigencies of domestic convenience or the purposes to which buildings or land may be applied. The following attach to land as incidents or appurtenances, to wit: The right of pasture on other land; of taking game on other land; of fishing in other waters; of taking wood, minerals, or other produce of the soil from other land; of receiving air, light, or heat from or over other land; of receiving or discharging water over, or having support to buildings from other land; of going on other lands to clear a mill stream, or repair its banks, or draw water from a spring there, or to do some other act involving ownership; of carrying on an offensive trade; of burying in a church, or a particular vault, etc. Some of these are affirmative or positive, that is, authorizing the commission of acts on the lands of another actually injurious to it, as a right of way,— or negative, being only consequentially injurious, as forbidding the owner from building to the obstruction of light of the dominant tenement. Easements of every kind must originate in a grant or agreement, express or implied, of the owner of the servient tenement. By the common law, the evidence of their existence may be by proof of the agreement itself, or by prescription, requiring actual and uninterrupted enjoyment immemorially, or for upward of 20 years, to the extent of the easement claimed, from which a grant is implied. Easements of the negative kind do not admit of possession, and by the civil law they cannot be acquired by prescription, and can only be proved by grant. Use is not essential, therefore, to their existence. Easements may be extinguished by release; by merger, when the dominant and servient tenements are united under the same title and to the same person; by necessity, as by a license to the servient owner to do some act incompatible with its existence; by cessation of enjoyment, when acquired by prescription,— the non-user being evidence of a release where the abandonment has continued at least as long as the user from which the right arose. A shorter time will answer in some cases.

Consult: Holland, 'The Elements of Jurisprudence' (9th ed., New York 1900); Goddard, 'Easements' (4th ed., London 1900); Jones, 'Treatise on the Law of Easements' (Boston 1898); Innes, 'Easements' (London 1893); Washburn, 'Easements' (4th ed., Boston 1885); Gale, 'Easements' (7th ed., London 1899).

East, Alfred, English artist: b. Kettering, Northamptonshire, 15 Dec. 1849. He studied in Paris at the École des Beaux Arts and under Julian and Bouguereau. He has exhibited at the Royal Academy for many years, and amo ; hi works are: 'A Passing Storm,' in the Luxembourg, Paris; 'A Haunt of Ancient Peace,' in the National Gallery of Hungary; 'The Nene Valley,' in the Permanent Gallery of Venice; 'An Idyl of Spring,' in the Preston Gallery.

East. In European countries the East, also called the Orient, signifies the countries of Asia lying east and southeast of Europe. In the western parts of the United States the East is a colloquialism for the region east of the Mississippi River, more especially that north of Maryland and of the Ohio River.

East Africa, British, comprises an area of over 1,200,000 square miles, situated to the north of German East Africa and south and west of Italian Northeast Africa, and extending inland to the Congo State and the Anglo-Egyptian Sudan, but here the boundaries are not definitely settled. It has a coast line of about 450 miles, from the river Umba on the south to the river Juba on the north. This vast region has a population estimated at over 13,000,000, and includes Masailand and the Kenia Uplands, parts of Somaliland and Gallaland, lakes Rudolf and Stefanie, the Albertine head-waters of the Nile, Lake Albert, part of Albert Edward Nyanza, the northern part of Victoria Nyanza, the countries of Uganda, Kavirondo, Unyoro, Ankole, Koko, etc. Great Britain has authority also over the coast islands of Pemba and Zanzibar. In 1888 a charter was granted to a company called the Imperial British East Africa Company, from the initials of whose name the country was for a time called Ibea, and on this body devolved the preliminary work of opening up the whole country. In 1893, however, the company retired from Uganda owing to political and other difficulties, and the protectorate was declared in the following year over that portion of the country. In 1896 this Uganda Protectorate was extended to the neighboring regions of Unyoro, Usoga, Ankole, etc., and the whole district of Uganda is now placed under a commissioner resident at Entebbe, the administrative capital of Uganda. The province of Uganda is recognized as a native kingdom under a "Kabaka." For Europeans and non-natives of the Uganda Protectorate, justice is administered by the British consular courts. Forts have been established at various places, and are garrisoned mainly by Sudanese troops, part of whose duty is to restrain the Unyoro and other peoples from predatory incursions on their neighbor's territory. All the rest of the country, with the exception of the islands of Zanzibar and Pemba, constitutes the East Africa Protectorate, declared in 1895. (See East Africa Protectorate.) In the interior are many extensive plateaus; the highest mountains of this part of Africa are Mt. Kenia (18,370 feet), Mt. Elgon, and in the extreme west Ruwenzori. The most important rivers are the Nile and its head-waters, with the Tana, Juba, and Sabaki, entering the Indian Ocean. A considerable trade is carried on chiefly with Great Britain and British India. The natives of Uganda and other parts show great skill in various arts, and great capacity for adaption to European conditions and customs. Zanzibar and Pemba are still ruled by a sultan, but form a British protectorate. Some German firms are now in trade here and some trade has been established with Persia and Arabia.

East Africa, German, the German possessions in east Africa, acquired in 1885-90, lying immediately to the south of British East Africa, and having an estimated area of about 400,000 square miles, and estimated population of 4,000,000, of whom 1,000 are Europeans. They are bounded on the north by a line running northwest from the Umba River to the eastern shore of the Victoria Nyanza, and continuing west from this lake to the Congo State. Lake Tanganyika forms the western boundary, and thence a line to Lake Nyassa and the river Rovuma form the southwestern and southern boundaries. In September 1894 it was agreed that the German-Portuguese frontier should follow parallel lat. 10° 40′ S. from the coast to its intersection with the river Rovuma, leaving Kionga and the mouth of the Rovuma to Germany, and Cape Delgado to Portugal. Several stations have been established by the German East Africa Company. A narrow-gauge railway from the coast to lakes Victoria Nyanza and Tanganyika was projected in 1899. The products of the country are coffee, tobacco, cotton, ivory, caoutchouc, and gum. The highest mountain is Kilimanjaro, reaching 19,600 feet. Among the chief rivers are the Rovuma, Rufiji, Kingani, and Pangani, flowing to the Indian Ocean; the Kagera, Shimiyu, and Ruwara flowing into Victoria Nyanza; and the Malagarazi flowing into Tanganyika. In the north there are several small lakes, and in the southwest the larger salt lake, Rukwa or Hikwa. On the coast the chief towns are Mikindani, Lindi, Dar-es-Salaam, Bagamoyo, Pangani, Wanga, and the English mission station Saadani. Inland there are Mpwapwa, Kanyenye, Tabora (Kazeh), Urambo, and Ujiji, the last named being situated on the shore of Tanganyika. The country is under an imperial governor.

East Africa, Portuguese. The possessions of Portugal, comprising the three provinces of Lourenço Marques, Mozambique, and Zambesi. Its coast line extends south from Cape Delgado, the southern extremity of the coast-line of German East Africa to Kosi Bay, just below Delagoa Bay, at a point separating British from Portuguese territory, as fixed by the Anglo-Portuguese agreement of 1891; the northern boundary is the river Rovuma, running west from Cape Delgado to Lake Nyassa. The frontier between German and Portuguese East Africa runs along parallel lat. 10° 40′ S. from the coast to its intersection with the river Rovuma, leaving the mouth of the Rovuma and Kionga to Germany, and Cape Delgado to Portugal. The eastern boundary is the lake and British Central Africa, or the Nyassa Protectorate down to the junction of the Shiré with the Zambesi; while from that point the British South Africa Company's territory, including Mashonaland and Matabeleland, and the former South African Republic, form the boundary. Its area is about 3,000,000 square miles; population about 1,600,000. The principal exports are oilnuts and seeds, caoutchouc, and ivory. The Mozambique Company administers Sofala and Manica, the Nyassa Company has jurisdiction in the northern part between Lake Nyassa, the Rovuma, and the Lurio, and there is also a Zambesia Company. There is a railway from Delagoa Bay to Pretoria, and one from Beira to Fort Salisbury in the Transvaal. The coast-lands are low-lying and not very healthy, but in the region of the Namuli Mountains there is one of the finest and most beautiful tracts of country in the whole continent. There are several important rivers, including the Zambesi, Limpopo, Rovuma, Sabi, Pungwe, Lurio, Mtepwesi, Lukuga, and many others. The most important towns are Lourenço Marques, Inhambane, Sofala, Beira, Quilimane, Chinde, Mozambique, Ibo, Zumbo, Tete, and Sena. Gold is found in the Manica region on the west, and has been worked by British capitalists.

East Africa Protectorate, British possessions in East Africa, extending about 400 miles along the coast north from Umba, at the mouth of the Umba River. The south boundary runs from Umba in a northwest direction to the intersection of the Victoria Nyanza with the first parallel of N. lat., skirts the north shore of the lake, and thence west to the boundary of the Congo Free State. The river Juba begins the north boundary, which from the intersection of the river with the 6th parallel of N. lat. runs to the 35th meridian E. lon., and follows that to its intersection with the Blue Nile; the Congo Free State and the west water-shed of the basin of the Upper Nile forming the west boundary. The total area is about 300,000 square miles, embracing a great part of Somaliland, the Equatorial province, Usoga, Unyoro, etc. It is subdivided so as to consist of seven provinces and a tract of unorganized territory in the northwest. The provinces are under a sub-commission, and are divided into districts and subdistricts. Nandi and Kericho were formerly under the eastern province of Uganda, but 1 April 1902, they were transferred to the East Africa Protectorate. Mombasa is the largest town and the capital of the whole Protectorate. Pop. of Mombasa 27,000. The population of the Protectorate is estimated at 4,000,000. The Imperial East Africa Company opened up the country, having in 1888 obtained a concession of territory from the Sultan of Zanzibar and a charter from the British government. An arrangement for buying them out, was, however, made in 1895. The chief ports are Mombasa, the capital, Lamu, Umba, and Kismayu.

The prevailing religious belief is paganism of some form, but a large number are Mohammedans. A number of Christian missions have been established, and elementary schools founded. Legislation is by ordinances made by the commissioner, the codes of India being followed as far as applicable. The higher courts are at Zanzibar and Mombasa. Slavery is legal on the 10-mile coast strip, but nowhere else under the Protectorate. The principal exports are ivory, rubber, grain, cattle, hides, horns, gum-opal, and fruits. The principal imports are: Manchester and Bombay goods, brass, wire, beads, and some provisions. Trade is chiefly under the control of the East Indian merchants. In 1901 the railroad from Mombasa to Kisumu on Lake Victoria was completed, and other railroads are in process of construction. Post-offices, telegraph lines and other public improvements have been introduced and are being extended. See EAST AFRICA, BRITISH.

East Anglia, an ancient kingdom of England, its territory corresponding to what is now Norfolk and Suffolk counties. Redwald was its first historical king (593–615).

East Aurora, N. Y., village in Erie County, on the Western N. Y. & P. R.R., 18 miles southeast of Buffalo. The place is noted as the home of the colony of Roycrofters. (See ROYCROFTERS). It is a residential suburb of Buffalo.

East Cape, the name of the southeastern extremity of New Guinea, in Goschen Strait, and of the most easterly headlands of Madagascar; also on the North Island of New Zealand; also in Siberia, on Bering Strait, in lon. 169° 38′ W., in the eastern extremity of Asia. The latter is a bold, rocky promontory, almost cut off from the mainland by swamps and shallow lakes. On the north side is a village, Uédle, of less than 100 huts, with a population of about 260.

East Greenwich, R. I., town, county-seat of Kent County; on Greenwich Bay, and the New York, N. H. & H. R.R. The manufactories are cotton and yarn mills; it has also a large cotton bleachery. Pop. 2,825.

East Hampton, N. Y., town in Suffolk County, in the eastern part of Long Island; on the Long Island R.R., about 122 miles east of New York. The first settlement was made in 1649 and the place was considered as belonging to Connecticut from 1657 to 1664 when it came under the jurisdiction of New York. It was the home of John Howard Payne (q.v.). Pop. 3,800. Consult: Gardner, 'Records of East Hampton'; Hedges, 'History of the Town of East Hampton.'

East Hartford, Conn., town in Hartford County, on the New York, N. H. & H. R.R. The railroad shops and paper-mills give employment to a number of people. Large quantities of tobacco and garden vegetables are raised on the surrounding farms. Pop. 6,500.

East Humboldt Mountains, a range of mountains in Nevada, principally in Elko County. Fremont's Pass is in these mountains. Their slopes have more and larger trees than some of the other mountain ranges in the vicinity.

East India Companies, the various European trading companies chartered by their respective governments for the control of their trade in India and the adjacent countries and islands. From an early period, the Italian republics had established a flourishing trade with these eastern dominions, which was interrupted by the Moslem conquest of Egypt and Constantinople, and the establishment of Turkish rule in Africa and Europe. Under these circumstances arose that spirit of maritime exploration in the 15th century for the discovery of a new passage to the Indies which resulted in the discovery of America by Columbus while seeking a westward route, and in Vasco da Gama sailing around the Cape of Good Hope and reaching the Malabar coast in 1498. This latter discovery gave a new impulse and direction to commercial enterprise and in nearly all the leading nations of Europe, steps were taken to participate in the advantages prospectively revealed in the opening up of this new ocean highway. The 16th century was marked by the Portuguese establishing themselves in India; by English efforts to discover overland and northern passages to India, which while fruitless in the latter direction gave rise to commercial relations with the northern coast of Russia; by the union of Portugal and Spain in 1580, and the war with England which closed the Spanish-Portuguese avenues for Indian produce to that country; and by the revolt of the Netherlands against Spanish dominion which gave a parallel check to the Dutch Indian trade. These two latter events compelled Holland and England to seek direct communication with India; in 1582, a Capt. Stephens was the first Englishman to reach India via the Cape of Good Hope, and in 1586 Sir Francis Drake and Thomas Cavendish followed by way of Cape Horn. In the following decade the great historical commercial corporations known as the Dutch and the English East India companies, were organized, and later were followed by Danish, French and Swedish enterprises.

The Portuguese East India Company was organized in 1587, when, owing to laxity in the official management of the trade developed since 1498, it was entrusted to a company of Portuguese merchants in consideration of an annual payment. The company had a turbulent existence, chiefly of conquest by the Dutch until its dissolution in 1640, since when the unimportant Portuguese settlements have been under crown administration.

The Dutch East India Company formed at Amsterdam in 1595 as "a company for remote parts," in 1602 amalgamated with several minor companies and received a charter conferring the exclusive privilege of trade to the East Indies for 21 years, with the necessary civil and military powers. It had a wonderfully prosperous career and its charter was extended to 1644, when French and English competition had made itself so felt that the Dutch company had difficulty in raising the government subsidy for a 21 years renewal of the charter.

The peace of Westphalia in 1648, ensuring the independence of Holland, inaugurated a new era of prosperity; the company colonized the Cape of Good Hope between 1650 and 1670; in 1658 captured Ceylon from the Portuguese; the same year took Formosa, from which they were driven three years later by a Chinese adventurer; in 1663 obtained possession of the chief Portuguese settlements along the Malabar coast, and in 1666 monopolized the spice trade by the capture of Macassar. Their charter was renewed periodically until 1776; in 1781 owing to the expenses of the prolonged struggle against English encroachment, the company had to be assisted with a government loan, and in 1795 the proclamation of the Batavian republic terminated its existence; in 1798 the mother-country assuming the administration of the company's former possessions.

The English East India Company formed in 1599 and chartered by Queen Elizabeth in 1600, under the title of the "Governor and Company of Merchants of London trading with the East Indies," was the most important, commercially and historically of the East India companies. The trading limits assigned by the charter for 15 years were "all the islands, ports, havens, cities, creeks, towns and places of Asia, Africa, and America, or any of them, beyond the Cape of Bona Esperanza to the Straits of Magellan, with the exception of such places as are already in possession of any Christian prince in league or amity with the British crown who shall refuse his consent to such trade." The company comprised 125 stockholders, including a governor and 24 directors elected annually to supervise the company's business. The early voyages of Lancaster, Beal, Best and others resulted in large profits; in valuable commercial treaties being entered into with native princes; and in English prestige being considerably enhanced throughout the Orient by naval and political successes over the Portuguese. The establishment of factories in various stations, however, excited the jealousy of the Dutch, who in 1623 massacred the members of the English factory at Amboyna, an atrocity for which Cromwell in 1654 compelled the Dutch government to cede an island and to pay a sum of $1,500,000 as compensation to the victims' families. This incident inaugurated the struggle which resulted in the loss to the Dutch of all their possessions on the Indian peninsula. With periodical renewals of its charter, the company, overcoming all rivalry and opposition, maintained its position. From 1745 to 1761 it was engaged in a crucial fight throughout the Carnatic for supremacy with the French company established in 1664, and which under La Bourdonnais and Dupleix had obtained almost paramount power in India; Clive (q.v.) brought it safely through the struggle. It was with reluctance, however, that the company accepted the position which their victories over the French and the native states was forcing upon them of territorial magnates, and unconsciously, of founders of the British empire in India; especially when their growing political importance inspired the home government with a desire to control their company.

In 1766 the right of the company to acquire territorial possessions formed a subject of inquiry in the British Parliament; and a year later a resolution of the proprietors to raise their dividend to 12½ per cent was vetoed. The question of the political rights of the company being thus raised, the British ministry acted on their view of it by sending a crown plenipotentiary to India, and after a protracted struggle, a regulating act was passed in 1773 remodeling the powers of the company and placing it under the control of Parliament. The constitution of the councils of the presidencies was regulated and their superintendence assigned to a crown official, Warren Hastings (q.v.) being appointed first governor-general. A further act introduced by Pitt in 1784 modified the political power of the company by a board of control, to superintend, direct, and control all acts, operations, and concerns relating to the civil and military government or revenues of India. From this time the political power of the company was little more than nominal, the right of nominating its officials still remained with the directors, but the absolute right of recall was vested in the crown. The company's charter was renewed with a few changes in 1793 and subsequently at intervals of 20 years; in 1813 they lost the monopoly of the Indian trade, which under certain restrictions was thrown open to all British subjects; their right of exclusive trade was restricted to China, but in 1833 this monopoly was also abolished. Their charter was renewed for the last time in 1853; the Indian mutiny, 1857–8, discredited the company's administration, and in 1858 a proclamation at Calcutta announced that Queen Victoria had assumed the government of India. The company continued to receive and distribute the dividends guaranteed by the government until the East India Stock Redemption Act became operative in 1874 when the company was dissolved.

The Danish East India Company, founded in 1618, dissolved in 1634, reconstituted in 1670, again dissolved in 1729, was succeeded in 1732 by the Danish Asiatic Company. This company had a prosperous career until the war between Great Britain and Denmark in 1801, when its trade declined and ended with the cession of Tranquebar and Serampore to Great Britain in 1845.

The French East India Company, known as "La Compagnie des Indes Orientales," was founded in 1664 by Colbert, minister to Louis XIV. It had extensive privileges, and in 1675 made a settlement at Surat, and in the following year at Pondicherry. It had a long and prosperous career, notwithstanding the loss of trading privileges at various periods and its connection with the Mississippi Bubble (q.v.). It reached the height of its prosperity under Dupleix and La Bourdonnais (qq.v.), extending its operations until the Deccan and the Carnatic were practically under French control, when antagonism with the English under Clive, the recall of Dupleix, and practical abandonment by the French government, led to the dissolution of the company by royal decree in 1769.

The Swedish East India Company, founded at Gothenburg in 1741, was reorganized in 1806. Consult: Bruce, 'Annals of the East India Company' (1810); Stevens, 'Dawn of British Trade to the East Indies' (1886); Castonnet des Fosses, 'L'Inde Française avant Dupleix' (1887).

East India House, the home of the East India Company in Leadenhall Street, London, well known during the 17th century. Charles Lamb, James Mill, and John Stuart Mill had clerkships at East India House. See EAST INDIA COMPANIES.

East Indies, a name given to what was once called the peninsula of Hindustan and Farther India, and includes also the Malay Archipelago. This name was given to distinguish the Indies reached by sailing east from the Indies (West Indies) reached by sailing west.

East Lake, Ala., town in Jefferson County, about seven miles northeast of Birmingham. Howard College was established here in 1841, under the auspices of the Baptist Church. In 1902 there were in this college 10 teachers and 120 students. Pop. 3,150.

East Liverpool, Ohio, city in Columbiana County; on the Ohio River, and on the Pennsylvania R.R., 45 miles west of Pittsburg. It has freight packet connections with all important Ohio river ports, extensive china, porcelain, earthenware, terra cotta and glass works, foundries, and machine shops. It has the largest pottery works in the United States, natural gas furnishes light and fuel, and the waterworks are owned by the city. It has good schools, one business college, three national banks, and daily and weekly newspapers. Under the charter of 1882 the government is administered by a mayor and city council elected biennially. Pop. (1900) 16,485.

EAST INDIA ISLANDS.

SCALE OF MILES ON EQUATOR.

0 100 200 400 600 800

Population of places is indicated by different lettering, thus;

200,000 and over .... MANILA

100,000 to 200,000 .... Batavia

50,000 to 100,000 .... Palembang

10,000 to 50,000 .... Brunei

Smaller towns .... Cavite

——o—— Railroads

PHILIPPINE
(United States)
ISLANDS
LUZON
MANILA
VISAYAS
MINDANAO
PALAWAN
(PARAGUA)
Sulu
Archipelago
SULU SEA
CELEBES SEA
BOUNDARY OF DUTCH POSSESSIONS
CELEBES
MOLUCCAS
HALMAHEIRA
(JILOLO)
TIMOR
FLORES SEA
BANDA SEA
ARAFURA SEA
INDIA
PACIFIC
OCEAN
NEW GUINEA
AUSTRALIA
EQUATOR
South West Islands
Palao or Pelew Is.
Sumbawa
Sumba or Sandalwood
Mindoro
Samar
Cebu
Bohol
Negros
Panay
Babuyan Is.
Mt. Apo
Mt. Halcon
Mt. Urdaneta
Ceram or Serang
Buru
Obi Is.
Sula Is.
Morotai
Waigeu
Misol
Aru Is.
Kei Is.
Tenimber Is. or Timor Laut
Melville I.
Bathurst I.
Port Darwin
Greenwich
120°
125°
130°
135°
15°
10°
5°
0°
MANILA.
SCALE OF FEET
MANILA BAY
TONDO
BINONDO
SANTA CRUZ
QUIAPO
S. MIGUEL
B. DE S. NICOLAS
B. DE LA CONCEPCION
Pasig River

EAST INDIAN MANUFACTURES.

1, 2. Musical Instruments.
3. Bangle.
4. Pendant of a Necklace.
5, 6. Vases of Glazed Pottery.
7. Earring,
8. Engraved and Gilded Bottle.
9. Spearhead.
10. Dagger; from Khuttar.
11. Saw-edge Sabre.
12. Flint Matchlock.
13. Wooden Spoon.
14. Border of a Mat.
15. Symbol of Juggernaut
16. Nose Ornament.
17. Printed Cotton.
18. Cotton Carpet.
19. Emblem of Jain Sect.
20. Illuminated Manuscript

East Lynne, a novel by Mrs. Henry Wood, which appeared in 1861. It takes its name from the ancestral home of the heroine, Lady Isabel Vane. Several years after marriage, mistakenly doubting her husband's fidelity, she leaves him for another, but later returns in disguise as nurse to her own children, and on her death-bed receives his forgiveness. Although 'East Lynne' has little literary merit, it secured immediate popularity, has been through many editions on two continents, and proved extremely successful as an emotional drama.

East Main, a region of the Dominion of Canada which formerly belonged to the Hudson Bay Territory, but which is now in the Ungava District. It is a bleak and desolate country, yielding little to commerce but fish oil and a few furs.

East Orange, N. J., city in Essex County, on the main line of the Lackawanna R.R., and on a branch of the Erie R.R.; about 12 miles west of New York. It is a residential city, its population being made up largely of people who do business in New York and Newark. The city contains many handsome churches, and private residences, a public library, high and graded schools, a national bank, and weekly newspaper. Pop. (1900) 21,506.

East Providence, R. I., a town in Providence County, on the Seekonk River, and on the New York, New Haven & Hartford R.R. It lies directly opposite the city of Providence. East Providence and the town of Seekonk, Mass., were once a part of the old town of Rehoboth. The town has extensive chemical works, electrical and wire works, bleacheries, linen manufactures, and other industries. The government is administered by a town council, which elects a majority of the local officials. The council members are elected annually by popular vote. The town was incorporated in 1862. Pop. (1890) 8,422; (1900) 12,139.

East River, the strait connecting Long Island Sound and New York harbor, separating the boroughs of Manhattan and Brooklyn. It is about 10 miles long, and is navigable by the largest ships.

East River Bridge. See WILLIAMSBURG BRIDGE.

East Saginaw, Mich. See SAGINAW.

East Saint Louis, Ill., city in Saint Clair County on the Mississippi River and on the Baltimore & Ohio, Chicago, B. & O., the Illinois and other railroads, opposite Saint Louis, Mo., and connected with it by the Ead's Bridge. This is an important railroad and industrial center, the converging point of all the railways, 22 in number, entering Saint Louis, Mo.; it is also the great livestock distributing center of the United States, there being large stock yards here, numerous packing-houses and kindred establishments. It also has the largest and most important horse and mule market in the world. As a manufacturing city it contains rolling mills, steel plants, iron works, locomotive and machine shops, glass factories, sugar mills, grain elevators, flour mills and manufactories of various wood products. Seven miles distant are the great fields of Illinois. In public buildings the City Hall, High School, Public Library, Roman Catholic Academy, and Business College are notable examples. There are three national banks, and one daily and four weekly newspapers. The city has electric light, gas and water works plants and electric street car service, municipal and suburban. East Saint Louis was incorporated as a village in 1861, and as a city in 1865. It expended over $5,000,000 for public improvements from 1890 to 1900. The city is governed by a mayor and city council, elected biennially. The minor municipal officials are likewise elected by the people. Pop. (1870) 5,664; (1880) 9,532; (1890) 15,000; (1900) 29,655; (1903) estimated 40,000.

JAMES W. KIRK,
Editor East Saint Louis Journal.

East'cheap, at one time a large market in the east of London. It occupied what is now Billingsgate and Leadenhall market. Several streets or roads converged at the great square, then called Eastcheap. Two of those highways were the old Roman roads which extended northeast and northwest out of the city. Some of the old taverns, notably «Boar's Head,» mentioned by Shakespeare and others of the English writers, were at Eastcheap. At the north end of London Bridge there is now a small street called Eastcheap.

Easter, the festival commemorative of the resurrection of Jesus Christ, is called in the Greek and Latin and in the languages derived from them *Pascha, Pasch, Pasqua, Pascua, Pâques,* etc., from the Chaldee word *Pascha,* the equivalent of the Hebrew *Pesach:* and that name recalls the act of the Destroying Angel in «passing over» the households of the Hebrews when he smote the Egyptians (Exod. xii.). In languages of Germanic origin the festival has a name *Ostara,* derived from the goddess of spring, in Teutonic mythology. Besides being commemorative of the resurrection of Jesus Christ the Easter festival is a memorial of the Christian passover — of the atonement wrought by the death of Christ upon the cross. At first the Christian passover was celebrated on the same day as the Hebrew, the 14th day of the month Nisan. But before long in the Church of Rome and in other churches of the Latin world, the observance was transferred to the Sunday next after the 14th Nisan; this doubtless primarily to make the difference between Judaism and Christianity.

The churches of Asia and some in the West which were founded by missionaries from the East, were slow to adopt the usage of Rome, and the diversity of usage gave rise to no little controversy; the westerns taunting the easterns with subservience to Judaic custom, and the easterns accusing the westerns of innovation and departure from the ways of Jesus Christ and his apostles. It was not till the year 235 that a general law of the Church was enacted at the Council of Nice prescribing for the universal Church a day for this solemnity. To the bishops of Alexandria was committed in permanence the task of computing for all the churches the time of Easter, that city being the metropolis of science in those times. But the Alexandrine Paschal Cycles fixing the date of Easter for a long course of years were unsatisfactory, being both obscure and incorrect, and hence were not accepted generally; and as a result, in 444, Rome observed 26 March as Easter Day, while Alexandria observed 23 April; and earlier, in 387 Easter Day in Gaul was 21 March, in Italy 18 April, in Egypt 25 April. The churches in Great Britain and in Ireland were, like those of Gaul and Egypt, at variance with Rome, and from that circumstance has been rashly inferred an Oriental origin of the Gaelic, Scotic, and pre-Saxon British churches: in fact those churches were but adhering to an antiquated rule which they had received from Rome, but which Rome herself had abandoned having reformed her calendar. It was in 669 that Theodore, Archbishop of Canterbury, established the reformed Roman calendar in England. The movable feasts of the Roman Catholic and the Anglican churches are determined by the day of the month upon which Easter Day falls. (See CALENDAR.) The way by which Easter Day is now determined is that of the first Sunday after the paschal full moon (14th day of the calendar moon, or the full moon which happens upon or next after the 21st of March). If the full moon happens upon a Sunday then Easter Day is the first Sunday following.

Easter Island, an island in the South Pacific Ocean, lon. 109° 17′ W.; lat. 27° 6′ S. The surface is hilly and the soil fertile; yams and sweet potatoes are the principal crops. A number of remarkable sculptures have been found on this island, gigantic stone images. In 1888 Chile took possession of the island, and has since made it a penal settlement. Pop. about 1,500.

Eastern Empire, the ancient empire lasting from 394 A.D. to 1453 A.D., which had its metropolis at Constantinople as distinguished from the western empire with its capital at Rome. It is known also as the Byzantine empire, the Roman empire of the East, and the Greek empire. See BYZANTINE EMPIRE.

Eastern Question, The, the name originally given to the diplomatic and national interests affected by the gradual retrocession of the Turkish empire in Europe, and the problem of disposing of the territory thus left, or presumably to be left. Bulgaria, Rumania, Servia, and Greece are the new states which have naturally arisen on the withdrawal of the Turkish power, and their history in connection with the respective policies of England, France, Austria, and Russia toward them is the history of the phases of the "Eastern Question" so far. The Crimean war of 1854–6, with the Treaty of Paris which followed; the Russo-Turkish war of 1877–8, with the Treaty of Berlin; and the Greco-Turkish war of 1897, are among the notable events connected with this subject. British diplomacy on this question has mainly aimed at checking the attempts of Russia to extend her empire and strengthen her strategic position by the absorption of part or all of the territory now belonging to the decaying Turkish empire. Of late years, however, the meaning of the phrase has been much extended, and may now be said to embrace the problem of preventing the aggression of Russia, either in Europe or Asia, from becoming a menace to the authority or commerce of Great Britain. The Russo-Chinese phase of the subject is the most recent one, and arose after the Japanese triumph of 1895 had shown the essential military, naval, and administrative weakness of China. The Turkish atrocities in Armenia showed how jealous of each other the Great Powers are in connection with these questions.

Whenever any phase of the Eastern question is reopened, all the world is concerned, and Russia becomes particularly interested because the question affects her route to the sea, and what is more her relations with England, the United States, and others of the Great Powers. Austria is concerned because it affects her prospects among the Balkan states. France is concerned because it affects her commercial ambitions in the Orient, her claims in Africa, her route to the East, and the interests of Russia, her great ally. Germany is concerned because of her relations to Russia and France. England is concerned because of Russia and her own life-and-death interests as the maintainer of a world empire in the Suez canal. All the colonial interests in southern Asia and in Africa are concerned. International politics all over the world, whatever the apparent issue and habitat, are resolvable into some form of the Eastern question and stand in sensitive connection with this great political storm centre of the world, the Ægean and the Bosporus. America is also concerned with the Eastern question in its larger bearings.

The struggle between Occidentalism and Orientalism, and who is to lead as champion of the former, constitutes what may be called the greater Eastern question. When one crosses the Ægean, which is at one part only 100 miles wide, or crosses the Bosporus which is merely a broad river, deep and rich, flowing down out of the Black Sea, and comes to the shores of Asia Minor, one becomes aware that he has passed out of one world into another world. He has passed out of the Occident into the Orient. The contrast between them, one cannot mistake. The West is full of creation, progress, restlessness, achievement, failure, disappointment, exultation; the East abounds in quietism, resignation, and blissful stagnation. Those are the great outlines of the difference, but they are outlines which force an absolute frontier through life, through the nations of men. Greece stands there at the gateway, and whatever comes from Asia to Europe comes through it. This is the lesson of early European civilization; will, force, empire came down from the North; refinement and civilization moved back in the reverse of their track. The reaction from Alexander's onslaught on the East came late, but it came strong. It came in the form of Islam. Mohammedanism is inspired Orientalism. On came Islam in a mighty tide, seeming, as it were, to have gathered force from the strong impact of Alexander's onslaught a thousand years before, as well as from having been pent up under that tremendous pressure which the Roman empire urged on it for so long. It came on in a terrible tidal wave, swept across northern Africa, across Spain, half across France, all over Asia Minor, up into the map of Europe to the gates of Vienna, and buried old Greece under a terrible slavery for centuries.

That was the reverse tide. The reaction set in long ago. Spain was long since cleansed. The Balkan states have been freed; Greece since the twenties has been free. The Sick Man of Constantinople lingers there by slender footing. He stays where he is by the sufferance of the Powers, or rather as the Persian empire stood — namely, so long as the Greeks could not agree among themselves about the leadership of Occidentalism. That is what we are waiting for now. Who is to be the leader, who is to be the champion of Occidentalism in the 20th century? This is the practical form in which the greater Eastern question is stated to us now.

First of all, Turkey commands our attention. She still sits at the old-time gate by the Bosporus, and her guns at the fort at Kum Kaleh still command the entrance to the Dardanelles. As a state, Turkey is a heterogeneous assemblage of people under the absolute sway of the sultan. It is a government lacking altogether a sense for the right of a community to choose concerning its own government. It thoroughly represents the Oriental idea whereby government is transcendent, a power above and outside the people, and not imminent, a power within the people. Herein lies the application of the Occidental-Oriental antithesis to political institutions. Turkey, though thoroughly Oriental in its political ideas, maintains its place on Occidental soil because the forces of Occidentalism cannot agree among themselves as to leadership.

Among the various peoples and races whom the fate of history has assigned to Turkish sway are the Armenians. Though their proper district is a province in northeastern Asia Minor, they are found scattered all through the Orient, nearly a quarter of a million of them living in Constantinople alone, and constituting nearly a quarter of its population. The Turkish empire, however, in its lack of sense for what we call distributed government, has no place for their individuality in its scheme. They are to the Turks, as far as they possess individuality and the tendency to use it, simply a plague spot in the empire. Crete is another plague spot on the Turkish map. The population of the island is essentially Greek. Of the quarter million inhabiting it there are perhaps 50,000 Mussulmans, but all speak Greek. Since the 17th century it has been in the hands of Turkey. The insurrection of 1866–8 stirred profoundly the sympathy of Christian people, but the governments of Europe as represented by the Powers insisted, even with a severe menace to Greece, in maintaining the *status quo* of Turkish possession. Repeated insurrections have taken place, notably those of 1891 and 1896; indeed the island has been in a perpetual state of unrest during most of the past century. Various promises of reformed administration have been at different times made by Turkey, but no satisfactory government has resulted. Turkey is unable to administer government. To the Turk the Greek is what the Armenian is — a nuisance. Similar conditions exist in the coast districts of Macedonia and in Epirus, though in the latter the discontent is not so acute or so well formulated. In both, the prevailing population is Greek, and the language, even of the Mussulman, in the latter, Greek. The unnaturalness of the situation teaches that postponement of a settlement can only be temporary. The greatest apprehension attaches to any consideration of any change whatsoever in the existing status. The moment the dismemberment of the Turkish empire in Europe begins, a long list of long-filed claims must be considered. They are unwilling to recognize preferred creditors. Crete, too, lies on the route to the Suez Canal. It is possible there are other ambitions than those of Greece.

The Greeks are a people that must be reckoned with in the future settlement of Eastern questions. Commercial interests around the entire line of the Ægean are largely in Greek hands. More than one fourth of the population of Constantinople itself is Greek. Now that the Greek state has been created, it constitutes a rendezvous and point *d'appui* for the sentiment of nationality among the scattered millions of Greek blood and language. The Greek nation itself is bankrupt. The land offers no great hope of greatness under present day conditions. It is not suited to agriculture. It has neither water power, minerals in abundance, nor coal supply. But it has an energetic, active, optimistic, though restless and impulsive and, as yet, half-educated people. They are abstemious and thrifty. In foreign lands they accumulate wealth. They are profoundly patriotic. All the traditions of their glorious past are molded into the substance of their modern national life. They are thorough Occidentals, and their antagonism to Orientalism, both in spirit and in the concrete forms of Turkey and Turks, is thorough. The fight with them is on and it will last to the death, because it is grounded in an indestructible difference of thought, mood, and character.

Among the small states of the Balkan peninsula, Bulgaria is now the one developing most rapidly in strength and prestige. She has become the rival of Greece among the lesser states. They both look with greedy eyes toward Macedonia, whose inland population is Slavic, but whose coast population is Greek. Bulgaria is now reconciled with Servia and Montenegro, and by the formal act of allowing the baptism of the crown prince into the eastern Church sealed her acceptance of Russia's headship. As the Prince of Bulgaria said on the occasion of the baptism, "I turn my face toward the East." All the Balkan states, with the exception of Rumania, have, therefore, now virtually accepted the suzerainty of Russia. Rumania, in her isolation, has re-established friendly relations with Greece.

Austria of all the great powers fears most acutely the reopening of the Eastern question. The Slavic-Balkan states, consolidated now under Russia's protection, interpose between her and the Ægean a solid wall. It has been her eager ambition to secure a port on the Ægean (Salonica), and a right of way to it. She has now no chance. Any dislodgment of conditions in the Orient at this time could bring her no good, and would produce only relative injury.

Germany utilizes her influence as a power apparently in Russia's interest, so far as the Eastern question is concerned. She stands between France and Russia. If both are hostile she is lost. It is, therefore, her policy to trade the interests of the East for Russian favors. The failure of England's effort a year ago to extort reforms from the sultan was due more or less directly to Germany's duplicity. Germany played secretly Russia's game, with the result that Turkey became a province of Russia. This brings us to Russia.

Russia seems to-day the destined possessor. She was once at its gates, and only England's intervention kept her out. England's prestige in the Orient has suffered severe loss by the collapse of her Armenian policy. Russia has made steady gains. The Slavic-Balkan states are her children, first by natal claims, for she freed them; now by formal diplomatic recognition. They are closing in steadily about Constantinople. Turkey herself has become virtually a Russian province. Russia has besides a natural geographic claim. So great a power as that cannot be cooped up away from the seaboard. The Bosporus is her natural exit. She is a great world-power, bestriding Europe and Asia. France and China, as well as Turkey, are her allies, almost her provinces. She is immensely strong in her position for diplomatic aggression, because her whole power can be swung by a single hand. Safe in her position, unmenaced from the rear, she has only to bide her time, and as occasion offers to push forward. She is strong furthermore in a certain sympathy her semi-barbarism has with that of the border peoples of Asia. The peoples of the East always prefer the Russian to the Englishman. Russian diplomacy understands the Oriental use of language. Language is used by the Oriental for the purpose of producing kindly feeling or inducing another mortal to see things as you do, but certainly not for the purpose of reporting on objective verities. It is a mechanism for reporting on the greater subjective verities. The Englishman is not liked, though England is everywhere highly respected, feared, and trusted.

Constantinople has been for the last dozen years systematically fortified against the English but not against Russia. A Russian army can enter Constantinople at will. When the question of forcing the Dardanelles with an English fleet was agitated, the English naval authorities estimated that of the 19 ships lying at Salonica, 6 must be sacrificed to do it. The cards have been stacked for Russia. It looks to-day as if the ultimate occupation of Constantinople by Russia were a foregone conclusion. The opening of the Suez Canal has changed things, and as if by jealous interposition of geographic fate, drawn the issue back to the old fighting ground in the eastern Mediterranean. England must, if she is to hold India and Australia, control the Suez Canal and its approaches. England stands in political isolation, a grand isolation, strong not by alliances, but in and by her own intelligence, rectitude, and Anglo-Saxon grit. Within the last five years England has made up her mind that she must be strong enough, if necessary, to face all Europe single-handed. Within that time her navy has been doubled in strength. She is preparing for an inevitable conflict. The conflict concerns this question: who is to be the leader and champion of Occidentalism in the 20th century? Shall it be the Anglo-Saxon or the Slav?

The world is arraying itself in two great camps. Russia spans the north from China to France, and guiding the foreign policy of Germany rules in the last decision northern Asia and all Europe, except England and Italy. England spans the seas and holds in a mysterious bond of common interest and guaranteed justice the diverse elements of her world-empire. Russia's strength has been possibly greatly overestimated. The bonds which hold her empire together might weaken under the testing of adversity. Those which bind the British empire together would strengthen. The financial difficulties which Russia would face in the event of a great struggle are an element of great weakness in her situation. England's resources are unlimited, infinitely varied and self-supplied. The power of the British empire as it is now organized has never been called to the test. It is no longer a question merely who shall hold Constantinople or who shall control the Suez Canal, who shall command the pass of Thermopylæ, or who shall control the oracle of Delphi. It is a larger question, and it concerns larger interests. It concerns the habitable globe.

See BALKANS; DARDANELLES; RUSSIA; SUEZ CANAL; TURKEY, etc.

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Eastern Rite, Churches of, a name given to various bodies of Eastern Christians who are members of the Roman Catholic Church, but who have been permitted to retain many of their ancient customs, which differ from those in general use throughout the world. The Armenians, Coptics, Greeks, Maronites, and some others belong to the Eastern Rite. They differ from the Latin Church in nothing doctrinal, only in some matters of discipline. Their liturgy is in the language first used by their bishops and priests, and in no case is the Mass said in their vernacular of to-day. For instance, the Syrians use now the Arabic language (in some places modified) but the Maronite liturgy is in the old Syriac language, as used at the time of Christ. (See MARONITES.) They differ as to the manner of administering communion; some using for consecration only the leavened bread, others only the unleavened, and some giving communion to the laity under the form of both bread and wine, others using only one of the species as in churches of the Latin Rite. The discipline of marriage for the clergy differs from the Latin Church. Candidates for the priesthood may marry before becoming deacons, not after. All points of difference between the Eastern and Latin Rites are of discipline, not of faith.

Eastern Shore, a name given to all that part of Maryland lying east of Chesapeake Bay, and also the counties of Accomac and Northampton in Virginia. Delaware is sometimes included in the Eastern Shore. The country is noted for its fruit and for its mild climate. Great quantities of oysters are taken annually from the waters of the Eastern Shore lands.

Eastern Star, Order of the, a secret society composed exclusively of Freemasons in good standing, and their wives, mothers, sisters, and daughters, and the widows of Freemasons. The order originated in New York 1868. In 1904 there were 44 grand chapters in as many States, and nearly 297,116 members. Its rites and services are conducted with all the impressive secrecy peculiar to Freemasonry. A five-pointed star, between whose points the word "Fatal" is inscribed, is the badge of the order.

Eastern States, in popular parlance, the six New England States — Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut; in the Mississippi valley the inhabitants refer to the Eastern States as that section lying east of the Alleghany Mountains.

Easthampton, Mass., town in Hampshire County; on the New York, N. H. & H., and the Baltimore & M. R.R.'s; 12 miles northwest of Springfield. The chief manufactures are cotton goods, yarns, buttons, shoe-web, rubber and elastic goods. Williston Seminary, a preparatory school for boys, is located here. Easthampton was settled in 1665; and on 13 May 1704 an Indian attack upon the settlement resulted in 19 killed and much loss of property. Three villages are included in the town of Easthampton. Pop. 5,700.

East'lake, Sir **Charles Lock,** English artist: b. Plymouth 17 Nov. 1793; d. Pisa, Italy, 23 Dec. 1865. He entered the schools of the Royal Academy, where Haydon supervised his education. In 1816 he went to Italy, and for 14 years his home was at Rome, his Italian life being broken by visits to England and Greece. Pictures of banditti and other subjects exhibited in England procured him the associateship of the Academy in 1827. 'Pilgrims Arriving in Sight of Rome' (1828) became so popular that the artist became tired of repeating it in different versions. In 1830 he was made an R.A., his diploma picture being 'Hagar and Ishmael.' 'Escape of Francesco Carrara' (1834); 'Gaston de Foix' (1838); 'Christ Blessing Little Children' (1839); and 'Christ Weeping Over Jerusalem' (1841), were next among his noteworthy productions. 'Helena' (1849); 'Ippolita Torelli' (1851); 'Violante' (1853); may also be mentioned. He translated Goethe's 'Theory of Colors' (1840), and published in 1847 'Materials for a History of Oil-painting.' He became president of the Royal Academy in 1850, being knighted on the occasion; was keeper of the National Gallery in 1843–7, and director of the same institution from 1855 onward.

Eastlake, Charles Locke, English art critic: b. Plymouth, England. He studied in the Royal Academy schools, but subsequently devoted himself to literary work and design, and was keeper and secretary of the National Gallery 1878–98. He has published: 'History of the Gothic Revival in England' (1871); 'Hints on Household Taste' (4th ed. 1874), a book which exerted much influence in its day; 'Lectures on Decorative Art and Art Workmanship' (1876); 'The Present Condition of Industrial Art' (1877); 'Our Square and Circle' (1895); 'Pictures at the National Gallery' (1898).

East'man, Charles Alexander, American homœopathic physician, and author: b. Redwood Falls, Minn., 1858. His father was a Santee-Sioux Indian, Many Lightnings (Jacob Eastman), and his mother a half-breed Sioux, Nancy Eastman. He was graduated at Dartmouth College 1887, and at the Boston University School of Medicine 1890. He married the poetess, Elaine Goodale, 1891. He served as government physician at Pine Ridge Agency 1890–3, being Indian secretary of the Y. M. C. A. 1894–7. He acted as attorney for the Santee Sioux at Washington 1897–1900, later becoming government physician at Crow Creek, South Dakota. He published 'An Indian Boyhood: or Recollections of a Wild Life' (1901).

Eastman, Charles Gamage, American poet: b. Fryeburg, Me., 1 June 1816; d. Burlington, Vt., 1861. He published (1848) a volume of 'Poems' descriptive of rural life in New England, and edited the Vermont *Patriot* at Montpelier from 1846 until his death.

Eastman, Charles Rochester, American palæontologist: b. Cedar Rapids, Iowa, 5 June 1868. He was graduated at Harvard University in 1890. Subsequently he served on the United States and Iowa State geological surveys; and was an instructor in geology and palæontology in Harvard and Radcliffe colleges. He afterward took charge of the department of vertebrate palæontology in the Agassiz museum at Harvard. He published an English translation of Von Zittell's 'Palæontology' (1901). In 1901 he was tried for the murder of his brother-in-law, and acquitted.

Eastman, George, American inventor: b. Waterville, Oneida County, N. Y., 12 July 1854. As an amateur photographer in Rochester, N. Y., he turned his attention to the production of dry plates, which achieved an instantaneous success. In 1881 the Eastman Dry Plate Company was organized, which developed later into the Eastman Kodak Company. Eastman companies have also been established in London, Paris, Berlin, and elsewhere, and the business has now reached vast proportions.

Eastman, Harvey Gridley, American educator: b. Marshall, N. Y., 1832; d. 1878. In 1859 he founded the Eastman National Business School at Poughkeepsie, N. Y.

Eastman, John Robie, American astronomer: b. Andover, N. H., 29 July 1836. He was graduated at Dartmouth College in 1862; and became assistant in the United States Naval Observatory. In 1865 he was appointed professor of mathematics in the navy. He has been a member of several astronomical expeditions in the United States, and accompanied one to Sicily in 1870. Most of his observations, computations, and researches appear in the annual volumes of the 'Naval Observatory,' which, in 1872–82, were edited by him.

Eastman, Julia Arabella, American writer for juveniles: b. Fulton, N. Y., 17 July 1837. Among her writings are: 'Short Comings and Long Goings' (1869); 'Beulah Romney' (1871); and 'Young Rick' (1875).

Eastman, Joseph, American physician: b. Bleeker Mountains, Fulton County, N. Y., 1842. He learned blacksmithing, served for a time as a private in the Federal army during the Civil War, subsequently studied medicine, and has long been prominent as a physician in Indianapolis, his specialty being abdominal and pelvic surgery.

Eastman, Mary Henderson, American prose writer: b. Warrenton, Va., 1818. She has published: 'Dacotah or Life and Legends of the Sioux' (1849); 'Romance of Indian Life' (1852); 'Tales of Fashionable Life' (1856); and many stories and sketches.

Easton, Morton William, American philologist: b. Hartford, Conn., 18 Aug. 1841. He was graduated at Yale in 1863, and at Columbia in 1866, and afterward studied at the University of Vienna. He was for several years professor of comparative philology in the University of Tennessee, and later in the University of Pennsylvania. He has contributed numerous papers on Phonetics, Sanskrit, Iranian, and English to 'The Journal of the American Oriental Society,' 'The American Journal of Philology' and other periodicals.

Easton, Nicholas, American colonial statesman: b. Wales 1593; d. Newport, R. I., 15 Aug. 1675. Emigrating to America in 1634 he was the first settler in Agawam, now Newbury, Mass., 1635. He built the first English house in Hampton, N. H., 1638, and the first one on the site of Newport, R. I., 1639, and was elected president of Providence Plantations 1649 and 1654. He was deputy-governor of Rhode Island for four years, and governor 1672–5. His son, John Easton, was governor 1690–5, and wrote a 'Narrative of the Causes which led to King Philip's War,' edited by F. B. Hough, Albany, 1858.

Easton, Mass., town in Bristol County, on the New York, N. H. & H. railway, about 25 miles south of Boston. The town includes several villages, and has important manufactures of shovels, thread, foundry and machine-shop products, hardware, automobiles, shoes, shoe heels, and wire. It has public library and high school buildings, churches, and several banks. Pop. (1890) 4,493; (1900) 4,912.

Easton, Md., town, and the county-seat of Talbot County; on the Philadelphia, W. & B., and the Baltimore, C. & A. railways; about 28 miles southeast of Annapolis; 50 miles south-southeast of Baltimore; near a navigable inlet of Chesapeake Bay. It is the seat of a Protestant Episcopal bishop and has a fine county-building, high school, churches, etc. It is the market centre for a rich grain and fruit-growing country. The manufactures are chiefly iron machinery, fertilizers, carriages, wagons, handles and spokes, lumber, brick and tile, flour, canned fruits, furniture, and shirts. Pop. (1890) 2,939; (1900) 3,124.

Easton, Pa., city, county-seat of Northampton County; on the Delaware at the confluence of the Lehigh River; on the Pennsylvania, the Lehigh V., the Central of N. J., Delaware, L. & W., and other railways; 75 miles southwest of New York, and 67 miles north of Philadelphia. It has water communication with Newark and New York by the Morris and Essex Canal, and with Philadelphia and the coal regions by the canals of the Lehigh Coal & Navigation Company. The city is picturesquely situated in a deep valley surrounded by rugged hills. The older part, near the rivers, is regularly laid out, with a public square at the intersection of the two principal streets in which a daily market is held. Many of the buildings in this section antedate the revolutionary period; the newer residence portions are built on the surrounding hills. The scenery of both the Delaware and Lehigh valleys is of unusual beauty. Handsome bridges for railway and general traffic connect the city with Phillipsburg, N. J. (q.v.) on the opposite side of the Delaware and with the former South Easton across the Lehigh, now a part of Easton. It has many fine residences, business buildings, churches (in some of which service is held in the German language), public schools, a large high school building, a public library, opera house, etc. Paxinosa Inn is a well-known summer hotel on the summit of Chestnut Hill (about 900 feet) north of the city. Lafayette College (q.v.), founded in 1832, with its beautiful grounds and buildings overlooks the city from a high bluff, approached by stairways and winding driveways.

Industries, etc.— The census of 1900 returned 285 manufacturing establishments, with $4,829,879 combined capital; 3,912 employes; paying $1,516,525 annually in wages; using $3,794,496 in materials; and with an annual product valued at $6,746,078. An abundance of iron ore and fluxing limestone in the vicinity, and its proximity to and easy communication with the anthracite coal-fields, have from an early date made Easton an important centre for the manufacture of iron. It has several large blast-furnaces, rolling mills, foundries, and manufactories of sheet-iron, wire, and wire rope. Slate, building stone, burning lime, and talc are quarried extensively, and in recent years Easton has come into importance as the jobbing and distributing centre for the great New Jersey-Pennsylvania cement belt, some of the largest cement works in the world being within a few miles radius of the city. It has extensive silk mills, and manufactures of compressors and drills, railway supplies, chemicals, boots and shoes, and organs; flour, saw and planing mills; furniture factories, machine shops, etc. Easton has good banking facilities, daily and weekly newspapers, and an extensive local and general trade.

Government, Public Service, etc.— The mayor and city council, which consists of two houses, are elected for three years. The mayor makes the appointments to the board of health and the fire department, subject to the approval of the council, who elect the city engineer. The city treasurer is chosen by popular election. Easton operates its own electric lighting plant. It has good gas and electric service, high-pressure water service, supplied largely by spring water, and sewers. It has good local street railway service, and is connected by electric railway with Philadelphia (two lines, Bethlehem, Allentown, Nazareth, and the slate and cement region along the southern slope of the Blue Ridge Mountains, near the Delaware Water Gap.

History and Population.— Before and during the War of Independence "the forks of the Delaware" was an important outpost. Here in 1744 David Brainerd (q.v.) began his missionary labors among the Indians. The city was laid out in 1750, became a borough in 1789, and was chartered as a city in 1887. South Easton was annexed in 1898. In 1756, 1757, 1758, and 1761 important conferences were held here with the Indians and treaties made. General John Sullivan (q.v.) set out from here in 1779 upon his expedition against the Iroquois. The Reformed Church in North Third Street was the scene of one or more of these Indian conferences; and was used as a hospital by the patriots during the War for Independence; and at the corner of Ferry and Fourth streets stands the home of George Taylor, a signer of the Declaration of Independence. Population, largely of German descent, (1890) 14,481; (1900) 25,238. Consult 'The History of Easton,' Condit.

Eastport, Maine, city and port of entry in Washington County, on Moose Island, in Passamaquoddy Bay, and on the Washington County Railway; 190 miles east-northeast of Portland. A bridge crosses the narrow channel to the mainland. It is the northeast frontier city of the United States, and has a fine harbor, which on account of its high tide, 25 feet, is clear of ice all the year, and has daily steamship service with Boston, Calais and Portland. Eastport and the island of Campobello, on the opposite side of the harbor, are popular summer resorts. The city has extensive fishing and shipbuilding interests, and is the centre of the American sardine-canning industry, with 20 factories. It also manufactures shoes, box shooks, etc. It has a custom-house, public library, the Boynton high school, churches, national and savings banks, weekly newspapers, and is lighted by electricity. Eastport was settled about 1782. The islands in Passamaquoddy Bay were long under dispute and claimed by Great Britain. The town was captured by an English force 11 July 1814 and held for four years. It was known for its smuggling industry which flourished in the years immediately preceding and following the War of 1812. Pop. (1890) 4,908; (1900) 5,311. See Kilby, 'Eastport and Passamaquoddy.'

Eastward Ho! a comedy written by Marston, Chapman, and Johnson, and produced in the season of 1604–5. It is best known for its satire on the Scotch, which caused the imprisonment of its authors.

Eastward Position, the position assumed by many clergymen of the Anglican Church during part of the communion service, the clergyman being placed in front of the communion table with his back to the congregation. This position has been a cause of much controversy. It was decided, in 1870, that such a position during the prayer of consecration is illegal; but if the "manual acts" of the priest are visible, the position appears to be legal by a decision of 1891.

East'wick, Edward Backhouse, English Orientalist and diplomatist: b. Warfield, Berkshire, 13 March 1814; d. Ventnor, Isle of Wight, 16 July 1883. He was a voluminous writer on Oriental (especially East Indian) subjects, and rendered very important service to English literature by many translations from Persian and Hindu, for example: Sadi's 'Gulistan,' or 'The Rose Garden' (1852); and the version of Pilpay's fables called 'Anvār-i-Suhailī' (1854). He also wrote a 'Journal of a Diplomat's Three Years' Residence in Persia' (1864); and 'Venezuela,' or 'Sketches of Life in a South American Republic' (1868). Between 1878 and 1882 he brought out a sumptuous edition of the 'Kaisar-nama-i-hind,' or 'Lay of the Empress.' He was a frequent contributor to literary journals.

Eaton, Amos, American scientist: b. Chatham, N. Y., 1776; d. 1842. He was graduated at Williams College 1799; settled in Catskill, N. Y.; practised law, and engaged in civil engineering, while prosecuting studies in chemistry, geology and mineralogy. He made a survey of Albany and Rensselaer counties 1820, and later of the Erie Canal region. Among his works are: 'An Index to the Geology of the Northern States' (1818); 'A Manual of Botany of North America' (1833); and 'Geological Note-Book' (1841).

Eaton, Amos Beebe, American army officer: b. Catskill, N. Y., 1806; d. 1877. He was graduated at West Point, served on the northern frontier, and after 1838 served in the Department of Subsistence in Florida, New York, etc. He was chief commissary of subsistence under Gen. Zachary Taylor in the Mexican War, and received the brevet of major in 1847. He served as purchasing commissary at New York during the Civil War, was made commissary-general of subsistence in 1864, and was brevetted major-general 1865. He was retired in 1874.

Eaton, Arthur Wentworth Hamilton, Canadian writer: b. Kentville, Nova Scotia. He was graduated from Harvard in 1880, entered the Episcopal ministry, and was rector of St. Andrew's Church, Chestnut Hill, Mass., 1885–7. Since 1888 he has been an assistant master in the Cutler school for boys in New York. He is the author of 'The Heart of the Creeds: Historical Religion in the Light of Modern Thought' (1888); 'Arcadian Legends and Lyrics' (1889); 'Letter Writing: Its Ethics and Etiquette' (1890); 'The Church of England in Nova Scotia, and the Tory Clergy of the Revolution' (1891); 'Tales of a Garrison Town' (with C. L. Betts) (1892); 'College Requirements in English' (1900).

Eaton, Charles H., American Universalist clergyman: b. Beverly, Mass., 15 Aug. 1852; d. Tryon, N. C., 14 April 1902. He was graduated at Tuft's College in 1874, and at Tuft's College divinity school 1877. He was ordained at Palmer, Mass., 1877; and in 1881 became pastor of the Church of the Divine Paternity in New York 1881, succeeding Rev. E. H. Chapin.

Eaton, Charles Warren, American artist: b. Albany, N. Y., 22 Feb. 1857. He studied at the National Academy of Design, and the Art Students' League, New York, and in London; and is a member of the American Water Color Society, New York. He exhibited at the Paris Exposition 1900.

Eaton, Daniel Cady, American botanist: b. Fort Gratiot, Mich., 12 Sept. 1834; d. New Haven, Conn., 29 June 1895. He was a grandson of Amos Eaton (q.v.); was graduated at Yale College in 1857, and professor of botany there 1864–95. He accompanied the government expedition to the Wasatch Mountains in Utah. His best-known publications are 'The Ferns of North America'; and 'Ferns of the Southwest.'

Eaton, Dorman Bridgman, American lawyer: b. Hardwick, Vt., 27 June 1823; d. New York 24 Dec. 1899. He was graduated at the University of Vermont in 1848, and at the Harvard Law School in 1850; was admitted to the New York bar; and later became widely known by his advocacy of civil-service reform. In 1883 he was appointed a commissioner of the United States Civil Service Commission, resigning in July 1885. He was reappointed in November of the same year, but again resigned in April 1886. In the latter year he drafted the laws which created the Metropolitan Board of Health of New York; subsequently those on which the present police courts were organized; and in 1883 the National Civil Service Act. His publications include: 'The Independent Movement in New York' (1880); and 'Civil Service in Great Britain' (1880).

Eaton, John, American educator: b. Sutton, N. H., 5 Dec. 1829; d. Washington, D. C., 9 Feb. 1906. He was graduated at Dartmouth College in 1854; studied theology; and in 1862 became chaplain of the 27th Ohio Volunteer infantry. Subsequently he was appointed superintendent of freedmen for Mississippi, northern Louisiana, Arkansas, and west Tennessee, and remained on duty till May 1865. He was brevetted brigadier-general of volunteers in 1865. In 1871–86 he was commissioner of the United States Bureau of Education; in 1895 became president of Sheldon Jackson College at Salt Lake City; and in 1898 was appointed a special commissioner to arrange for the establishment of the American system of education in Porto Rico. His publications include: 'History of Thetford Academy'; 'Mormons of To-day'; 'The Freedmen in the War' (report); 'Schools of Tennessee' (report); and reports of the United States Bureau of Education.

Eaton, John Henry, American statesman: b. Tennessee 1790; d. 1856. He practised law in Nashville, and was secretary of war 1829–34, when he became governor of Florida. He was appointed minister to Spain 1836, and published a 'Life of Andrew Jackson' (1824).

Eaton, Margaret O'Neill («Peggy O'Neill»): b. Washington 1796; d. 1879. As the wife of Major J. H. Eaton, Jackson's secretary of war, she was the subject of a social war in government circles owing to certain charges connecting her name with that of Major Eaton, while she was still wife of purser Timberlake, her first husband. It was said that from this social disturbance arose an estrangement between Gen. Jackson and Calhoun, leading to the nomination of Van Buren for the presidency 1836. After the death of her second husband she married a third, an Italian dancing-master, much her junior, from whom she was divorced.

Eaton, Seymour, American editor and author: b. Canada 1859. He served for five years as director in the Drexel Institute, and was director of the Home Study Circle of the Chicago *Record* for several years. He is widely known as the founder and president of the Book-lovers' Library. Among his works are: 'Business Forms'; 'How to do Business'; 'The New Arithmetic.'

Eaton, Theophilus, American colonial governor: b. Stony Stratford, Buckinghamshire, England, about 1591; d. New Haven, Conn., 1658. He came over to Massachusetts with the Rev. John Davenport, 1737, founding with Davenport the town and colony of New Haven, in 1638. He was chosen governor October 1639, and re-elected annually as long as he lived. He was prominent in the organization of the New England Confederation 1634, and the so-called Connecticut «Blue Laws» were drawn up by him, assisted by Davenport, 1655.

Eaton, Thomas Treadwell, American Baptist clergyman, and author: b. Murfreesboro, Tenn., 16 Nov. 1845. He was graduated at the Washington and Lee University 1867; was ordained (1870) to the Baptist ministry, holding pastorates successively at Lebanon, Chattanooga, Tenn.; Petersburg, Va., and Louisville, Ky. Since 1887 he has been the editor of the 'Western Recorder.' Among his works are: 'The Angels' (1873); 'Talks to Children'; 'Talks on Getting Married'; 'The Bible on Women's Public Speaking'; 'Wives and Husbands'; 'The Theatre'; 'How to Behave as a Church Member'; 'Conscience in Missions'; and 'Faith of Baptists.'

Eaton, Timothy, Canadian merchant: b. Clogher, Ireland, October, 1835; d. Toronto, Canada, 31 Jan. 1907. While a boy he was apprenticed to a draper at Portglenone, but having served his five-year term and received his wages of about £100, in 1857 he emigrated to Canada. He first opened a store at Kirkton, in Huron County; later went to Saint Mary's; and finally settled in Toronto, where, in 1869, he opened the store which has since expanded into one of the largest department stores in America, with a branch at Winnipeg.

Eaton, William, American officer: b, Woodstock, Conn., 23 Feb. 1764; d. Brimfield, Mass., 1 June 1811. He served in the army 1780–3, and then went to Dartmouth College, where he was graduated 1790. Becoming captain in the United States army in 1792, he served in campaigns against the Indians till 1798, when he was sent to Tunis as American consul. During the war against Tripoli in 1801 he resolved to re-establish Hamet Caramelli as Bey of Tripoli, but was not supported in his attempt by the American naval officers. He returned to America in 1803, and was subsequently appointed naval agent of the United States for the Barbary powers. Returning to Africa he captured the city of Derne 27 April 1805, but the United States concluding a treaty of peace with the usurper Yussuf, Eaton returned to America.

Eaton, William Wallace, American politician: b. Tolland, Conn., 11 Oct. 1816; d. Hartford, Conn., 19 Sept. 1898. He received a common school education; became a lawyer; and settled in Hartford in 1850. During the Civil War he was called a «Peace Democrat,» and urged resistance to any Massachusetts troops passing through Connecticut. He was a member of the United States Senate in 1875–81; and of the House of Representatives 1883–5.

Eaton, Ohio, village, county-seat of Preble County, on the Pittsburg, C., C. & St. L. R.R. It is a trade centre for an agricultural section. Pop. 3,246.

Eatonton, ē'tŏn-tŏn, Ga., city, county-seat of Putnam County; on the Central of Ga. R.R.; about 68 miles southeast of Atlanta. It is the trade centre for a section in which are raised fruit, and cotton. Its manufactures are dairy products, and cotton goods. Pop. 2,000.

Eau, ō, a French word signifying water, and used in English with some other word for several spirituous waters, and particularly perfumes: (1) *Eau de Cologne,* a fragrant water made originally and in most perfection in Cologne. It was invented by Farina. (2) *Eau Créole*, a highly esteemed cordial made in Martinique, West Indies, by distilling the flowers of the mammee apple with spirit of wine. (3) *Eau de Javelle*, a preparation of chloride of soda, used as an antiseptic, and a bleaching agent. (4) *Eau de Luce*, invented by a person named Luce, at Lille, in Flanders, is a volatile preparation, made from oil of amber, alcohol, and ammonia. It is a milky fluid, powerfully antispasmodic, and stimulant. Mixed with nitric acid it forms a substitute for musk. (5) *Eau de Paris*, a substitute for cologne, and which is sometimes taken in sweetened water as a cordial, and stimulant. (6) *Eau de Vie*, a brandy; specifically the less perfectly purified varieties, the best being called cognac. (7) *Eau de vie de Dantzig*, a white liqueur, or cordial, sweet and strong, in which are introduced for ornament small particles of gold-leaf. (8) *Eau de vie d'Hendaye*, a sweet French cordial, of which there are three varieties — white, green, and yellow.

Eau Claire, ō klăr, Wis., city, county-seat of Eau Claire County, at the mouth of the Eau Claire River, and the head of navigation of the Chippewa River, and on the Chicago & N.; Wisconsin C., and several other railroads; 85 miles east of St. Paul, and 150 miles northwest of Madison. It is the commercial centre for northwestern Wisconsin, and the outlet of the Chippewa lumber district, with extensive water power. It has a great trade in lumber, and manufactures over 300,000,000 feet annually. There are extensive manufactures of iron and linen goods, furniture, machinery, and shoes. The city is noted as a summer resort, and has electric railroads, and street lights, waterworks, public library, and high school, Sacred Heart Hospital, national and savings banks, daily and weekly newspapers. Pop. (1900) 17,600.

Eaux-Bonnes, ō-bŏn, France, a celebrated watering-place, department Basses-Pyrénées, at the bottom of a narrow gorge, about 25 miles south of Pau. The springs, which have a temperature of about 90°, are strongly impregnated with sulphur. About 6,000 to 10,000 visitors resort hither in the course of the season, which lasts from June to October. Pop. (1891), 735.

Eaux-Chaudes, ō-shōd, France, a watering-place in France, three miles southeast of Eaux-Bonnes. Some of its springs have the same properties as those of the Eaux-Bonnes, and others are more strongly impregnated with sulphur.

Eaves or **Cliff Swallow,** one of the familiar North American swallows (*Petrochelidon lunifrons*) common about buildings where, as explained under BARN-SWALLOW, it has taken up its residence as fast as the country became settled. It is to be recognized by the squareness of the tail (not deeply forked as in its larger associate, the barn-swallow), the chestnut rump, whitish belly and blue spot on the breast. It is most peculiar, however, in its nests, which are always attached to the outside of the building, and usually in close row under the protection of the eaves. These nests are made of pellets of mud; are shaped like bulbous flasks with a curved neck forming an entrance; and are attached by their base to the wall. In the primitive wilderness these nests are attached in crowded colonies to the faces of cliffs, where whole masses would frequently scale off by reason of the weight or of the loosening action of rain. Much safer and better conditions are found under the protection of the eaves of buildings; and not only has this swallow everywhere taken advantage of this fact, but striking modifications in their architecture have followed. The eggs closely resemble those of the barn-swallow, and two broods are usually raised. The species abounds in suitable localities all over the continent, migrating to the tropics in winter.

Eaves'drip, an ancient custom, or law, corresponding to the well-known urban servitude of the Romans called stillicide, where a proprietor was not allowed to build to the extremity of his estate, but must leave a space regulated by the charter by which the property was held, so as not to throw the eavesdrop on the land of his neighbor.

Ebal, ē'bal, a mountain in Palestine, nearly 3,000 feet in height; 35 miles north of Jerusalem, situated north of Mount Gerizim, from which it is separated by a narrow valley containing the town of Nablus, anciently Shechem. Here the Israelites were commanded, on their entrance into the Holy Land, to set up an altar to Jehovah of hewn stones. The fulfilment of this is recorded in Joshua (viii. 30–35). From Mount Ebal the curse for disobedience to the law was pronounced, the blessing for obedience being given from Mount Gerizim, which lies across the valley. The modern Arabic name of Ebal is Jebel Eslamiyah.

Ebel'ians, German sect, named after Ebel, a Prussian archdeacon, one of the founders. It arose in Königsberg, Prussia, about 1836, the Archdeacon Ebel and Dr. Diestel being its leaders. They believed in spiritual marriage. In 1839 sentence was passed against their leaders, who were charged with unsound doctrine and impure lives, but it was removed in 1842. Their enemies called the sect Mucker, that is, in German, hypocrites.

Ebeling, ā'bel-ĭng, **Christoph Daniel,** German scholar: b. Garmissen, near Hildesheim, Hanover, 20 Nov. 1741; d. Hamburg 30 June 1817. He was noted for his extensive knowledge of Oriental languages, of classic and foreign literature, and of history and geography. He published a history and geography of North America (1796–1816), for which he received a vote of thanks from the United States Congress. He paid special attention to the geography of the New World, and collected about 10,000 maps and nearly 4,000 books, all relating to America. This library was purchased in 1818 by Israel Thorndike of Boston, and presented by him to Harvard College.

Ebenezer, ĕb-ĕ-nē'zėr (Heb. "the stone of help"), commonly used as any memorial of divine assistance, originally the name of a field where, at Samuel's request, the Lord discomfited the Philistines with thunder, etc. On this occasion Samuel set up a stone, and gave it this designation, to indicate that the Lord had helped them. The site has never been definitely ascertained.

Ebensburg, Pa., borough, county-seat of Cambria County; on a branch of the Pennsylvania R.R., about 113 miles east of Pittsburg. The manufactories include woolen-mills, tanneries and saw-mills. It is about 2,300 feet above sea-level. Pop. 1,621.

Eberhard, ā'bĕr-härt, **Christian August Gottlob,** German poet and descriptive writer: b. Belzig 12 Jan. 1769; d. Dresden 13 May 1845. His verse is a reminiscence of the 18th century style and of the school of Gleim, the idyl 'Little Hans and the Cookie' (1822); and 'Various Poems' (1833), eminently so. His best prose is in 'Italy as It Impressed Me' (1839).

Eberhard, Johann August, yō-hän ow'-goost, German philosophical writer: b. Halberstadt 31 Aug. 1739; d. there 6 Jan. 1809. He first attracted attention with a 'New Apology of Socrates' (1772), an attack upon the narrow theology of the day, to which succeeded 'Universal History of Philosophy' (1788); 'Handbook to Æsthetic' (1803–5); and other works from a Wolffian standpoint, in harmony with Leibnitz and in opposition to Kant.

Eberle, ā'bĕr-le, **Robert,** German artist: b. Meersburg 22 July 1815; d. Eberfing, near Munich, 19 Sept. 1860. He was a pupil of Biderman and later of Van de Velde. His talent was particularly displayed in painting sheep. One of his works, 'A Shepherdess,' is in the Modern Gallery, Munich.

Eberlein, Gustav, German sculptor: b. Spierkershausen, Hanover, 1847. His chief work is a long frieze ornamenting the façade of the Ministry of Cults, Berlin, with 50 figures attending religion. He did other decorative work for the University of Kiel. Among his works are: 'Drawing out a Thorn'; 'Greek Flute Player'; 'Psyche,' and the 'Archer.' From his hand also are five allegorical groups at Stuttgart, and monuments of William I. at Elberfeld, Geisslingen, Mannheim, Altona, and Ruhrort, and one of Frederick I. in Berlin. He is the author of 'Aus Eines Bildners Seelenleben, Plastik, Materie und Poesie' (1892).

Ebers, Emil, ā'mēl ā bĕrs, German artist: b. Breslau 14 Dec. 1807; d. Beutheir 1884. He studied at the Academy of Düsseldorf and early turned his attention to dramatic subjects such as scenes of battle in the Middle Ages, brigandage, sailors, fishermen, etc. In later years, after traveling much and visiting the shores of the North Sea, Holland, and Normandy, he devoted himself to marine painting exclusively. Among his works are: 'Smugglers About to Land' (1830), in the National Gallery, Berlin; 'Fisherman's Hut' (1831); 'Smugglers Surprised' (1832); 'Smugglers in Tavern' (1835); 'Repressing Revolt'; 'Dutch Smugglers on Coast of Normandy' (1842); 'Prussian Hussars Maltreating French Peasants' (1843); 'Life Boat' (1844); 'Pilot Boat' (1845); 'Storm on Inland Sea' (1845); 'Mutiny on Brig' (1848); and some historical paintings, such as 'St. Goar converting the Rhine Provinces.'

Ebers, Georg Moritz, gā-ōrg mō'rĭts, German Egyptologist and novelist: b. Berlin 1 March 1837; d. Tutzing, Bavaria, 7 Aug. 1898. About 1859 he began to devote himself almost exclusively to Egyptological studies, and in 1868 was appointed extraordinary professor of the language, history, and antiquities of ancient Egypt at Jena. In the following year he traveled in Egypt, Nubia, and Arabia, and on his return in 1870 became ordinary professor of Egyptology at Leipsic. Another visit to Egypt in 1872–3 resulted in the discovery of the important medical papyrus, now known by his name. Among his published contributions to Egyptology are: 'Disquisitiones de Dynastia vicesima sexta Regum Ægyptiorum' (1865); 'Ägypten und die Bücher Moses' (Vol. I., 1868, not completed); 'Durch Gosen zum Sinai' (1872); 'Papyrus Ebers' (1875); 'Eine Galerie antiker Portraits' (1889); 'Die hieroglyphischen Schriftzeichen der Ägypter (1890); and 'Ägypten in Bild und Wort' (1878–9), translated into English as 'Egypt, Descriptive, Historical, and Picturesque' (1880). Besides these works he published many novels, mostly dealing with Egyptological subjects, among which are: 'Eine Ägyptische Königstochter' ('An Egyptian Princess' 1864); 'Uarda' (1877); 'Homo Sum' (1878); 'Die Schwestern' ('The Sisters' 1880); 'Der Kaiser' (1881); 'Serapis' (1885); 'Josua' (1889); 'Per Aspera' (1892); 'Kleopatra' (1894); and 'Arachne' (1897). He also published a poem called 'Elison' (1888), and an autobiography (1892), entitled 'Die Geschichte meines Lebens.' A collective edition of his works was published at Stuttgart (1893–7).

Eberswalde, ā-bĕrz-väl-de (ancient NEUSTADT-EBERSWALDE), Germany, town on the Finow Canal, about 28 miles northeast of Berlin. It is a busy industrial centre, having a number of machine-shops, saw-mills, paper-mills, and iron-works, and doing a considerable trade in lumber and coal. There is here a royal academy of forestry. Eberswalde is a favorite summer resort for the people of Berlin. Pop. 18,500.

Ebert, ā'bĕrt, **Karl Egon,** Austrian poet and dramatist: b. Prague 5 June 1801; d. there 24 Oct. 1882. He began with dramas of Bohemian history, many of which were staged but only one printed, 'Wratislav and Jutta' (1835). As a lyric poet and balladist he was more successful; his 'Poems' (1824) contain fine lyrics, and 'Schwerting the Saxon Duke' is still high in popular favor. His longer poems — 'Vlasta: a National Hero-Poem of Bohemia,' and 'The Monastery,' are fluent in style as well as pure and elegant in language. 'A Monument to Karl Egon, Prince of Fürstenberg,' consists of a garland of sonnets; 'Devout Meditations of a Man of the World' is a didactic poem.

Ebionites, ē'bĭ-ŏn-īts, a sect composed of Jewish believers in Jesus of Nazareth as being the Christ or Messiah, who nevertheless retained many of the practices and beliefs of their ancestral religion. Their name, Ebionites, seems to be formed from the Hebrew word *ebionim*, poor folk; but some of the ancient writers, unacquainted with the history of the primitive church of Jerusalem and Judea and with the Hebrew language, derive the name from that of a suppositious heresiarch Ebion. If the name was originally *ebionim*, "the poor," the sect will have chosen for itself in effect the same name as the mediæval sect of the Poor Men of Lyons. The Ebionites are by many authors confounded with the Nazarenes or Nazarites, another body of Christians Jewish by race and in a measure also Jewish in religion. The rise of the Ebionite sect is commonly referred to the time of Trajan, when, the whole Jewish race being excluded from Ælia Capitolina (as Jerusalem was named anew), these people, despised alike by Jews, Christians, and pagan Romans, migrated to Peræa, the country beyond the Jordan, and there freely developed their religious tenets and practices. They were Jewish rigorists, zealots, with some tinge of Christian belief, in that they held Jesus to have been the Messiah; but they held him to be only man and begotten like other men. The Mosaic law they believed to be of everlasting obligation upon all believers in Jesus Christ whether of Jewish or Gentile race. St. Paul they regarded as a traitor and arch-apostate for his having declared Mosaism superseded by the law of Christ. Of the Christian sacred books they held the Hebrew gospel of St. Matthew to be the only one given through Divine inspiration.

Eb'lis, or **Father of Devils,** in Arabian mythology, the ruler of the evil genii or fallen angels. Before his fall he was called Azazel or Hharis. When Adam was created, God commanded all the angels to worship him; but Eblis replied: "Me thou hast created of smokeless fire, and shall I reverence a creature made of dust?" God was very angry at this insolent answer, and turned the disobedient angel into a Sheytân (devil), and he became the father of devils. He is described as of enormous size, with a red-striped skin, a ring-pierced nose, long hair, large flapping ears and a very long tail. See DEVIL.

Ebner-Eschenbach, āb'nĕr ĕsh'ĕn-bäH, **Baroness Marie von,** Austrian author: b. (COUNTESS DUBSKY) Castle Zdislavic, Moravia, 13 Sept. 1830. Beginning in 1860 as a playwright, her 'Mary Stuart in Scotland' (1860), and the tragedy 'Marie Roland,' with the one-act dramas 'Doctor Ritter,' 'Violets,' and 'The Disconsolate One,' were but moderately successful. Turning to fiction, 'The Princess of Banalia' (1872), a satiric tale, made little impression; but 'Two Countesses' (1885), a story of Austrian high society, met with striking favor. Her other writings include: 'Tales of Village and Castle'; 'The Child of the Parish' (1887); 'The Rival'; 'Aphorisms' (1880); and 'Parables, Stories and Poems' (1892).

Eb'onite, or **Vulcanite,** a name given by Goodyear for what is generally known as hard rubber. It is a vulcanite with a larger proportion of sulphur and certain added ingredients. The proportion of sulphur is from 30 to 60 per cent, and to this may be added certain amounts of shellac, gutta-percha, sulphates of zinc, antimony, or copper. It is used of many colors, as may be gathered from the above list of ingredients, and of hardness and consequent facility for taking polish. The compound, despite its name, may resemble horn, ivory, bone, wood, etc. See VULCANITE.

Ebony, various kinds of wood obtained from several species of *Diospyros,* a genus of trees of the natural order *Ebenaceæ.* The most valued and most frequently used varieties are very close-grained, hard and dark-colored, the best qualities black. This grade is obtained from *D. ebenus,* a native of the eastern tropics, especially India. It is a large tree from which logs containing a cylinder of the dark heart wood more than 18 inches in diameter are often obtained. The sap wood is less valued, being of lighter color and less hard. The wood is especially valued for inlaying, cabinet work, musical instruments, etc. Various other names are given to certain varieties of ebony obtained from other regions, as calamander wood, cadoobergia wood, etc. Occasionally specimens of *D. virginiana,* popularly known throughout the southern United States as the common persimmon, furnish a fair grade of ebony. Several other trees, especially of the genus *Maba,* yield varieties of ebony, as do also a few trees of the order *Leguminosæ.* Bastard ebony is obtained from species of Jacaranda, Brazilian trees. Imitations of ebony are sometimes made by dyeing hard, close-grained woods so as to resemble the genuine ebony.

Eboracum, ē-bŏr'a-kŭm, the Latin name of York. Hence New York is styled in Latin works "Novum Eboracum."

Ebro, ā'brō (Lat. *Iberus*), a river in Spain, once the boundary between the territory of Rome and Carthage, has its source in the province of Santander, 10 miles west by north of Reynosa. Pursuing a southeast course of about 500 miles, it flows into the Mediterranean by two mouths. It is navigable for boats up to Tudela, about 180 miles from its mouth, but is obstructed by shoals and rapids, to avoid which a canal, about 100 miles long, has been constructed south of and nearly parallel to the river.

Ebs'worth, Joseph, English dramatist and musician: b. London 10 Oct. 1788; d. Edinburgh, 22 June 1868. He wrote, adapted, or translated many successful plays; among them 'The Rival Valets' (1825), a comedy drama, and 'The Crusaders' (1850–1), a drama. He was an adapter rather than a creator. His songs, learning, and versatility made him a distinguished figure in Edinburgh circles. He wrote also in collaboration with his wife, Mary Emma (Fairbrother).

Ebullition, ĕb-ĭl-lĭsh'ŏn, the bubbling up or agitation which results from the action of heat on a liquid. The escape of vapor from water depends not merely upon the temperature, but upon the presence of gases and other bodies, upon the vessel, and a variety of circumstances, so that a strict definition is necessary. The usual statement is that ebullition is the conversion of a liquid into a vapor or gas having the same tension or elastic force as the air. This conversion takes place at different temperatures for different substances, but it is so constant for each substance that the fixity of the boiling-point of a fluid is regarded as a very good test of its purity. In determining what that point is, it is of course necessary to ascertain what the atmospheric pressure is, to see that it does not vary during the experiment, and to fix upon some standard pressure for comparison of results. The pressure is estimated by the barometer. It is possible to heat water 20° F. above its boiling point without ebullition. See HEAT.

Eça de Queiroz, José Maria, hō-sā' mä-rē'ä ā'sä-dā-kā'rōs, Portuguese novelist: b. Póvoa do Varzim 25 Nov. 1845; d. Neuilly, France, September 1900. At first a journalist, he traveled and was in the consular service in many parts of the world. He introduced the naturalistic school into Portugal. His powers of observation and description are extensive, and in his novels — 'The Crime of Father Amaro'

(1874, rewritten in 1880); 'The First Monk of St. Basil' (1877); 'A Relic' (1886) — he portrays in master strokes the failings of Portuguese society. His strange, half realistic, half fanciful story, 'The Relic,' weaves into a narrative of Oriental travel a dramatic representation of the Passion of Christ in the form of a dream. In collaboration with Ramalho-Ortigão he wrote the spirited tale of adventure, 'The Mystery of Cintra Street.'

Écarté, ā-kär-tā, from the French, meaning discard, a game at cards for two persons. The game is played with a piquet pack, that is 32 cards, the small cards, from 2 to 6, being excluded. For convenience of dealing, two packs are generally used. The players cut for the deal; the lowest card (in France the highest) deals. The dealer gives 5 cards to each player, 3 and 2 at a time, and turns up the 11th card as trump (French, *atout*). If the turn-up is a king he scores 1, and if a king turns up in the hand of either player the holder may score 1, but in each case this must be announced before the first trick by saying, «I mark king.» The king is the highest card, the queen next, then knave, ace, 10, etc. Trump takes all other suits. In playing the non-dealer leads; the other player must follow suit, and take the trick if he can; if he cannot follow suit, he must play trump, if he holds one. The winner of the trick leads again till the 5 tricks are exhausted. Three tricks count 1 point, 5 tricks 2 points. Five points make a game. The player, according to the French game, must announce the suit he plays, and if he plays differently, can be compelled to play as he announces, or if he cannot, as his adversary pleases.

Ecbatana, ĕk-băt'a-na, the chief city or ancient metropolis of Media, built, according to Pliny, by Seleucus. It was the summer residence of the Persian and Median kings, and existed in great splendor at a very early period in the history of the world. There are no traces now remaining of the site of this celebrated city.

Eccard, Johannes, German composer: b. Mühlhausen, Thuringia, 1553; d. Berlin 1611. He became Kapellmeister to the Margrave of Brandenburg at Königsberg in 1589, and in 1608 became Kapellmeister in Berlin. He is noted as a composer of hymns and other church music.

Ecce Homo, ĕk'sē hō'mō («Behold the Man»), the rendering, in the Latin Vulgate, of the words with which Pilate presented Christ, in scarlet robe and crowned with thorns, to the populace. The figure of Christ in this scene is the subject of a celebrated painting by Correggio which is preserved in the National Gallery of Painting in London. Other great painters have chosen the same subject, among them Guido Reni, whose 'Ecce Homo' is in the Picture Gallery of Dresden.

Eccentric, or **Eccentric Circle**, in ancient astronomy, a circle whose centre was supposed to be displaced from the centre of motion. It was a makeshift to try to account for the motions of the planets before Kepler's discovery of their true motion in ellipses with the centre of attraction at one of the foci of the ellipse. Also, in mechanics, a term applied to contrivances for converting circular into reciprocating rectilinear motion, consisting of variously shaped disks attached to a revolving shaft.

Eccentric'ity, deviation from a centre; the state of a circle with respect to the non-coincidence of its centre with that of another circle; also applied to persons.

Ecchymosis, ĕk-ĭ-mō'sĭs, a subcutaneous hemorrhage due either to bruising or some form of external injury, or occasionally the result of a peculiar blood disease hæmophilia. Ecchymoses usually result in varying grades of discoloration, and are best treated by means of hot water, locally applied.

Ecclefechan, ĕk-l-fĕʜ'ăn, Scotland, village of Dumfriesshire, nearly a mile from a station on the main line of the Caledonian R.R., 20 miles northwest of Carlisle. Its interest is that it is the birth- and burial-place of Thomas Carlyle, and is unmistakably the «Entepfuhl» of his famous spiritual autobiography, 'Sartor Resartus.' The house in which he was born, 4 Dec. 1795, still stands, and in the west corner of the churchyard around the United Presbyterian Church, which represents the old Secession Church, he was laid, as he wished to be, beside his father and mother. Pop. 750.

Eccles, Robert Gibson, American chemist: b. Scotland 1 Jan. 1848. He came to the United States in 1862 and became chemist in the Bureau of Indian Affairs; and professor and dean in the Brooklyn College of Pharmacy. He has discovered calycanthic acid and the alkaloids calycanthine, glaucusine, etc., and devised the official method of assaying pepsin and investigated the effects of drugs on peptic digestion. He also exposed numerous fraudulent medicines, among them the Scotch oats essence. He has written more than 100 articles on philosophic and scientific subjects.

Eccles, England, a municipal borough in Lancashire, four miles from Manchester, of which it is a suburb. There are here numerous cotton-mills. Pop. 34,369.

Ec'clesfield, England, a township in the West Riding of Yorkshire, six miles north of Sheffield. The chief manufacture is cutlery, then flax, linen, paper, and nails; while in the vicinity there are coal and iron mines. Pop. 26,000.

Eccle'sia («convocation»), a popular assembly, especially that of Athens, where the people exercised full sovereignty, and at which every citizen of 20 years of age was entitled to vote. The people voted either by show of hands or occasionally by ballot, the latter method being by white and black pebbles. Beside the legislative powers of the assembly, it could make inquisition into the conduct of magistrates, and in turbulent and excited times exercised a power resembling that of impeachment, as in the cases of Demosthenes and Phocion. The assembly was sometimes suddenly broken up at the occurrence of an unfavorable omen, as thunder and lightning, sudden rain, or any unusual natural phenomenon. The Athenian ecclesia held originally 4, ultimately 40, ordinary meetings in the year. The term was also applied by the Septuagint translators to the Jewish commonwealth, and so was naturally adopted by New Testament writers to designate the Church.

Eccle"sias'tes, or **The Preacher** (Heb. *Koheleth*, «assembler»), one of the didactic books of the Old Testament canon, professing to be the words of the preacher, the son of David, king in Jerusalem. It contains allusions to the writer's riches, palaces, and parables, and its sententious style reminds one of the author of the Proverbs. Yet its diction is marked by Chaldæisms and linguistic usages which are thought not to have been introduced into the Hebrew language till about the period of the Babylonian captivity. The authorship of the Ecclesiastes has been attributed to Solomon, whose claims have often been challenged and always defended; and if it be not his, it must remain entirely uncertain, for no writer of the Babylonian period is known so nearly resembling him in wisdom and wealth of thought. The book consists of philosophical reflections upon human life, and while it affirms: «Vanity of vanities, all is vanity,» it also comes to the conclusion of the whole matter in the words: «Fear God and keep his commandments, for this is the whole duty of man.» Some entertain the opinion that its original form must have been a dialogue in which the sage carries on a discussion with a skeptic and a libertine. Yet it is more commonly regarded as the monologue of a Hebrew moralizing on life and searching for the highest good, scanning the perversities and follies of man, and at length, after a review of the evidence, declaring the verdict that obedience to God is the only real and substantial good.

Ecclesias'tical Commissioners, for England, are a body corporate with a common seal, perpetual succession, and power to hold real estate, constituted by acts 6 and 7. Will. IV. chap. lxxvii., 3 and 4 Vict. chap. cxiii., and 13 and 14 Vict. chap. xciv. It consists of all the bishops of the Church of England, the deans of Canterbury, St. Paul's, and Westminster; the chief justices, 5 cabinet ministers, and other legal dignitaries, and 12 lay members appointed by the crown and the archbishop of Canterbury. This body has extensive powers in regard to the organization of churches, the distribution of episcopal duties, revenues, etc. The schemes adopted by the commission, on being laid before the king in council, approved of, and gazetted, acquire the force of acts of Parliament.

Ecclesiastical Titles Act, a law of the British Parliament, enacted in 1850 (14 and 15 Vict. chap. 60) to prohibit, under penalty, the assumption of ecclesiastical titles (for example: Archbishop of Westminster, Bishop of Clifton, Dean of Sheffield) by any persons not duly appointed to such stations according to the laws of the realm touching the Church establishment. There was already in the statute book a law of 10 Geo. IV., chap. 7, which provided that any person who should assume or use the name, style or title of archbishop of any existing ecclesiastical province, or bishop of any existing diocese, or dean of any existing deanery of the Established Church of Great Britain, and Ireland, the same not having due legal right to such name, etc., should for each violation of the act forfeit £100. But in the year 1850 Pope Pius IX., by apostolic brief, instituted an ecclesiastical province or archbishopric comprising all England and Wales, with Nicholas Wiseman (afterward cardinal) as archbishop, with the style and title of Archbishop of Westminster, and with 12 suffragan bishops presiding over dioceses named: Beverley, Birmingham, Clifton, Hexham, Liverpool, Newport and Menevia, Northampton, Nottingham, Plymouth, Salford, Shrewsbury and Southwark; none of these towns was then the see of any bishop of the Established Church; and therefore the prohibition of the statute of George IV. did not apply. But the announcement of the setting up of these Roman Catholic dioceses provoked a fierce anti-popery agitation, and the prime minister, Lord John Russell, introduced in the Parliament a bill, which was speedily passed, extending the penalty of the act of George IV. to persons who should assume the titles archbishop, bishop or dean «in respect of any places within the United Kingdom.» The new dignitaries ignored the act, assumed their titles, braved prosecution, and not one of them was ever called into court for contumacy. After the act had stood on the statute book as the law of the realm during 20 years it was amended by the act of 34 and 35 Vict., chap. 53. The penalty was dropped, but the so-called repealing act recited again the legal grounds for the penal enactment and declares that «no ecclesiastical title of honor or dignity derived from any see, province, diocese, or deanery recognized by law, or from any city, town, place or territory, within the realm can be validly created»; and that «no pre-eminence or coercive power can be conferred otherwise than under the authority of Her Majesty»; decisions of law that had never been impugned in England since the time of Henry VIII.

Ecclesiol'ogy, the science of the Church as an organized society, a branch of knowledge which deals with ecclesiastical antiquities, such as buildings, rites, vestments, etc.

Ec'cleston, Samuel, American Roman Catholic prelate: b. Kent County, Md., 27 June 1801; d. Georgetown, D. C., 21 April 1851. He was educated in St. Mary's College, Baltimore, and ordained to the priesthood of the Roman Catholic Church 1825. He subsequently served St. Mary's College as vice-president and president; became archbishop of Baltimore in 1834; and established the College of St. Charles in 1850. He was president of five provincial councils and inaugurated the movement which resulted in the laws for the transmission of church property from a bishop to his successor and for the excommunication of any Roman Catholic who, after being divorced by the State, should marry again.

Ecdysis, the process of casting the skin (see MOLTING). The term is used mainly in reference to the exuviation of the pupa of insects, and of the outer cuticle of lower invertebrates, as crabs.

Ech'ard, or **Eachard, Laurence,** English clergyman and historian: b. Barsham, Suffolk, 1670 (?); d. Lincoln 16 Aug. 1730. His 'History of England from the First Entrance of Julius Cæsar and the Romans to the End of the Reign of James the First' (1707) contains a wealth of information, including the particulars of Cromwell's interview with the Devil on the morning of the battle of Worcester. Other historical and scholarly works increased his reputation.

Echegaray, José, hō-sā' ā-chā"gä-rä'ē, Spanish dramatist: b. Madrid 1832. He is author of several treatises on mechanics and civil engineering, and was for a time minister of commerce and of public instruction. Since 1874, when the production of 'The Avenger's Bride' opened a new and brilliant life for the Spanish stage, he has given himself wholly to the drama; producing in a few years 30 plays rich in imagination, dramatic force, and lyric talent. In 1905 he was presented with the Noble Prize for literature by the Swedish Academy. Of his greatest pieces may be named: 'The Great Galeotto'; 'Madman or Saint'; 'Conflict Between Two Duties'; 'A Merry Life and a Sad Death.' See Zacher, 'Don José Echegaray' (1892).

Echellen'sis, Abraham, Maronite scholar: b. Ekhel in the Maronite country of Mount Lebanon; d. 1664. He was an alumnus of the College of the Maronite nation at Rome, and was called to the chair of Syriac and Arabic in the College of the Propaganda. From 1630 till 1642 he was engaged at Paris in making Arabic versions of books of Scripture for a Polyglot Bible; afterward, from 1652 till his death, he was employed in similar work under the auspices of the Congregation de Propaganda Fide at Rome. He made Latin translations of numerous works in Arabic.

Echelon, ĕsh'ĕ lŏn (Fr. «a ladder or stepping stone»), used in military language. A battalion, or regiment, marches *en échelon,* or *par échelon,* if the divisions of which it is composed do not march in one line, but on parallel lines. The divisions are not exactly behind each other, but each is to the right or left of the one preceding, so as to give the whole the appearance of a stairway. This order is used if the commander wishes to bring one part of a mass sooner into action and to reserve the other. If the divisions of the *échelon* are battalions, these are generally from 100 to 200 steps from each other. An *échelon* is said to be direct if its head maintains a position perpendicular to the original line, as in direct attack or retreat; it is said to be oblique when it deviates from the line, as in changing the order of formation.

Echeneis, ĕk-ĕ-nē'ĭs, a genus or family of fishes. See REMORA.

Echenique, José Rufino, hō-sā' roo-fē'nō ā-chā-nē'kā, Spanish-American soldier and statesman: b. Puno, Peru, 1808; d. Arequipa 18 Oct. 1879. He joined the Patriotic party as a boy, rose to the rank of colonel and induced the revolted troops of Gamarra and Bermudez to return to their allegiance in 1833; at the battle of Yungay 1839, he fought on the side of Vera Cruz, in 1845 was a member of Castillas council of state, and in 1851 was elected president of Peru. In 1854 he was charged with financial irregularities and Domingo Flias led a revolt against him which terminated in the battle of Saraija 1854. He was defeated in a second revolt, at the bridge of Iscuchacha, 2 Aug. 1854, retired to Lima, was again defeated at the battle of La Palma, 5 Jan. 1855, and driven into exile. He was permitted to return as a private citizen and was even a presidential candidate in 1872, but spent the last years of his life in retirement.

Echeverria, ā-chā-vā-rē'ä, **Estaben,** Argentine poet: b. Buenos Ayres, Argentina, 1809; d. Montevideo, Uruguay, 1851. He was educated in France and was banished from Argentina by Rosas. Among his works, which are in great repute among his countrymen are: 'Consuelos' (1834); 'Rimas'; 'Cautiva' (1837), containing delightful descriptions of the pampas; 'Guitarra' (1842); and 'La Insurreccion del Sud' (1849).

Echid'na, or **Spiny Ant-eater,** an Australian monotreme animal of the family *Echidnidæ,* or *Tachyglossidæ,* closely related to the duckbill, but very different in outward appearance. Echidnas are spiny, porcupine-like creatures, 12 to 18 inches long, with broad bodies, stout legs terminating in large, strong claws well suited for digging, and a small head, ending in a slender snout. The mouth is toothless but the palate bears a number of recurved spines, which answer the purpose of teeth; the tongue is extensile and glutinous. The animal resembles the hedgehog in that it curls up when in danger, presenting its long spines, and protecting by this method its naked belly. It lives in burrows and feeds chiefly on the juicy larvæ of ants, into whose hill its digs with its great claws. Like the duckbill, the echidna lays eggs, but little is known as to their hatching. The creatures are docile and are easily tamed, becoming playful in captivity and exhibiting considerable intelligence. They are nocturnal in habits, and spend periods of drought curled up in their burrows. The common echidna (*E. aculeata*) is found in Tasmania and New Guinea. It is so variable in color and size that it is sometimes held to form two species, differentiated by their general size and habitat. The «nodiak» of Papua (*Proechnida* or *Acanthoglossus bruijni*) is a kindred animal hunted by the natives for food.

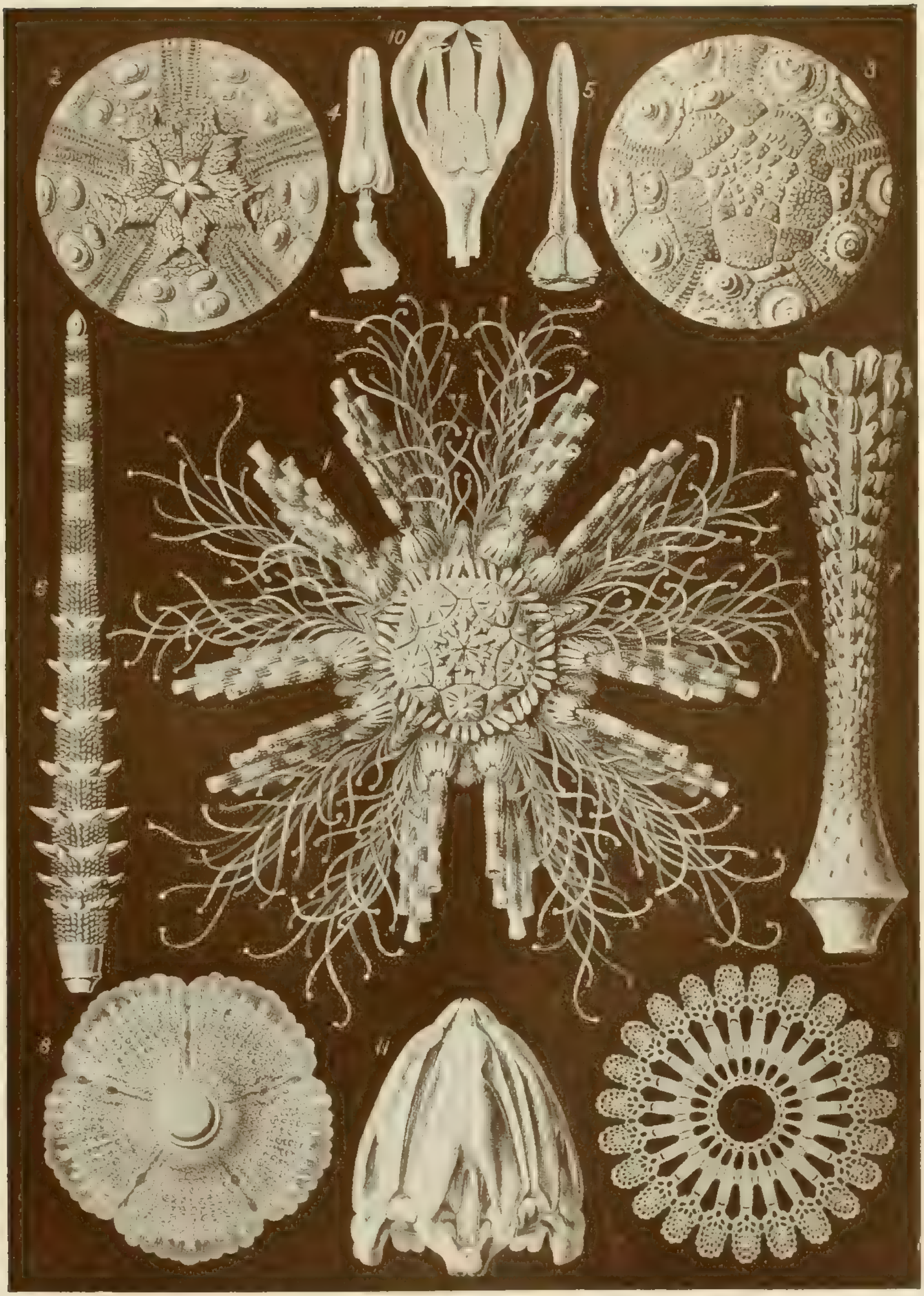
Echinades, ĕ kĭn'ạ-dēz (modern KURZOLARI), a group of islands at the entrance of the Gulf of Corinth, and now in part united to the mainland by deposits brought down by the Achelous River. It was near these islands that the Battle of Lepanto was fought in 1571. See LEPANTO, BATTLE OF.

Echinocactus, ĕ-kī-nō-kak'tŭs, a genus of plants of the natural order *Cactaceæ,* characterized by globular or shortly cylindrical forms with prominent ribs and strong spines. Over 200 species, mostly Mexican, have been described; about 40 species are natives of the southwestern portion of the United States, extending as far north as southern Utah, Colorado, and Nevada. The flowers, which are highly colored, mainly in shades of yellow and red, are borne just above the areas producing the youngest spines and are succeeded by dry or succulent fruits of no economic use. The plants are raised with comparative ease from seeds, given abundant light, but not direct sunlight, which tends to dry the little seedlings, supplied moderately with water before the soil has a chance to bake, and kept in a temperature of about 60 degrees. When about two inches in diameter they may occupy single pots as specimens. About 50 species are cultivated in American greenhouses, and are among the favorite plants of their order.

Echinococcus, ĕ-kī-nō-kŏk'us, a small tapeworm (*Tænia echinococcus*), to which is due the disease called «hydatids» in man and in various animals. See TAPEWORM.

Echinoce'reus, a genus of plants of the natural order *Cactaceæ,* with generally low, thickly clustered stems, mostly short funnel-formed, brilliantly colored flowers of various tints, and globose or ellipsoidal fruits which are spiny until they reach maturity. By some botanists the genus is united with Cereus, from which it is distinguished mainly by technical characters that are present in some species of

ECHINODERMS.



[1] Cidaris tribuloïdes. [2], [3] Cidaris baculosa. [4] Dorocidaris papillata. [5] Strongylocentrus nudus.
[6] Phyllacanthus annulifera. [7] Phyllacanthus baculosa. [8] Psammechinus miliaris.
[9] Centrostephanus longispinus. [10], [11] Sphaerechinus esculentus.

each group. About 25 pieces are general favorites in American greenhouses. They are cultivated in about the same way as Echinocactus and Cereus (qq.v.).

Echinodermata, ē-kī-nō-dėr-ma′-ta, or **Echinoderma,** one of the most distinct phyla of the animal kingdom, embracing the crinoids, sea cucumbers, sea urchins, and starfishes. On account of a predominating radial symmetry Cuvier united them with the *Cœlenterata* in his type *Radiata.* Leuckart was the first to clearly perceive that only a superficial resemblance exists between the members of these two great groups and to him is due the elevation of the *Echinodermata* to the importance of a distinct phylum. The skin is always more or less indurated by the deposition of calcium carbonate in the form of variously shaped spicules, spines, disks or plates, either isolated or united to form a reticulum or a continuous test. There is a principal axis around which most of the organs of the body are repeated five times in a radial manner. While this pentamerism is generally predominant, certain organs (madreporic plate, stone canal, «heart») occur in but one radial axis which, therefore, lies in a median plane to which all other organs are bilaterally related. Of the repeated organs the digestive glands, radial canals, nerves, various vessels, the eye-spots, and some others, are radial, the genital organs (single in *Holothuroidea*) and polian vesicles interradial in position. The partial suppression of one ray or two rays, and among the starfishes a multiplication of rays, may take place; furthermore, in some *Echinoidea* and *Holothuroidea* certain of the organs or rays may shift so extensively with regard to the principal axis and the median plane that the original pentamerism becomes obscured. There is a well-developed cœlom or body cavity and a closely connected «blood» or pseudohæmal system which consists of an axial organ or «heart,» a circumœsophageal ring, radial vessels, and a more or less extensive system of lacunæ. In addition to the blood vascular system there is a very characteristic water-vascular system which, when typically developed, consists of a median madreporic or sieve plate and stone canal, a circumœsophageal canal bearing polian vesicles and other diverticula, and giving rise to radial canals which in turn bear rows of ampullæ and tube feet. The latter are the chief organs of locomotion, and the most important function of the water-vascular system is to provide for their distention by means of the water which is strained through the madreporic plate and enters the stone canal. In some cases the tube feet assume an exclusively respiratory function. With few exceptions the sexes are separate and, following fertilization in the water external to the body, a free swimming larval form develops, except in a few cases, from the egg. This is always bilaterally symmetrical, has a curved alimentary canal with mouth and anus, and a more or less complicated ciliated tract of cilia or separate circles of cilia, and a pair of cœlomic pouches. Older larvæ often develop irregular processes and a larval skeleton. The larvæ of the several classes differ considerably in structural details and have been named auricularia, bipinnaria, pluteus, etc. The Echinodermata are exclusively marine. Four classes may be recognized, as follows:

Crinoidea, usually fixed to the sea bottom by the aboral surface; the mouth uppermost and the viscera all contained in the central disk or theca. When arms are present they are solid and usually branched. Stone lilies or crinoids. Here belong also the extinct blastids and cystids which are often regarded as forming separate classes.

Stelleroidea, never fixed to the sea bottom; the mouth or oral surface always in contact with the surface over which they are moving; tube feet confined to the oral surface; form stellate. There are two quite distinct sub-classes, the *Ophiuroidea,* or brittle stars, serpent stars, and basket stars; and the *Asteroidea,* or true starfish.

Echinoidea, never fixed to the sea bottom; ambulacral areas with the tube feet extending more or less over the aboral surface; form compact, more or less discoid or spheroidal. Sub-classes, *Regularia,* or regular sea-urchins; and *Irregularia,* or irregular sea-urchins.

Holothuroidea, never permanently fixed to the sea bottom; water-vascular system with a circle of oral tentacles; more or less elongated along the principal axis to a cucumber or wormlike form; skeleton in the form of separate plates or sometimes totally wanting. See CUCUMBERS.

For further information consult: Lankester, 'Treatise on Zoology,' (Part III.), and articles on the several classes.

Echinoidea, ĕk-ĭ-noi′de-a, or **Sea Urchins,** a class of *Echinodermata* with a more or less spheroidal or discoidal body enclosed in a continuous test or shell composed of polygonal pieces of various shapes accurately fitted together and arranged in radial rows. Alternating ambulacral and interambulacral areas, usually repeated five times, may be recognized. The former exhibit rows of perforations for the tube feet, generally reaching to the aboral pole. The skeletal plates support movable spines which sometimes attain a great size and are used in defense and to a certain degree in locomotion. In addition, the integument bears the remarkable structures known as pedicellaria, which are three-jawed pincers borne on movable stalks, which by continually snapping and bending carry away particles of fæcal matter and secure cleanliness. The beginning of the digestive canal is frequently provided with a complicated masticatory apparatus known as Aristotle's lantern, and the canal itself is tubular and looped, usually not pouched. The gonads are interradial with outlets to the exterior near the aboral pole. Development may be direct or through the larval form called pluteus, which is provided in its later stages with long processes supported by movable spicules. The number of known Echinoidea is very great, many of them being fossil. There are two sub-classes:—*Regularia,* form regular, spheroid; mouth and anus at opposite poles of the central axis, and the latter usually surrounded by small skeletal plates; in only a few cases are external gills present. Here belongs the common sea-urchin (q.v.). *Irregularia,* form markedly bilateral; anus always displaced from the apical pole into the posterior interradius and the mouth frequently in the opposite direction, in which case the form is sometimes heart-shaped. Examples are the sand-dollar and heart urchin (q.v.).

Echinorhynchus, ĕ-kī-nō-rĭng'kŭs, a parasite worm. See ROUNDWORMS.

Echo, from the Greek, meaning «sound,» noise; a sound repeated by reflection, or a sound heard again at its source. The waves of sound on meeting the surface are turned back in their course according to the same laws that hold for reflection of light. Even clouds are capable of producing echoes, as is observed at sea when a gun is fired off under a dense cloud. Echoes from the clouds also, in all likelihood, play an important part in the long rolling of thunder. In order that the echo may return to the place from which the sound proceeds the reflection must be direct, and not at an angle to the line of transmission, otherwise the echo may be heard by others but not by the transmitter of the sound. This may be effected either by a reflecting surface at right angles to the line of transmission, or by several reflecting surfaces which end in bringing the sound back to the point of issue. To make a distinct echo the reflected sound must be concentrated rather than diffused. To this result a degree of concavity in the reflecting body is conducive. If the sound is repeated several times, which is the case when it strikes against objects at different distances, many echoes are heard. The reflecting surface must be at a certain distance, in order that the echo may come to the ear after the sound, and be distinctly separated from it. Sound travels about 1,100 feet in a second; consequently, an observer standing at half that distance from the reflecting object would hear the echo a second later than the sound. Such an echo would repeat as many words and syllables as could be heard in a second. This is called a *polysyllabic* echo. If the distance is less, the echo repeats fewer syllables; if only one is repeated, then the echo is monosyllabic. The most practised ear cannot distinguish in a second more than from 9 to 12 successive sounds, so that a distance of not less than 60 feet is needed to enable a common ear to distinguish between the echo and the original sounds. Echoes at least distances, as from the walls of churches and public halls, are liable to mix with and destroy the distinctness of the original sound.

Echo, in classical mythology, a nymph (one of the Oreads), who, according to fable, was changed by Hera (Juno) into a rock, because her loquacity prevented Hera from listening to the conversation of Zeus with the nymphs. The use of her voice, however, was left her so far as to be able to repeat the last word which she heard from others. Another account is that Echo fell in love with Narcissus, and because he did not reciprocate her affection she pined away until nothing was left but her voice.

Echo Cañon, a gorge in northern Utah, not far from Salt Lake, through which the Union P. R. R. passes. The high almost vertical walls of the cañon have fantastic carvings made by the elements, principally water. The peculiar echo heard within the gorge has given it its name.

Echolalia, ĕk-ō-lā'lĭ-ạ, a peculiar form of verbal repetition which occurs in certain nervous, hysterical, and insane people. It consists in the ceaseless repetition of words that rhyme, or apparently rhyme, or the continued utterance of some definite sentence or parts of a sentence. A like symptom termed verbigeration is frequently found in terminal dementias and allied mental states, and is to be distinguished from echolalia, which it closely resembles, by the repetition of meaningless and disconnected phrases. Echolalia is seen to best advantage in hysteria and in a peculiar type of mental disease known as catatonia (q.v.).

Echter, ĕH'tėr, Michael, German painter: b. Munich 5 March 1812; d. there 4 Feb. 1879. He studied at the Munich Academy, as a pupil of Hess, Zimmerman and Olivier. He assisted Kaulbach in work on the mural paintings in the Berlin Museum, painted the ‹Battle of Lechfeld› for the Maximilianeum; the ‹Betrothal of Frederick Barbarossa with Beatrice of Burgundy› and ‹The Burial of Walther von der Vogelweide› for the National Museum in Munich; and 30 scenes from the ‹Nibelungenlied› for the royal residence. He was appointed professor in the School of Industrial Arts, and was a member of the Munich Academy.

Echtler, ĕHt'lėr, Adolf, German painter: b. Dantzic, Prussia, 1843. He studied at the Venice Academy under Karl Blaas, and at the Munich Academy, and took the gold medal at Berlin 1875. Among his works are: ‹A Difficult Problem›; ‹Peaceful Company›; ‹Honi Soit qui mal y pense› (1877); ‹Souvenir of Italy›; ‹Those whom I have always loved› (1879); ‹The Kiss› (1880); ‹Neapolitans in Normandy›; ‹In the Morning› (1881); ‹Repentant Sinners› (1882); ‹Ruin of a Family›; ‹All is Vain›; ‹Souvenir of Venice› (1884); ‹Five Orphans› (1885).

Echuca, ĕ-choo'kạ, Australia, town in the colony of Victoria, on a peninsula at the junction of the Campaspe with the Murray River. It is opposite Noama, in New South Wales. It has a trade, partly by the river, in timber, wool, and wine, and the vine is cultivated in the neighborhood. Pop. about 5,000.

Ecija, ā'thē-hä (Rom. ASTIGI; AGUSTA FIRMA), Spain, a town in the province of Seville, on the Genil, 42 miles northeast of Seville. It is of very ancient origin, and according to tradition was visited by the apostle Paul. At a very early period it became an episcopal see, and its importance under the Romans is attested by many ancient remains. The climate is so hot that Ecija is often called the «Oven of Andalusia.» Pop. in 1887 23,615.

Eck (Eccius), Johann Maier von, a Catholic theologian, life-long adversary of Luther: b. Eck, Suabia, 13 Nov. 1486; d. Ingolstadt 1543. His father, a peasant named Maier, assumed the name Maier von Eck or Maier of Eck, after becoming bailiff of his village. Johann, at the age of 11 years, entered the University of Heidelberg whence he passed to the University of Tübingen and there at the age of 14 years took the degree of master of arts. He now successively at Tübingen, Cologne, and Freiburg universities studied divinity, jurisprudence, and mathematics, and at the same time was instructor in philosophy. He was appointed professor of theology in the University of Ingolstadt (1510). While on his travels in Italy (1515) he took part in a public disputation in the University of Bologna and won high distinction; in 1516 on a similar occasion at Vienna he had a like success. In 1518 he published a pamphlet, 'Obelisci,' in defense of the Catholic doctrines attacked in Luther's celebrated 'Theses' of 31 Oct. 1517. Eck was now chancellor of the University of Ingolstadt and Luther put forward Carlstadt as a defender of the 'Theses'; Carlstadt not only replied to Eck in print, but challenged him to a public disputation. Eck accepted the challenge, and the disputation was held at Leipsic, with Eck as the champion of Catholicism against both Carlstadt and Luther. The disputation was commenced 27 June 1519, and lasted till 15 July. Upward of a year previously Luther in a letter to one of his friends credited Eck with eminent scholarship and great natural gifts, but after the disputation he was for Luther «a pitiful theologian» and «a miserable sophist.» The numerous audience and the townsmen with unanimity awarded the crown of victory to Eck, and Luther in a private letter to his intimate friend Spalatinus, confesses defeat. Eck, stimulated by his success, devoted himself thereafter wholly to working for the overthrow of his adversaries. He procured from the universities of Cologne and Louvain a condemnation of Luther's writings and was honored at Rome with the commission to publish in Germany Pope Leo's bull *Exsurge Domine* against Luther. But he was received with manifestations of popular enmity almost everywhere; even at Leipsic the bull was solemnly committed to the flames by the students and the populace. On several notable occasions afterward — at the diet of Augsburg (1530), the conferences at Worms (1540) and those at Ratisbon (1541), he was again a principal champion of Catholicism. Some of his works are a German translation of the Old Testament, and a revision of Luther's translation of the New Testament. His pamphlets and books against the doctrines of Luther are included in 'Operum Johannis Eccii contra Lutherum.'

Eckels, James Herron, American financier: b. Princeton, Ill., 22 Nov. 1858; d. Chicago, Ill., 14 April 1907. He was graduated at the Albany, N. Y., Law School, 1880, and practical law at Ottawa, Ill., 1881–93. From 1893 till 1897 he was United States comptroller of currency. He was president of the Commercial Bank of Chicago till his death.

Eckermann, Johann Peter, yō'hän pä'tėr ĕk'ĕr mä, German poet: b. Winsen, Hanover, 21 Sept. 1792; d. Weimar 3 Dec. 1854. He has a permanent place in literature through his record of 'Conversations with Goethe in the Last Years of his Life' (1823–32); which has been translated into nearly all the languages of Europe, even Turkish. He edited the 40-volume edition of Goethe's works (1839–40).

Eckert, Thomas Thompson, American telegrapher: b. St. Clairsville, Ohio, 23 April 1825. In 1852–9 he was superintendent of the telegraph line between Pittsburg and Chicago; in 1859–61 superintendent of a gold-mining company in North Carolina; and in the latter year was appointed superintendent of the military telegraph department of the Potomac, with the rank of captain. Subsequently he was general superintendent of the military telegraph of the army, and was brevetted brigadier-general of volunteers for his services. In 1864–6 he was assistant secretary of war; in 1866–75 general superintendent of the eastern division of the Western Union Telegraph Company; in 1875–81 president of the American Union Telegraph Company, and in 1892 became president and general manager of the Western Union Telegraph Company. He retired in 1902.

Eckford, Henry, American naval architect: b. Irvine, Scotland, 12 March 1775; d. Constantinople 12 Nov. 1832. He became a ship-builder in New York, in 1796; designed and constructed a fleet of war vessels for the United States government in 1812–14; built the Robert Fulton, which made the first voyage by steam to New Orleans and Havana; became naval constructor at the Brooklyn navy yard in 1820; and built several war vessels for European and South American governments.

Eckhart, ĕk'härt, **Johannes** («Meister Eckhart»), the first of the German mystics in order of time and among the foremost in rank; the probable place of his birth is Cologne, and the year 1260 or a little earlier; d. 1329. He studied philosophy and theology in the University of Paris and joined the order of the Preaching Friars, or Dominicans, in which he was promoted to offices of high responsibility, for example, that of vicar-general of the Dominicans for Bohemia, provincial of the order in Saxony. In these places he effected many reforms in the houses of the order and was in high estimation as a preacher notwithstanding the abstruseness of his mystical speculations. Toward the end of his life this dissemination of his mystical views touching the nature of God and the relations between Deity and the human soul brought him under suspicion of being in sympathy with the Beghards, the Brethren of the Free Spirit, the Apostolic Brethren, and other fanatics, and 1327 he was cited before the court of inquisition at Cologne to make answer to charges of heretical teaching based on passages in his sermons. There he defended the inculpated propositions as entirely orthodox, but expressed his readiness to repudiate them if in the judgment of the head of the Church they were in conflict with the Church's creeds. In 1329 the decision arrived from Rome: 28 propositions contained in his sermons were condemned as heretical and Eckhart was ordered to recant; but he was now dead.

Whether these 28 propositions were or were not formally heretical, contradictory of the express teachings of the Church, they certainly contain doctrines that never have been put forth in any of the Church's formularies. However extravagant, they might have been tolerated or ignored, had they been entertained or discussed merely in the schools of theology and philosophy; but proclaimed from the pulpit and addressed to the common people, some of them ignorant, they were incitations to rebellion against all Church authority in teaching. His doctrine concerning the Godhead is plainly pantheistic-agnostic. For him there is no real being but God. God is the unknown and the unknowable. We cannot validly affirm anything of the Godhead; to predicate anything of Deity is to limit infinity. Yet though God is unknown and unknowable, and though we cannot predicate anything of him, still we can know the true God, the personal God, the Father; in this personal God, the Godhead itself. The triune God, Father, Son and Spirit, is evolved from the Godhead. And the Father comes to know himself in the Son; the return of the Son into the Father is the Spirit. In begetting the Son — who is coeternal with the Father — the Father brings into existence the universal world of things. Having gone to such lengths of mystic speculation it was well for his fame that he died before he was forced to recant. His death occurred a little while before the arrival of the Pope's condemnation of his doctrines.

Eckhel, ĕk'ĕl, **Joseph Hilary,** Austrian numismatist: b. Enzersfeld, Austria, 1737, d. 1798. After becoming a member of the society of St. Ignatius he was appointed keeper of the imperial cabinet of medals and professor of archæology at Vienna. Eckhel may be regarded as the founder of the science of numismatics, the principles of which are elaborately developed in his treatise, 'Doctrina Nummorum Veterum' (1792–8). He also published catalogues of the ancient coins and gems in the imperial cabinet.

Eckstein, ĕk'stīn, **Ernst,** German humorist, poet, and novelist: b. Giessen 6 Feb. 1845; d. 1900. From the university he went to Paris, and there completed his comic epos 'Check to the Queen' (1870), and wrote 'Paris Silhouettes' (1873), the grotesque night-piece 'The Varzin Ghosts,' and the 'Mute of Seville.' Later he wrote the stories: 'Margherita'; 'At the Tomb of Cestius'; 'The Mosque at Cordova.' He was editor of a literary and critical journal, 'Hall of Poets,' and of a humorous weekly, 'The Wag,' at Leipsic for some years, and in 1885 settled in Dresden. He also wrote 'The Claudii'; 'Aphrodite, a Story of Ancient Hellas'; 'Decius the Flute-player: a Merry Story of a Musician in Ancient Rome.'

Eck'storm, Fannie Hardy, American author: b. Brewer, Maine, 18 June 1865. She was graduated at Smith College 1888. She has published 'The Bird Book' (1901); 'The Woodpeckers' (1901).

Eclamp'sia. See PUERPERAL ECLAMPSIA.

Eclampsia Infantum. See INFANTILE CONVULSIONS.

Eclecticism (from the Gr. ἐκ, out of, and λεγεῖν, to choose or select) is a term that may be applied to any body of theories or doctrines that are combined without regard for their systematic coherence and real unity. We may thus find eclecticism in theology, in philosophy, in medicine, politics, or in the sphere of any of the theoretical sciences. The eclectic is usually guided by practical motives: he adopts from the various conflicting systems what seems to him the most plausible and useful opinion on this point or that, drawing now from one school, now from another. He is not concerned primarily with the systematic connection, or even the logical consistency, of these various doctrines with one another, but rather with the plausibility and practical applications of the views taken singly.

In philosophy there have been many men, both in ancient and in modern times — some of them writers of great popularity and influence — who, without attaching themselves to any particular system or forming one of their own, undertook to select from various quarters the particular doctrines that appeared to them to be true, and to combine them in their teaching. This eclectic tendency was most prominent in the ancient world during the latter period of Greek philosophy, when the theoretical interest of earlier times had greatly declined, and when skepticism had infected many of the best minds. The differences between the three principal schools (Platonists, Peripatetics, and Stoics) began to be less emphasized and elements from one school were adopted by adherents of another. Moreover, a form of eclecticism appeared in Alexandria also, where thinkers like Philo sought to unite Hebrew theology with Platonic and Neo-Pythagorean conceptions. Cicero, who did more than anyone else to acquaint his fellow countrymen with Greek philosophy, was a thorough-going eclectic, troubling little about the systematic connection of the doctrines and selecting freely from the various schools what seemed to him true. In modern times, the school founded by the French philosopher, Victor Cousin, is known as eclecticism. Cousin sought to unite German idealism, as represented by Kant and his successors, with the Scottish philosophy of «common sense» and the doctrines of Descartes. Consult Zeller, 'Eclecticism in Greek Philosophy' (English trans. 1883); Janet, 'Victor Cousin et son Œuvre' (1885); Simon, 'Victor Cousin' (1887).

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Eclecticism, a term applied at the present day to the principles and practice of an ancient as well as a modern school of medicine. It is derived from a Greek word meaning «to select» and was well applied to the ancient school. In the modern school, however, «selecting the best,» has played but a minor part in comparison to doctrines originating within the school, such as the theory of specific medication, a doctrine distinctly its own. In the early centuries a number of distinct schools of medicine arose. Among these were the dogmatic, methodic, pneumatic, and empiric. From these arose the Eclectic, or episynthetic. The physicians of this sect wished it implied that they had made a rational selection of all that was best in the other medical schools. The practice of Areteus, who, though not the founder, did the most to consolidate its doctrines, was simple, rational, and by far the most judicious of the ancients up to his time.

Modern Eclecticism, in the United States, embodies the principles and practice of the Eclectic, or American school of medicine founded by Dr. Wooster Beach in New York city, in 1825. It was first known as the American Reformed school. While it employs most largely remedies of vegetable origin it must not be confounded with Thomsonianism, a popular form of botanic practice taught and practised by Dr. Samuel Thomson in New England in the early part of the 19th century, the peculiar theories and extreme measures of which were never adopted by the Eclectics. Among the most bitter antagonists of the latter were the followers of Thomson. As students and developers of indigenous materia medica the American Eclectic practitioners have been the most assiduous in all history, and in this field they have won the admiration of the rival schools of medicine. The majority of Eclectics of the present day adhere to the doctrine of specific medication, the basic theory of the modern school, promulgated by Dr. John Milton Scudder, of Cincinnati, Ohio, in 1869. The Eclectic or American school of medicine of to-day is distinctively a school of specific therapeutics. (See MEDICINE, ECLECTIC.)

H. W. FELTER, M. D.

Eclipse (Gr. ἔκλειψις, from ἐκλείπειν, to forsake the accustomed place, to fail to appear), an obscuration of the light of a heavenly body by another, effected either, directly, by its intervention between the body and the observer, or, indirectly, by its interception of the source of light which illumines the body. The earth, by means of its shadow, may indirectly cause an eclipse of the moon. Similarly, eclipses of the Jovian satellites are caused by immersion in the shadow of Jupiter, and for the system of Saturn a more complicated result arises on account of its ring. When the shadow of a satellite falls upon either of these planets it is called a transit of the shadow. Eclipses are not observable in the other planetary systems, since, in the case of Mars, the satellites disappear in the light of the planet, and with the more distant planets the shadow cone extends too slight a distance beyond the disk. Again, our moon can by its direct interposition between the sun and the earth produce eclipses of the sun. Similar occurrences are observed in the Jovian and Saturnian systems and are then called transits of the satellites, but in the outer planets have not as yet been observed. The moon may interpose itself between the stars or planets and occult them (see OCCULTATION), and the other bodies of the solar system may act similarly. The eclipses of the sun by the inner planets are designated transits (see TRANSITS), but the obscuration of satellites and stars by the disks of planets are called occultations. The most important of these phenomena are the eclipses of the sun and moon.

Eclipses of the Moon.— A lunar eclipse is caused by the interposition of the earth between the sun and the moon and the moon's consequent immersion in the shadow of the earth. This can occur only when the moon is in opposition to the sun on the heavens, at the time of full moon, and both sun and moon are near the moon's nodes, i. e. the points where her orbit crosses the plane of the ecliptic. Let the sun, earth and moon be regarded as spherical bodies and their centres ranged in a right line. Then the sun will project beyond the earth a conical shadow called the *umbra*, in which the moon is centrally immersed. The surface of this cone will be described by a line tangent to the same side of both sun and earth and moving about the line joining their centres. The apex of the shadow cone, or of the umbra, is on the average about 157,000 miles beyond the earth's centre, and the diameter of the umbral cone at the point where the moon crosses it on the average about two and two thirds the diameter of the moon, with a variation from scarcely twice to more than three times the lunar diameter. If, again, two lines tangent on opposite sides of the sun, and crossing between sun and earth, move about the line joining the centres of these bodies, these lines will describe the surface of two cones of which the one extending beyond the earth is that of the *penumbra*. Unless the moon be near one of her nodes at the time of full moon, she will not strike the shadow, but pass below or above it. If the sun is less than 4 days from a node of the moon's orbit, an eclipse must occur; if more than 14 days from a lunar node, an eclipse is impossible. These are called the lunar eclipse limits. Since the moon must be quite near her node to produce a lunar eclipse, it may happen that an entire year may elapse without an eclipse of the moon. The lunar eclipses may be either partial or total according as the moon is immersed either partly or entirely in the earth's shadow cone. The phenomena of a total lunar eclipse are of a simple character. The immersion of the moon in the penumbra can be observed only with difficulty. The edge of the shadow itself presents a hazy outline when seen in a telescope, and the times of contact cannot be observed with accuracy. When completely within the earth's shadow, the moon is usually still plainly visible in a dull copper-colored illumination which is produced by the sunlight shining through the earth's atmosphere, suffering absorption of its higher tints, and experiencing deflection into the shadow cone through refraction. Lunar eclipses have, however, occurred in which the moon was almost entirely invisible during the total phase. The obscuration of the earth's atmosphere by clouds accounts for these dark eclipses. Specially bright lunar eclipses have, on the other hand, been attributed to terrestrial auroras occurring at the same time. The most interesting physical observations effected during its eclipse concern the luminous and heat radiations of the moon. Valuable astronomical observations then possible are the determinations of the times of occultation of faint stars whence precise values of lunar position, diameter, and parallax may be derived.

Eclipses of the Sun.— Solar eclipses can occur only at the time of new moon. If the sun be more than 19 days from a node of the moon's orbit, an eclipse is impossible, if less than 10 days, a central solar eclipse is inevitable. These are the solar eclipse limits. The sun causes the moon to project toward the earth at new moon, umbral and penumbral shadow cones differing in the main only in size from those which the earth projects toward and beyond the moon at full moon. The method of conceiving the generation of the shadow cones of the umbra and of the penumbra are the same in solar as in lunar eclipses if the moon be substituted for the earth. The shadow cone of the moon may strike the earth's surface, but on the average does not. Two distinct cases may arise. First, the axis of the shadow cone strikes the earth's surface, and upon it the right line joining the centres of the solar and lunar disks, traces the curve of centrality. Here three cases result: (1) The apex of the shadow cone reaches the earth's surface and a central *total* eclipse occurs. (2) The apex of the shadow cone does not reach the earth's surface and there occurs a central *annular* eclipse. (3) The apex of the shadow cone reaches the earth's surface only at a middle stretch of the curve of centrality and there occurs a central *annular-total* eclipse. Secondly, the axis of the shadow cone does not strike the earth's surface but the earth still enters the shadow cone, or shadow cone produced, and there occur total, annular, and annular-total eclipses, all of which are of a non-central character. The path of a total eclipse on the earth cannot exceed 167 miles in width and is often not over 135 miles, but it may traverse a length from west to east of several thousand miles. An annular eclipse has also a «path of the annulus» in which the annular phase is visible. Outside of both of these paths the sun is only partially eclipsed. The least number of eclipses, solar and lunar, which can occur in a year, is two, and these must be central eclipses of the sun, while the maximum number occurring is seven, two of the moon and five of the sun. The average number hardly exceeds four. The minimum number of two eclipses is determined by the fact that the sun in its annual path crosses both nodes of the moon's orbit. The retrograde motion of the moon's nodes around the ecliptic continually changes the two eclipse seasons of the year, and is also responsible for the famous cycle of eclipses discovered and used long before its physical explanation was possible. A simple record of the date and character of the eclipses revealed to early astronomers the fact that after a period of about 18 years, eclipses again recur in the same order and kind whether solar, lunar, total, or partial. This cycle, called the saros, is one of 223 lunar months, each of a little more than 29.5 days, and is precisely 6,585.32 days in length. Depending on the number of leap years, 5, or 4 intervening, this is equal to 18 years, 10.32 days, or 11.32 days. At the end of the saros, the relative positions of the sun, moon, and node of the moon's orbit are nearly the same as at the beginning, and other favoring factors of the motions of the sun and moon also recur, as Newcomb first pointed out, to nearly original values. The excess of one third of a day in the cycle causes the eclipse to be thrown about eight hours of longitude farther west on the earth's surface. Hence only after three cycles does the eclipse again recur in approximately the same longitude. If the intervening leap years be regarded, the application of the saros to various series of solar eclipses of the following table may readily be made.

Ancient eclipses are chiefly of value in historical and chronological investigation (see TIME). The records of the supposed eclipses of the ancient historians are usually very uncertain as to place, time, and character of the occurrence, and hence have proved of questionable value to the astronomer. The precise circumstances of an eclipse occurring centuries ago can readily be computed from the modern tables, but the comparison with the vague historical references has apparently contributed but little to science. Ginzel has, in his 'Special Canon of Eclipses,' collected a splendid array of ancient eclipse literature, and this has been used to derive corrections to the lunar tables, but Newcomb seems justly to question the validity of the results. The eclipses observed by the older astronomers and carefully recorded are of great value. And in later times the description of eclipses has been so accurately interwoven with even historical accounts as to furnish unquestionable data for chronology. The terror and apprehensive uncertainty associated with an eclipse in ancient times has given place to a lofty appreciation of the grand occasion, and to a careful and inspiring scientific study of the phenomena.

The annexed table of total solar eclipses occurring during the present century has been prepared with the aid of the memoirs of Oppolzer and Mahler, and is a complete list of all the eclipses of the century having a total phase, however brief. The first column gives the date for the point on the earth where at noon the eclipse is central. The second column gives the Greenwich civil time of the conjunction of the sun and moon in longitude. The next column states the greatest interval in minutes during which the most favored place may experience the total phase. The fourth column gives the latitude and longitude of the place where the eclipse is central at noon. The last column indicates the areas traversed by the moon's shadow. Several of the eclipses, occurring in the polar regions, have no noon-point and hence, for these, the place of the beginning or end of the eclipse, lowest in latitude, is placed in the fourth, and the corresponding time, sunrise or sunset, in the last column. The nine annular-total eclipses of the century are indicated by a *, and in these the duration of total phase may be but a few seconds. Two of the list, namely 1928 and 1967, are non-central in character, the moon's shadow just grazing the pole of the earth.

It is not likely that the brief duration of total phase of a number of these eclipses will bar their astronomical use, particularly in the direction of spectroscopic and photographic investigations. The ever increasing importance of a thorough study of the rare and intricate phenomena of total solar eclipses, attested alike by the marvels still awaiting explanation, and by the progress already made, demands that every second of totality available shall be turned to the highest scientific uses.

The Phenomena Observed in Total Solar Eclipses.— As totality approaches, a pale purple coloring spreads over the landscape. Within a minute of the total phase the phenomena begin to succeed each other so rapidly that no single observer can note them all. By those glancing at the landscape in the direction of the approaching shadow a majestic darkness will be seen to sweep forward with a swiftness truly impressive. Those looking at the earth, and away from the eclipsing sun, will see a succession of flitting bands, alternately dark and bright, known as the *shadow bands,* which for many decades remained an unexplained puzzle. About 15 seconds before the total phase, the moon, with its sharp irregular outline, due to the elevations and depressions in its surface, will have diminished the solar crescent to such an extent that the remnant of it usually begins to be crossed by black lines, — the mountains on the moon's edge connecting the limbs of moon and sun. Then it rather suddenly presents the appearance of a string of detached brilliant points, irregular in size and spacing. These are the well-known *Baily's beads,* seen by Francis Baily on the occasion of the annular eclipse of May 15, 1836, and in an extended memoir on the remarkable phenomenon fully described. The explanation of the appearances was rightly suggested, as due to irradiation which alike exaggerates the length and thinness of the projected lunar mountains and the size of the resulting bright points or *beads* of the disappearing solar crescent. On each side of the point of disappearance, the chromospheric arc may be observed as a scarlet «sierra.»

TOTAL ECLIPSES OF THE SUN OCCURRING DURING THE TWENTIETH CENTURY.

Date of Eclipse, Central at noon.	Greenwich M. T. (Civil) of Conjunction in Longitude.	Max. Dur. of Total Phase	Locality of Eclipse Central at Noon Lat. Long.	Course of Moon's Shadow.
	h m	m		
1901, May 18	5 38	6.7	2°S 97° E	Sumatra, Borneo, New Guinea.
1903, Sept. 21	4 30	2.3	70 S 101 E	Indian Ocean, Antarctic Ocean.
1904, Sept. 9	20 43	8.2	5 S 133 W	Polynesia, Pacific Ocean.
1905, Aug. 30	13 13	4.0	45 N 12 W	Canada, Spain, Egypt.
1907, Jan. 14	5 57	2.6	39 N 89 E	Russia, Chinese Empire, Siberia.
1908, Jan. 3	21 44	4.5	12 S 145 W	Polynesia, Pacific Ocean.
1908,* Dec. 23	11 49	0.4	53 S 3 E	South Atlantic Ocean.
1909, June 17	23 29	0.5	88 N 173 W	Siberia, Arctic Ocean, Greenland.
1911, Apr. 28	22 26	5.4	1 S 155 W	Australia, Polynesia, Pacific Ocean.
1912,* Apr. 17	11 40	0.2	46 N 1 W	Spain, France, Germany, Russia.
1912, Oct. 10	13 41	2.2	35 S 33 W	Ecuador, Peru, Brazil.
1914, Aug. 21	12 27	2.4	71 N 2 E	Scandinavia, Russia, Persia.
1916, Feb. 3	16 06	2.9	16 N 62 W	Pacific Ocean, Isthmus of Panama, Venezuela, West Indies.
1918, June 8	22 03	2.5	51 N 152 W	Pacific Ocean, United States.
1919, May 29	13 12	6.1	4 N 18 W	Peru, Brazil, Central Africa.
1921, Oct. 1	12 26	...	84 S 19 W	Antarctic Ocean.
1922, Sept. 21	4 38	6.4	12 S 106 E	Indian Ocean, Australia.
1923, Sept. 10	20 53	3.8	38 N 128 W	Pacific Ocean, United States, West Indies.
1925, Jan. 24	14 46	3.3	42 N 44 W	United States, Atlantic Ocean.
1926, Jan. 14	6 35	4.4	10 S 82 E	Cent. Africa, Sumatra, Borneo, S. America.
1927,* Jan. 3	20 29	0.1	52 S 125 W	Pacific Ocean, South America.
1927, June 29	6 32	1.0	78 N 84 E	England, Scandinavia, Siberia.
1928, May 19	13 14	...	50 S 30 E	At sunset; Antarctic Ocean.
1929, May 9	6 32	5.5	1 S 89 W	Sumatra, Malay Peninsula, Borneo.
1930,* Apr. 28	19 10	0.2	45 N 113 E	United States, Canada.
1930, Oct. 21	21 47	2.2	36 S 155 W	Pacific Ocean, Patagonia.
1932, Aug. 31	19 55	1.9	78 N 100 E	British America, United States.
1934, Feb. 14	0 44	2.0	19 N 168 E	Borneo, Celebes, Pacific Ocean.
1936, June 19	5 15	2.7	56 N 101 E	Greece, Russia, Siberia.
1937, June 8	20 43	7.3	10 N 131 W	Pacific Ocean, Peru.
1938, May 29	14 00	4.3	52 S 27 W	South Atlantic Ocean, Antarctic Ocean.
1940, Oct. 1	12 41	5.9	19 S 16 W	Colombia, Brazil, South Africa.
1941, Sept. 21	4 39	3.7	30 N 114 E	Central Asia, Pacific Ocean.
1943, Feb. 4	23 31	2.8	47 N 176 W	Yezzo, Pacific Ocean, Alaska.
1944, Jan. 25	15 25	4.4	7 S 49 W	Peru, Brazil, North Africa.
1945,* Jan 14	5 07	0.0	51 S 108 E	South Atlantic Ocean, Indian Ocean.
1945, July 9	13 36	1.4	70 N 20 W	United States, Canada, Scandinavia, Russia.
1947, May 20	13 44	5.6	2 S 25 W	Argentina Paraguay, Brazil, Cent. Africa.
1948,* May 9	2 31	0.2	44 N 138 E	Chinese Empire, Yezzo, Pacific Ocean.
1948, Nov. 1	6 03	2.2	37 S 82 E	Central Africa, Indian Ocean.
1950, Sept. 12	3 29	...	34 N 115 W	At sunset; Arctic Ocean, Siberia.
1952, Feb. 25	9 17	3.5	22 N 39 E	Central Africa, Arabia, Central Asia.
1954, June 30	12 27	2.7	62 N 5 W	United States, Canada, Scandinavia, Russia, Asia.
1955, June 20	4 12	7.3	15 N 117 E	India, Siam, Philippine Islands.
1956, June 8	21 30	4.9	40 S 141 W	South Pacific Ocean, Antarctic Ocean.
1958, Oct. 12	20 52	5.4	26 S 139 W	Pacific Ocean, Argentina.
1959, Oct. 2	12 31	3.3	23 N 6 W	Atlantic Ocean, Morocco, Central Africa, Abyssinia.
1961, Feb. 15	8 11	2.9	53 N 53 E	France, Italy, Austria, Siberia.
1962, Feb. 5	0 11	4.3	4 S 179 E	Borneo, Celebes, New Guinea, Polynesia.
1963, July 20	20 43	1.8	62 N 126 W	Alaska, British America.
1965, May 30	21 14	5.6	4 S 137 W	Pacific Ocean.
1966,* May 20	9 43	0.1	41 N 31 E	N. Africa, Greece, Asia Minor, Central Asia.
1966, Nov. 12	14 27	2.2	38 S 43 W	Chile, Argentina, Brazil.
1967, Nov. 2	5 48	...	54 S 15 W	At sunrise; South Atlantic Ocean.
1968, Sept. 22	11 09	...	42 N 90 E	At sunset; Russia, Nova Zembla.
1970, Mar. 7	17 43	3.9	25 N 88 W	Mexico, Yucatan, Florida.
1972, July 10	19 39	2.8	67 N 111 W	Alaska, British America, Labrador.
1973, June 30	11 39	7.2	19 N 6 E	Venezuela, Central Africa.
1974, June 20	4 56	5.4	32 S 107 E	Indian Ocean, Southwest Australia.
1976, Oct. 23	5 10	5.0	31 S 95 E	Central Africa, Indian Ocean, Australia.
1977, Oct. 12	20 31	2.9	16 N 127 W	Pacific Ocean, Venezuela.
1979, Feb. 26	16 47	3.0	61 N 77 W	United States, British America.
1980, Feb. 16	8 52	4.4	1 N 48 E	Central Africa, India, Chinese Empire.
1981, July 31	3 53	2.2	54 N 127 E	Russia, Siberia, Pacific Ocean.
1983, June 11	4 38	5.5	7 S 111 E	Indian Ocean, Sumatra, New Guinea, Pacific Ocean.
1984,* May 30	16 48	0.0	38 N 74 W	Mexico, United States.
1984, Nov. 22	22 57	2.2	39 S 170 W	South Pacific Ocean.
1985, Nov. 12	14 20	...	52 S 146 W	At sunrise; Antarctic Ocean.
1986, Oct. 3	18 55	...	66 N 26 W	At sunrise; Arctic Ocean.
1987,* Mar. 29	12 45	0.4	6 S 17 W	Atlantic Ocean, Central Africa.
1988, Mar. 18	2 03	4.1	28 N 146 E	Sumatra, Borneo, Philippine Islands.
1990, July 22	2 54	2.7	73 N 142 E	Russia, Nova Zembla, Arctic Ocean, Siberia.
1991, July 11	19 06	7.2	22 N 105 W	Mexico, Yucatan, Venezuela, Brazil.
1992, June 30	12 19	5.5	26 S 5 W	South Atlantic Ocean.
1994, Nov. 3	13 36	4.6	36 S 31 W	Pacific Ocean, South America, South Atlantic Ocean.
1995, Oct. 24	4 37	2.4	10 N 110 E	India, Malay Peninsula, Polynesia.
1997, Mar. 9	1 15	2.9	71 N 154 E	Central Asia, Siberia.
1998, Feb. 26	17 27	4.5	6 N 81 W	Pacific Ocean, Panama, Venezuela, Atlantic Ocean.
1999, Aug. 11	11 08	2.6	46 N 18 E	Germany, Russia, Chinese Empire, India.

* Annular Total Eclipses.

Totality, the appearance of the prominences, whether *red* or *white*, along the moon's edge, and the presence of the radiant, outspreading corona, are simultaneous. The phenomena of the earlier eclipses were recorded in the most general manner. Hasty drawings of the streamers of the corona, accompanied by descriptions reflecting but the dawn of scientific method, are the chief results. It was not until the application of the spectroscope and the photographic camera that the astronomer attained real insight into the stupendous phenomena.

The great eclipse of July 8, 1842, may be said to mark the beginning of serious and accurate attention to the complex physical features of total solar eclipses. Then the path of totality swept from Spain across France, Italy, Austria, Russia, and central Asia, and thus permitted many expert European astronomers to view and record the marvelous phenomena. It is noteworthy that in reports of this eclipse the red solar prominences were first described with precision, three large ones having been seen on the upper edge of the moon. The corona was also described as of a brilliant white luminosity and extending at least 15′ from the moon's edge. Among the many phenomena observed, the objects of special speculation were the newly discovered *red flames* or *protuberances* which Baily considered as "evidently forming a portion of the corona," and no less an authority than Airy, who had observed the eclipse through clouds, attributed to "some irregularity in the density of the cloud's edge."

The total solar eclipse of July 28, 1851, carrying the moon's shadow across Greenland, lower Sweden, and Russia, is notable as being probably the first for whose observation distinct aid was given by government authority, since with the assistance of the admiralty, the British astronomer royal, Airy, was able to conduct an important expedition to Sweden. Both the corona and the prominences were observed in greater development than in 1842, and by several observers a scarlet *sierra* or reddish arc of light was noted near those parts of the lunar disk where the rays of the sun had disappeared, or else were about to appear. The observers for the most part became certain that the prominences were true solar appendages, because they were apparently uncovered by the moon's edge on the western edge, and extinguished on the eastern limb. A precious photographic achievement was the single successful daguerreotype taken by Barowski with a telescope of 2.4 inches aperture, attached to the Königsberg heliometer, and with an exposure of 84 seconds. It distinctly pictured the corona and several prominences, and thus became the first unchallenged record of these features of an eclipse.

It was, however, at the eclipse of July 18, 1860, which traced its total path across northern Spain, the Mediterranean, and northeastern Africa, that photography was first applied with marked scientific success. Mr. Warren De la Rue, stationed at Rivabellosa with the Kew photo-heliograph, and Padre Secchi, at Desierto de las Palmas, with the Cauchoix refractor, each secured good representations of the prominences; the former also faint traces and the latter good portrayal of the corona. Comparison of these photographs set at rest, once for all, any doubt still existing as to the true solar character of the prominences. The moon was undeniably shown to pass over them, and all the speculation which had attributed these strange scarlet projections either to lunar, or to terrestrial origin, was at an end. Many sketches of the corona, or of parts of it, had been made during this eclipse, some showing its extension to fully one degree. But Padre Secchi's plates, although depicting the corona as scarcely a quarter of a degree in width, exhibited the whole of it in great delicacy of tone and as traversed by curious dark rifts. The method of making hasty sketches and drawings of the corona had, as shown by the results of this and previous eclipses, brought no end of contradiction and had permitted comparison only in some of the most pronounced features. It was therefore destined more and more to fall into discredit, and to have its results accepted only as rude and preliminary. The photographic method of attacking the problems arising in total solar eclipses was from this time firmly established. Its progressive development was determined chiefly by three elements: First, increase in the sensitiveness of the plates; second, knowledge of the exposure times required; and third, necessary advancement in practical optics. The gelatin emulsion process introduced by Maddox in 1871, and given the touch of great sensitiveness by Bennett, in 1878, secured the first. Successive failure and success, coupled with scientific method in photometric study, brought the second. And, finally, refined theoretical discussion of the principles of optics as applied to celestial photography, coupled with marked improvements in optical manufacture, supplied the third. So that now by separate and regulated exposures, with specially designed instruments, either the outer long, delicate, coronal wings may be pictured to an extreme limit, or the intensely brighter parts of the inner corona, shown with all their involved filaments and rich tracery, and with many a curious relation to the prominences and chromosphere.

The unknown nature of the brilliant red prominences, boldly projecting beyond the moon's edge during an eclipse, had for a quarter of a century remained an unaccepted challenge. And hence the first and highly successful application of the spectroscope to their study during the total solar eclipse of Aug. 18, 1868, will always be memorable. Tracing its course across the Indian and Malayan peninsulas, and affording a total phase of more than five minutes and a half, this eclipse was spectroscopically observed by Janssen, Major Tennant, Lieutenant Herschel, Pogson, and Rayet. The light of the prominences was recorded by each of these experts as consisting of several bright lines clearly indicative of the gaseous nature of those remarkable objects. The hydrogen lines C and F were certainly identified, and a yellow line, thence to figure famously in astronomy as D_3 and as due to *helium*, was too hastily assigned to sodium. Another notable result of this eclipse was the discovery, by Janssen, of a method by which the bright lines of the prominences could be observed apart from any eclipse whenever the sky was sufficiently clear. "During the total obscurity, I was struck by the vivid splendor of the light of the protuberances; the thought immediately came to me that it would be possible to see them irrespective of eclipses," his famous report begins. On the day following the eclipse he was able successfully to apply the new method; to demonstrate beyond controversy that the bright lines of hydrogen prevailed in the protuberances; and to make a third discovery always to be associated with this great Indian eclipse, namely, that of pronounced and rapid changes of form occurring in the prominences. Lockyer in England had for some time been at work on the same method for observing the bright prominence lines, and his final success was reported to the French Academy at the same meeting at which Janssen's achievements were announced. The coincidence was evidently rather determined by the progressive advancement of spectroscopic science than by accident. Huggins, who had previously indicated the theory of the Janssen-Lockyer method now suggested the widening of the spectroscopic slit as a means of disclosing the entire form of a prominence in a spectroscope of considerable dispersive power. The spectrum of the corona of this eclipse was generally observed as a faint continuous one without lines dark or bright. Rayet, indeed, noticed a certain bright line near E as extending above the prominences. The polariscopic observations of Lieutenant Campbell and Captain Branfil proved that the coronal light was polarized in planes passing through the sun's centre. The inference thus seemed doubly plain that some solar light was reflected by the corona, although the absence of the dark Fraunhofer lines required explanation.

The path of the moon's shadow during the total eclipse of August 7, 1869, lay diagonally across North America from Bering's Strait to North Carolina. The spectroscopic observations made in Iowa, at Burlington by Professor Young, and at Des Moines by Professor Harkness, established the existence of a bright green line crossing the continuous spectrum of the corona. It was estimated by the former as coincident with an iron line at 1474 of Kirchhoff's scale, or of a wave-length (λ) of 5317 ten millionths of a millimetre; and by the latter as at $\lambda 5300 \pm 14$. Professor Young's reading for the line of the unknown *coronium*, as it came to be designated, was practically that of a bright chromospheric line of approximately the same wave-length, shown by his observations some time prior to this eclipse. Young in 1876 by means of a higher dispersion proved 1474 K to be double. But it remained for the photographic records of the powerful spectrographs applied to the eclipses of 1896 and 1898 to furnish the data according to which Lockyer, Campbell, and Evershed could place the famous coronal line definitely at λ 5303 and thus separate it from its neighbor in the chromosphere.

The eclipse of December 22, 1870, trailing its path of totality over southern Spain, Sicily, and Greece, was of particular interest to the American observers who had studied that of 1869, and this resulted in the despatch of two large parties to Europe, one directed by the United States Naval Observatory and the other by the officers of the Coast Survey. If there remained any doubt as to the gaseous nature of the inner corona it was to be dissipated by the fine drawing and description of the inner corona furnished by Professor Watson of Ann Arbor, stationed at Carlentini, Sicily, and observing this gaseous shell to an elevation of about 5′; and by Professor Young's observations in Spain at Jerez de la Frontera, of the now familiar green line of coronium, visible plainly in this area, and traceable as far as 16′ from the solar limb. The bright hydrogen lines C and F and the helium line D_3 were seen projected on the moon, and also about 5′ outside of the lunar limb by Young. Plainly the light of the prominences and chromosphere must have been reflected from the earth's atmosphere, and possibly also from the corona itself, and commingled with its intrinsic radiation. This eclipse will, however, always be peculiarly famous for Professor Young's discovery of the *reversing layer* as a thin shell lying immediately above the photosphere. Kirchhoff's theory had demanded the existence of a solar atmosphere of vapors above the photosphere, which by its elective absorption should produce the dark lines of the solar spectrum. Janssen had expected to see the reversed solar spectrum in 1868, but in his notable report was obliged to say: "It must be admitted either that this atmosphere does not exist, or that its height is so meagre that it has escaped observation." Peculiarly interesting then for this time, and for the future, was Young's observation of a sudden bursting forth, at the disappearing solar edge, of innumerable bright lines having the general arrangement of the familiar dark lines of the spectrum. The existence of the reversing layer has since 1870 been repeatedly verified visually, and more recently by photographic records. The layer comprises an envelope of glowing vapors of an estimated depth of about 600 miles lying at the base of the chromosphere. Its thinness causes the bright lines to appear for but a few seconds, or as a brief *flash*, unless the observation be made at some station near the edge of the lunar shadow. Photographs of this eclipse taken by Willard in Spain, and by Brothers in Sicily, exhibited the corona as divided by the same rifts as shown in Watson's drawing, and, although differing in extent of corona depicted, markedly agreed in all details to be expected in plates exposed for different intervals and in cameras of widely different light-grasp. Incidentally the advantage of large angular aperture in a camera intended to trace the considerable extent of the corona became evident. In photographs by Brothers, at Syracuse, the corona was traceable to a height of at least 40′ above the sun's limb.

The eclipse of December 12, 1871, whose path lay across southern India, and northern Australia, was photographed with similar instruments according to a consistent plan by Davis at Baikal, and Tennant at Dodabetta, and these photographs subsequently studied with consummate skill by Ranyard and Wesley, and the delicate results reproduced in detail with masterful accuracy. (Vol. XLI., 'Memoirs Royal Astronomical Society.') Here for the first time was available a representation of the corona in all its complex glory of spaced polar rays, dark rifts, filaments straight, curved, and interlacing, and of stupendous *synclinal* structures with rich nebulous mottling. The delicate portrayal of the wet-plate process was only equaled by the scientific and artistic appreciation of Ranyard and Wesley in integrating the noble results. Double charm and value was added to the photographic achievements by the vivid and accurate descriptions of the corona at Baikal by Lockyer, at Dodabetta by Captain Herschel, and at Shoolor by Janssen. In the spectrum of the corona four hydrogen lines and 1474 K were seen both by Lockyer and Janssen, and in it the latter also found the dark line D and several faint dark lines in the green.

The eclipse of April 16, 1874, was visible only in southern Africa, and observed at Klipfontein by Mr. E. J. Stone, the astronomer royal of the Cape Observatory. He confirmed Young's observation of the reversal of the Fraunhofer lines near the photosphere, and traced the main, green coronal line to more than a degree from the moon's edge. The corona exhibited extended equatorial wings, covering in some parts more than three lunar diameters. The spectroscopic character of the corona, and its unchanged features, as viewed from different stations in Africa, led Stone to insist on the solar origin and cosmical nature of the outer corona.

The eclipse of April 6, 1875, traced its total path across Siam and French Indo-China, and in the former country was observed by Lockyer, Schuster, and Janssen, who obtained photographs of the corona showing that its extent increased rapidly with increasing times of exposure. Photographs were also secured with a prismatic camera which for the upper corona gave apparently Hγ, and for the lower parts of the corona, a strong continuous spectrum. The corona was of a type similar to that of the previous year, exhibiting a marked symmetry, and four synclinal groups making angles of more than 45° with the sun's axis.

The path of the total solar eclipse of July 29, 1878, lay diagonally across North America from Bering's Strait to the Gulf of Mexico, and afforded a memorable opportunity to many American and foreign astronomers. The direction of the line of totality across the Rocky Mountains permitted several astronomers to observe the phenomena at extraordinary altitudes. Langley on Pike's Peak, at an altitude of 14,100 feet, traced the corona in the direction of the ecliptic for a distance of at least 12 lunar diameters, and felt great confidence in saying that this, though covering a range of over 10,000,000 miles, was "but a portion of its extent." The eminent astronomer Newcomb, although observing at a lower level, Separation, Wyoming, made his very careful estimate of the length of these coronal wings "as six degrees from the disk." The polar rays and filaments of the inner corona received careful study from such experienced observers as Ormond Stone, Boss, Paul, Trouvelot, and Upton. The dry-plate photographs obtained by Professor Hall's party at La Junta, and by Professor Harkness' party at Creston, were in remarkable agreement as to the details of the inner corona, the same intensities of shading, to great delicacy, being in common, and the pronounced filamentous character of the polar rays, as well as the marked curvature and brightness of the equatorial extensions being clearly shown in both sets of plates. A photograph made by a member of Professor Holden's party by means of a small camera showed the east wing of the corona as extending 50′ from the moon's edge. It was the concurrent opinion of many observers that although the corona exhibited vast wings, it lacked, particularly in its inner portions, the brilliancy of the corona of 1869. As to the spectroscopic observations made by himself and others, Professor Young distinctly announced that they demonstrated a profound modification of the coronal spectrum; the bright lines of former eclipses, especially the 1474 K, having proved to be very faint and difficult of observation. The gaseous corona manifested, as it seemed, a pronounced sympathy and intimate relation with the eleven-year sun-spot period, giving faint spectroscopic lines at the minimum, 1878, and brilliant ones at the maximum, 1869, 1870, and 1871, of the period. Ranyard in his report on this eclipse, inspired by his recent observations and by his former masterful study of previous eclipses, made the deduction that "a greater development of the corona in the equatorial than in the polar regions is one of the characteristics of coronas which have been observed during periods when there were few sun-spots." The search made by Watson and Swift for an intra-Mercurial planet proved to be doubtful in result.

The total eclipse of May 17, 1882, visible in the Sudan, upper Egypt, and across to China, was in Egypt observed by Sir J. Norman Lockyer, Professor Schuster, Professor Tacchini, and by a French expedition equipped by M. Bischoffsheim. The photographs of the corona reproduced the form which it had in 1871, also near a sun-spot maximum, being most extended at points away from the solar equator and with no special structure at the poles. It was thus distinguished from the coronas of 1878 and 1867: near sun-spot minima, which were greatly elongated along the sun's equator and of marked structure at the poles. A striking object was a bright comet near the sun, photographed, as well as observed by the naked eye, and the first discovered on such an occasion. The spectral lines, C, F, D_3, H, and K, were observed in the corona. A photograph made by Lockyer with a prismatic camera gave continuous rings corresponding to 1474 K and D_3 for the corona. Professor Tacchini, through observations made during the eclipse on the size of the prominences, found that these appeared approximately twice as high and twice as wide at the base as the same prominences had prior to the eclipse, as observed by himself in Egypt, and by Professor Ricco at Palermo.

The eclipse of May 6, 1883, carried the track of the moon's shadow across the south Pacific. It was observed from Caroline Island, an atoll in the Polynesian group, by a number of astronomers from Europe and America. Professor Holden was in charge of the American expedition, and devoted himself to a careful search, during the long totality of 5 minutes 23 seconds, for an intra-Mercurial planet, with a negative result. Palisa of Vienna, assisted by Trouvelot, also engaged in the same search, and with like result. Professor Hastings having under view simultaneously the spectra of the eastern and of the western sides of the corona, observed the green line at beginning of totality as extending brilliantly about 12′ from the eastern limb, but fainter and about 4′ from the western limb; and at the end of totality these conditions reversed. He also saw the D line dark in the corona. Janssen, devoting himself specially to the detection of the dark Fraunhofer lines in the coronal spectrum, saw not only the principal lines, notably B, b, E, etc., "so marked that there was no possible doubt in that respect," but all told, "about 100 lines." Tacchini observed two lofty, finely silvered sheaves which he designated, *white prominences*, "protubérances blanches." He also thought he had detected the cometary carbon bands in the coronal plumes.

The eclipse of September 9, 1885, was visible on land in New Zealand only, and owing to bad weather yielded scarcely any scientific result. The corona was of a stellate character, the streamers extending in many directions. A brilliant prominence reported as *white* as well as *red* by different observers shot out near the main rift.

The eclipse of August 29, 1886, was visible in its total phase in a path extending from the Isthmus of Panama, across the Atlantic Ocean, and South Africa, to the Indian Ocean. It was observed by American, English, and Italian astronomers in the West Indies. Professor W. H. Pickering, of the Harvard College Observatory, made a valuable investigation in the photographic photometry of the corona, the result of which led Holden to employ a similar method in the two eclipses of 1889. The values obtained are given in connection with the later eclipses. The Harvard photographs of the eclipse were taken with a variety of cameras, the short exposures giving the details of the inner corona, and one, of long exposure, showing the corona as extending 90′ from the moon's limb. In the largest prominence of the eclipse, rising in a somewhat spiral form to the altitude of 150,000 miles, W. H. Pickering photographed only H and K lines with a faint trace of an ultra-violet line, while in the other prominences the hydrogen lines also were present. By means of this prominence Tacchini verified his discovery of *white* prominences and immediately announced to the Academy of the Lincei at Rome: "That during a total solar eclipse of the sun there may be seen most beautiful prominences not visible in full sunlight; that the prominences visible only during totality are white, especially in their more elevated parts, and have a special filamentous character, the threads being thin, long, and blunt at the top; that the luminous intensity of the white prominences is feeble, and for this reason they are not visible to the naked eye, unless their height surpass that of the more brilliant parts of the corona; and that the other prominences visible in full sunlight appear much wider and higher in a total eclipse, and, when of considerable height, have their summits white." Captain Darwin, using an instrument designed by Huggins for testing the possibility of obtaining photographs of the corona at other times than during eclipses, secured negative results. Schuster's photographs of the coronal spectrum showed many lines which on comparison with those of 1882 exhibited a great alteration in intensity. The hydrogen lines were visible in the corona only in the parts overlying strong prominences, while the H and K lines, though elsewhere visible, were stronger on the side of the corona having many prominences at its base. A drawing of the corona by W. H. Wesley, and one of the richest products of this eclipse, is based on seven negatives by Maunder, and five by Schuster, and exhibits a stellate distribution of the streamers.

The eclipse of August 19, 1887, whose line of totality lay across Russia and Japan, was notable for the extensive and complete preparations made to observe it, and for the general failure through cloudy weather. In this disappointment shared Struve's plan of measuring the precise ratio of the apparent lunar and solar diameters by means of a series of co-operative observations along the northern and southern boundaries of the shadow. A comparison of photographs of the corona taken at Petrovsk, Russia, and those taken two hours later at Youmeyi-yama, Japan, was probably too careless to prove the supposed displacement of one of the streamers.

The total eclipse of January 1, 1889, was visible in a path that lay across California and Nevada, and was successfully observed by many American astronomers. The photographs taken are notable alike for the fine detail of the inner parts of the corona registered, and for the immense extent of the streamers imprinted. A particularly fine negative by Barnard permitted Holden to trace rays similar in typical character to the polar rays all round the limb of the sun and to present a detailed study of the filamentous character of the corona. Professor Holden also drew the conclusion that: "Coronal forms seem to vary periodically as sun-spots and auroræ, and the coronas of 1867, 1878, and 1889 are of the same strongly marked type"; thus confirming Ranyard's previous deduction. Professor Charropin's negatives disclosed the corona out as far as 100′ or more, and confirmed many of Barnard's delicate details in the filaments and the trumpet-shaped extension of the outer corona. The outlines of the coronal wings were shown in the photographs of Ireland and Lowden as far as 135′ and 165′ respectively. Señor Valle was able to trace the streamers, with the naked eye, to a distance of more than three degrees. The coronal spectrum was characterized by simplicity and consisted of few lines other than those of coronium and hydrogen.

The eclipse of December 22, 1889, was observed by Burnham and Schaeberle at Cayenne. South America, and by Father Perry in the Salut Islands, French Guiana. This devoted astrono-

Photographic Photometry of the Solar Corona	August 1886 Pickering	January 1889 Holden	December 1889 Holden
Intrinsic actinic brilliancy of the brightest parts of the corona	0.031	0.079	0.029
Ditto of the polar rays	......	0.053	0.016
Total actinic light of the corona	37.	60.8	26.2
Ratio of total coronal to total sky light (actinic)	1 to 1400	1 to 3043	1 to 1285
Ratio of intrinsic brilliancy of the brightest parts of the corona to that of the sky (actinic)	44 to 1	16 to 1	32 to 1
Magnitude of the faintest star shown on the eclipse photographs	......	2.3	......

mer died, a few days after the eclipse, from the exposure to the dangerous malarial climate. The American and English expeditions at Cape Ledo, Africa, experienced cloudy weather. The main results of the measures in the photographic photometry of the corona made by Professor W. H. Pickering in 1886, and those deduced by Professor Holden from the eclipses of January and December 1889 are based on a standard giving fairly comparable results, and are presented in the preceding table. The photographs of January 1889 are the only ones of the group taken in a clear sky, and this the photometric results clearly indicate.

From a thorough study of his photographs of the eclipse of 1889, Prof. Schaeberle published 'A Mechanical Theory of the Solar Corona,' in which he holds that the "corona is caused by light emitted and reflected from streams of matter ejected from the sun by forces which, in general, act along lines normal to the surface of the sun; these forces are most active near the centre of each sun-spot zone." "The perspective overlapping and interlacing of the streamers cause the observed apparent variations in the type of the corona." From a study of his plates of the eclipse of 1893 he so modifies his theory as to conclude that the stream lines of the corona coincide with "elliptical arcs having one focus at the sun's centre; the origin of the streams being, in the main, confined to the spot-zone regions." Professor Schaeberle applies his theory to the location of half a dozen solar areas productive of the actual streamers photographed in the eclipse of 1893. Whatever the merit of the particular theory, it has had the advantage of pointing out the importance of dynamical and spatial study of the coronal streamers.

The eclipse of April 16, 1893, traced its course of totality from Chile northeast across South America and the Atlantic Ocean into West Africa. It was observed both in Africa and Brazil by English and French astronomers. At Mina Bronces, Chile, Professor Schaeberle, of the Lick Observatory, as Bigelow and Davis in 1889 at Cape Leds, employed a long focus telescope (5 inches aperture and 40 feet focal length) in the photography of the corona. This he set up in the direction of the computed place of the eclipsed sun and obtained notable delineation of the protuberances and the corona near the solar limb. A comet formed a fairly conspicuous feature of the corona on Professor Schaeberle's plates. Professor Hale, from a detailed comparison of photographs of the prominences made in full sunlight by himself at Chicago, and of eye-tracings made by Fényi at Kalosa, with those taken during this eclipse by Schaeberle in Chile, and by Fowler at Fundium, Africa, demonstrated the resemblance of the prominences as photographed in the K line to those of the eclipse, and marked differences in those as seen in Hα. Professor Hale also indicated that the *white* prominences probably appear so from the intense character of the H and K light. Prismatic cameras of considerable light-grasping power were used by Fowler in Africa, and Shackleton in Brazil, and from a comprehensive discussion of the photographs, Lockyer concluded that the spectrum of the corona in 1893 consisted, besides that of coronium with a wave length of 5303, of at least seven rings of $\lambda\lambda$ 3987; 4086; 4217; 4231; 4240; 4280; and 4486, which had also been seen in slit spectroscopes in 1886 and at other eclipses. The H and K lines, as well as those of hydrogen and helium, seen hitherto in the corona, by a number of observers, must therefore be attributed to a scattering of the prominence light by the earth's atmosphere, and possibly by the corona itself but not to the intrinsic coronal light. The English photographs also permitted the determination of the wave-lengths and intensity of several hundred chromosphere and prominence lines. Abney and Thorpe made photometric observations of the corona which disclosed a close agreement with those made by them in 1886, and indicated a brightness of the corona not dissimilar in both eclipses. Deslandres sought to determine the rotation of the corona by photographing its spectrum on both sides of the sun, but through his use of the H and K lines only, his result, of a speed almost equal to that of the solar surface and corresponding to a distance of 20′ from the limb, cannot be regarded as conclusive. De la Baume Pluvinel photographed at least 15 Fraunhofer lines in the coronal spectrum, and thus confirmed Janssen's previous observation. The form of the corona was described by several astronomers as that peculiar to the epoch of the maximum of sun-spots. Bigourdan explored the neighborhood of the sun for intra-Mercurial planets with negative result.

The eclipse of August 9, 1896, was visible in its total phase in Norway, Nova Zembla, and northern Asia. Notwithstanding the unfavorable character of the weather, excellent photographs were secured by Baden-Powell and by several Russian astronomers. The report of Hansky on the fine photographic results led him to a clear exposition of the relations of the forms of the corona to the sun-spot period, which has won marked attention and approval. His general prediction of the form of the corona of the eclipse of 1900, as made in his memoir, has been verified. Belopolsky adds another dynamical conception of the corona, in that he infers that, by the general eruption at the sun-spot maximum, matter is ejected into the surrounding corona and thus communicates its higher speed of rotation to the outer corona so that gradually the polar regions are laid bare and by the time the minimum sun-spot period arrives the coronal figure has broadened out into vast equatorial extensions. Both Russian and British photographs show some of the prominences with dark borderings or outlines, and in the former these veins suggest the dark interstices of a series of hoods above the prominences. Shackleton, with signal success, photographed the spectrum of the *reversing layer*, and demonstrated the coincidence of many of the lines with the Fraunhofer spectrum. It was thus for the first time that Professor Young's observation was photographically confirmed.

The path of the total eclipse of January 22, 1898, lay across east central Africa, India, and the Chinese empire. The eclipse was successfully observed by many astronomers and furnished a great wealth and variety of photographic material. Campbell, of the Lick Observatory, in the Crocker eclipse expedition to Jeur, India, employed an objective-grating spectograph which was so arranged as to give a continuous photographic account of the changes in the solar spectrum at second and third contacts. Many interesting results of differences of level and of intensity of radiation in the lines were obtained. An exposure for the coronal ring at λ5303 gave it in a very remarkable form which shows its principal masses to lie in the sun-spot zones. Professor Campbell also found that the source of the continuous spectrum of the corona had the same form as the monochromatic ring just mentioned. It is from the results of this eclipse that Campbell, and later Evershed, deduced the wave-length 5303 for coronium, now universally accepted. The British results obtained with the large prismatic cameras permitted Lockyer to give the wave-lengths of 45 coronal rings arranged in three groups defined by the position angle in which they have their greatest brightness. The different forms of the coronal rings seemingly indicate that they are due to at least three substances whose typical wave-lengths are at 5303, 3987 and 4359. A table of wave-lengths of more than 900 lines in the spectrum of the chromosphere resulted from the photographic spectra. With a small prismatic camera Evershed obtained highly valuable results. His spectra gave measured values of 29 of the hydrogen lines closely agreeing with the values computed by Balmer's formula. A remarkable band of continuous spectrum shown by the prominences and lower chromosphere and beginning in the ultra-violet end of the Balmer hydrogen series (see SPECTROSCOPY), he attributes also to hydrogen. In the flash spectrum the position of almost all the bright lines appears to coincide with dark lines in the solar spectrum, but the relative intensities of the lines in the two spectra are widely different. The dissimilarity in the relative intensities of lines of different elements in the two spectra is attributed to the unequal heights to which the gases of the various elements ascend in the chromosphere, and Mr. Evershed hence concludes, that «the wide divergence between the flash and Fraunhofer spectra with respect to intensities, would appear, therefore, to afford no ground for abandoning the original interpretation of the flash proposed by Young from his observation in 1870, and the evidence of these photographs certainly indicates that the flash does in fact represent the upper, more diffused portion of a true reversing stratum.» Professor Campbell's Jeur photographs of the corona made with the 40-foot telescope show a great wealth of detail. One of two seconds' exposure, clearly indicates the ultimate relation of the prominences with the synclinal structure of the corona; another, of eight seconds, gives a fine representation of the polar rays and rifts with a coronal form already clearly influenced by the approaching sun-spot minimum. Professor Burckhalter, using a special appliance for regulating the relative exposure given to the inner and outer portions of the corona, obtained a good representation of its entirety, which, however, still showed over-exposure for the inner details. A fine photographic representation of the four principal streamers of the corona was obtained by Mrs. Maunder, which showed them to distances from the moon's centre of three, four, four and a half, and six diameters respectively.

The total solar eclipse of May 28, 1900, will always be famous for its long course through civilized territory, its path crossing the United States from Texas diagonally to Virginia, and finally threading its way across Spain. It is chiefly memorable for the fine weather which prevailed along the track of totality, and for the magnificent array of optical and physical appliances employed in its observation. The chief American parties were those of the Lick, Yerkes, Allegheny, Smithsonian, Princeton, Brown, Harvard, and United States Naval observatories, conducted respectively under the direction of Campbell, Hale, Wadsworth, Langley, Young, Upton, W. H. Pickering, and S. J. Brown. Long focus telescopes either directly pointed at the sun or fed by cœlostats for coronal photography, huge Rowland grating spectrographs for photographing the flash, and the delicate bolometric appliances of Hale and of Abbot characterized the instrumental attack. The large photographs of the corona by Campbell with telescope of 40 feet focus, directly pointed, by Barnard with lens of 61.5 feet focus, and by Smillie with lens of 135 feet focus, gave a fine representation of the inner corona and prominences. The great prominence in the southwest quadrant was a mass of filaments. Its white summit in eruptive activity was visually observed by the writer. Striking changes in this prominence and in others are seen on comparing the American photographs with those of Christie, the astronomer royal, taken at Ovar, Portugal, and of Lockyer, taken at Santa Pola, Spain, about two hours later. The study of the form of the corona as presented by the photographs was of special interest since Professor Bigelow's precise forecast seemed in the main to be verified when compared with Jewell's fine drawing reproducing the corona from photographs. Already in 1891 Bigelow had computed the direction of the coronal streamers for the corona of 1878 and for the two coronas of 1889 on a «polarization theory» in which the coronal lines were shown to lie in the direction of the lines of force surrounding a spherical magnet. Such magnetization of the sun, although suggested, was then not necessarily assumed. The progress of physical science later made it probable that matter on the solar surface was electrically ionized after the manner of the cathode streams of the Geissler tubes. And these electrified particles, or electrons, required then only to be directed by a supposed magnetic field of the sun. Bigelow's «Magnetic Theory of the Corona,» supported by Eberts' experiments, seems likely both from the natural assumptions made, and from the deductions allowable, to furnish the master-key to the mysteriously definite arrangement of the corona at the sun's minimum of activity, so characteristic of the eclipses of 1900 and 1901. The modifications yet necessary to account for all the probable solar phenomena as pointed out by Bigelow, Schaeberle, Scheiner, Ebert, Perrine, Abbot, Arrhenius, Dr. Lockyer, and others cannot be foreseen, but it seems likely that we are rapidly approaching conceptions which will correlate not only all coronal, but all solar phenomena satisfactorily. Professor Burckhalter, by means of his method of regulating the relative exposure of inner and outer parts of the corona, attained remarkable success in photographically depicting the details of the entire corona.

The spectroscopic observations were manifold and in the main successful. Professor Frost, of the Yerkes Observatory, operating with a prismatic camera of very high dispersion, and two grating spectrographs, photographed and measured some 800 lines. He regards spectra of the cusps taken within 30 seconds of the contacts, and as produced by the powerful instruments he employed, as valuable as those taken at the precise instant of contact. A red sensitive plate was exposed to the coronal spectrum by Professor Frost, and registered rings at λλ 4230, 4341, and 4358. Professor Lord, employing a prismatic camera, obtained excellent photographs of the flash, which enabled him to determine the accurate wave-lengths of several hundred chromospheric lines. Professor Wadsworth's photography of the flash spectrum by means of a concave grating objective spectroscope of special type induced his thorough investigation of the optical theory of such appliances which ranks among the very choicest results of the memorable eclipse of 1900. Indeed, Wadsworth's masterful discussions are inseparable from the proper estimate of results of previous observers and furnish a trustworthy guide for future spectroscopic work, of a high degree of accuracy, in eclipses. Sir Norman Lockyer, observing in Spain, determined the wave-lengths of many prominence lines and the heights of the various chromospheric vapors. His comparison of the green coronal ring with the inner and outer corona showed that there is no apparent connection between the points of greatest brightness of the coronal rings and the positions of the prominences, and that the brightest parts of the green coronal ring correspond intimately with the brightest parts of the inner corona, but are not in apparent relation with the outer corona. Professor Evershed, observing in Algiers, just outside of the path of totality, obtained photographs of the flash spectrum in high solar latitudes, and concludes that, in its main features, it is the same as in low latitudes. He verifies the essential identity of the flash spectra as photographed by Shackleton in 1896 and those obtained in 1898 and 1900, and infers that "the flash spectrum is probably as constant a feature of the solar surface as is the Fraunhofer spectrum." In discussing the detailed spectroscopic results of the flash layer, Evershed infers that the abnormal intensities of the enhanced lines characteristic of all levels and all latitudes of the flash is due to a continuous circulation of the solar gases in a radial direction, while the cooler, more diffused gases, in their subsidence, determine the character of the absorption spectrum. His final conclusion is "that the flash spectrum represents the emission of both ascending and descending gases, while the Fraunhofer spectrum represents the absorption of the descending gases only." Professor Deslandres, by means of spectrographs with optical parts of Iceland spar and quartz, photographed the entire ultra-violet spectrum of the reversing layer from λ 4000 to λ 3000, the entire ultra-violet spectrum of the upper chromosphere, and the entire spectrum of the corona with two new coronal rings. Deslandres, observing visually with a powerful grating, inferred from the inclination of the green coronal line on the east side of the equator that the corona appeared to have a more rapid rotation than the disk. He remarked the feebleness of the green line characteristic of minimum solar activity. Professor Dyson, of the Portugal expedition of Christie, the astronomer royal, with spectroscope of quartz lenses and prisms, obtained a fine series of spectra of the sun's limb near the beginning of totality, and spectra of the corona. Professor Turner secured photographs, in polarized light, of the corona, permitting of a quantitative investigation. The polarization of the corona was radial and was "not only shown in the outer streamers, but right up to the moon's limb." An important bolometric measure of the heat of the corona was conducted by Abbot and Mendenhall, of the Smithsonian Observatory, which led to the conclusion that the corona neither reflects much solar light nor in the main gives light of its own on account of high temperature, "but seems rather to be giving light in a manner not associated with a high temperature, or at least with the preponderance of infra-red rays usual in the spectra of hot bodies." This result plainly points to the electrical character of the coronal light and is also in harmony with Bigelow's magnetic theory. Deslandres, using "a very sensitive Melloni pile" for detecting the heat of the corona, reports positive indications which are in strange contradiction with Abbot's results and intensify the regret at the accident which befell Hale's bolometric appliances at the critical moment. The heat measures in future eclipses will have an exciting interest in relation to coronal theory. The shadow bands were perhaps more systematically observed at this eclipse than at any other. The United States Weather Bureau carried out an extensive system of observation from which Professor Bigelow drew the conclusion that "the shadows were crescent-shaped and had a flickering motion, as if struggling through two or more conflicting movements in the atmosphere itself." Professor Elihu Thomson, observing at Barnesville, saw the bands "curved and broken, not complete lines," and immediately after totality, two sets of bands moving in opposite directions "as if due to opposing air currents at different altitudes." As a further confirmation that the bands are due to different air currents, the larger bands were seen to move in the direction of the wind. The different sets of shadow bands are probably produced by the shifting refraction due to the waves of warm and cool air at the different altitudes.

The total eclipse of May 18, 1901, traced its path across southern Madagascar, the Indian Ocean, Sumatra, Borneo, the Celebes and New Guinea, and, on account of its long duration of over six minutes and the high altitude of the sun at the best points of observation, attracted expeditions from the Netherlands, the United States, Great Britain, France, Russia, and Japan. The general weather conditions unfortunately proved to be unfavorable. At a few of the eclipse stations, however, observations of great value were made. Professor Perrine, observing at Padang, Sumatra, through a partly clear sky, obtained excellent results. His photographs showed "conspicuous series of coronal hoods," and also "a remarkable coronal disturbance resembling an inverted cone of considerable angle" and unlike anything previously recorded. This disturbance associated with a long thread-like prominence, Professor Perrine, subsequently, by means of the Greenwich solar negatives taken at Dehra Dûn, India, traced to a sun-spot and associated faculæ, near the solar limb on the day of the eclipse, and thus plainly exhibited faculæ, prominences, coronal disturbance, and sun-spots in a common origin and intimate relation. This wonderful phenomenon was without doubt due to a solar eruption which took place near the solar limb and at, or just prior to, the time of the eclipse. The spectrographs specially designed and prepared for photographing the delicate Fraunhofer lines of the corona by Professors Campbell and Wright proved very efficient in the hands of Perrine and gave a band of continuous spectrum for the inner corona, 35 Fraunhofer lines between $H\beta$ and H for the outer corona, and bright H and K lines extending entirely across the moon's disk, as well as 40′ east of the sun's limb. The latter indicates clearly that prominence radiation is diffused in the earth's atmosphere. The photographs of Mr. Peters, of the United States Naval Observatory, taken at Fort de Kock, Sumatra, confirm Perrine's results as to the formation of hoods or envelopes above some of the prominences, and are replete with structural detail. The corona, according to Perrine's photographic negatives, was polarized in the portions 10′ beyond the solar limb in all position angles including the polar regions. In negatives of the English astronomer, Newall, some of the streamers showed greater extension in the polarized than in the unpolarized light.

The spectroscopic results of this eclipse were not unimportant. Dr. Humphreys used a concave grating of 30 feet focal length without slit or lens and was able to present accurate wave-lengths of nearly 400 lines in the chromosphere, assign their intensity and character, and identify the substance in most cases. Hydrogen, helium, and the H and K light, generally attributed to calcium, but by Trowbridge to oxygen, gave arcs showing a height 34″, or greater than the solar diameter. Humphreys' investigations point to "a very extensive distribution of the elements in the chromosphere with no narrow separating boundaries producing distinct layers of any kind," and show that "in general the heavier and, only the heavier, Fraunhofer lines appear as bright lines in the flash, and that the relative intensities in the two cases are roughly comparable." Dr. S. A. Mitchell, using a Rowland flat grating of 15,000 lines per inch and a quartz lens, secured measures on some 480 bright lines for the flash at third contact. The theory of Sir Norman Lockyer that lines stronger in the spark than in the arc spectrum, known as "enhanced" lines, are found in the spectrum of the chromosphere, has been critically examined by Dr. Mitchell, by means of the spectroscopic data furnished by his photographs, and he concludes, "From these comparisons it would seem that there is no close connection between 'enhanced' lines and the bright lines of the chromosphere seen in the flash." In the special work on the corona contemplated by Professor Barnard's long exposure of a very large plate, and by Dr. Abbot's second attempt to measure the coronal heat bolometrically, there was universal interest among astronomers and universal regret at the compulsory postponement to a future eclipse on account of the clouds. A photographic search for an intra-Mercurial planet was conducted by Perrine using four lenses covering a stretch of 19° on either side of the solar equator. The faintest stars on the plates range from 6.5 to 9.3 visual magnitude, and Perrine infers that "unless at the time of the eclipse the planetary bodies were directly in line with the sun or with the brightest portion of the corona, there is no planetary body as bright as 5.0 visual magnitude within 18° of the sun, whose orbit is not inclined more than 7¼° to the plane of the sun's equator."

Bibliography.— The general theory of eclipses and the methods for their computation have been developed by Bessel in the 'Astronomische Nachrichten,' Nos. 151 and 152, but with the utmost rigor in his 'Astronomische Untersuchungen,' Vol. II.; and by Hansen in 'Astronomische Nachrichten,' Nos. 339–342, and in complete treatment in 'Abhandlungen der math., phys. Classe der Königlich Sächsischen Gesellschaft der Wissenschaften,' Vol. IV. The most reliable general tables for the computation of eclipses are those of Newcomb, 'Astronomical Papers of the American Ephemeris,' Vol. I. Oppolzer's 'Syzygientafeln für den Mond' (Publication der Astronomischen Gesellschaft, XVI.), and his 'Tafeln zur Berechnung der Mondesfinsternisse' (Denkschriften der K. Akademie der Wissenschaften zu Wien, Vol. XLVII.), are based on Hansen's 'Lunar Tables' and are employed in the production of that rich storehouse of eclipse knowledge: Oppolzer, 'Canon der Finsternisse,' published as Vol. LII. of the 'Denkschriften' of the Vienna Academy. It contains the elements of 8,000 solar and 5,200 lunar eclipses occurring between the dates —1207 Nov. 10 (Julian) and 2161 Nov. 17 (Gregorian), and the accompanying charts show the approximate path of each eclipse on the earth's surface. A valuable accessory to Oppolzer's 'Canon' is found in Dr. R. Schram's 'Tafeln zur Berechnung der näheren Umstände der Sonnenfinsternisse,' published in Vol. LI. of the Vienna 'Denkschriften.' Dr. Eduard Mahler, in Vol. XLIX. of the Vienna 'Denkschriften' has published valuable elements and tables entitled 'Die Centralen Sonnenfinsternisse des XX. Jahrhunderts.' Ginzel, in the 'Sitzungsberichte' of the Vienna Academy, LXXXV., LXXXVII., and LXXXIX., and in his 'Spezieller Canon der Finsternisse,' published by the Berlin Academy, has brought together a large array of references to ancient eclipses, and compared them with computation. The papers of Airy, Williams, Maguire, and S. J. Johnson in the 'Monthly Notices' of the Royal Astronomical Society are of interest. The physical data and problems of total solar eclipses are treated in a vast modern literature mostly issued by the observatories and learned societies. A highly important compend of physical information concerning total solar eclipses is that of Ranyard, 'Memoirs of the Royal Astronomical Society,' Vol. XLI. For the later eclipses the most valuable discussions are to be found in the publications of the United States Naval, Harvard, Lick, Yerkes, and Smithsonian observatories, in the 'Astronomische Nachrichten,' the 'Memoirs,' and the 'Monthly Notices' of the Royal Astronomical Society, and in the 'Astrophysical Journal.'

Monroe B. Snyder,
Director of the Philadelphia Observatory.

Eclip'tic, in astronomy, the sun's path, the great circle of the celestial sphere, in which the sun appears to describe his annual course from west to east. The Greeks observed that eclipses of the sun and moon took place near this circle; whence they called it the *ecliptic.* The sun does not always rise to the same height in the meridian, but seems to revolve round the earth in a spiral, and is in the equator twice a year, about 22 March and 22 September. The points of the equator in which the sun is on these days are at the intersection of the equator with the ecliptic. On 21 June the sun reaches its greatest height in the heavens, and 21 December it descends the lowest. The ecliptic has two poles, 90 degrees from it, which appear to revolve about the north and south celestial poles, respectively, every 24 hours. What appears to be the path of the sun, however, is in reality the path of the earth. The planets and the moon revolve in different planes; but these are inclined at only a very small angle to the plane of the ecliptic: hence these bodies can be but a small distance from the ecliptic. The plane of the ecliptic is very important in theoretical astronomy, because the courses of all the other planets are projected upon it and reckoned by it. By the obliquity of the ecliptic we understand its inclination to the equator, or the angles formed by the planes of these two great circles. This angle is measured by the arc of a third great circle, drawn so as to intersect the two others perpendicularly, in the points at which they are farthest apart. The ancients endeavored to measure the obliquity of the ecliptic. According to Pliny, it was first determined by Anaximander; according to Gassendi, it had been ascertained by Thales. The most celebrated measurement of this obliquity in ancient times was made by Pytheas, at Marseilles. He found it, 350 B.C., to be $23° 49' 23''$. A hundred years later, according to Ptolemy, Eratosthenes found it to be $23° 51' 13''$. In 1900 the obliquity was $23° 27' 8''$; it is diminishing at the rate of nearly half a second a year, and is expected to reach a minimum value of $22° 15'$ in about 15,000 years. See DAY; NUTATION.

Eclogite, ĕk'lō-jīt, or **Eklogite,** a crystalline rock composed of the grass-green amphibole called smaragdite, and red garnet. Another variety of eclogite is composed of omphacite, a grass-green granular variety of pyroxene, and garnet. Eclogite is not an abundant rock; it is usually associated with the older crystalline schists, but as a rule is not itself schistose. It is found in Norway, Greece and in parts of the German empire.

Eclogue, ĕk'lŏg, in poetry, the name is given to poems of the same form; thus the satires of Horace were called eclogues. Since Virgil's Bucolics received this name (from grammarians probably, and not from the poet), the term eclogues has usually been applied to what Theocritus called idyls — short, highly finished poems, principally of a pastoral nature. See IDYL.

Ecole des Beaux Arts, ā-kōl dā bō-zär, (School of Fine Arts), the French government school in Paris, founded by Mazarin in 1648, and provided with an extensive staff of teachers. The competitions for the *grands prix de Rome* take place at this school. All artists between the ages of 15 and 25, whether pupils of this school or not, may compete, after passing two preliminary examinations. The successful competitors receive an annual allowance from the state for three or four years, two of which must be passed at Rome.

Ecology. See BIONOMICS; PLANT GEOGRAPHY.

Economic Association, American, organized 1885 for the encouragement of economic research, the publication of economic monographs and the encouragement of perfect freedom of economic discussion.

Economic Development of the United States. See UNITED STATES — ECONOMIC DEVELOPMENT OF THE.

Economic Entomology. See ENTOMOLOGY, ECONOMIC.

Economics. See POLITICAL ECONOMY.

Economists, a name given to certain French writers of the 18th century, who maintained that agriculture is the only fountain of wealth, and therefore clamored for a land tax. Persons versed in the science of political economy, as Malthus, an English economist. Also applied to officers in some cathedrals in the Church of Ireland, who are appointed to manage the cathedral fund, to make payments, etc.

Economy, Pa., village in Beaver County, on the Ohio River, and Pittsburg, Ft. W. & C. R.R.; 20 miles northwest of Pittsburg. The first settlements were made by a colony of «Harmonists» who had formerly lived in Pennsylvania, then moved to Indiana, but returned and founded Economy in 1825. Pop. 1,062. See HARMONISTS.

Ecrevisse, ā-krĕv-ēs, **Peter,** a Flemish novelist: b. Obbicht, Limburg, 1804; d. 1879. In 1860 he withdrew from a promising political career and devoted himself to literature. He is noted for his power of description and his simple earnest style. Among his numerous historical novels may be mentioned: 'The Destruction of Maestricht'; 'The De Witt Brothers.' He was author also of some novels of society: 'The Cancer of Cities'; 'The Stepson'; 'The Servingman of Kempen.'

Ecrévisse. See CRAYFISH.

Ec'stasy, a state of consciousness, in which the natural powers or faculties are transcended by absorption in a fixed object or idea beyond normal cognition. In its theological aspect the term ecstasy is generally used as equivalent to rapture. Distinction should be made between true religious ecstasy and its simulations. Saint Thomas Aquinas, the great theologian of the Middle Ages, says that it may arise from three causes; first, bodily, as when a person is alienated from his senses by disease; secondly, it may be preternatural, as when it is wrought by the agency of devils; and lastly, and this is the case of true religious ecstasy, when it comes from the Spirit of God. Many instances of this latter are recorded in the Old and the New Testaments, and we also have accounts of this supernatural phenomenon in the lives of the Saints. Mystical writers describe this state as the complete suspension of the senses, the body being, as it were, dead, while the will, as Saint Teresa points out, retains its full power and is completely absorbed in God. Ecstasy arising from disease is described in the terms of modern science as a "condition of the nervous system and mind characterized by immobility, suspension of normal sensory and motor functions, and rapt concentration upon a limited group of ideas." There is little question but that ecstasy of this latter kind is a manifestation of the hysterical temperament. It is closely allied to hypnotism, catalepsy, trance, etc. Consult Maudsley, 'Pathology of Mind'; Tuke, 'Dictionary of Psychology'; Janet, 'Mental State of Hystericals'; Baldwin, 'Dictionary of Philosophy and Psychology' (1901); Mantegazza, 'Estasi Umane' (1887); James, 'Varieties of Religious Experience' (1902).

Ecthyma, ĕk-thī'ma, a complication of a number of general disorders manifesting itself as a form of pustular inflammation of the skin, particularly distributed on the extremities, the lower especially, the neck and trunk also often being affected. As a rule the affection begins as a small pimple which takes a rounded outline unless scratched. This pimple developes into an ulcer which is covered over with a thick dark crust. The ulcer heals slowly and there is a small scar resulting. The development of the disease is slow, usually running a fortnight, and the pimple may be single or appear in crops. There is burning and pain. The common cause of ecthyma is diminished bodily resistance, such as is found in starvation or in syphilis, tuberculosis, diabetes or anæmia. The common organisms causing the actual pustulation are streptococcus and staphylococcus. The initial injury is often brought about by scratching due to the bites of some house-pests, or the itching of diabetes, or senile itching, or some form of local skin irritation. Soap and water, good food, and antiseptic dressings, such as hydrogen peroxide, nitrate of silver, and sulphur ointment, are usually sufficient, with proper general hygiene, to bring about a cure.

Ec'toderm. See EMBRYOLOGY.

Ectozo'a, animals parasitic on the outside of living bodies, as distinguished from *Entozoa*, animals parasitic within them. Both terms are general and have no taxonomic significance.

Ectro'pion, or **Ectropium,** a Greek term meaning an everted eyelid, a turning outward; an abnormal eversion of the eyelids.

Ecuador (properly, *La Republica del Ecuador*: The Republic of the Equator), a country of South America. According to the claims of its own government, it is bounded on the east by Brazil, extending from the Pacific Ocean, at lon. 82° 55′ W., to lon. 72° 12′ W., and from lat. 1° 50′ N. to lat. 5° 30′ S., but nearly all of the region east of the Andes is claimed by Peru, and the boundary with Colombia is also in dispute (see COLOMBIA). Therefore, it is bounded on the north and northeast by Colombia, and on the southeast and south by Peru, according to the adverse views entertained by those competing governments. The area in its actual possession is about 120,000 square miles; the total area, if we include disputed territory and the archipelago of Galápagos, is nearly 276,000 square miles.

Political Divisions.—The country is divided into 16 provinces (counting as one the undefined eastern region), as follows: (1) Province of Pichincha, including the *cantones* of Quito, Cayambe, and Mejia. Its chief town, also capital of the republic, is Quito, with 80,000 inhabitants: seat of the central government, the archbishopric, the university, the supreme and superior courts, etc. (see below, *Judiciary*), headquarters of army corps, general commanding district, and superintendent of police. Quito's principal buildings and institutions are: The palaces of the president, of the archbishop, of the government, of the School of Arts and Trades, and of justice; city hall, university, three seminaries, astronomical observatory, Institute of Sciences, Medical School, two chemical laboratories, two museums of natural history, two botanical gardens, 33 churches with convents, six additional convents, four colleges, three schools for young women (116 schools in the canton), five public libraries, six asylums, two houses of refuge, two houses of correction, five cemeteries, four barracks and an arsenal, two public promenades, five squares with statues, the Sucre Theatre (which holds 2,000 spectators), and two banks. There are 16 journals. Industries of the province are: cattle- and sheep-raising, manufacture of cloth, candles, cheese, chocolate, etc. There are 22 mills. The embroideries and laces made by the women of Quito are famous. The city, built on the flank of the mountain which gives its name to the province, has beautiful suburbs; thanks to its elevation above sea-level (9,250 feet), the climate is temperate. The Alameda is a fine park, planted with oaks, eucalyptus, and other large trees. (2) The province of Carchi: principal town Tulcan (5,000 inhabitants), residence of the governor, police commissioner, commander of the military force of province, and municipal authorities. Industries are: cattle-raising and the cultivation of cereals in the higher and middle (temperate) regions. The products of the lowlands are sub-tropical — sugarcane, etc. (3) The province of Imbabura. Its chief town, Ibarra, which was destroyed by the earthquake of 1808, has now 5,000 inhabitants. It is the residence of a bishop, in addition to the civil and military authorities located in every province — those mentioned under Carchi. Principal buildings are the palace of the government, Roman Catholic schools, churches, and convents. Products of the region are cereals, sugarcane, cotton, and cattle. (4) Province of Léon: its principal town, Latacunga, has 12,000 inhabitants. Products are as given in 2 and 3; there are also potteries. The highest active volcano in the world, Cotopaxi (19,614 feet) is in this province. (5) Province of Tungurahua: the principal town, Ambato, has a population of 8,000. Special products of the region are wine, porcelain, and hats. It includes the Tungurahua volcano. (6) Province of Chimborazo, with five *cantones*. The principal town, Riobamba, which was destroyed by an earthquake in 1799, has 12,000 inhabitants. A leading product is cinchona, or Peruvian bark. The mountain which gives its name to this province is often called "the king of the Andes," though it is not equal to the highest peaks in Bolivia. (7) Province of Bolívar, a salt-producing region; chief town Guaranda (6,000). (8) Province of Cañar, with gold-mining as one of its industries; principal town Azogues (4,000). Ruins of a palace dating from the period of Inca supremacy are found in this province. (9) Province of Azuay: its principal city, Cuenca (q.v.), with 30,000 inhabitants, is a centre of literary and artistic life in the republic. (10) Province of Loja: its principal town, also called Loja, has 10,000 inhabitants. This province adjoins Peru, and its boundary with that country is disputed. It contains the ruins of the palace of Villamarca. (11) Province of El Oro, which has gold mines at Zaruma, and produces cacao and coffee on the lands along the Pacific coast. There are also fisheries. Chief town Machala, with 3,200 inhabitants. (12) Province of El Guayas, of which Guayaquil (pop. 60,000) is the commercial metropolis. The local authorities are: the governor, bishop, municipal council, general commanding the troops of the district, chief of police, justices of the superior court and judge of commerce, the consular corps, and the superintendent of the custom-house. Noteworthy buildings or institutions are: the city hall, palaces of the governor, bishop, and commanding general, cathedral, seminary, nine churches, several chapels, municipal library, civil and military hospitals, schools of medicine and law, university, chemical laboratory, national college, a ladies' philanthropic society, a school of arts and crafts, Convent of the Sacred Heart School for Young Women, orphan asylum, Olmedo Theatre, circus, etc. There is a statue of the poet Olmedo in the avenue which bears his name, and an equestrian statue of Bolivar in Seminario Park. A dozen newspapers are published in the city. Products of the region are: cacao, coffee, sugarcane, cereals, cotton, rubber, vegetable ivory or corozo, construction and cabinet woods, articles manufactured with sugar, tropical fruits, cattle, horses and mules, tobacco, beer, artificial ice, and mineral waters, chocolate, liquors, alcohol, soap, candles, hats, hammocks, and several varieties of fish. There are two banks of issue and a savings bank, four clubs and German and Spanish casinos. Guayaquil was partly destroyed by fire in 1896, but has been rebuilt. It has improved in appearance, and perhaps also in the matter of sanitation; yet it has not a good reputation for healthfulness. The climate is very hot. The city is lighted by gas, and has potable water, the source of supply being in the cordillera. (13) Province of Los Rios: its chief town, Babahoyo, has 3,000 inhabitants. (14) Province of Manabi; principal towns Portoviejo (5,000) and Jipijapa (6,000). The finest of the so-called "Panama" hats are made exclusively in Ecuador, especially in Jipijapa. Other products of this region are sarsaparilla, vanilla, and pearls from a small island. (15) Province of Esmeraldas, where tobacco is grown that is comparable with the Cuban product. Population of the chief town, also called Esmeraldas, about 6,000. (16) The vast, insufficiently explored Oriental province, with settlements at Napo, Archidona, Tena, and Canelos, and Indian tribes, the Jibaros, etc. A governor and chief of police represent the authority of the republic. Chapels have been built, and missions established. The soil is supposed to be uncommonly fertile, and it is watered by large rivers. (17) Galápagos Archipelago (q.v.), now called the Archipelago of Colón by some Ecuadorian writers who wish to create the impression that it is an attractive field for immigration. It was formerly a penal settlement, and was especially used as a place of banishment for political offenders. The population of Chatham Island was said to be about 2,000 in 1900; the other islands are nearly uninhabited. The authorities are the territorial governor, a priest, and a military commander. Products: the giant tortoises (Spanish, *galápagos*), whalebone, etc.

Topography and Physical Geography.— The cordilleras of the Andes traverse Ecuador, running nearly north and south, with elevated plains between the eastern and western mountains — some of the latter forming a sequence that has suggested to geographers two parallel chains; and it is, indeed, true that the eastern and western limits of the broad band of Ecuadorian upland roughly parallel each other. (See CORDILLERAS.) There are four facts of special interest: First, Though we do not find here the highest single peaks in the world, or even in South America, there are nowhere else so many peaks of very great height, forming a group. Second, their equatorial situation gives to these masses of granite, gneiss, schist, trachyte, porphyry, and volcanic detritus wholly exceptional contrasts in temperature (see below, *Climate*). Third, this region has been in the past, and is probably today, more subject to volcanic disturbances than any other in South America. Fourth, as an offset to the group of high peaks, the Andean ridges sink downward, forming the lowest pass that exists at any point between Colombia and the southern end of the continent. The principal rivers of the lowlands of western Ecuador, running from the central region of mountains and high plains to the Pacific, are the Guayas and the Esmeralda. The former empties into the Gulf of Guayaquil, one of the best harbors on the western coast of South America. In the eastern lowlands, the Napo and its tributaries belong to the Amazon River-system.

Mineral Resources.— Salt, mineral pitch, and gold are produced. The Zaruma mines, province of El Oro, were reported as being worked on an extensive scale in 1903. That district contains numerous gold-bearing quartz veins, which were worked by the Spaniards 100 years ago.

Climate.— The mean temperature of the coast at Guayaquil, etc., is 28° C.; that of the interior ranges from 35° C. in the lower valleys to 18° or even 10° C. on the plateaus, according to the altitude. The lower slopes of the mountains are torrid; the highest crests are snow-clad. The climate of the capital is temperate and spring-like throughout the year, with little variation, and it is said to be one of the best in the world for the cure of tuberculosis. (See also CUENCA.) There are two seasons only, the rainy and the dry.

Agriculture.— The cultivated area is limited, owing to the lack of laborers; nevertheless Ecuador produces more cacao than any other country, and not a little coffee. These products, with sugarcane and tobacco, are found in the lowlands of the coast and Amazon basin: cereals and vineyards in the elevated valleys. (See also *Political Divisions* for products of the different provinces.)

Exports and Imports.— In 1901 the total value of exports was 16,392,333 *sucres*, and the total value of imports for the year 15,126,281 *sucres* (value of *sucre*, $0.487). On the import list of the country the United States ranks first, Great Britain second, and Germany third. Imports from the United States in the fiscal year 1901 were valued at $2,015,085; exports to the United States $1,424,840. Shipments of cacao form Ecuador in 1901 amounted to 23,179,095 kilograms, showing a marked increase over those

1. Old Church at Quito.

2. A Pass in the Andes; Guayaquil and Quito Railway.

of 1900. Ecuador exported in 1900 through the port of Guayaquil 1,733 tons of coffee, with a value of $121,500. Imports are: cloth (cotton, woolen, silk), foodstuffs, boots and shoes, oils, alcohol, wines and liquors, beer, mineral waters, preserved and fresh fruits, and live-stock.

Railways, etc.— Sixty miles of the railway from Guayaquil to Quito were built before 1880, that is, from the coast to the village of Chimbo, at the base of the cordillera. There the enterprise was checked by the difficulties of construction. A company organized in the United States undertook to complete the road, and by 1903 had succeeded in laying rails from Chimbo to Guamote, on the plateau, a distance of 58 miles. There are 1,221 miles of telegraph, with 50 offices. The Ecuadorian landing-station of the Central and South American Telegraph Company's cable is at Salinas, which was declared open as a minor port by executive decree 21 Aug. 1902. Quito and Guayaquil have telephone services; the latter a street-car system. The mails are carried twice a week to all parts of the republic; to foreign countries once a week. Twenty passenger steamers ply on the Guayas River, and between Guayaquil and the other coast towns. English steamships of the Pacific line, and vessels of the Chilean line plying between Valparaiso and Panamá call regularly at Guayaquil.

Banks.—(At Guayaquil and Quito: see *Political Divisions.*)

Government.— Congress meets at Quito every two years, usually on 10 Aug., for 60 days. There are two chambers: the senate (two senators from each province; term, four years) and the chamber of deputies (one deputy for each 30,000 inhabitants; term, two years). Both senators and deputies are elected by direct popular vote. Eleven constitutions have been promulgated since 1830; that of 12 Jan. 1897 is now in force. The president and vice-president of the republic are elected for four years by direct vote of the people; they cannot be re-elected until eight years have passed after expiration of their terms of office. The president cannot go out of the country, either during the continuance of his functions or for a year after they have ceased. There were formerly five ministries, but the number has been reduced to four, namely, those of the interior, police, and public works; foreign relations, public instruction, justice, and worship; finance; and war and navy. The council of state is a body composed of the vice-president of the republic, the ministers, two officials of the law courts, the rector of the university, two senators, two deputies, and two citizens not holding other office. Governors of provinces are agents of the executive, appointed by the president; agents of the governors are the "political chiefs"; and agents of the latter are "political lieutenants," one for each parish, who have the rural authorities under their charge.

Finances.— The budget for 1902 showed the following sources of revenue for the government: customs 9,640,700 *sucres* (the chief items being, duties on imports with surtax 6,400,000, and duties on exports with surtax 1,800,000 *sucres*); receipts from industries controlled by the government, that is, salt and powder, 450,000 *sucres;* sundry taxes 2,868,804.25; public lands, etc., 423,000 *sucres;* and leases 36,000 *sucres.* Disbursements were: congress 111,780 *sucres;* the president of the republic 43,632 *sucres;* the vice-president 9,600 *sucres;* council of state 1,500 *sucres;* department of interior, police, and public works 3,603,168 *sucres;* department of foreign relations, etc., 2,168,034 *sucres;* department of finance 2,821,694.32; department of war and navy 3,691,502.18; additional public works 1,068,802.80 *sucres.* Total disbursements 13,319,764.30; surplus 98,739.95 *sucres.* The foreign debt, chiefly a relic of loans contracted by the old republic of Colombia, at the time of the union of Ecuador, Venezuela, and New Granada, was approximately $3,355,000 in 1901; the internal debt is much larger. The gold standard has been adopted in accordance with the law of 4 Nov. 1898.

Army and Navy.— In time of peace, the army consists of: infantry, about 3,690 men; artillery, 1,362; cavalry, 468; national guard (on paper), 95,329. The national guard includes companies of firemen — organizations which are especially numerous and influential in Guayaquil. The naval vessels are, one torpedo boat and a transport.

Population.— The boundaries of the republic being in dispute, and a large part of Ecuador's claim being unexplored territory, estimates of the total number of inhabitants vary, naturally. The Ecuadorians usually say about 1,500,000, including uncivilized Indians.

Education.— Primary instruction is gratuitous and obligatory for children between 6 and 12 years of age. Among the subjects taught, beside the familiar elementary branches, are morality and religion, and urbanity. In the boys' schools the constitution of Ecuador is added; in those for girls, sewing and domestic economy. In 1900 there were more than 80,000 pupils in the public schools, as compared with 47,913 in 1885. The number of schools increased from 789 in 1885 to nearly 1,250 in 1903. Secondary instruction is provided in 37 "colleges," with 371 professors and 4,500 students; the school year beginning 10 October and ending 30 July. The university at Quito — with associate universities at Cuenca and Guayaquil, has faculties of philosophy, belles-lettres, law, medicine, physical and natural sciences, mathematics, and agriculture. An officially authorized publication states that "a large number of primary and secondary schools have been confined hitherto [before 1900] to the religious orders, who have acquitted themselves of their task with zeal and success." Schools of arts and crafts are found in the provinces of Pichincha, Léon, Chimborazo, Azuay, Loja, and Guayas. Bahia has a commercial school.

Literature.— José Joaquín de Olmedo (b. Guayaquil 1780) and Juan Montalvo (b. Ambato 1833) are esteemed by loyal Ecuadorians, the former the greatest poet, the latter the greatest prose writer, of South America. Ecuador was also the birthplace of José Mejía, the "American Mirabeau," and of many historians, theologians, poets, romancers, and critics whose works are as highly regarded in Spain as in America. The Ecuadorian Academy (founded 1875) is the chief of the literary associations of the republic. Liberty of the press is guaranteed by the constitution. In painting and music the progress is less noteworthy.

Judiciary.— Ecuador's courts are: the supreme court, at Quito (five justices, attorney-general, two secretaries); superior courts at Quito, Guayaquil, Cuenca, Riobamba, Loja, and

Portoviejo; court of account, at Quito (seven judges); municipal civil tribunals of the first instance at Quito, Guayaquil, and Cuenca; fiscal judges for each province; judges of commerce in large towns; judges of mines, police, and parishes. In criminal cases, trial by jury is provided for, but only in the larger towns.

Local Government.— This is controlled, as we have shown, by the central government. Chief towns of *cantones* have municipal councils, commonly of five members. There are rural (mounted) and urban police, with a director or chief in each provincial capital.

History.— The Quito Indians, who held the country near the present capital, were conquered, perhaps in the 10th century, by a more warlike race led by chiefs called Scyris. These in turn yielded to the Incas of Peru. On the death of Inca Huayna-Capac, the empire was divided between his two sons, Atahualpa and Huascar. The former, whose mother was a Scyri princess, revived the Quito kingdom; Cuzco and the southern empire were given to the latter. War broke out between the brothers shortly before the Spaniards under Francisco Pizarro arrived upon the scene, and this civil strife made possible the conquest of a great nation by a handful of adventurers (see Cuzco and Peru). Benalcazar, the famous Spanish captain, completed the conquest of the Scyri kingdom, and seized the city of Quito (1534). Between 1564 and 1820 this region was administered as a presidency; and 36 presidents exercised authority there as representatives of Spain before the series of "presidents of the republic" began. Quito's first demonstration in favor of independence, 10 Aug. 1809, was quickly and savagely repressed; Guayaquil was more fortunate in her belated attempt (9 Oct. 1820). A campaign which resulted in the capture of Quito, after the battle of Pichincha, was organized by a triumvirate whose members were the poet José Joaquín de Olmedo, mentioned above, the merchant, F. Roca, and the soldier, Rafael Jimena. The battle of Pichincha was won for the patriots by the Venezuelan general, Antonio de Sucre, Bolivar's lieutenant: the territory thus liberated was naturally drawn into the Colombian federation, which Bolívar dominated for a time (see Colombia). In 1830, after the dissolution of that greater Colombia, Ecuador was constituted as an independent republic. The convention of Riobamba placed Gen. Juan José Flores at the head of the government. His successor (1835–9) was Vicente. Flores was again in power from 1839 to 1845, and, with the approval of many partisans, tried to secure a much longer term and dictatorial powers. A second triumvirate, composed of Olmedo, Roca, and Noboa, carried on the government until a convention was held at Cuenca. This convention elected Vicente Ramón Roca, who served as president from 1845 to 1849. Vice-President Acásubi assumed the presidency when congress and the country could not agree upon a candidate: the country, however, continued to be disturbed until 1851, when Diego Noboa was chosen by a constituent assembly. In the following year he was displaced by Gen. José María Urvina, at the head of a successful revolution. Urvina was president until 1856. Slavery was abolished during his term. Gen. Francisco Robles followed (1856–9). During the next two years the country had a varied experience: war with Peru, the dictatorship of Gen. Franco, and the provisional government of Gabriel García Moreno. The convention of Quito elected García Moreno to the presidency (1861–5). Jerónimo Corrion, elected in 1865, retired in 1867. Javier Espinosa served from 1868 to 1869. García Moreno, as the leader of an insurrection, took office again (1869–73), and in 1873 secured re-election by the use of force. He was assassinated 6 Aug. 1875. Antonio Borrero, his successor, was driven from office by Gen. Ignacio de Veintemilla in 1876. After the expiration of the legal period, President Veintemilla made himself dictator. José María Placido Caamaño was president from 1884 to 1888; Antonio Flores from 1888 to 1892; Luis Cordero from 1892 to 1895 — when he resigned to put an end to bloodshed. Gen. Eloy Alfaro, at first "supreme chief," was legally elected in 1897. Gen. Leonidas Plaza succeeded him in 1901.

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Marrion Wilcox.

Eczema, ĕk'zĕ-ma, an acute or chronic disease of the skin, showing a vast variety of changes in the skin itself, and accompanied by intense itching, burning, or pain. The changes in the skin at first are usually marked by redness, papules, then small vesicles or pustules which later become crusted and dry; or the surface is weeping. Infiltrated and scaly patches are common. All of the different forms of eczema (and no less than a dozen varieties are described by skin specialists) have certain definite changes occurring in the skin. There is usually swelling, congestion, and increase of temperature locally. There is almost invariably an exudation of fluid into the tissues, with the formation of vesicles and pustules, as described. There is further a certain amount of plastic exudation which produces in the skin papulous areas that are thickened and infiltrated. Finally there are the subjective symptoms of itching, which may be only a slight tingling or prickling sensation, or may be so intense as to demand continued and deep scratching, until bleeding or oozing takes place. This itching is, as a rule, intermittent in character, being almost invariably worse at night when the patient is covered, the heat of the body causing the aggravation. Sometimes exposure to cold brings about intense itching. The disease usually runs an acute course, and may be limited to one region of the body, or may be general. Its general tendency is to progress rather than to get well. It is perhaps one of the most obstinate of all skin diseases, and at the same time one of the most difficult to diagnose and to treat. The treatment of each case is a particular study. Sometimes the disease is beyond the power of the best skin specialist. At other times corrections of minute errors in diet will bring about cure. So far as household remedies are concerned, only those that can relieve the itching are deserving of notice in this place. One of the best of these is carbolic acid in weak solution — two to three per cent. This may be applied on a bit of absorbent gauze. Special care being taken not to enclose a particular part completely with the weak carbolic acid. Bland non-irritating powders such as calamine and oxide of zinc are often useful. When the disease becomes chronic it is apt to be extremely obstinate.

Edam, ē'dăm, Holland, town 12 miles north-northeast of Amsterdam, and about a mile from the western shore of the Zuyder-Zee, with which it is connected by a canal. This place is chiefly noted for its trade in cheese, of which nearly 1,000,000 pounds are annually sold in its market. (See CHEESE.) The town was once fortified, and has still a wall with seven gates. Pop. 6,444.

Edar, India, a Rajput state of Guzerat in the Mahi Kantha agency, tributary to the Guicowar of Baroda, and subject to the political superintendence of the presidency of Bombay. It has an area of about 4,966 square miles, and an estimated population of 260,000. Its capital, a picturesque town of the same name, contains 6,300 inhabitants.

Edda, ĕd'a, the name of two of the most important mythological works handed down to us from the Teutonic middle age. One is called the Elder, the Poetic, or Sæmund's Edda. The other is called the Younger, the Prose, or Snorre's Edda. As a matter of fact the name Edda belongs only to the latter, that is Snorre's work, but the name belongs to the other as a result of long custom and to abandon it now would cause confusion. The Elder Edda was evidently collected from the mouths of the people in the same manner as Homer's 'Iliad,' and there is a similar uncertainty in regard to who put it in writing. It has generally been supposed that the songs of the Elder Edda were collected by Sæmund the Wise (born 1056, died 1133), but it has been proved that the work was not put in writing before the year 1240. There are thirty-nine poems in the Elder Edda, all dealing with the mythology and Volsung stories of the olden North.

The Younger Edda is written by Snorre Sturlason, the author of the famous 'Heimskringla' (born 1178, died 1241) and is mainly in prose and may be regarded as a sort of commentary upon the Elder Edda. It is a presentation of Scandinavian mythology and cosmogony as understood by Snorre.

Translations of both the Eddas are found in nearly all modern languages. Both are published in one volume in Norrœna Library, edited by R. B. Anderson.

Eddy, Henry Turner, American educator: b. Stoughton, Mass., 9 June 1844. He was graduated at Yale College in 1867. He was assistant professor of mathematics and civil engineering in Cornell University 1869–73; professor of mathematics, astronomy and civil engineering in the University of Cincinnati 1874–90; president of the Rose Polytechnic Institute, Terre Haute, Ind., 1891–4; in the last-named year accepting the chair of engineering and mechanics in the University of Minnesota. His publications include: 'Analytical Geometry' (1874); 'Researches in Graphic Statics' (1878); 'Thermodynamics' (1879); 'New Constructions in Graphic Statics' (1880, in German); 'Maximum Stresses Under Concentrated Loads,' etc.

Eddy, Mary Baker Glover: b. Bow, N. H. The world's highest meed of praise is eventually bestowed upon those who have made the largest contribution to its spiritual good, and it is in the light of this fact that the honored place of Mrs. Eddy's name, in the annals of the race, is unqualifiedly assured. The prominence in public thought which she has already attained, as the Discoverer and Founder of Christian Science, and the tender love which glows for her upon the altars of unnumbered hearts, find their explanation in the ministry of good which she has brought to her fellowmen.

Born in the town of Bow, N. H., her youth was spent in sympathetic touch with that picturesque beauty of nature for which the region is famed. Mrs. Eddy's great-grandfather, Captain Joseph Baker, was a man of honored reputation and bore a commission conferred by the Provincial Assembly. Her father and grandfathers were sturdy husbandmen who served God and their country as best they knew, and fostered in their children the elements of a noble character. The intellectual tastes and assertive strength of her father, and the piety and loving winsomeness of her mother, were united in her nature, and one who knew her intimately in her girlhood has spoken of her as being distinguished even then for "her superior ability and scholarship, her depth and independence of thought, and her spiritual-mindedness," all of which were but prophecies of her character, her ministry, and eminence as a religious leader.

She was a student of Sanbornton Academy, and later pursued her studies under Prof. Dyer H. Sanborn, and her brother Albert, who was a gifted and scholarly man. At 16 her fertile pen, as well as her ceaseless inquiry and investigation, began to disclose that impelling and insatiable instinct of the poet and truth-seeker which in later years was to achieve such beneficent and far-reaching results. In all the years which were revealing to her the vanity and unsatisfactoriness of earthly hopes, she was seeking, in the quiet cloisters of spiritual aspiration, for that revelation of truth which would bring her heart assurance and peace. Unaccompanied save by patient and unfaltering faith, she followed that ascending path which leads from the plane of common experience to the higher levels of spiritual apprehension, and in an hour of hopeless physical suffering she reached such a realization of the present healing potency of the Master's word that she was immediately made whole. Mrs. Eddy's life since this epoch-making experience and discovery in 1866 has been devoted to that interpretation of the teaching of Jesus, and the practical application of its saving truths to human need, which she has denominated Christian Science.

Her great work, 'Science and Health with Key to the Scriptures,' was published in 1875, and has now reached its 280th edition. This is the text-book of Christian Science, embodying not only its teaching, but the practical rules by which every sincere inquirer may avail himself of its benefits. She has written and published many other works relating to Christian

Science, including ‘Miscellaneous Writings,’ 471 pp.; ‘Retrospection and Introspection,’ 120 pp.; ‘Pulpit and Press,’ 132 pp.; ‘Unity of Good,’ 80 pp.; ‘Rudimental Divine Science,’ 35 pp.; ‘No and Yes,’ 55 pp., and many other pamphlets, poems, annual messages to the Mother Church, etc. She has organized and conducted the movement, established its periodicals and educational system, and as leader, lecturer, teacher, editor and counselor has accomplished a work whose magnitude, substantiality, and success are a marvel to men.

The First Church of Christ, Scientist, the “Mother Church,” in Boston, Mass., was chartered in 1879, and the church edifice was completed in 1895. Its present membership is about 28,000. Seven hundred and sixty-five Christian Science churches and societies, many of them provided with splendid church edifices, are now found in America, England, and other countries.

Mrs. Eddy has ever been known as a very generous and public-spirited woman. Her public and private benevolences have been large, amounting to hundreds of thousands of dollars. She recently gave $100,000 toward the erection of an adequate Christian Science church in her native town.

Beloved and honored by all who know her, Mrs. Eddy lives in modest retirement at her country home in Concord, N. H., where, with unabated vigor and untiring devotion, she continues to direct that beneficent movement with which her name will ever be associated.

John Buckley Willis,
2nd Ed. C. S. Publications, Boston, Mass.

Eddy, Richard, American Universalist clergyman: b. Providence, R. I., 21 June 1828; d. Gloucester, Mass., 16 Aug. 1906. During the Civil War he served as chaplain of the 60th New York Volunteers 1861–3. From 1877–1906 he was president of the Universalist Historical Society. He was editor of ‘The Universalist Quarterly Review’ (1884–91) and of the Universalist Register’ from 1887. He published: ‘History of Sixtieth New York State Volunteers’ (1864); ‘History of Universalism in America 1836–86’ (1884–6); ‘Alcohol in History’ (1887); ‘Alcohol in Society’ (1888); ‘Universalism in Gloucester, Mass.’ (1892); ‘History of Universalism A.D. 120–1890’ in American Church History series (1894); and ‘Life of Thomas J. Sawyer, D.D., and Caroline M. Sawyer’ (1900).

Eddy, Thomas, American philanthropist: b. Philadelphia, Pa., 5 Sept. 1758; d. New York 16 Sept. 1827. He entered the insurance business in 1790, in which he made a large fortune. With Philip Schuyler and Ambrose Spencer he presented a bill for establishing a penitentiary system in 1796, which was passed. He had charge of erecting the first building and for four years was its director. In 1793 he was appointed by the Society of Friends to visit the Indians in New York State; was one of the governors of the New York Hospital; and in 1815 one of the founders of the Bloomingdale Insane Asylum. He was also one of the originators of the New York Savings Bank and the New York Bible Society, and a conspicuous promoter of the Erie Canal. He received the title of the “American Howard” for these labors, and in 1801 published ‘State Prison of New York.’

Eddy, Thomas Mears, American clergyman: b. Newton, Hamilton County, Ohio, 7 Sept. 1823; d. New York 7 Oct. 1874. He studied in the classical seminary of Greensboro, Ind., and joined the Indiana Methodist conference in 1842. He was editor of the ‘Northwestern Christian Advocate’ from 1856 to 1868; served as pastor in Baltimore for three years; was appointed to the Metropolitan church in Washington, D. C., in 1872, and in the same year he was elected corresponding secretary of the Methodist Missionary Society. He was eminent as a journalist and was an author of no mean ability. Among his works was a ‘History of Illinois during the Civil War’ (2 vols. 1865).

Eddy Currents are short local currents set up in the iron masses of dynamo electric machinery; according to the law of Lenz they absorb a part of the energy expended in running the machine. The usual way of preventing them is to construct the parts affected, namely, the pole pieces and the armature cores, of laminæ built up so that the mass of the iron is divided by planes in a direction perpendicular to the direction of the electromotive forces tending to start the eddies.

Eddystone Lighthouse. The frequent shipwrecks on Eddystone rocks off the coast of Cornwall, England, led to the erection of a lighthouse on them by Henry Winstanley in 1696–1700. It was a wooden polygon, 100 feet high, with a stone base; but the great storm of 20 Nov. 1703, completely washed it away, with the architect. Another lighthouse was built in 1706–9, also of wood, with a stone base, and 92 feet high, by Mr. Rudyerd, a silk-mercer. This erection was burned in 1755. The next, noted for its strength and the engineering skill displayed in it, was constructed by Smeaton in 1757–9, on the model, it is said, of the trunk of the oak tree. It was built of blocks, generally one to two tons weight, of Portland oölite, encased in granite. The granite was dovetailed into the solid rock, and each block into its neighbors. The tower, 85 feet high, had a diameter of 26¾ feet at the base and 15 feet at the top. The light, 72 feet above the water, was visible at a distance of 13 miles. As the rock on which this tower was built became undermined and greatly weakened by the action of the waves, the foundation of another was laid on a different part of the reef in 1879. The new lighthouse, completed in 1882 by Sir James N. Douglass, is, like its predecessor, ingeniously dovetailed throughout. Its dioptric apparatus gives, at an elevation of 133 feet, a light equal to 159,600 candles, and visible in clear weather to a distance of 17½ miles. See Eddystone Rocks; Light-House.

Eddystone Rocks, well known to seamen who navigate the English Channel, consisting of three principal ridges, and extending 600 or 700 yards in length. They lie nearly in the fair way from the Start to the Lizard, and are therefore an object of the utmost importance to mariners. On the summit of the largest rock a lighthouse has been erected, to serve as a beacon or signal to avoid the danger, as they are covered at the flood tide, but become dry at the ebb. It is situated 15 miles south-southwest of Plymouth, 45 east of Lizard Point; lon. 4° 16′ W.; lat. 50° 10′ 54″ N. The swell at these rocks is tremendous. After a storm, when the sea is to all appearance quite smooth, and its surface unruffled by the slightest breeze, the ground-swell or under-current, meeting the slope of the rocks, often causes the sea to rise above the lighthouse in a magnificent manner, overtopping it as with a canopy of foam. See EDDYSTONE LIGHTHOUSE.

Edelfelt, ā'dĕl-fĕlt, **Al'bert Gus'tav A'ristid,** Finnish painter: b. Helsingfors, Finland, 21 July 1854. He began his artistic studies at Antwerp and afterward became a pupil of Gérôme, in Paris, where he developed a high skill in draughtsmanship, in the department of genre and portrait painting. He gained a second medal in the Paris Salon of 1882, and a medal of honor in the Paris Exposition of 1889. Two of his pictures have been purchased by the French nation for the Luxembourg.

Edelinck, ā'dĕl-ĭnk, **Gerard,** Flemish engraver: b. Antwerp 20 Oct. 1649; d. Paris 2 April 1707. He was patronized by Louis XIV., and produced over 420 plates.

Edelweiss, ĕd'ĕl-wīs, Ger. ā'dĕl-vīs ("Noble-white"; *Gnaphalium* or *Leontopodium alpinum*), a perennial plant of the order *Compositæ*, growing at great altitudes in the Alps, the Pyrenees, and also in parts of Austria and Siberia. Its flower is white and somewhat star-shaped, the heads surrounded with a characteristic woolly involucre, and its leaves also having the same woolly character. It is comparatively scarce; generally grows in inaccessible positions; is eagerly sought by Alpine tourists, and has become so rare in some of the Swiss cantons that it is protected by law. The supposed difficulty of gathering it is the groundwork of various legends and poems; as the emblem of purity, it is given by the Tyrolese youth to his affianced bride. It is not difficult to cultivate and is found in American and European gardens, but is apt to lose its distinctive woolly character under cultivation.

Edema. See DROPSY.

Eden, Emily, English novelist and traveler: b. Old Palace Yard, Westminster, 3 March 1797; d. Richmond, England, 5 Aug. 1869. Among her works are: 'Portraits of the People and Princes of India' (1844); 'The Semi-detached House' (1859); 'The Semi-attached Couple' (1860).

Eden, SIR **Robert,** last proprietary governor of Maryland: b. Winderstone Hall, Durham, England; d. Annapolis, Md., 2 Sept. 1784. As captain in the Coldstream Guards he served in the Seven Years' war. He was appointed governor of Maryland in 1768, where he remained until 1776, when that State committed itself to the principles of the Revolution, and virtually declared the proprietary governorship at an end. He left in an English warship, but returned a few months before his death. See Steiner, 'Life and Administration of Sir Robert Eden.'

Eden, William. See AUCKLAND, WILLIAM EDEN, LORD.

Eden, the garden of paradise. It would be difficult in the whole history of opinion, to find any subject which has so invited and at the same time so completely baffled conjecture, as the Garden of Eden. The three continents of the Old World have been subjected to the most rigorous search; but no locality which in the slightest degree corresponded to the description of the first abode of the human race has been left unexamined. Philo Judæus (flourished about 20) first broached the allegorical theory of interpretation, teaching that paradise shadowed forth the governing faculty of the soul, and that the tree of life represented religion, the true means of immortality. Origen, adopting a somewhat similar view, regarded Eden as heaven, the trees as angels, and the rivers as wisdom; and Ambrosius considered the terrestrial paradise and the third heaven, mentioned by St. Paul (2 Cor. xii. 2–4), as identical. Luther taught that Eden was guarded by angels from discovery and consequent profanation until the Deluge, when all traces were destroyed. Swedenborg, who regarded the first 11 chapters of Genesis as constituting a divine allegory, taught that Eden represented the state of innocence in which man was originally created and from which he degenerated in consequence of the Fall. The account given in Genesis of the situation of Eden is not such as to enable us to identify it with any existing locality. It is said to have had a garden in the eastern part of it, and we are told that a river went out of Eden to water this garden, and from thence it was parted into four heads, which were called respectively Pison, Gihon, Hiddekel, and Euphrates (Phrat). The Pison is said to compass the whole land of Havilah; the Gihon that of Ethiopia (Cush); and the Hiddekel to go toward the east of Assyria. Of the rivers mentioned the Phrat of the original seems to have been correctly identified with the Euphrates, and the name Hiddekel appears elsewhere in Scripture (Dan. x. 4) to be applied to the Tigris; but it is impossible to say what rivers or places were meant by the names Pison, Gihon, Havilah, and Cush. See ADAM.

Eden, a river in England, rising in a hill in Westmoreland, near the northwest boundary of Yorkshire; flows northwest, passing Appleby and Carlisle, and empties into the Solway Firth. Total course, about 50 miles.

Eden of America, a name bestowed on the island of Aquidneck, off the coast of Rhode Island, on account of its great fertility.

Edenhall, the ancient seat of the Musgraves in Cumberland, four miles northeast of Penrith, England. Here is still preserved the famous "Luck of Edenhall," an old painted glass goblet, said to have been snatched from the fairies, on the safety of which the welfare of the house depends. It is supposed to have been a chalice, and its leathern case bears a sacred monogram. Uhland's well-known ballad, 'The Luck of Edenhall,' has carried its fame beyond the British islands.

Edentata, ē-dĕn-tā'ta, one of the smaller orders of mammals, most of which are found in South America. It includes the South American sloths, ant-eaters, and armadillos, and two Old World groups, all of which are characterized by an absence of front teeth, and in a few instances, of completely toothless jaws, whence the generic name. Where teeth are present they are without enamel, and lack distinct roots, are all alike, and generally are not preceded by a set of milk teeth. These animals are ranked comparatively low in the scale of mammals, not only on account of their deficiency in teeth, but also because their brains are relatively small, and lack the convolutions characteristic of the more highly developed orders. With two exceptions, the armadillos and pangolins, the Edentata are clothed with coarse hair. The armadillos are peculiar among mammals, in that their bodies are covered with an armor of bony plate; and in the pangolins the entire body is protected by a coat of overlapping, horny scales. The typical edentates are the sloths (*Tardigrada*), the ant-eaters (*Vermilinguia*), and the armadillos (*Loricata*), all of which are American; the two groups in the order, native to Africa and Asia, are the pangolins (*Squamata*), and the aard-varks (*Fodientia*), although Lydekker questions the correctness of placing the last two among the edentates, preferring to consider the present and extinct forms as an entirely American order. The sloths live on vegetable food exclusively, the other group chiefly on insects or animal matter softened by decay.

Fossil Edentates.— Of the large and numerous edentate fauna which lived in South America during the Tertiary and Quaternary periods, some (Mylodon, Megalonyx, Glyptodon) spread to North America during the Pliocene and Pleistocene epochs; the armadillo is still found as far north as the Mexican border of the United States. Their earliest ancestors were, perhaps, North American, but their development was exclusively in the southern continent during most of the Tertiary Period. The earlier stages in their evolution were of small or moderate size; later on they became of huge size and very highly specialized. The most remarkable among them were the *Megatheriidæ* of the *Bruta* order, ground-sloths, distantly related to the modern true sloths, but terrestrial animals, very heavily proportioned, with massive hind quarters and tail, and immense digging claws; and the *Glyptodonts*, related to armadillos but much longer, with massive unjointed carapace like that of a tortoise, and with hoofs instead of claws. Besides these were numerous true armadillos, both large and small, some ancestral to the modern species, others of extinct races. No fossil ant-eaters have yet been discovered, and fossil tree-sloths are almost equally unknown; but the fossil beds of South America have been so imperfectly explored that this fact is not surprising.

Edenton, N. C., town, county-seat of Chowan County; on the Albemarle Sound, near the mouth of the Chowan River; on two branches of the Norfolk, Va., B. & S. R.R.; about 90 miles north of Beaufort and 115 miles northeast of Raleigh. Four steamship lines enter Edenton, thus making it a good shipping point for the trade of the northeast part of the State. The shallow waters of the Albemarle Sound are a hindrance to more extensive shipping. The name given to the town when founded in 1712 was Queen Anne's Creek, but this was changed to Edenton in honor of a governor of the colony, Charles Eden. In less than one year after the "Boston Tea Party" a number of the housewives of Edenton resolved not to assist in supporting England by paying a tax on tea; and they formed themselves into an organization, none of whose members should drink tea. In addition to being first among those who held Revolutionary tea parties, they seem to have been pioneers in America in the formation of organizations for women. The chief industries are lumbering and fishing. Pop. 3,210.

Eder, ā'dĕr, **Joseph Maria,** Austrian chemist: b. Krems on the Danube 16 March 1855. He taught photo-chemistry at the Technical School, Vienna, and 1882 was made professor of chemistry at the Industrial School in that city. He has made great contributions to the development of the art of photography, particularly with reference to the use of chloride or bromide of silver. He also invented a photometre for measuring the invisible ultra violet rays by the oxalate of mercury. Among his works are: 'Photographie aux sels de chrome'; 'Etudes sur l'action de la lumière colorée' (1879); 'Manuel de photographie' (1882).

Edes, Robert Thaxter, American physician: b. Eastport, Maine, 23 Sept. 1838. He was graduated at Harvard 1858, and at the Harvard Medical School 1861; served as surgeon in the United States navy 1861–5; was professor of materia medica 1870–84; and professor of clinical medicine 1884–6 at the Harvard Medical School. He was physician at the Boston City Hospital 1872–86, and at the Garfield Memorial Hospital, Washington, 1889–91, and resident physician at the Adams Asylum 1891–7. Among his works are: 'Nature and Time in the Cure of Diseases' (1868); 'Physiology and Pathology of the Sympathetic or Ganglionic Nervous System' (1869); 'Therapeutic Handbook of the United States Pharmacopœia' (1883); 'Therapeutics and Materia Medica' (1887); and many contributions to medical journals at home and abroad.

Edes'sa, the name of two ancient cities. (1) The ancient capital of Macedonia, and the burial place of its kings, now Vodhena. It is probably the same with the still more ancient Ægæ. (2) An important city in the north of Mesopotamia, which, subsequent to the establishment of Christianity, became celebrated for its theological schools. During the centuries which were affected by the Christianizing of Rome, Edessa became the centre of learning of Syria. (See SYRIA; SYRUS.) The modern city of Urfah or Orfa stands on the site once occupied by Edessa. (See URFAH.) In 1089, in the first crusade, Edessa came into the hands of Baldwin, but ultimately became part of the Turkish empire. It was one of the greatest four cities of Syria, the other three being Antioch, Damascus, and Nisibis.

Edfu, ĕd'foo, town of Upper Egypt; situated on the Nile, 54 miles southeast of Thebes. It contains the remains of two temples, the larger of which is the best preserved monument of its kind in Egypt. It was founded by Ptolemy III. Philopator more than two centuries before Christ, and added to by his successors down to Ptolemy XIII. Dionysus, a period of 170 years. The general plan of the temple resembles that of Dendera. Its length is 451 feet, the breadth of its façade is 250 feet. Its entrance is by a gateway 50 feet high, between two immense truncated pylons, 37 feet wide at the base, and 115 feet high, the whole surface covered with sculptures and inscriptions in low relief. This splendid façade is visible from a great distance, and is one of the most commanding sights in the Nile valley. Passing through this entrance, a court is reached 161 feet long, and 140 feet wide, enclosed by a splendid colonnade of 32 columns of every variety of capital, and surrounded by walls between which and the pillars there is a stone roof, forming a covered portico. From this court opens a hypostyle hall of 18 columns, joined by an intercolumnal screen, through which access is obtained to an inner hall of 12 columns, leading to the sanctuary, where a great monolith of gray granite was evidently intended to encage the hawk, the sacred emblem of Hor-Hud, the local Horus, to whom the temple was dedicated.

The sanctuary and surrounding chambers, together with the outer and inner halls, are separated by an open corridor from the outer wall of the temple, and both sides of this passage are covered with elaborate reliefs and numerous inscriptions, which present a sort of encyclopædia of ancient Egyptian geography, ritual, and ecclesiastical topography, with calendars of feasts, lists of divinities in the various names and cities, and even a species of church directory, including the names of singers and other temple officials. The smaller temple, erected by Ptolemy Physcon and Lathyrus, consists of only two chambers. The manufactures of Edfu at present are blue cotton cloths, and earthen-ware similar to the ancient Egyptian pottery. Pop. 2,500.

Consult: Wiedemann, 'Religion of the Ancient Egyptians'; Mariette, 'Monuments of Upper Egypt.'

Edgar ("The Peaceable"), one of the most distinguished of the Saxon kings of England, was the son of King Edmund. He succeeded to the throne in 958, and managed the civil and military affairs of his kingdom with great vigor and success. He maintained a body of troops to control the mutinous Northumbrians, and repel the incursions of the Scots, and fitted out a powerful navy to protect his subjects from the Danes. During the reign of Edgar wolves were nearly extirpated from the southern parts of the island, by exchanging a tribute from Wales for payment in the heads of these animals. He married Elfri, daughter of the Earl of Devonshire, in 965. It was during his reign that Dunstan was primate of England. (See Dunstan, Saint.) He died in 975, and was succeeded by his son, Edward the Martyr.

Edgar Atheling, Anglo-Saxon prince: b. Hungary about 1057; d. toward the end of the 11th century. He was a grandson of Edmund Ironside, and his life may be epitomized as a series of abortive attempts. Selected by Edward the Confessor as his prospective heir, he was kept out of the throne by William the Conqueror (1066); having twice engaged in the northern revolts against the Normans, he was twice compelled to take refuge in Scotland, with Malcolm Canmore, who married Edgar's sister, Margaret; then, embracing the cause of Robert, Duke of Normandy, against William Rufus, he was driven away (1091) from the duchy to Scotland; then he embarked (1099) in a bootless crusading expedition to the East; and finally was taken prisoner at Tenchebrai (1106) fighting for Duke Robert against his brother Henry I. Almost the only successful achievement of his life seems to have been that of reseating his nephew Edgar on the throne of Scotland (1097), which had been usurped by Donald Bane. His last days were spent in obscurity; the date of his death is not precisely known.

Edgar, James David, Canadian statesman: b. Hatley, P. Q., 10 Aug. 1841. He was admitted to the bar 1864, first practising in Toronto; was made a Q.C. by the Ontario government in 1890. In 1872 he was elected to Parliament for Monck, being chief Liberal "Whip"; served on a political mission to British Columbia, and was re-elected from West Ontario 1884. He was elected speaker of the commons in the new parliament 1896, and was instrumental in passing the Canadian Copyright Act 1889. Later he devoted much attention to the question of international arbitration. He was elected a Fellow of the Royal Society of Canada 1897. He has published: 'The White Stone Canoe' (1887); 'This Canada of Ours and Other Poems' (1893); an 'Annotated Edition of the Insolvent Law' (1864); and several other law books.

Edgar, John George, English biographer and historian: b. 1834; d. 1864. In business at Liverpool, he left it for literature: edited 'Every Boy's Magazine,' contributed to the London press, and wrote biographies and histories, mainly for the young; among them: 'The Boyhood of Great Men' (1853); 'Footprints of Famous Men' (1853); 'Crusades and Crusaders' (1859); 'Sea Kings and Naval Heroes' (1860); 'Cavaliers and Roundheads' (1861).

Ed'gartown, Mass., town, county-seat of Duke's County; situated on the eastern shore of the island of Martha's Vineyard. At present it is a summer resort, but it was once a whaling station of importance. The town was settled in 1642. Pop. (1900) 1,209.

Edgcumbe, ĕj'cŭm, Sir **Edward Robert Pearce,** English traveler: b. 13 March 1851. He was educated at Cambridge, was mayor of Dorchester 1891, and sheriff of Cornwall 1896. He has published: 'Zephyrus, or Travels in Brazil and on the River Plata' (1887); 'Bastiat's Popular Fallacies' (4th ed. 1893); 'Popular Fallacies Regarding Bimetallism' (1896); 'The Parentage and Kinsfolk of Sir Joshua Reynolds' (1901).

Edgehill, ĕj'hĭl, England, an eminence in Warwickshire, 12 miles south of Warwick. Here was fought the first battle of the civil war Sunday, 23 Oct. 1624, between the Royalists under Charles I. and the forces of the Parliament under the Earl of Essex. It was an indecisive engagement.

Edgeworth, ĕj'wėrth, **Maria,** English novelist: b. Hare Hatch, near Reading, Berkshire, 1 Jan. 1767; d. Edgeworthtown, Ireland, 21 May 1849. In 1782 her father, Richard Lovell Edgeworth, succeeded to the family estate of Edgeworthtown, in the county of Longford, Ireland and thither he proceeded and took up his abode. In 1802 she established her position as an author by her 'Castle Rackrent,' a novel of Irish life, in which the manners and customs of a by-gone generation are most graphically and humorously described. A 'Treatise on Irish Bulls' appeared in 1803, and about the same time she began the series of tales on which her fame will rest. These comprise: 'Moral Tales';

'Popular Tales'; and 'Tales of Fashionable Life', all written in the clearest and most vigorous style, without the least affectation of sentiment or fine writing. She also wrote: 'The Parents' Assistant,' a collection of tales for children, and the well-known series of 'Early Lessons'; 'Harry and Lucy'; 'Frank'; and 'Rosamond.' Belonging to the class of regular novels are 'Belinda'; 'Leonora'; 'Patronage'; 'Harrington'; and 'Ormond.' In estimating Miss Edgeworth's literary merits too much praise cannot be given to her terse and nervous style, alike simple and elegant, or to the lucidity and consecutiveness which characterize all her compositions. Her skill in plot is considerable, and the interest excited in the characters and issue of the story is never allowed to flag. See Thackeray Ritchie, 'Book of Sibyls' (1883); Zimmern, 'Life of Maria Edgeworth' (1883).

Edgren, Anne Charlotte Leffler, än shär-lŏt'tĕ lĕf-lėr ĕd'grĕn, Swedish novelist and dramatist: b. Stockholm 1 Oct. 1849; d. Naples 24 Oct. 1892. A volume of short tales, 'By Chance,' and the dramas, 'The Actress'; 'The Curate'; etc., were a great success anonymously; and she then put her own name to three successive volumes of short stories called 'From Life,' followed by 'A Summer Story'; 'Woman and Erotism'; and many others. 'Ideal Women'; 'The Struggle for Happiness'; and 'A Rescuing Angel' (the most successful of her plays), are notable among her later dramas.

Edgren, August Hjalmar, Swedish-American educator: b. Wermland, Sweden, 18 Oct. 1840. He came to the United States in 1860, joined the 99th New York Regiment as second lieutenant January 1862; and in August 1863 entered the engineer corps. He was connected with Yale University 1874–80, and since 1893 has been professor of Sanskrit and linguistic science at the University of Nebraska. His numerous publications include a Swedish work on the 'Literature of America' (1878); 'Swedish Literature in America' (1883); and 'American Antiquities' (1885); besides many valuable papers for students, pertaining to Sanskrit, romance, and Germanic philology.

Edhem Pasha, pash-â' or päsh'a, Turkish soldier and statesman: b. Scio of Greek parentage 1813. He studied in Paris, and on returning to Turkey was attached to the staff of the army with the rank of captain, rapidly attained that of colonel, and was appointed a member of the Council of Mines at the time of its formation. Having been appointed aide-de-camp to the Sultan in 1849, he soon was placed at the head of His Majesty's household troops. In 1856 he resigned the functions which he had fulfilled at the palace, and was appointed a member of the council of the Tanzimat, and afterward minister of foreign affairs, with the rank of muchir. Subsequently he played an important part in the affairs of his country, where he was nominated president of the Council of State. He was also for some time ambassador at Berlin. At the Conference of Constantinople (1876–7) he acted as the second Turkish plenipotentiary, and was appointed to succeed Midhat Pasha as grand vizier, 5 Feb. 1877.

Edhem Pasha, Turkish soldier: b. 1851. In 1877 he held the rank of colonel in the Turkish army and rose rapidly during the war with Russia. He was appointed governor-general of the Vilayet of Kossowo, and was later made adjutant-general and field marshal. In the war with Greece (1896–7) he had the chief command of the Turkish army.

Edible Birds' Nests. See BIRDS' NESTS, EDIBLE.

Edict, a public proclamation. In ancient Rome, the higher officers of state, who were elected annually, publicly declared, at their entrance upon office, the principles by which they should conduct their administration. This was done particularly by the ædiles, who superintended buildings and markets, and by the prætors, as supreme judges. These annual proclamations, by which the deficiencies of the general statutes were supplied, and the laws were adapted to the peculiar wants of the period, gradually acquired a certain permanency, as each officer retained, unaltered, most of the regulations of his predecessor (*edictum tralatitium*); and they became, in fact, the source of that branch of Roman law which, being founded on the official authority of the authors, was called *jus honorarium*, and was opposed to the strictly formal law, *jus civile*. Though according to Roman jurists these usually indirect forms of legislation had their object in rendering the civil law more expedient to the public welfare, and always received the seal of the people's approval. Edicts were sometimes made for some special occasion, in which case they were called *edicta repentina*. It was against the abuse of this kind of edicts that the Lex Cornelia in 67 B.C. was directed. Those which were applicable in all cases during the tenure of office of the magistrate who issued them were called *edicta perpetua*. The name of *edictum perpetuum* was also given to a collection and arrangement of the clauses which the prætors were accustomed to put into their annual edicts, made under the Emperor Hadrian by Salvius Julianus about 131 A.D. What the exact nature of the work thus done by Julianus was is not known, but the edict prepared by him, and sanctioned by imperial authority, had unquestionably a special force, and it is likely that it restricted in future the right enjoyed by magistrates of issuing edicts, to such cases as were not provided for in the edict of Julianus. Only a few fragments of the ancient Roman edicts have been preserved. See CIVIL LAW.

Edict of Nantes, a decree of Henry IV. king of France, published 13 April 1598, by which he conceded to the Huguenots, or Protestants of that kingdom, toleration for their religious beliefs, teachings, and practises; freedom of public worship and liberty to erect churches, except at Paris and the royal residences, and to maintain the four Protestant universities of Saumur, Montauban, Montpellier, and Sedan; admission as members to the parliament of Paris and the right to special chambers in the parliaments of Grenoble and Bordeaux; further, the right to hold provincial and national synods. In 1620 the Huguenots in their political congress at La Rochelle confiscated all the property of the Roman Catholic churches and constituted throughout France a military and civil organization for Huguenot ends.

Before the formal revocation of the Edict of Nantes the liberties of the Protestants were largely restricted by partial acts of revocation, which precluded them from office in the government, from membership in trade corporations, etc., and from marriage with Roman Catholics. The edict was formally revoked by a decree of Louis XIV. 18 Oct. 1685. It ordered the churches of the Huguenots to be destroyed, forbade the holding of religious meetings and of synods by Protestants on penalty of confiscation of goods; banished all Protestant ministers; ordered the children of Protestants to be baptized and brought up as Roman Catholics.

Edinburgh, Edinburghshire, or **Midlothian,** a maritime county of Scotland; area, 231,724 acres. The surface is hilly and the productions are about as in Scotland generally. The chief town is Edinburgh. (See EDINBURGH.) Pop. (1900) 488,647.

Edinburgh (Edinboró), the metropolis of Scotland and one of the finest cities in the British Isles, is built on ridges and hollows that run east and west. It is picturesquely situated on the southern shore of the Firth of Forth, 47 miles east of Glasgow, and 400 north of London. From the Firth the ground slopes somewhat unevenly upward to the top of the Castle Rock, 438 feet above sea level. The Central Ridge, which constituted the site of the old town, is terminated on the west by the Castle Rock, and by Holyrood Palace on the east. Arthur Seat (822 feet high) overlooks the whole of the eastern and southern part of the city, and between it and the Palace are the elevations known as Salisbury Crags. The new town lies between the old town and the sea. The houses, streets, squares, and gardens are all handsome, built of beautifully dressed freestone found in the neighborhood of the city. The principal streets of the new town are Princess street, George street, and Queen street, running parallel with each other.

Geological Formation.— The geological formation upon which Edinburgh is built is of a very interesting character. The rocks which underlie the town belong to the lowest divisions of the carboniferous system, but here and there in the neighborhood, such as in the rocks of the Pentlands, Blackford Hill, and a portion of Arthur Seat, there are several veins of igneous rock. The district has always been an interesting one for the geologist, and several writers of standing have dealt with the subject, among whom may be named — Hutton, Playfair, Forbes, Millar, McLaren, and Geikie.

Principal Buildings, Galleries, Museums, etc. —In Princess street there are some notable buildings, and on the Mound connecting it with the old town is the National Gallery, while near at hand to the east is the Scott Monument. The old town has suffered very much at the hands of the improver, but there are still "Closes," "Lands," and "Wynds," which are interesting to the visitor. From the Castle to Holyrood House there is one continuous street, known at different parts as the Lawnmarket, the High street, and Canongate. It is upward of a mile in length, and is frequently termed "The Royal Mile." Among the notable buildings in and around this "Royal Mile" are the Tolbooth Church, the meeting place of the General Assembly of the Church of Scotland; the United Free Church Assembly Hall, Saint Giles' Cathedral, Parliament House, the Advocates' Library, the Signet Library, and the Municipal Buildings. The Tron Church is at the junction of South Bridge with the High street. Continuing down the Canongate on the left is the house of John Knox, the great Reformer, while on the right further down is Moray House, once occupied by the Regent, Murray, in the garden of which stood, till quite recently, a tree said to have been planted by Queen Mary. In the garden is still existing a summer-house where it is averred the Treaty of Union was signed. Moray House is now the Training College for Teachers, in connection with the United Free Church of Scotland. There are other interesting buildings in the Canongate, such as the Tolbooth and Queensbery House. To the north of the "Royal Mile" there are such buildings as the Bank of Scotland in Bank street, and the Scotsman Buildings in North Bridge. From the head of the Canongate a particularly good view can be got of the the Calton Hill, with its Nelson Monument and the never-to-be-finished National Monument. To the south the public buildings in George IV. Bridge are the County Buildings, the Sheriff Court-house, and the Public Library (the latter erected in 1887 at a cost of £50,000, given by Andrew Carnegie; total stock now is 165,000 volumes); while in Chambers street there is the Royal Museum of Science and Art, the Heriot Watt College, and the University (q. v.). Near at hand are the Students' Union, M'Ewan Hall, Heriot's Hospital, and the Royal Infirmary, all of which are distinctive buildings. The Castle contains accommodation for 2,000 soldiers, and the Armory has places for 30,000 stands of arms. The Regalia of Scotland is kept in an apartment by itself. Another attraction to visitors, besides this, is Queen Mary's room, which is visited annually by large numbers. Holyrood Palace and Abbey stand at the east termination of the "Royal Mile," and the former is only now used on the occasion of the visit of the Royal Commissioner to the General Assembly. The older buildings were replaced by a modern structure in the time of James the Fifth, and the greater portion of the present building dates only from the time of Charles Second. The apartments occupied by Queen Mary are in the northwest corner of the building, and in very nearly the same state as that in which they were left by that unfortunate Princess. There are the Royal Museum of Science and Art, the National Portrait Gallery and Antiquarian Museum in Queen street, Fettes College, Daniel Stuart's College, and the Cathedral of Saint Mary (Episcopal). Saint George's Church in Charlotte Square is a notable modern ecclesiastical building. Along with the University the more prominent educational institutions are the New College, the School of Medicine, Heriot Watt College, Fettes College, the High School, the Academy, Daniel Stewart's College, and George Watson's College. The southern part of the city is modern, but extends now to the foot of the Pentland Hills, including the Braid Hills, the golf course of which is one of the best inland courses in Scotland.

Manufactures.— The principal manufactures in Edinburgh are: Printing, type founding, coach building, ale brewing, and cabinet-making.

It is the seat of the principal Government Departments for Scotland, and the headquarters of the book trade.

Government.— The Town Council consists of Lord Provost, six Magistrates known as Bailies, Treasurer, a Dean of Guild, and 41 ordinary Councillors. Edinburgh was a Royal Burgh as early as the time of David the First, its designation at that time being Edwinesburgh.

Railways.— The two principal railways connecting Edinburgh with other parts of the country are the Caledonian and North British Railways. There are cable tramways throughout the leading parts of the town, and these have been on the whole fairly successful. Electric tramways are about to be introduced into some of the suburbs, but there has been strong opposition to the overhead system, as a disfigurement of the fine streets.

Electricity.— The city is beautifully lit by an electric installation, which has been one of the most successful in the Kingdom. Not only is the public supplied on an extensive scale, but the private houses of the modern parts of the town have all got electricity as the domestic light.

Parks.— Edinburgh is particularly well off with open spaces. The King's Park, including Arthur Seat, Salisbury Crags, etc., is one of the most handsome in the kingdom, although very little is done to adorn it either by the Government or the local authority. The Braid Hills and Blackford Hill, on the latter of which is the Royal Observatory, are picturesque resorts in the summer time, while in the very centre of the town there are the East and West meadows and Bruntsfield Links. There are innumerable smaller parks and squares.

Churches.— Edinburgh is noted for its churches. In connection with the Church of Scotland there are 43 places of worship, while in connection with the United Free Church there are no fewer than 70. There are also denominations, such as the Episcopal Church, the Congregational Church, and many others. Pop. (1901) 317,400; it is now estimated at 340,000.

Charitable Institutions and Libraries.—Among benevolent institutions are the Royal Infirmary; Donaldson's Hospital; Deaf and Dumb Institution; Royal Blind Asylum and many others. There are four large libraries situated in the centre of the old town: the Advocates' Library, the University Library, the Library of Writers to the Signet, and the Public Library.

History.— The history of the city is largely the history of Scotland. Before the 11th century it did not figure more than as a fortified town, but in the time of David I. it begins to be mentioned in charters under the name of Edwin'sburg. In 1128 the Abbey of Holyrood was founded by David I. and between it and Edinburgh was the Canongate, which had a separate municipal authority down to 1856. The old wall of the city is said to have been built in 1450, and was extended after the Battle of Flodden in 1513. The English under Hertford in 1544 burnt the city to the ground, with the exception of Saint Giles Cathedral, and 17 years later, Mary, on her return from France, took up her residence at Holyrood Palace. The modern history of the town is more associated with literature than with commercial and industrial enterprise.

Bibliography.— Maitland's 'History of Edinburgh' (1753); Arnot's 'History of Edinburgh (1758); Crauford's 'History of the University of Edinburgh' (1808); Bower's 'History of the University of Edinburgh' (1817); Chambers' 'Traditions of Edinburgh' (1824); Steven's 'Heriot's Hospital;' Wilson's 'Memorials' (1890); Grant's 'Old and New Edinburgh;' and 'Burgh Record Society Publications'; Williamson, 'Edinburgh: An Historical and Topographical Account of the City' (1906).

HEW MORRISON,
Chief Librarian, Edinburgh Public Library.

Edinburgh, University of, the youngest of the four Scottish Universities, was originally known as "the College of Edinburgh," or "the Town's College," having been founded in 1583.

King James VI., in 1582, granted to the Town Council of Edinburgh a charter, conferring upon that body certain powers and privileges, and under this charter the Town's College, which afterward became known as "the College of James VI.," was founded by the Town Council as a degree-conferring institution, and the University of Edinburgh remained under the control of the Town Council until 1858, when, by the Universities Act, all the universities of Scotland were made practically autonomous. From 1858 to 1889, the Senatus Academicus (that is to say, the principal and the professors) was the governing body of the University, but, by the Universities (Scotland) Act of 1889, the University Court became the governing body, having full control of all the property belonging to the University. The Senatus, however, still regulates the teaching and discipline of the University.

The University Court consists of the Rector (the chosen representative of the undergraduates); the Principal; the Lord Provost of Edinburgh for the time being; three Assessors nominated by the Chancellor, the Rector, and the Town Council respectively; four Assessors elected by the General Council; and four Assessors elected by the Senatus.

The University has six Faculties, *videlicet* — Divinity, Law, Medicine, Arts, Science, and Music, each presided over by a Dean elected by the separate Faculties. The Faculty of Divinity embraces the Chairs of Divinity, Hebrew and Semitic Languages, Ecclesiastical History, Biblical Criticism, and Antiquities. In the Faculty of Law there are the following eight Chairs: Public Law, Civil or Roman Law, History (constitutional, etc.), Scots Law, Forensic Medicine, Conveyancing, Political Economy, and Ancient History and Palæography. The Faculty of Medicine has 13 Chairs: Botany, Physiology, Medicine, Anatomy, Chemistry, Midwifery, Natural History, Materia Medica, Surgery, Clinical Surgery, Forensic Medicine, Pathology, and Public Health. The Faculty of Arts consists of the Chairs of Humanity (Latin), Greek, Mathematics, Logic and Metaphysics, Moral Philosophy, Natural Philosophy, Hebrew and Semitic Languages, History (3 Chairs), Rhetoric and English Literature, Sanskrit and Comparative Philology, Commercial and Political Economy, Fine Art, and Celtic. The Faculty of Science comprises the Chairs of Natural Philosophy, Mathematics, Botany, Anatomy, Chemistry, Physiology, Natural His-

1. The Castle and Museum.
2. The Old Town, from Princess Street.

tory, Astronomy, Agriculture, Engineering, Geology, and Public Health. In the Faculty of Music, the Chair was founded in 1839.

The General Council of the University consists of the Chancellor, the members of the University Court, the Professors and the Graduates. The Council does not exercise any direct control in the government of the University, but "may make reports to the University Court on all matters affecting the well-being and prosperity of the University, and the University Court shall consider the same, and return to the Council their deliverance thereon." The General Council, together with the General Council of St. Andrews University, return a Member of Parliament, who represents the two Universities jointly. The Chancellor of the University is appointed for life by the General Council, and acts as President of that body. The General Council is represented on the University Court by four Assessors elected every four years, two retiring biennially.

A Students' Representative Council, elected annually, was founded in 1884, to represent the students in matters affecting their interests, and to afford a recognized means of communication between the students and the University authorities, as well as to promote the social life of the undergraduate community.

Enrolment as a student in one or more classes, the payment of the fees for such classes, the signing of the University Album, and the payment of a matriculation fee of one guinea per session (or half a guinea for a summer session only) are conditions precedent of matriculation. The matriculation fee entitles students to the use of the University Library. The Rector of the University, who presides over the University Court, is elected by the matriculated students.

The University buildings consist of (1) the College or University (old building) in South Bridge Street; (2) the new buildings (School of Medicine) Teviot Place; (3) the Music classroom, Park Place; (4) the John Usher Institute of Public Health, Warrender Park Road; and (5) the Engineering department, Infirmary Street. The old buildings of the University, which were erected on the site of "Kirk o' Field," the scene of the murder of Darnley, contain the library and reading-rooms, the classrooms of the Faculties of Arts, Divinity, and Law, the Natural History and some of the Science classrooms, the Examination Hall, the Physical, Geological, and Pathological Laboratories, the Fulton Engineering Laboratory; the Physical, Geological, Fine Art, and Natural Museums; the Senate Hall; the University Court Room, and the Officers of the Senatus, the Court, and the Students' Representative Council. The new buildings, begun in 1878, were partly opened for teaching purposes in 1880, being completed in 1888. They contain the lecture-rooms of the Faculty of Medicine (excepting those of Botany, Natural History, and Public Health); the various Museums connected with the Medical Faculty; a students' reading-room and common room; the Faculty of Medicine reception and reading-rooms, and the offices of the Faculty.

Immediately contiguous to these new buildings, there was erected in 1901, the Hughes Bennett Physiological Laboratory, in memory of a former Professor of Physiology. The laboratory is connected directly with the other Physiological Laboratories and has been designed on the most modern lines.

The M'Ewan Hall was built between 1888 and 1897, and is a spacious hall of the early Italian renaissance style, capable of holding 2,600 people, and is used for all academic functions.

The John Usher Institute of Public Health was opened in 1902, and is equipped with the most modern appliances for teaching and research in Bacteriology and Chemistry. It is the gift of Sir John Usher, Baronet, and was erected at a cost of over £21,000.

The new block of buildings for the Engineering department was completed in 1905, and provides extensive accommodation for carrying on the work of that department.

The School of Music was built in 1858 from designs by the late Mr. David Cousin, and contains, in addition to the Music classroom, an excellent organ, and Museum of musical instruments.

The University Union, with extensions, has cost over £37,000. It is situated in Park Place, near the M'Ewan Hall, and is held by trustees for the students.

The University Library, which contains over 200,000 volumes, and about 7,500 MSS., many of great value, was founded in 1580 by the transference from the Town Council to the University of a collection of books left to "Edinburgh and Kirk of God, thair to reman," by Mr. Clement Little. In addition to the University Library proper, there are separate Libraries in connection with the following departments: Theological, Classical, Philosophical, Historical, Physiological, Astronomical, Modern Languages, Natural Philosophy, Engineering, and Music.

The income of the University is derived from benefactions and bequests for the foundation of bursaries, scholarships, and prizes; from matriculation, graduation, and other fees; from funds bequeathed for general purposes and for the endowment of Chairs; and from Parliamentary grants. The salaries of the Principal and Professors are paid from a fee fund account, the whole of the fees being pooled. The total net annual revenue is about £100,000.

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John Minto,
Librarian of the Signet Library, Edinburgh.

Edis, Robert William, English architect: b. Huntingdon, England, 13 June 1839. He was president of the Architectural Association for two years, and among his constructions may be mentioned the club houses of the Constitutional, Junior Constitutional, and Badminton clubs, London; and the Conservative Club, Glasgow; The Great Central Hotel, London, and the Inner Temple Library. He has written and lectured much upon domestic art and house sanitation, and is a strong advocate of the extended use of terra-cotta in building. He has published: 'Decoration and Furniture of London Houses'; 'Hand-book on Healthy Furniture'; etc.

Edison, Thomas Alva, American electrician and inventor: b. Milan, Ohio, 11 Feb. 1847. His family moved to Port Huron, Mich., when he was seven years of age, but he obtained no schooling, and at the age of 12 became a train-boy on the Detroit and Port Huron branch of the Grand Trunk Railway. While in this capacity, in 1862, he bought a small hand press and edited, printed, and published a small paper of his own, naming it the 'Grand Trunk Herald.' It had a circulation of 300 among the employees of the road. For the rescue of the son of a station agent he was taught telegraphy by the father, and later became an operator at Mount Clemens, but, owing to his dislike of routine work, his fondness for reading, and his inventive genius, he lost several subsequent positions, and became a "tramp operator," although known to be remarkably proficient. While in Indianapolis in 1864, he invented an automatic telegraph repeater, the first of a long series of improvements and inventions. He soon after went to Boston, where he invented a commercial stock indicator, which he sold to New York capitalists for $40,000. This gave him the long-cherished opportunity of establishing an extensive laboratory, which he did at Newark, N. J., for the special manufacture of electrical, printing, automatic and other apparatus. In 1876 his health failed and he gave up manufacturing, confining his labor to investigation and invention. He established his laboratory at Menlo Park, N. J., and later at West Orange, N. J., gave employment to hundreds of workmen and became known as one of the greatest inventors of the 19th century. More than 300 patents have been issued on his inventions, and he has besides produced hundreds of minor contrivances and improvements not covered by patents. Among his more important inventions may be named the phonograph, a telephone for long distance transmission, a system of duplex telegraphy (which he subsequently developed into quadruplex and sextuplex transmission), the carbon telephone transmitter, the microtasimeter, the ærophone, megaphone, the incandescent electric lamp, the kinetoscope, and a storage battery for street railway cars and automobiles. There is not an electrical instrument, or an electrical process now in use, but bears the mark of some great change wrought by the most ingenious of Americans. In 1878 he was made chevalier of the Legion of Honor by the French government, a commander of the Legion in 1889, and was the recipient of the insignia of a grand officer of the Crown of Italy bestowed the same year by King Humbert. In 1892 he received the Albert medal of the Society of Arts of Great Britain.

Edison is a man of remarkable personality. To those who believe his work is the product of an inspiration given by nature to but few, the story of the manner in which he achieves success will seem shockingly unromantic. In the genius who works by inspiration Edison has no great faith. "Genius is 2 per cent inspiration and 98 per cent perspiration," is the incisive, epigrammatic answer he once gave to a man who thought that a genius worked only when the spirit moved him. Not being given to scientific rhapsodies, Edison does not concern himself with what may be of service a century hence; he confines himself rigorously to the needs of the present. Knowing full well that he is probably not the first who has set for himself the task in the performance of which he is engaged, he reads all that is pertinent to his subject in the vast library which forms an important adjunct of his laboratory. Not content with the information gathered from his own shelves his literary agent is ordered to send him more. After a thorough review of his subject, Edison begins laboratory work — an expert keenly alive to the failures of his predecessors, careful to avoid useless repetitions of old experiments. It is now that the 2 per cent inspiration gained by exhaustive reading, and the 98 per cent perspiration which he is ready to expend, are applied. Experiments are made; not a few, but hundreds and even thousands. Model after model is built. Failure upon failure is met with, until further efforts seem hopeless. Undismayed, Edison performs more experiments, builds more models. Failure spurs him on. At last an experiment is performed or a model made which gives faint encouragement. So far from being elated, he regards the promising result with great suspicion. The failures have been too many; the apparent success after all may be due to an accidental combination of circumstances that may never occur again. Only after the partial triumph has been confirmed by many trials does complete assurance come. Edison knows exactly what he wishes to accomplish, and how his end is to be attained. Absolute certainty of purpose and of method saves him from frittering away his time in useless experimentation. Chance has given perhaps an occasional idea, but it has not lightened his work. Tireless perseverance and long hours of work are the secrets of Edison's success. In 1897 Edison devoted his exclusive attention to the invention of a new storage battery, on which problem he had been engaged for some five years. For over a year he worked harder than a day laborer. He was at his laboratory at 7.30 in the morning. His luncheon was sent to him. In the evening he left for dinner, but returned at 8. At 11.30 at night his carriage called for him; but often the coachman had to wait for three or four hours until the inventor came out of his laboratory. Yet when vacation time comes, and with it a chance to leave his laboratory, Edison plays just as he works, with his whole heart and soul. He will hear nothing of business. Science is thrown to the winds.

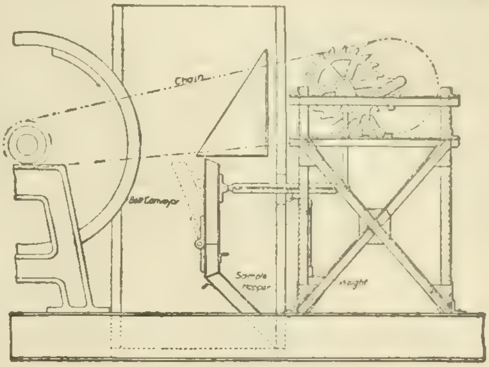
Edison Portland Cement Works, a manufacturing establishment located at Stewartsville, N. J., and interesting for its employment of new methods, devised by the well-known inventor, T. A. Edison (q.v.), in the making of Portland cement. The rock, having been drawn on flat-cars to the crusher-house, is raised by electric hoists and dumped into the crushing-rolls. These rolls are arranged in four sets, one above the other, the material passing downward by gravity. The first set of rolls is 5 feet in length and diameter, the moving portions weighing approximately 25 tons each. They can receive and crush rocks of 5-ton weight, and are driven at a speed of 200 revolutions per minute. Beneath these rolls is a 10-ton hopper, from which the material is fed to three sets of

THOMAS ALVA EDISON,

AMERICAN ELECTRICIAN AND INVENTOR.

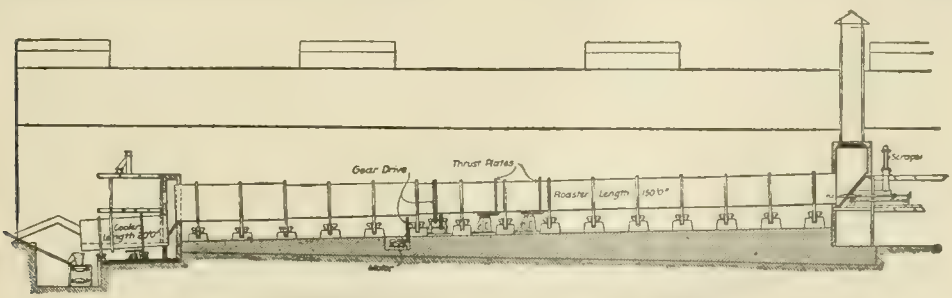
36-inch rolls. The rock in passing through the four sets is reduced to one half inch in size. The crusher house has a capacity of 3,000 tons per day of 24 hours, allowing for 16 hours of actual running and a maximum of 4 hours for stoppages. From the lowest set of rolls the crushed rock drops through a chute to a 24-inch belt conveyer, which transfers it to the top of the drier-house. Having arrived at the top of the drier-house, the material falls by gravity over screens composed of one half inch mesh screened plates. The rejected spalls are recrushed and returned to the drier-house. The recrushed material falls to the drier. The drier consists of a cast-iron box, 40 feet high and 8x8, filled with baffle-plates. Like the crusher, it has a capacity of 3,000 tons daily. The fall of the rock from the last screen to the bottom of the drier requires 26 seconds; the moisture in the crushed rock is reduced from 3 to 4 per cent to within 1 per cent. From the bottom of the drier stock a 24-inch belt conveyer transfers the dried rock to a transfer-tower, where it is received by another 24-inch belt conveyer, which passes along the entire length of the stock-house cupola, and deposits the rock in any bin desired by a self-propelling tripper. There are three bins for cement rock, three for lime rock, and one for mixing purposes. At the transfer tower an automatic sampler is installed, and this withdraws samples of the material as it is dumped from one conveyer to the other. By analysis of the material removed by the sampler, the general constituents of the material in any given bin may be ascertained. Great precautions are taken to dry the material in stock-house, should it become wet after leaving the drier. A 15-foot fan, passing 60,000 cubic feet of air per minute, creates a suction of warm air through the building from the furnaces at the other end, and thus removes excess moisture in the stored stock.

For the next step in the process of manufacture, the crushed rock emerges on a conveyer in a tunnel underneath the bins. By another conveyer it is raised to the first dump at the upper part of the weighing-house. Here are two bins, of 60 tons capacity each, one for the cement rock and one for the limestone. Beneath each of these bins is located a 10-ton weighing bin, the proper proportion of the raw veyer which traverses the length of the building and passes two stationary trippers. Each tripper supplies 8 bins, whence the material is supplied to the discharge pipes of an equal number of fan-blowers. By a system of baffle-plates the material falls through the current of air maintained by the blower. The fine material is carried by the air-current to settling-chambers, whence it passes to bins. The coarse material is taken by conveyers to the chalk-grinding



The Automatic Sampler.

house for a further reduction. The set of fine grinding-rolls in the chalk-grinding house have a record of 280 barrels per hour. Of this ground material, 85 per cent passes through a sieve of 200 meshes per linear inch. From the stock-house, which has a capacity of 1,000 tons of chalk, the finely-ground material is conveyed to the burning plant. The kilns are of cast iron, 150 feet long and from 8 to 9 feet in exterior diameter. Each rotary kiln is supported on 30 wheels at 15 points of its length, and is moved at a speed varying from one revolution in 35 seconds to one in 40. The output of each kiln is about 750 barrels per day of 24 hours. The clinker formed by the vitrification of the chalk drops out at the lower end of the kiln into a revolving cylindrical cooler. Ordinarily the clinker from the cooler is spouted directly from the bucket conveyer. A second spout carries the clinker away to the bad clinker elevator. Thus defec-



A longitudinal section of one of the 150-foot kilns.

materials being secured in these latter bins. At the small rock stock-house begins a long tunnel, containing a 36-inch belt conveyer, which passes another raw-material or chalk-grinding house, where it receives the material furnished by the rolls, and whence it rises to the top of the blower-house. It is there received by a con- tive product is isolated. The clinker crusher-house has two sets of 36-inch rolls, duplicates of those in the rock crusher-houses, with a capacity of 200 tons daily. The crushed clinker is transferred to the stock-house by chutes, the proper amount of sulphate of lime being added in transit. Thence it goes to an elevator, and to the clinker grinders; then to a second blower-house, where fine and coarse are separated, and thence to the stock-house. See CEMENT.

Edisto, ĕd'ĭs-to, a river in South Carolina, which has its rise in the southern part of the State, and which flows in a general direction southeast into the Atlantic Ocean. Its source is at the junction of two streams called North and South Forks of Edisto River. The river is 150 miles in length and navigable for 100 miles.

Edmonton, Canada, city in the Province of Alberta, situated upon the North Saskatchewan river; on the Calgary and Edmonton branch of the Canadian Pacific and on the main line of the Canadian Northern R.R's.; 340 miles west of Prince Albert. It is the principal town in Northern Alberta, the newly chosen provisional Capital of the new Province, and with every probability of being confirmed in that position, despite the rival claims of Calgary. On the opposite bank of the river is the town of Strathcona, with its 3,000 or more people.

Industries and Business Interests.— A bustling railway centre; situated on a large and navigable river; built upon and in the centre of a great region of lignite coal; with cheap fuel for its people and its industries; surrounded by a rich agricultural and ranching country; the new capital of the new Province of Alberta has great resources for its future prosperity. The city owns and operates its electric light and power system, telephone and water works, and has obtained a charter to build and operate a street railway. It has six branch banks, four churches and two public schools. Its chief industries are saw, grist and planing mills, stock-raising and farming. It is the shipping point for a radius of, at least, 150 miles around. The net assessment in 1905 was $6,620,985, as against $673,694 in 1892 and the total taxes levied in 1905 were $115,637, or a total rate of 20 mills on the dollar.

History, Government, and Population.— Commencing as a Hudson's Bay fort in 1795, Edmonton was, for three-quarters of a century, a mere market for furs and a central meeting and trading place for bands of Crees, Stonies, and other Indian tribes. Until the middle of the 19th century it was the furthest unloading point to the North for the York boats from Hudson's Bay and its first permanent white settlers came in caravans from Fort Garry (Winnipeg) 1,000 miles away in hopes that the projected Canadian Pacific Railway would adopt this route. In 1892 the northern branch line from that railway did arrive and on 9th January the town was incorporated. In 1897–8 the place became a centre and stamping-ground for the Klondike rush and many thousands of people passed along the Edmonton trail. The iron-bridge across the river to Strathcona was completed in 1901 and, in December 1905, the Canadian Northern Railway entered Edmonton. Meantime, on 7 Nov. 1904, it had been incorporated as a city with a civic government consisting of a mayor and 8 aldermen and an executive board of three commissioners. With a population in 1904 placed at 6,500 it is now (March, 1906) estimated to be 10,000.

J. CASTELL HOPKINS,
Editor of 'The Canadian Annual Review of Public Affairs.'

Edmonton, England, town in the county of Middlesex, on the New River, eight miles north of London. The "Bell at Edmonton" has become famous by association with the adventures of John Gilpin. Charles Lamb died at Edmonton in 1834. Pop. (1901) 46,899.

Edmund, Saint, king of the East-Angles: b. Nuremberg 841; d. Oxen, now Hoxon, England, 20 Nov. 870. Edmund belonged, by blood, to the English-Saxon kings, but was not a direct heir to the throne. When Edmund was only in his 15th year he was crowned by Humbert, bishop of Elma, on Christmas Day 855, at Burum, a royal villa on the Stour, now called Bures. In the 15th year of his reign the land was attacked by the Danes, and they laid waste all the country through which they passed. The king tried to protect his people, but the Danes outnumbered them and spared none. He was captured at Oxon and terms, prejudicial to religion, were offered and rejected. Hinguar, the Dane, ordered most terrible tortures to be inflicted. Again he was offered terms of surrender, and again he refused. Hinguar at last ordered his head to be cut off.

Edmund, Saint, Archbishop of Canterbury: b. Abingdon, England, about 1190; d. Soissy, France, 16 Nov. 1240. His first studies were made at Oxford and from there he was sent to Paris, from which school he returned home at the death of his mother; but remained in England only long enough to attend to placing his sisters in good homes. After returning to Paris he devoted himself to the study of theology and the Scriptures, and for a time taught the Scriptures in Paris. Returning to England, after his ordination, he became a teacher at Oxford from 1219 to 1226; he was the first who taught Aristotle's logic at Oxford. He desired to work among the poor, and at his own request was transferred to Salisbury Cathedral. While at Salisbury he received a commission from the Pope to preach the crusade against the Saracens, which he did with the result that not only many of his hearers joined the crusade, but numbers became exemplary Christians.

In 1234 Pope Gregory IX. appointed Edmund as Archbishop of Canterbury. The chapter of Canterbury was unanimous in his favor and the appointment was pleasing to the king, Henry III., but when Edmund was informed of the "honors heaped upon him," he at first refused to listen to the committee appointed to wait upon him. He assured them that they were mistaken, and, if not that he would not consent to become Archbishop of Canterbury. The bishop of Salisbury went to him and induced him to accept the office, and he was consecrated Archbishop of Canterbury on 2 April 1234. He at once entered upon a series of reforms in courts, monasteries, and among his clergy. Adversaries arose among those who ought to have been his advocates. His 'Constitutions' in 36 canons, dealing with matters of reform, are still extant. Troubles arose between Edmund and the king, when the king's greed sought various means to secure Church revenues. Both the archbishop and the king appealed to the Pope, who, failing to finally settle the disputes, left the archbishop almost powerless to cope with adversaries. Fearing that by remaining he might seem to sanction what he could not redress, he left the country secretly and went to France, where he received a warm welcome.

He was canonized in 1246, only four years after his death. Some of his works extant are: 'Constitutions,' to be found in 'Editions of the Councils' by Linwood, Spelman, Wilkins, Johnson, and Labbe; 'Speculum Ecclesiæ,' or 'Mirror of the Church'; and several of his works in manuscript, one on the Sacraments, are in the Bodlein library, Oxford. Consult: Wood, 'History and Antiquity'; Tanner, 'Notitia Monastica'; Butler 'Lives of Saints'; Ward, 'His Life, as told by Old English Writers' (1903).

Edmund I., or **Eadmund,** king of England: b. about 921; d. 26 May 946. He was a son of Edward the Elder and succeeded his brother Athelstan in 940. He subdued Northumbria and the Five Danish Boroughs in 944, and in the following year conquered Cumbria, which he bestowed on Malcolm, king of Scotland, on condition of homage. He was killed at a banquet by Liofa, an outlaw.

Edmunds, George Franklin, American lawyer: b. Richmond, Vt., 1 Feb. 1828. He received a common school education, as well as the instructions of a private tutor; studied law, and began its practice in 1849. In 1851 he removed to Burlington, Vt. He was a member of the Vermont legislature 1854–9, being speaker 1856–9, and was a member of the State Senate, and its president 1861–62. He was by this time very prominent in Vermont politics, and at the opening of the Civil War, when a State convention assembled with the intention of uniting war Democrats and Republicans, he outlined the resolutions which the convention finally adopted as the principles of union. On the death of Solomon Foot, in 1866, Edmunds was elected to the United States Senate to fill Foot's unexpired term, and was thrice re-elected for full terms, resigning in 1891. During his quarter-century in the National Senate he served on many important committees, displaying the qualities of an able, accomplished statesman. He was a member of the electoral commission in 1877, and was the author of the act of 22 March 1882 known as the "Edmunds Act" (q.v.), which provided for the suppression of polygamy in Utah and the disfranchisement of any person convicted of practising it. He was also the author of the "Anti-Trust Law" of 1890. During the term of President Arthur he was president *pro tempore* of the Senate. In 1897 he became chairman of the monetary commission which had been appointed by the executive committee of the Indianapolis monetary conference. Since his retirement from the Senate he has devoted himself to his profession, and has a wide fame as a constitutional lawyer.

Edmund II., or **Eadmund** (surnamed **Ironside**), king of England: b. about 981; d. 30 Nov. 1016. He was a son of Ethelred II., and on the latter's death in 1016 was chosen king at London, whilst Canute was elected to the same dignity at Southampton. Edmund several times defeated the forces of the Danish ruler, but was himself defeated at Assandun (now Ashington) in Essex. A compromise was then effected, by which the midland and northern counties were assigned to Canute and the southern to Edmund.

Edmunds Act, passed by Congress 22 March 1882; an act to root out polygamy in Utah, not only by direct punishment but by barring out votes, public careers, and official action from polygamists. Mormons held control of the Territory not only through the local offices, but from the fact that all juries were composed of Mormons who would not convict their fellows or admit evidence of polygamy; and the act not only disfranchised but excluded from juries all who either practised polygamy or believed it rightful. The disfranchisement was even more effective, as Utah had woman suffrage, and each polygamous wife was disfranchised also. The act made the living with more than one woman in marital relations a misdemeanor, and several leading Mormans were convicted, including their delegate to Congress; which office, as well as all from justice of the peace to probate judge or sheriff, was made inaccessible to polygamists.

Edom, ē'dŏm, in the New Testament, Idumæa, in ancient times a country lying to the south of Palestine. The Edomites are said in Genesis to be the descendants of Esau. The Edomites were subdued by King David, and after the separation of the 10 tribes remained subject to the kingdom of Judah till the reign of Jehoram, when they revolted and secured their independence for a time. They were again subdued by Amaziah and again in the reign of Ahaz, recovered their independence, which they maintained till the time of the invasion of Judea by Nebuchadnezzar. They fell under the rule of the Persians, and latterly their fortunes were merged in those of Arabia.

Ed'red, king of England: d. Frome, England, 23 Nov. 955. He was a son of Edward the Elder, and succeeded to the throne on the murder of his brother, Edmund I., in May 946. He quelled a rebellion of the Northumbrian Danes, and compelled Malcolm, king of Scotland, to renew his homage for his English possessions. Edred died after a reign of nine years, and left the crown to his nephew, Edwy.

Edriophthalmata, ed"rĭ-of-thăl'ma-ta, a name sometimes used for one of the great divisions of the *Crustacea,* including all those genera which have their eyes sessile, or embedded in the head, and not fixed on a peduncle or stalk, as in the crabs, lobsters, etc. These malacostracous *Crustacea* which were formerly included in this group are now generally called *Arthrostaca,* in which all of the thoracic segments, except the first and sometimes the second, are free from the head.

Ed'risi. See Idrisi, Abu Abdallah Mohammed.

Edson, Cyrus, American bacteriologist: b. Albany, N. Y., 8 Sept. 1857; d. 1903. He was graduated at the New York College of Physicians and Surgeons in 1881 and in the following year was appointed a sanitary inspector. In 1893–5 he was health commissioner of New York. He discovered a new treatment for consumption, malaria, and other germ diseases, in 1896, which he named aseptolin. His publications include about 80 papers on medical and sanitary subjects. He was the inventor of many surgical instruments.

DEPARTMENT OF EDUCATION.

Education. *Introductory.*— Responding to the request of the editors of the 'Encyclopedia Americana,' I have seriously endeavored to make (in the necessary limits) as complete a presentation of the growth and present status of popular education in America as practicable. The list of titles is as comprehensive as one would expect to find in any ordinary work exclusively devoted to the subject. A list of other authors who would be welcome in this connection would certainly be a long one, and a few of marked prominence in educational activities are missed with decided regret. But no one who is at all familiar with educational work will be disposed to question the authority, born of experience and accomplishment, which is behind the extended list of titles that has been prepared at my request.

No attempt has been made to develop here anything like a history of educational progress in America. It has been in mind to indicate the present educational situation as clearly as may be in the space permitted, to show the educational organization of the country and the methods of its administration, to suggest the paths which have been heretofore followed, to exploit in some measure the thought which has actuated what has been done, and to do it through men and women whose writings are bound to carry very considerable weight.

With this in mind every branch and grade of the school organization has been treated. All institutions, high and low, whether tax supported, or endowed by private benefactions for the good they may do, or sustained by religious or other interests for the propagation of the same, or only of a proprietary character and operated for private gain, have been considered a part of the school organization of the country. Of course it has not been practicable to include any class of institutions which has not attained some prominence by reason of numbers, of thoroughness of organization, or of distinct and recognized public significance. Special and recent movements in education have been presented, so far as the general purposes of the plan allowed. Educational activities which are wholly outside of the schools have not been passed unnoticed. Libraries, study clubs, public lectures, art movements, instruction by correspondence, work in Christian and other associations, and every organized movement for aiding study or culture outside of the schools have been given such recognition as was practicable.

Educational work in the Dominion of Canada has been presented to some extent. It has come to influence and be influenced by educational work in the United States to an extent which warrants its inclusion. The democracy of learning recognizes no political boundaries, and educational movements in the great Dominion at the north of us — not only because they are coming to interlace with those of the United States, but also because they are often specially instructive — may well have place in any treatment, even in a necessarily brief and summary exposition, of American education.

In the interest of comprehensiveness, Latin-America has not been ignored.

The liberal education of women is rather fully and certainly very capably presented by those who are wholly familiar with the subject.

The distinct tendency of the present time toward training in manual expertness and business efficiency, for their own sake and for a sane and balanced intellectual quickening, as well as the no less decisive movement toward a mastery of world knowledge upon geography, productivity, transportation, and trade, in the interest of the nation's commercial and intellectual primacy, promise to be more adequately reflected here than in any other single place.

Most of the authors of these educational titles are well known, by name at least, to all students of education. Their names have become familiar by reason of length and eminence of service or by reason of special expertness in the field which they treat. A small number might have a word of introduction or explanation by me without impropriety. But it must suffice to say that no one of them is without the right to speak in such a forum. Every one of them has studied seriously, worked industriously, and succeeded in accomplishing something of decided concern to the educational world. Indeed, there has been some effort to introduce several names which are not yet as well known as they are likely to be.

And is there not considerable ground for gratification that education may have even so extended a treatment as this in an encyclopedia?

The leading articles on educational subjects are as follows: ADULT EDUCATION; AGRICULTURAL EDUCATION; AMERICAN UNIVERSITY, THE; ARCHITECTURE, EDUCATION IN; BLIND, EDUCATION OF THE; CANADA: HIGHER, SECONDARY, PRIMARY, CATHOLIC, AND PUBLIC EDUCATION; CANADIAN UNIVERSITIES; COEDUCATION; COLLEGE, THE AMERICAN; COLLEGES FOR WOMEN; COMMERCIAL EDUCATION; CORRESPONDENCE SCHOOLS; EDUCATION: IN THE UNITED STATES; BOARD OF, UNITED STATES; ELEMENTARY; THE DEVELOPMENT OF THE OFFICE OF SCHOOL SUPERINTENDENT; ENGINEERING; HIGHER, IN THE UNITED STATES; INDUSTRIAL; MILITARY; PROFESSIONAL, IN AMERICA; ROMAN CATHOLIC, IN AMERICA; SCIENTIFIC AND TECHNICAL; SECONDARY; SUPPLEMENTAL; IN LATIN-AMERICA; OF WOMEN; UNITED STATES BUREAU OF; EDUCATIONAL ORGANIZATION AND ADMINISTRATION; ENGINEERING, CIVIL; ENGINEERING, MECHANICAL; HOME EDUCATION; INDIAN, EDUCATION OF THE; KINDERGARTEN, IN AMERICA; LAW, AMERICAN SCHOOLS OF; LIBRARY ADMINISTRATION; MANUAL TRAINING; MEDICAL EDUCATION; NEGRO, EDUCATION OF THE; PAINTING, EDUCATION IN; PARISH SCHOOLS; PUBLIC OR COMMON SCHOOLS; RELIGIOUS EDUCATION; SCHOOL SUPERVISION; SCHOOL SYSTEM, AMERICAN; SCHOOLS, COUNTY TRAINING; SCIENCE OF LANGUAGE; SCULPTURE, EDUCATION IN; STATE UNIVERSITIES, THE; STUDY OF EDUCATION; TECHNICAL EDUCATION; TECHNOLOGY, SCHOOLS OF; TRADE SCHOOLS.

ANDREW S. DRAPER.

Education in the United States. Education in the United States since colonial days has been of irregular growth, but rapid and entirely unhampered. Till late in the first half of the 19th century there was no uniformity in schoolroom methods or administrative details, but in each part of the country instruction of children was governed by the customs and traditions which were derived from the early settlers of that section. Through the storm and stress of colonial days, however, education had come to be regarded as a fundamental principle in the development of the new country, and the same theory which controlled the early development of the States and the nation may be said to apply with equal strength to the growth of the schools, namely, equal opportunities for all citizens and freedom from tradition and precedent. Whether the schools had their origin in New England, where Puritan English ideas predominated, or in New York, where the liberal spirit of the Dutch toward popular education influenced their growth, or in the South, where the influence of wealthy landholders, with continental ideas of education for the few, had been less favorable to popular education, they rapidly acquired an individuality and rugged power which led to an incredibly swift development toward free public instruction when the appointed day arrived. The strength of the American school system has been its unquestioned precedence in the minds of the people over all other matters of administration, its careful nurture on independent bases, and the virility with which the different forms have grown into a related system.

What Education Means.—When we speak of the education of a country we must go much deeper than its courses of study, its methods and its administrative machinery. To thoroughly appreciate the growth of education in the United States we must know the history of the people, their temperament, their traditions, and the spirit of their institutions. Education is the outcome of all these. It is the embodiment of the genius, the aspirations and the compromises of a people. No adequate idea of Greek art or Greek literature could be obtained unless there were known the characteristics of the Greek people, their intense love of freedom, and their passion for physical beauty and development. We must look to historical beginnings. The United States has been particularly fortunate in this respect. They have had no legacy of ignorance and stupidity bequeathed to them from the Middle Ages. The very fact that the settlers of the 17th and 18th centuries must have had keen minds and stout hearts to lead them to brave the dangers of the ocean and the wilderness, precluded the forming of the stolid, inert mass of citizenship which every older civilization inherits.

The United States has never been burdened with blind allegiance to precedent or servility to a creed. Whatever nation of Europe you may choose for an example — whether we take France, or Prussia, which for nearly a century have been engaged upon the problem of education for the masses, or England, which has been engaged upon it for a lesser time, or Russia, which is just making a beginning — they have all had first to penetrate down through the ignorance, the superstition, and even the antipathy to culture developed by centuries of mental apathy. They have had first to awaken a responsive spirit — a problem which the United States has escaped. In fact, our educational policies, like other administrative features, have sprung into being in response to the demands of the people and the spirit of the times. Education is a broad term and means not only the mechanism of instruction, but the national life outside the schools and that vital intelligence of the people which maintains its institutions and establishes its ideals.

Government Assistance.—The policy of the general government has always been most liberal toward educational matters. The Federal Constitution of 1789, it is true, assumed no powers over public education and in accordance with the theory which had prevailed during colonial days left the matter entirely to the States for regulation. The reason was not that the framers of the Constitution were in any wise indifferent to education,— quite the contrary; but the theory prevailed that the real responsibility and therefore the expense should fall upon the localities legally chargeable with the custody of the children. The policy from the earliest period of the government in the disposal of the lands of the West was to set aside one section in each township for the support of the common schools, and the famous Ordinance of 1787 for the government of the Northwest Territory contained the provision that «religion, morality and knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall forever be encouraged.» The total amount of land, according to statistics furnished by the United States Bureau of Education, which has been given to the several States for educational purposes since 1785, amounts to 78,659,439 acres, having an original value of about $100,000,000. In addition to this immense endowment of public education throughout the country, Congress by the Act of 1887 authorized a perpetual appropriation of $15,000 per year for each agricultural experiment station connected with a State agricultural college, and under the Act of 1890, $25,000 per year to each of the colleges themselves. In addition to this, the general government provides for the education of the Indians, and the children of Alaska, and has given many independent grants of land, particularly in the southern and western States, for educational purposes. The aggregate value, according to the commissioner of education, of lands and money given for education in the several States, is nearly $300,000,000.

In 1867 Congress authorized the establishment of the National Bureau of Education, «for the purpose of collecting such statistics and facts as shall show the condition and progress of education in the several States and Territories, and of diffusing such information respecting the organization and management of school systems and methods of teaching as shall aid the people of the United States in the establishment and maintenance of efficient school systems, and otherwise promote the cause of education throughout the country.» The Bureau has no direct control over educational matters within a State, but has exercised a tremendous controlling influence through the value of its statistics, the breadth of its investigations and the public confidence in its recommendations.

A National System.— In view of the complicated growth of education in this country the question has often been asked whether there is a national system of education in the United States, or whether there are 50 independent systems, corresponding to the number of States and Territories within our borders. Some doubt might have occurred in answering this question even as late as 20 years ago; but at the present time there is no hesitation in asserting that the United States has a greater unity and similarity in courses of study and methods of administration than exist in any other country of the world, with the exception perhaps of France. This was clearly demonstrated by the educational exhibits of the United States, both at the Paris Exposition of 1900 and at the Saint Louis Exposition of 1904. Had the labels over a portion of the work of Boston and New York been interchanged for those of Denver, Saint Louis or San Francisco, no one not having a knowledge of local touches and coloring could have detected the difference. It was impossible for any person to go from State to State in the educational exhibits at Saint Louis and detect any radical distinction in the work presented or the methods illustrated. Such differences as exist are entirely local in their reasons and are the evidence of the personality of the superintendent or the progressiveness of the community. The fact that there is in this country a truly national system of education has been conceded with some surprise by foreign critics and accepted with a high degree of gratification by the American public. The simultaneous advance in any line of progress of a nation vast in extent and power is an impressive fact. It indicates a flexibility of mind and a solidarity of purpose which would be irresistible applied to any problem. There is the same element of strength in a union of ideas on mental training in every section of a great country as in its physical and constitutional union.

Two reasons seem ready at hand and fully sufficient to account for the fact that 45 States, each under a distinct government in all local matters, separated by climate, tradition and culture, are practically a unit in their educational organization. The first is the influence of the United States Bureau of Education, the second the influence of the National Educational Association. As has been stated, the Bureau of Education can not arbitrarily shape any educational policy. But so wisely has the power of suggestion been used, so forcibly has the inference from statistics been drawn, and so clearly has the comparison of systems, foreign and domestic been set forth, that our educational policies have by force of logic formed in parallel columns. No statement of the influence of the Bureau would be accurate without an acknowledgment of the strong personal influence and acknowledged premiership in all educational matters of the present United States commissioner of education, Dr. William T. Harris.

The second reason, the influence of the National Educational Association, is fully as apparent and one peculiar to this country. Drawing its constituency from every part of the Union, meeting once a year, alternately east and west, in full numbers and twice a year through its Department of Superintendence, there is a constant change of criticism and information which holds in close relation every component factor. No experiment or innovation which has proved a success in the East or the West but has been thoroughly discussed and presented to the representatives of every State in the Union. The Association has become a clearing house for educational ideas, where what is good is adopted and what is bad is rejected, and where the personal relations entered into by the members of the Association insure the respectful consideration of any ideas submitted. The Association at the present time has between 4,000 and 5,000 active members and about 15,000 associate members. The special investigations under its auspices carried on by the Committee of 15, and the Committee of 10, and their reports which have become almost classic, are the basis of the courses of study now pursued in the elementary and secondary schoolrooms of every State in the Union. As a result of these two great forces public education in the United States is to-day maintained and administered on practically similar lines everywhere throughout the country.

Theory of Education in the United States.— The theory upon which the educational system of the United States has been developed is in distinct contrast to that of European countries. In every State the entire course of construction is articulated so as to form a symmetrical unit. The transitions from the elementary to the high school, from the high school to the college, and from the college to the professional school are made without a break and form a steady progression. A pupil may drop out at the end of the elementary or at the end of the high school or in the middle of the high school course, but he has had the same training as those who go on to the end, and if he returns to his school after an interim of two or three years he can take up his work where he left off, handicapped in no respect but by age. Our policy has been to place the entire sequence of studies under one administrative head, and much of our recent thought has been given to so interrelating the different parts as to put forward the time when a student may become a self-supporter.

In the foreign educational systems, on the contrary, there are two distinct courses of study, both under government control, both classed under public education, and parallel in point of time with each other. The first, usually termed primary education, covers instruction from the ages of 5 to about 15 years and is designed to train children of the masses manually and artistically for the trades in store for them. Its influence is to perpetuate social castes. The course parallel to this is known as secondary instruction and covers the ages from 5 to 18 years, fits pupils for the universities, and embraces a study of the classics and humanities in general. It is designed to lead to the cultural professions. Tuition is charged in all secondary schools.

This radical difference in the theory of administering public instruction must always be borne in mind in comparing the American educational system with that of foreign countries. The United States treats all children alike from their earliest years to the last year or two of the high school course. No discrimination is made, or option given, except those based upon the mental capacity of the pupil. As has been tersely said, every child in the United States is educated in the possibility of one day becoming President of the country. In continental Europe, on the other hand, the average child is destined from infancy to follow the occupation of his father and it is only accident that throws him from this rut. His training is highly specialized from his earliest years with this object in view, and while he becomes manually the most expert workman in the world in his own particular craft, he has lost sight of the relations of his trade to every other trade and has never gained that power of initiative essential to the highest success of an individual or of a State. It is firmly believed in this country that the superiority both of American workmen and of American methods, as demonstrated in the remarkable progress made in the commercial and industrial world by the United States during the last quarter-century, is due much more to the liberal training of our public school children till they are 14 or 15 years of age than to an extensive development of any form of special training. First develop the mind on broad, liberal lines so that as a citizen the pupil can grasp all sides of the question, then build on this solid sub-structure the trade, profession or specialty which he is to follow. The conditions in the United States do not require nor do our people demand that there shall be in our courses of study a dominant tendency toward any particular phase of industrial progress. The conditions which govern our growth and development prevent the possibility of a perpetual or hereditary working class. Such a state can exist only in an old and stratified civilization, where all chances of sudden wealth and preferment have been exhausted, and nothing remains for the masses but to attain the highest possible industrial skill in the arts and trades. This is the rock on which every attempt to adopt foreign methods *in toto* in American systems must go to wreck. There is no common basis for adjustment. The differences are fundamental and incident to the different theory which underlies the spirit of popular education in the Old World and the New. A freedom and elasticity is demanded in the educational system of this country to correspond to the possibilities existent in its material development. In making this comparison there is no intention of criticising European educational systems. Facts only are given, and no one can say that the European system is not altogether the best for the social conditions which Europeans have to face. Nothing is more certain, however, that their system is not in accord with the theory of American institutions, and that a system of instruction in this country which tended even in the slightest degree to promote class perpetuity could not stand.

Support of Schools.—The liberal support of education in the United States has been a marked characteristic of its development ever since the great school revival which took place from 1830 to 1845. Prior to this period the establishment of schools had been desultory or without uniform action even in the same State. It consisted mostly in the authorization of detached schools of various grades, each of which was independent in its administration and curriculum. At the period above mentioned, however, the general awakening as to the necessity of organized free public education accessible to every child in the land became a firmly established policy. The influence of great leaders like Horace Mann and Henry Barnard was felt throughout the country and every one of the States then in existence, and every new State as rapidly as formed, assumed the control of all common school education within its boundaries.

The theory of taxation for the support of the schools was founded upon the principle that all property holders, whose interests would be promoted by an intelligent observance of laws on the part of the public, were liable to taxation for common school purposes whether or not they had children who were receiving the benefits of this instruction. The key note of the popular feeling of the time was forcibly put by Webster in his Plymouth Oration: "For the purpose of public instruction," he said, "we hold every man subject to taxation in proportion to his property, and we look not to the question whether he himself have or have not children to be benefited by the education for which he pays; we regard it as a wise and liberal system of police, by which property, and life, and the peace of society are secured. We seek to prevent, in some measure, the extension of the penal code by inspiring a salutary and conservative principle of virtue and of knowledge in an early age. We hope to excite a feeling of respectability and a sense of character by enlarging the capacities and increasing the sphere of intellectual enjoyment. . . . Knowing that our government rests directly upon the public will, that we may preserve it we endeavor to give a safe and proper direction to the public will. We do not, indeed, expect all men to be philosophers or statesmen; but we confidently trust . . . that by the diffusion of general knowledge, and good and virtuous sentiments, the political fabric may be secure as well against open violence and overthrow as against the slow but sure undermining of licentiousness."

Another mighty force which affected not only the public support of education but also the character of the instruction itself was the intense industrial life and the development of unsettled territory which followed the applications of steam and electricity. For 200 years after the foundation of Harvard higher education had followed the same time-honored curriculum, and so long as it was expected to turn out only lawyers, doctors and preachers it sufficed. But an age of material development was at hand, which has already run over half-a-century, and which reads like the tale of a magician. The population of the country has increased from ten to eighty millions of people; the broad areas of an entire continent have been brought under subjugation; systems of transportation bind every part of this great country in close relation; New York and San Francisco are no farther apart than Boston and Philadelphia at the beginning of the period; the inventions of science in every field of human endeavor are a catalogue of wonders; the growth of applied arts to public service has become a prime consideration. The genius of man seems to have sprung forth fully armed to meet the call of opportunity. All this has demanded a variety of talent and a wealth of special training which the old institutions could not furnish, and higher education has been constantly undergoing changes to meet the demands of commerce and industry. Schools of technology and applied science have sprung up by scores; and the curriculums of the older universities have been expanded to furnish the required training. The percentage of students in higher educational institutions has increased at a ratio double the increase of the population. To put the matter briefly it may be said that the colleges, universities, professional and technical schools, whether State supported or privately maintained, have put themselves in closer relations with the people and are aiming to give the highest degree of practical training to their graduates.

The result of this great demand for practically educated men and the result of the general awakening from 1830 to 1850 has led to a liberality both on the part of the States and of the general government in the support of public education which has been unparalleled in history. The establishment of high schools throughout every State in the Union and of state universities in every State west of the Alleghany Mountains — all as a part of the free public school system — are examples of this spirit. The amount expended yearly for public school buildings and school sites has increased at a rapid rate, till in the year 1903 it reached the enormous sum of $46,289,074. The total amount expended for schools in 1903 was $251,457,625.

One of the most striking features in the development of American education has been the immense total of private gifts and benefactions to the cause of education. In many instances they are princely in amount and the sum total during the last 10 years alone approximates $360,000,000. Two great universities, Chicago and Leland Stanford Jr., owe their foundation and growth entirely to the gifts of a patron. In the year 1902–03 an aggregate sum of $20,378,000 was given and bequeathed to colleges, universities, professional and technical schools. In 1904–5 approximately $30,000,000 has been given, of which J. D. Rockefeller's gift of $10,000,000 to the General Education Board is the largest. The year 1901 was the record year for educational gifts. Not less than $73,000,000 were donated to educational institutions and educational enterprises. Mrs. Stanford led the list with her $30,500,000 to the Leland Stanford Jr. University; Andrew Carnegie next with a $10,000,000 endowment for an institution at Washington which shall foster and develop individual research and investigation; Jacob S. Rogers next with his $5,500,000 to the Metropolitan Museum of Art; in all 25 millions more than was given in 1900 and 10 millions more than in 1899. During the last half-century over a half-billion dollars have been given to promote educational institutions of higher rank.

Kinds of Schools.— Co-ordinate with the development of free public schools, the country has also assumed a most liberal attitude towards the growth and development of private and parochial schools. The schools of the United States at the present time may be classed under two main heads: first, those supported by public tax; second, those maintained at private expense. Under the first are included public kindergartens, elementary and secondary schools, normal schools, State universities, agricultural and mechanical colleges, and experiment stations; under the latter academies, private schools, colleges and universities of independent foundation, and other educational institutions supported by incomes and endowments from private sources.

The course of instruction in the United States is practically the same in every locality, and consists of eight years of elementary school work, four years of secondary work, four years in a college or university, and four years in a professional school. The usual age of pupils beginning the elementary course is five or six years, bringing the pupil to the beginning of the high school course at the age of 13 or 14. The high school or secondary course is four years in length in nearly all cities and villages throughout the country, and the entire twelve years' instruction is free to every pupil residing in the school district, and in many parts of the country text-books are provided at public cost. There were according to the statistics of 1903, 15,417,148 pupils in the United States attending public elementary schools and 608,412 attending public high schools. At the same time there were in private and parochial schools 1,093,876 taking elementary subjects and 168,223 taking high school subjects.

About four students out of every 100 who enter the elementary schools continue in the high schools. Upon leaving the high school students may have the choice of entering a college of liberal arts having a four year course, a school of technology, leading to the degrees of civil, mechanical or electrical engineer, or of entering directly a professional school. A few of the universities require for entrance to the professional schools, graduation from the arts department of the university or from a college of liberal arts; but in the great majority of cases it is possible to enter upon the study of law, medicine, dentistry or veterinary surgery immediately upon leaving the high school. In spite of this a majority of pupils graduating from the high schools who intend to enter the professions of law or theology take the arts course in a college or university before beginning their study in a professional school. The average age, therefore, of a graduate from a college of liberal arts and from the scientific and technical schools of the country is about 22. The average age of graduates from professional schools who have not taken the A.B. course is the same; and the average age of those who have entered on their professional study after receiving the A.B. degree is 25 or 26. In the professional schools of many universities an allowance is made of one year to the holders of A.B. degrees, and in several universities having medical faculties the first year in the medical school is permitted to count as the last year of the baccalaureate course. In the profession of medicine, particularly, there is a tendency to look with favor upon this combination, inasmuch as the hospital work required of medical students in addition to the work of the professional school brings them to the age of 26 or 27 before they become wage-earners.

The teachers for the public schools are certified under State laws, and are trained in normal schools maintained at State expense, in training schools and classes, and in pedagogical departments of universities. The number of students enrolled in these institutions in 1903 was 88,003. In the cities and villages of nearly every State in the Union professional training is required of all teachers. In the rural districts ability to pass the State licensing examinations is sufficient qualification. Boards of education have power to demand any qualifications they see fit in addition to the minimum fixed by the State. In 1903 there were 564,755 teachers employed in all grades of school and higher institutions, of which 403,244 were women.

Other Schools and Educational Agencies.—The special schools for the education of the deaf and dumb, blind and feeble-minded are maintained either at State expense or under the auspices of the departments of charity. The prevailing theory, however, is that the training of children defective in any degree is as much a duty of the State as the training of children possessed of all their normal faculties and is in no sense to be construed as a charity.

The training of the Indians is done at government expense and is directed largely in the line of industrial training in order to make them self-supporting and self-reliant. The education of the negro is carried on at public expense exactly the same as for white children, and in the North where the percentage of colored children is very small they are usually educated in the same school. In the South, however, and in some of the larger cities of the North separate schools are maintained for negro children, but with the same equipment and course of study as for white children.

The agencies through which supplemental education is carried on in the United States are very numerous and with many other special features connected with education in the United States are treated in separate articles. Chief among these, however, may be mentioned summer schools, home education, traveling libraries, evening schools, popular lectures, and extension courses in arts and science.

Illiteracy.—In comparing statistics on this subject with those of other countries due regard must be had for two facts: First, the immense number of unschooled negroes of the South; second, the startling increase of foreign immigration. Both of these conditions are being grappled with heroically and the awakened condition of public sentiment in the South toward the education of the negro as a business and economic proposition is already having great effect. The formation of the Southern Educational Board and the General Education Board with particular reference to this problem is one of the most salutary measures of recent years. For foreign immigrants little can be done except to reach the children, and the public schools of our seaboard cities are the great crucibles wherein the varied elements of Europe's miscellaneous population are melted down, cleansed, and run into the molds of American citizenship. The children of immigrants are loyal and enthusiastic lovers of their country, and the eagerness with which the great majority of immigrants place their children in school and the sacrifices which they make to keep them there are pathetic and instructive. According to the educational statistics of 1903 the percentage of native white illiterates in the United States is 4.9; of foreign white illiterates is 11.5; and of negroes is 47.4.

Tendency of Modern American Education.—The history of education in the United States for the last century has shown it to be eminently practical, and peculiarly responsive to public demand. Its close relation and responsibility to the people preclude its taking any other form. It is not a thing apart from the public and for the benefit of the few as in the days of Egyptian priesthood, but rather is the instrument of the people in shaping the destiny of the country. Given, then, the trend of the development of this country and there follows as its corollary the tendency of its education. The 20th century will be the scene of a struggle for commercial and industrial supremacy. The rivalry of nations has already become intense and their activities are turned toward the thousand-fold phases of commerce and industry, each requiring special training, and each dependent on the flexibility of mind and adaptability to conditions of its followers. The United States has entered this world conflict with all its energy, and the successes it has already gained have startled its competitors. The kind of education, therefore, of value to these changed conditions, and best likely to train our citizens for their future work, will be the kind of education to which our schools will perforce adapt themselves. This falls naturally into three divisions: education for commerce, education for trades and other industries, and education for agriculture. The educational leaders of the country are already busily engaged upon the problem of how to adapt sufficient training in these lines to meet the demands of the age, and not destroy at the same time the balance which has been maintained in our curriculums with the more clearly cultural subjects, the broad and liberal training in which has been the source of our past strength and present power. This must not be sacrificed in the adjustment which must inevitably come, for to do so would be to remove the cornerstone of the edifice.

The education of a democracy determines its duration. We are engaged upon the greatest experiment in popular government the world has ever seen. Our remarkable progress should not blind us to the inherent danger of a republic. The advancing tide of socialism, the destructive doctrines of anarchy, the theories of Utopians, and false principles of government, can only be met by making our general public familiar with true economic principles. To bring economic science within the reach of the masses is the vital problem for a democracy. There is only one machinery that can effectually do this — continuous and extensive drill on the rational principles of political and social economics, during the formative period of the minds of our future citizens, is the only inoculant to protect our body politic. It is an old saying that every artisan philosophizes in his own way; but it is a responsibility that the state may well assume to teach him the right way. The strength and promise of our great country lie in the fact that this may be insisted upon without *lèse majesté* to a ruler, or enmity to a creed.

Howard J. Rogers,
First Assistant Commissioner of Education, State of New York.

Education, Agricultural. See Agricultural Education.

Education Board, General. This board was founded in New York City in February, 1902, and chartered by Congress on 12 Jan. 1903, its object being the promotion of education throughout the United States, without distinction as to race, sex, or creed. Beside gifts from several philanthropists, the board received, when chartered, a special gift of $1,000,000 from John D. Rockefeller for carrying on the work in the southern states. Upon the assurance of the success of this movement, on 30 June 1905 he made an additional gift of $10,000,000 and in 1907 a further sum of $32,000,000. See GENERAL EDUCATION BOARD.

Education, Commercial. See COMMERCIAL EDUCATION; TRADE SCHOOLS.

Education, Compulsory. Some one has said that America is a country where no one is compelled to do anything. One might say that the democratic temperament is so universal in America that compulsory processes, save for interests that are generally thought to be imperative, are extremely difficult of execution. This difficulty has been met wherever the effort has been made to secure or to enforce laws requiring attendance upon the schools. The cause is not to be attributed to any indifference to the importance of education, for in no land has the public recognition of this been more common or the provision for it been more universal and munificent; the trouble has arisen from the disinclination of legislators and administrative officers to compel the people in anything which is not clearly seen to be vital to the public safety. So marked has this been that practically all efforts to require general and regular attendance at school was left to the officers and teachers until the labor organizations came to their assistance for the purpose of lessening the competitions with adult labor in the shops and the factories as well as for assuring schooling to the children of the wage earners.

It is more than 50 years since school attendance laws were first enacted in this country, but not until very recently have they begun to take form which would make them effective. Commonly they have declared the duty of the citizen to send his children to school and the duty of the State to assure schooling to every child, but they have not fixed the ages within which all children must be in school, they have not required lists of all children in order to know that all are accounted for, they have not given point to the fact that a parent who robs a child of an education merits punishment until he will be glad to perform a parent's and a citizen's duty, and they have not provided officers seriously charged with the execution of attendance laws and punished them for failure to perform their duties.

Public sentiment not only produces statutes, it is produced by them. The common thought of the masses is guided and seasoned by legislative enactments. If those enactments seem rational, if they spring from world experience and are sustained by the opinions of publicists and statesmen they are accepted by the people. If such enactments are executed with steadiness and uniformity they consolidate sentiment and fix the common thought of the country. This process has been going on for many years in other lands less democratic than ours until we are confronted with the serious fact that in many other countries the attendance upon the schools is not only far more general than here, but the necessity of schooling is much more universally recognized by the masses than here. It is probably the fact that in Germany the law is so exact in its provisions and so uniformly enforced, and has therefore become so universally believed in by the people that in the city of Berlin, with a million and a half of people, there are not at any time ten children out of school when they ought to be there.

A fair beginning has just been made in this direction in the American States. Not only has a substantial advance been made in very recent years in the way of new legislation, but the necessities of the matter are being much more clearly recognized and the principles which must be incorporated in an attendance law to enable it to be effective are much more generally understood.

In the United States, Alabama, Arkansas, Delaware, Florida, Georgia, Maryland (except the city of Baltimore), Mississippi, North Carolina, South Carolina, Tennessee, Texas and Virginia have no school attendance laws whatever.

Thirty-two States have compulsory attendance statutes more or less effective. In practically all of these, children are required to attend school from the age of 7 or 8 to that of 14 or 16, for a portion or the whole of the school year. In Illinois, Indiana, Kansas, Maine, Massachusetts, in the cities but not the rural districts of Michigan, in Minnesota, Montana, New Hampshire, New Jersey, North Dakota, Ohio, Oregon, Pennsylvania and Rhode Island, the attendance within the required ages must be during all the time the schools are in session. In New York it must be for eight months, which is the minimum length of the school year. In Wisconsin the period is eight months in the cities and five months in the rest of the State. In Vermont it is 28 weeks. In California it is five months for which 18 weeks must be consecutive. In Utah it is 20 weeks, of which 10 must be consecutive. In Colorado, Connecticut, Idaho, Iowa, Michigan, outside of the cities, Nebraska, Nevada, South Dakota and Wyoming it is from 12 to 18 weeks. In Kentucky it is eight weeks.

In the States having such laws violations are punished by fines varying from $5 to $50 in amount. In California, Indiana, Maine, Michigan, Minnesota, Missouri, New Jersey, New York, Ohio, Pennsylvania, Utah, and Wisconsin the offender may be imprisoned. In New York, Massachusetts, Pennsylvania and Washington the school moneys may be withheld from a city or district which neglects to enforce the law.

The more advanced States are beginning to provide for an enumeration of children of school age in order to supply information as to who should be in school and also for special officers whose duty it is to see that all are accounted for.

A noticeable difference between the compulsory attendance laws in America and in the more advanced European nations is that with us attendance within specified ages is required, while with them the attendance must continue until a specified measure of educational proficiency is proved to the satisfaction of school officers.

There is no doubt of effective attendance laws reducing illiteracy. The comparisons between the European nations themselves as well as between our States and the European nations are exceedingly interesting; and the comparisons of one American State with another are no less so. In Italy with no law in force the percentage of illiterates above 20 years of age is 52, while in France with an effective law it is less than 5. In Russia with no law it is 61 per cent, while in Holland with a good law it is 2 per cent, and in Sweden and Denmark it is less than 1 per cent. In Spain it is 68 per cent with no law and in England with a stringent law the percentage of illiteracy almost disappears.

Of course other factors than compulsory attendance upon school enter in some degree into the measure of illiteracy in a State, but there can be no doubt about systematic and enforced school requirements being the overwhelming factor. The following figures taken from the United States census of 1900 are conclusive:

Percentage of illiterate voters in States having compulsory attendance laws:

California	6.2
Colorado	4.1
Connecticut	6.8
Idaho	5.4
Illinois	4.8
Indiana	5.6
Iowa	2.7
Kansas	3.4
Kentucky	18.8
Maine	6.4
Massachusetts	6.4
Michigan	5.5
Minnesota	4.1
Missouri	7.0
Montana	6.1
Nebraska	2.5
Nevada	12.8
New Hampshire	7.9
New Jersey	6.9
New York	5.9
North Dakota	5.4
Ohio	4.8
Oregon	4.8
Pennsylvania	7.7
Rhode Island	9.2
South Dakota	5.0
Utah	3.7
Vermont	7.9
Washington	3.4
West Virginia	12.9
Wisconsin	5.5
Wyoming	4.3

Percentage of illiterate voters in States without compulsory attendance laws:

Alabama	33.7
Arkansas	20.0
Delaware	14.0
Florida	22.1
Georgia	31.6
Louisiana	37.6
Maryland	12.5
Mississippi	33.8
North Carolina	29.4
South Carolina	35.1
Tennessee	21.7
Texas	15.4
Virginia	25.3

The States of Kentucky, Nevada, and West Virginia in the first table above may seem exceptional. They are really not so, for their compulsory laws are new or not enforced. Their chief educational officers have officially said, of Kentucky: "In the rural districts the law is almost a nullity." Of Nevada: "The law has never been enforced. It is sometimes used to scare foreigners. As it now stands it is a dead letter. We can not force the legislature to amend it." Of West Virginia: "The law is new and not yet fully developed." The evidence seems conclusive that the sentiment of a State determines the percentage of illiteracy, and the best proof as well as the necessary instrument of a healthful public sentiment is a compulsory attendance law which compels. There will, of course, be special circumstances, like the presence of large cities, or of a large body of recent immigrants, or of particularly hard economic conditions, but ordinarily it may be safely said, with entire confidence, that a low rate of illiteracy and effective compulsory attendance upon the schools will be found to be companions in the same State.

Much has already been done in Europe to assure the attendance of defective children; that is, the deaf, dumb, blind, etc., while practically nothing has been done in that direction in America. Much provision has been made for them in the more advanced of our States, but their attendance has not been made obligatory to any extent.

It cannot be assumed that all parents wish or are even willing that their children shall go to school. There are parents who are idle and criminal themselves and are without any interest in the well-being of their children and in the welfare of the State. There are parents who are neither idle nor vicious, but who are so lacking in outlook that they will keep their children at work without cause when they should be in school. And there are still other parents whose necessities are real and overcome any interest they may have in the schooling of their children. Of course there are many children who are without parental care and interest.

In all such cases it is the imperative function of the State to intervene and not only see that the child not only has the training which his living in this country gives him as his natural right, but also that he is saved from being a load upon other people, and is prepared to carry his share of the burdens of the State and contribute his share to the prosperity and greatness of the State.

Experience has shown conclusively enough the steps by which, and by which alone, this may be accomplished. Speaking generally they may be enumerated as follows:

1. There must be a registration of all children and of their ages.

2. All within fixed ages must be in school or accounted for.

3. They must be in school at all times when the schools are in session.

4. Absence of children within the attendance limits of age must be for none but imperative reasons satisfactory to the attendance officers, such as sickness or physical disability, or they must be able to satisfy school officers that they are proficient in the work which children within the attendance age may be expected to acquire. Doubtless it would be even better if the only excuse for absence, aside from physical inability, should be proficiency in work rather than the attainment of an age limit.

5. Parents or legal guardians must be held responsible for attendance and neglect must be punished by fine at first and then by imprisonment sufficient to emphasize the seriousness of the offense.

6. Special officers must be charged with the execution of attendance laws. They must operate upon a well ordered system. They must be sufficiently compensated to enable them to be respected and must be vested with powers which will enable them to be regarded. They must

account for all children within the prescribed ages. They must be authorized to enter shops and factories where children are employed and apprehend employers who violate the school and labor laws. They must co-operate with teachers to reduce truancy to a minimum and they must initiate proceedings to punish parents or guardians who are delinquent.

7. Attendance laws must apply evenly to all parts of the State, country as well as city.

8. Attendance officers must be subject to the direction and discipline of the general officers of the school system.

The uniform habit of having all children in school is somewhat inherent and somewhat dependent upon economic conditions. It is acquirable where it is not common. It will be acquired and become fixed under the steady and persistent requirements of the State. It is imperative to the security of government and the strength of it will measure the true greatness of a people. Illiteracy may be steadily and surely reduced by systematic policy, and the State which has the most heterogeneous or indifferent population and which goes farthest in reducing illiteracy should have the place of highest honor and respect in the American republic.

Compulsory attendance upon American schools is as yet in its earliest stages, but a good start has been made, public sentiment is ripening, and the movement must advance until it covers the land with very considerable uniformity and is enforced with very general effectiveness.

ANDREW S. DRAPER,
Commissioner of Education, State of New York.

Education, Elementary. In all the schools of the United States, public and private, elementary, secondary and higher, there were enrolled in the year 1899–1900 about 17,500,000 pupils. The actual average attendance for each pupil in the public or common schools did not exceed 98 days, although the average length of the school session was 1,446 days.

Out of this entire number deduct the pupils of private and parochial schools of all kinds, elementary, secondary, higher, and schools for art, industry and business, for defective classes and Indians, there remain over 15,300,000 for the public school enrolment, or nearly 90 per cent of the whole. The great growth of public schools in the last 30 years may be gathered from a 60 per cent increase in the cost of common schools, owing to better apparatus and more commodious school buildings, but especially to longer terms and higher salaries to teachers. The effect of the great increase of railways in the same period is to extend the suburbs of cities and vastly increase the urban population. The rural schools in sparsely settled districts still continue their old practice of holding a winter school with a session of 60 to 80 days only, and taught by the makeshift teacher who works at some other employment for two thirds of the year. The school year of ideal length should be about 200 days, or five days per week for 40 weeks, that is, nine and one half months. In the early days of city schools the attempt was made to hold a session of over 46 weeks in length, allowing only six weeks or less for three short vacations. But experience of their advantage to the pupil has led to the increase of the holidays to nearly double the former amount.

The average schooling, it appears from the above showing, amounts to enough to secure for each person a little more than one half of an elementary school course of eight years,— enough to enable the future citizen to read the newspaper, to write fairly well, to count, add, subtract, multiply and divide, and use the simplest fractions. In addition he acquires a little geographical knowledge, so important to enable him to understand the references or allusions in his daily newspaper to places of interest in other parts of the world. But the multiplicity of cheap books and periodicals makes the life of the average citizen a continuation of school to some extent. The transformation of an illiterate population into a population that reads the daily newspaper, and perforce thinks on national and international interests, is thus far the greatest good accomplished by the free public school system of the United States. That this general prevalence of elementary education is accompanied by a comparative neglect of the secondary and higher courses of study is evident from the fact that out of the number of pupils enrolled more than 95 in every 100 are pursuing elementary studies; less than 4 in 100 are in secondary studies in high schools, academies and other institutions; only 1 in 100 (13 in 1,000) is in a college or a school for higher studies.

In considering the reasons for the increase of the length of the term of the elementary school and its adoption of a graded course of study, one comes upon the most important item of improvement that belongs to the recent history of education, namely, the introduction of professionally trained teachers. The first normal school established in the United States was founded at Lexington, Mass., in 1839. The number of public normal schools supported by the State or municipal governments has increased since that year to nearly 200, and there is about an equal number of private normal schools. In 1880 there were 240 normal school students in each 1,000,000 of inhabitants; in 1897 there were 936, or nearly four times as many in each 1,000,000. The professionally educated teacher finds his place in the graded schools, and he continues to improve in skill and efficiency for many years. The advantage of the professionally educated teacher above others is to be found in the fact that he has been trained to observe methods and devices of instruction. The normal school graduate, too, other things being equal, has a better idea than other teachers of the educational value of a branch of study. He knows what points are essential, and what are accidental and subsidiary. He therefore makes his pupils thoroughly acquainted with those strategical positions, and shows him how to conquer all the rest through these.

As it would appear from the statistics given, the rural districts are precluded by their short school terms from securing professional teachers. The corps of teachers in a highly favored city will be able to claim a large percentage of its rank and file as graduates of its municipal training schools — perhaps 50 to 60 per cent; but the cities and villages as a whole in their graded schools cannot as yet show an average of more than one teacher in four who has received the diploma of a normal school. Another important advantage has been named as belonging to the schools of the village or city. They are graded schools, and have a regular course of study, uniformity of text-books, and a proper classification of pupils. In the small rural schools some 20 to 50 pupils are brought together under one teacher. Their ages vary from 4 years to 20, and their degree of advancement ranges from beginners up to those who have attended school for 10 or 12 winters, and are now attempting Latin and algebra. It often happens that there is no uniformity of text-books, except perhaps in the spelling-book and reader, each pupil bringing such arithmetic, geography or grammar as his family at home happens to possess. This was the case in the old-time district school — such as existed in 1790, when 29 out of 30 of the population lived in rural districts, and 50 years later when only 1 in 12 lived in a city. As the railroad has caused villages to grow into cities, so it has virtually moved into the city a vast population living near railway stations in the country by giving them the morning newspaper and rapid transportation. In 1890 one third of the population was living in cities of not less than 8,000 inhabitants. But the suburban populations made urban by the railroad swell the city population to one half of the whole nation. Hence the great change now taking place in methods of building school-houses and in organizing schools.

With the growth from the rural to the urban condition of population the method of "individual instruction" has been supplanted by class instruction, which prevails in village and city schools. The individual did not get much instruction under the old plan, for the simple reason that his teacher had only 5 or 10 minutes to examine him on his daily work. In the properly graded school each teacher has two classes, and hears one recite while the other learns a new lesson. Each class is composed of 20 to 30 pupils of nearly the same qualifications as regards the degree of progress made in their studies, and all pupils learn more by a class recitation than by an individual recitation, for in the class each can see the lesson reflected in the minds of his fellow pupils, and understand his teacher's views much better when drawn out in the form of a running commentary on the mistakes of the duller or more indolent pupils. The possibilities of a class recitation are, therefore, very great for efficient instruction in the hands of a teacher who understands his business. From beginning to end, for 30 minutes, the class recitation is a vigorous training in critical alertness. The pupil afterward commences the preparation of his next lesson from the book with what are called new "apperceptive" powers, for he finds himself noticing and comprehending many statements and a still greater number of implications of meaning in his lesson that before had not been seen or even suspected.

It is presupposed that the chief work of the pupil in school is the mastery of text-books containing systematic treatises giving the elements of branches of learning taught in the schools. The evil of memorizing words without understanding their meaning or verifying the statements made in the text-book is incident to this method and is perhaps the most widely prevalent defect in teaching to be found in the schools of the United States. The oral method of Germany escapes this evil almost entirely, but encounters another. The pupil taught by the oral method exclusively is apt to lack power to master the printed page and get out of it the full meaning; he needs the teacher's aid to explain the technical phrases and careful definitions. The American method of text-book instruction throws the child upon the printed page and holds him responsible for its mastery. In the hands of a trained teacher the good of the method is obtained and the evil avoided. The pupil is taught to assume a critical attitude toward the statements of the book and to test and verify them, or else disprove them by appeal to other authorities, or to actual experiments.

In the graded school the pupil is held responsible for his work in a way that is impossible in the rural school of sparsely settled districts Hence the method of investigation, as above described, is found in the city schools rather than in the rural schools. Where the ungraded school makes some attempt at classification of pupils it is obliged to unite into one class say of arithmetic, grammar, or geography, pupils of very different degrees of progress. The consequence is that the most advanced pupils have not enough work assigned them, being held back to the standard of the average. It must be admitted that in many village schools just adopting the system of grading, this evil of holding back the bright pupils and of over-pressure on the dull ones exists, and furnishes just occasion for the criticism which is made against the so-called "machine" character of the American public school. I have dwelt on this somewhat technical matter because of its importance in understanding the most noteworthy improvements in progress in the schools of the United States. Briefly, the population is rapidly becoming urban, the schools are becoming "graded." Here there is division of labor on the part of teachers, one taking only classes just beginning to learn to read and write, another taking the pupils in a higher grade. The inevitable consequence of such division of labor is increase of skill. The complaint urged against the machine character of the modern school is made quite as often against good schools as against poor ones. But the critical-probing method of conducting a recitation is certainly not machine-like in its effects. It arouses in the most powerful manner the activity of the pupil to think and observe for himself. It is admitted that about 50 per cent of the teachers actually teaching in the schools of villages and cities use this poor method. But it is certain that their proportion in the corps of teachers is diminishing, thanks to the two causes already alluded to: first, the multiplication of professional schools for the training of teachers; and second, the employment of educational experts as supervisors of schools.

Another phase of the modern school that more than anything else gives it the appearance of a machine is its discipline, or method of organization and government. In the graded school with 300 to 800 pupils order and discipline are necessary even to the last particular, for the safety of the pupils as well as for the accomplishment of the ends for which the school exists. There must be regularity and punctuality, silence and conformity to order, in coming and going. These things seem at first to be so much waste of energy. But the moment the question of moral training comes to be investigated, the superiority of the education given in the large school is manifest. The pupil is taught to be regular and punctual in his attendance on school and in all his movements, not for the sake of the school alone, but for all his relations to his fellow men. He learns to respect the serious business of others. In moving to and fro by a sort of military concert and precision he acquires the impulse to behave in an orderly manner, to stay in his own place and not get in the way of others. Hence he prepares for concerted action, — another important lesson in citizenship, leaving entirely out of account its military significance. With the increase of cities and the growth of great industrial combinations this discipline in the virtues that lie at the basis of concerted action is not merely important, but essential. Precision, accuracy, implicit obedience to the head or directive power, are necessary for the safety of others and for the production of any positive results. The rural school does not fit its pupils for an age of productive industry and emancipation from drudgery by means of machinery, but the city school performs this so well that it reminds some people unpleasantly of a machine.

In the matter of school discipline again the graded school has an advantage over the school of the rural district. A corps of teachers can secure good behavior more efficiently than a single teacher. The system, and its very "mechanism," help this result. In many cities of the largest size in the United States, corporal punishment is seldom resorted to, or is entirely dispensed with, and the discipline of the school seems to improve as a result. The adoption of a plan of building giving each class-teacher a room to herself, in which pupils to the number of 50 or so prepare their lessons under the eye of the same teacher that conducted their recitations makes it possible to manage a school with little or no corporal punishment. That the public schools of cities have worked great and favorable changes to the advantage of civil order cannot be doubted. They have generally broken up the feuds that used to prevail between the people of different precincts. Learning to live without quarreling with school-fellows is an efficient preparation for an orderly and peaceful life with one's neighbors. It is a stronger moral force than the rural school because of its superior training in the social habits named — regularity, punctuality, orderly concerted action and self-restraint.

Even in colonial times as far back as 1642 a compulsory law was enacted in Massachusetts inflicting penalties on parents for the neglect of education.

In the Connecticut colony in 1650 the Massachusetts law was adopted. Amendments were adopted in 1805 and 1821. By a law of 1813 manufacturing establishments were compelled to see that "the children in their employ were taught to read, write and cipher, and that attention was paid to their morals." In 1842 a penalty was attached to a similar law which forbade "the employment of children under the age of 15 years unless they had been instructed at school at last 3 months of the 12 preceding." At the present 30 States, one Territory and the District of Columbia have laws making education compulsory, generally at a public or approved private school. Sixteen States and one Territory do not make education compulsory, although all of these have fully organized systems of schools free to every child of school age of whatever condition. The most general period of required attendance at school is from 8 to 14 years of age, as is the case in Vermont, District of Columbia, West Virginia, Indiana, Michigan, North Dakota, South Dakota, Nebraska, Kansas, Montana, Colorado, Utah, Nevada, Idaho, Oregon and California. It begins likewise at 8, but is extended to 15 in Maine and Washington, and is from 8 to 16 in New Hampshire, Connecticut, New York, Pennsylvania, Minnesota and New Mexico. The child is required to begin attendance at the earlier age of 7, and continue to 12 in New Jersey, to 13 in Wisconsin, to 14 in Massachusetts, Kentucky and Illinois; to 15 in Rhode Island, and to 16 in Wyoming. In Massachusetts and Connecticut the child is required to attend the full time that the schools are in session; in New York and Rhode Island, also, the full term, with certain exceptions in favor of children employed to work. In Pennsylvania the attendance is required for 70 per cent of the full term; in California for 66 2-3 per cent; for 20 weeks annually in Vermont, New Jersey, Ohio and Utah; 16 weeks annually in Maine, West Virginia, Illinois, Michigan and Nevada; 12 weeks annually in New Hampshire, District of Columbia, Indiana, Wisconsin, Kansas, North Dakota, South Dakota, Nebraska, New Mexico, Idaho, Washington, Oregon; and 8 weeks annually in Kentucky. Massachusetts requires counties, and New York requires cities to maintain truant schools, or provide for their truants in the truant schools of neighboring localities. Illinois requires cities of over 100,000 inhabitants to maintain truant schools. In Rhode Island towns and cities must provide suitable places for the confinement and instruction of habitual truants. Clothing is furnished in case of poverty to enable children to attend school in Vermont, Indiana and Colorado.

In both the central and the western divisions the education of boys and girls in the same schools is common and exceptions rare in the public schools. In the North and South Atlantic divisions many of the older cities continue to educate the girls in separate schools. In newly added suburban schools, however, coeducation is the rule (as in Boston, for example). In the rural districts of the Atlantic divisions north and south, coeducation has always been the custom. Considering the whole country, it may be said that coeducation, or the education of boys and girls in the same classes, is the general practice in the elementary schools of the United States. The cities that present exceptions to this rule are fewer, apparently, than 6 per cent of the total number. In the majority of these cities the separation of boys and girls has arisen from the position or original arrangement of buildings, and is likely to be discontinued under more favorable conditions. Of the 50 principal cities, four, namely, Philadelphia, Newark, Providence, and Atlanta report separation of the sexes in the high schools only; two cities of this class, San Francisco and Wilmington, reported in 1892, separation in all grades above the primary. In six cities, New York, Brooklyn, Boston, Baltimore, Washington and Louisville, both separate and mixed classes are found in all grades. Five cities of the second class, having a population of 8,000 or more, report separation of the sexes in the high schools, and 10 cities of the same group separate classes in other grades. Of cities whose population is less than 8,000, nine report separate classes for boys and girls in some grades. Coeducation is the policy in about two thirds of the total number of private schools reporting to this bureau, and in 65 per cent of the colleges and universities.

In connection with this matter of State compulsory laws against neglect of schools it is well to mention the provisions made in the several States prohibiting appropriations of money to aid denominational schools. There are 40 States with constitutional provisions forbidding all, or at least sectarian, diversion of the money raised for the support of education.

1. *Constitutions which prohibit sectarian appropriations.*— California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Montana, New Hampshire, North Dakota, Oregon, South Dakota, Texas, Washington, Wisconsin, Wyoming — 21 States.

2. *Constitutions which do not prohibit sectarian appropriations.*— Alabama, Arkansas, Connecticut, Delaware, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Nebraska, Nevada, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia — 23 States.

3. *Constitutions which prohibit any diversion of the school fund.*— Alabama, Arkansas, California, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, Nevada, New Jersey, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Washington, West Virginia, Virginia, Wisconsin — 36 States.

Manual training is by no means a novelty in American schools. Thomas Jefferson recommended it for the students of the University of Virginia, and Benjamin Franklin included it in his plan for an academy in Philadelphia. An active propaganda was carried on in behalf of manual labor in educational institutions for many years, beginning about 1830, and some of our foremost institutions had their origin under its influence. But what is now known as "manual training" is traced to an exhibit of a Russian institution at the Centennial Exposition in 1876. The value of the system of hand training there suggested was recognized by such men as John D. Runkle and C. M. Woodward, who became advocates of the new idea and introduced it into the institutions under their charge. Strong opposition was met among schoolmen for a time, but manual training has steadily grown in popularity, and with its growth it has constantly improved in matter and method, and consequently in usefulness. In 1898 manual training was an essential feature in the public school course of 149 cities. In 359 institutions other than city schools there is training which partakes more or less of the nature of manual training, and which belongs in a general way to the same movement. These institutions embrace almost every class known to American education, and the manual features vary from the purely educational manual training of the Teachers College in New York city to the specific trade instruction of the apprentice schools. In many cases the legislatures have taken cognizance of the movement. Massachusetts requires every city of 20,000 inhabitants to maintain manual training courses in both elementary and high schools. Maine authorizes any city or town to provide instruction in industrial or mechanical drawing to pupils over 15 years of age; industrial training is authorized by general laws in Connecticut, Illinois, Indiana (in cities of over 100,000 population), Maryland, New Jersey, New York, Pennsylvania, Utah, Wisconsin and Wyoming. Congressional appropriations are regularly made for manual training in the District of Columbia; Georgia authorizes county manual labor schools, and in Washington manual training must be taught in each school under the control of the State Normal school. See MANUAL TRAINING.

Kindergartens are authorized by general law in Arizona, California, Colorado, Connecticut, Illinois, Indiana, Iowa, Michigan, New York, Ohio, Oregon, Pennsylvania, Vermont and Wisconsin. Cities also establish kindergartens through powers inherent in their charters. In 1897–8 there were public kindergartens in 189 of the 626 cities of 8,000 population and over. In these 189 cities there were 1,365 separate kindergartens supported by public funds. The number of kindergarten teachers employed in this year was 2,532, and under their care were 95,867 children, 46,577 boys and 49,290 girls. Information was obtained concerning 2,998 private kindergartens in 1897–8 and it is probable that at least 500 others were in existence. The 2,998 private kindergartens had 6,405 teachers and 93,737 pupils. It will be seen that the total number of kindergartens, public and private, was 4,363, with 8,937 teachers and 189,604 pupils. The actual number of pupils enrolled in kindergartens in the United States in 1897–8 must have exceeded 200,000, as these reports were not exhaustive.

Education in the United States is regarded as something organic, and as belonging essentially to our political and social structure. We are making the experiment of self-government, and it has seemed a logical conclusion to all nations of all times that the rulers of the people should have the best education attainable. Then, of course, it follows that the entire people of a democracy should be educated, for they are the rulers. This necessity for education has been felt in all parts of the nation, and the whole subject is reasoned out in many a school report published by city or state. By education we add to the child's experience the experience of the human race. His own experience is necessarily one-sided and shallow; that of the race is thousands of years deep, and it is rounded to fulness. Such deep and rounded experience is what we call wisdom. To prevent the child from making costly mistakes we give him the benefit of seeing the lives of others. The successes and failures of one's fellow men instruct each of us far more than our own experiments. The school attempts to give this wisdom in a systematic manner. It uses the essential means for its work in the shape of text-books, in which the experience of the race is digested and stated in a clear and summary manner, in its several departments, so that a child may understand it. He has a teacher to direct his studies and instruct him in the proper methods of getting out of books the wisdom recorded in them. He is taught first in the primary school how to spell out the words and how to write them himself. Above all, he is taught to understand the meaning of the words. All first use of words reaches only a few of their many significations; each word has many meanings and uses, but the child gets at only one meaning, and that the simplest and vaguest, when he begins. His school work is to train him into accuracy and precision in the interpretation of language. He learns gradually to fill each word of the printed page with its proper meaning. He learns to criticise the statements he reads, and to test them in his own experience and by comparison with other records of experience. In other words, the child at school is set to work to enlarge his own puny life by the addition of the best results of other lives. This is the clue to the hopes founded on education. The work of the school produces self-respect, because the pupil makes himself the measure of his fellows and grows to be equal to them spiritually by the mastery of their wisdom. Self-respect is the root of the virtues and the active cause of a career of growth in power to know and power to do. Webster explained the effect of the school as exciting "a feeling of responsibility and a sense of character." Each youth educated in the school has been submitted to a training in the habit of self-control and of obedience to social order. He has become to some extent conscious of two selves; the one his immediate animal impulse, and the second his moral sense of conformity to the order necessary for the harmonious action of all. The statistics of crime confirm the anticipations of the public in regard to the good effects of education. The jails of the country show pretty generally the ratio of 8 to 1 as the quotas of delinquents furnished from a given number of illiterates as compared with an equal number of those who can read and write. And it is found on investigation that the criminals who can read and write are mostly from the ranks bordering on illiteracy. They may be described as *barely* able to read and write, but without training in the use of those arts for acquainting themselves with the experience and wisdom of their fellow men. Thus the political problem, which proposes to secure the general welfare by entrusting the management of the government to representatives chosen by all the people, finds its solution in the establishment of schools for the people.

All who become interested in the system of education prevailing in the United States and see the direct bearing it has on the realization of the ideal of self-government, feel an interest in the question of its origin. Immigrants to America in the colonial period laid stress on the establishment of schools. Education is called "the foundation of the commonwealth," in 1583, in a school law of Holland. At that time there was a stringent school law passed. In Sweden education was common before 1650, and every peasant's child was taught to read. Boston, in 1635, voted a school and funds to support a master. Roxbury was quite active in the founding of free schools. Plymouth, Weymouth, Dorchester, Salem, Cambridge, and other towns had schools before 1650. A law of the general court of Massachusetts decreed that in every town the selectmen should prosecute those who refused to "train their children in learning and labor," and to impose a fine of 20 shillings on those who neglected to teach their children "so much learning as may enable them perfectly to read the English tongue." Schools were established in the Connecticut colonies immediately after their settlement. The Rhode Island colonies had schools by 1650. Meanwhile in New York the Dutch had brought over their zeal for education. The Dutch West India company, in 1621, charged its colonists to maintain a clergyman and a schoolmaster. It seems that in 1625 the colonial estimate included a clergyman at 1,440 florins, and a schoolmaster at 360 florins. In 1633 the first schoolmaster arrived — Adam Roelandson. His name is revered like that of Ezekiel Cheever and Philemon Purmont, schoolmasters of early Boston. New Jersey established schools as early as 1683, and an example of a permanent school fund is found in an appropriation made that year. In 1693 a law compelled citizens to pay their shares for the maintenance of a school. The original charter given William Penn required that the government of his colony should erect and aid public schools. Within 20 years after its settlement, schools were founded in Philadelphia, and others in towns of that colony.

Most of these schools mentioned were more truly secondary than elementary. See EDUCATION, SECONDARY.

The management of the district (elementary) schools began in most cases with the church and gradually came into the hands of the smallest political subdivision, known as "districts." Each township was divided into districts for school purposes, and for minor political purposes such as repair of the public highways. Each district contained an average of four square miles, with a school-house near the centre of population, usually a little distance from some village, and holding a maximum of 40 or 50 pupils. The school committee employed teachers. The schools held a three-months' session in the winter, and sometimes this was made four months. When the villages began to catch the urban spirit and establish graded schools with a full annual session, there came a demand for a higher order of teacher, the professional teacher, in short. This caused a comparison of ideals; the best enlightened in the community began an agitation of the school question, and supervision was demanded. In Massachusetts, where the urban civilization had made most progress, this agitation resulted in the formation of a state board of education of 1837, and the employment of Horace Mann as its secretary (June, 1837). Boston had been connected with Providence, Worcester and Lowell by railroads before 1835, and in 1842 the first great trunk railroad had been completed through Springfield to Albany, opening to Boston a communication with the great West by the Erie canal and the newly completed railroad from Albany to Buffalo. This was the beginning of the great urban epoch in America that has gone on increasing the power of the city to this day. Horace Mann came to the head of education in Massachusetts just at the beginning of the epoch of railroads and the growth of cities. He attacked with unsparing severity the evils of the schools as they had been. The school district system, introduced into Connecticut in 1701, into Rhode Island about 1750, and into Massachusetts in 1789, was pronounced by him to be the most disastrous feature in the whole history of educational legislation in Massachusetts. Horace Mann extended his criticisms and suggestions to the examination of teachers and their instruction in teachers' institutes; to the improvement of school buildings; the raising of school funds by taxation; the creating of a correct public opinion on school questions; the care for vicious youth in appropriate schools. He discarded the hide-bound text-book method of teaching and substituted the oral discussion of the topic in place of the memorizing of the words of the book. He encouraged school libraries and school apparatus. Horace Mann's influence founded the first normal school in the United States at Lexington (afterward moved to Framingham), and a second one founded at Bridgewater in the fall of the same year (1839). Inspired by the example in Massachusetts, Connecticut was aroused by Henry Barnard, who carried through the legislature the act organizing a state board of commissioners, and became himself the first secretary of it (1839). In 1849, Connecticut established a normal school. In 1843, Mr. Barnard went to Rhode Island and assisted in drawing up the state school law under which he became the first commissioner, and labored there six years.

These were the chief fermenting influences in education that worked a wide change in the management of schools in the middle and western States within the past 50 years. Superintendents of city school systems began in 1837 with Buffalo. Providence followed in 1839; New Orleans in 1841; Cleveland in 1844; Baltimore in 1849; Cincinnati in 1850; Boston in 1851; New York, San Francisco and Jersey City in 1852; Newark and Brooklyn in 1853; Chicago and St. Louis in 1854; and finally Philadelphia in 1883. State superintendents began with New York, 1813; New York was followed by 16 of the States before 1850. From 1851 to the Civil War, eight States established the office of State superintendent; since then, 19 other States, including 10 in the South, that had no State systems of education previously. Normal schools in the United States increased from one, beginning in 1839 in Massachusetts, to 138 public and 46 private normal schools in 1889, with an attendance of upwards of 28,000 students preparing for the work of teaching. This would give a total of some 12,000 a year of new teachers to meet the demand. It may be assumed, therefore, that less than one sixth of the supply of new teachers comes from the training schools specially designed to educate teachers. The history of education since the time of Horace Mann is very largely an account of the successive modifications introduced into elementary schools through the direct or indirect influence of the normal school.

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U. S. Commissioner of Education.

Education, Engineering. One of the most marked features of recent educational history is the increasing attention given to engineering education. Engineering has been defined as the direction and control of the forces of nature for the use and convenience of man; but until comparatively recently there was no systematic attempt to formulate the principles of engineering nor any organized effort to instruct beginners in these principles.

Engineering education, the application of the sciences to the needs of man, in this country has been a growth entirely within the past 100 years. At the beginning of the 19th century organized instruction in engineering was confined to two or three schools on the continent of Europe. The United States Military Academy was founded in 1802, and for about 30 years was the only organized agency for engineering education in America. For three quarters of a century a surprising proportion of the graduates of this institution practised engineering in civil life, not because the education there given was what would now be called engineering instruction, but because it was the best preparation for engineering practice that could then be obtained. At Troy, N. Y., between 1825 and 1835 was established the first institution in the world for giving instruction in engineering not military. In the next 30 years only four engineering schools were founded, of which only two were really entitled to the name engineering. At the close of the Civil War the graduates of the engineering schools, exclusive of West Point, numbered less than 300.

In 1862 Congress passed an act giving to the several States public lands for the benefit of "instruction in the arts and sciences relating to agriculture and the mechanical arts"; and shortly after the close of the Civil War many of our engineering schools were organized under this act. Never was there a movement more timely or more successful than this, since it has resulted in the establishment of 64 technical colleges — at least one in each State and Territory. Fifty of these give instruction in one or more branches of engineering.

At present there are something over 100 institutions claiming to give instruction in engineering, of which nearly 100 give more or less complete courses in one or more branches of engineering. Of these institutions, 67 offer complete courses in civil engineering, 61 in mechanical engineering, 49 in electrical engineering, 21 in mining engineering, 15 in architecture, 2 in naval engineering, and 2 in sanitary engineering. The number of students in these courses has increased with astonishing rapidity in recent years; in 1889 there were 3,043; in 1899, 9,659; in 1900, 11,874; in 1901, 13,753; in 1902, 16,538. The rate of increase is most remarkable; during the first decade above the average annual increase was about 660, while during the last three it is practically 2,300. The increase in the number of students pursuing an engineering course is much greater than the increase in the number of male students pursuing a non-engineering collegiate course; in 13 years the former increased 444 per cent, while the latter increased only 48 per cent. At present the engineering students constitute 21 per cent of the total number of male students pursuing a collegiate course.

But the most significant fact connected with the growth of engineering education is the improvement in the methods employed and in the scope of instruction. The teaching force of the engineering schools has been increased and the material equipment has been extended, thus permitting a radical change in the methods employed and in the scope of the instruction given. The best engineering colleges of America are offering unexcelled opportunities for the acquisition of the fundamentals of an engineering education. Few, if any, Americans now attend European engineering schools, for it is generally conceded that the American schools, in equipment, methods, and scope of instruction, are superior to any European schools — at least for American engineers. German and British engineers quite generally concede the greater effectiveness of American methods of engineering instruction, particularly in the use of fully equipped laboratories and shops and in the value of various forms of practical instruction. The curriculum of the engineering college at present consists of about 10 per cent of English or modern foreign language, usually the latter; 30 to 40 per cent of indirect technical studies, as mathematics, physics, and drawing; and 50 to 60 per cent of technical work. Over half of the engineering students are in institutions requiring for entrance the completion of a four-year high-school course, and another quarter require a three-year high-school course.

At the beginning of the specialization of engineering education practising engineers doubted or denied the value of a technical training for young engineers, and distrusted the engineering graduate; but now general managers and chief engineers prefer technical graduates, since they have been trained in scientific methods of working, and have a knowledge of the fundamental principles underlying all engineering practice, and look out upon the world of truth from the viewpoint of a man of science. The national engineering societies now give credit for training in the engineering school toward the requirements for admission to membership, and the most cordial relations now exist between practitioners and the schools of engineering. Within recent years, largely if not mainly through the influence of the technical colleges, engineering has ceased to be traditional and has become scientific; and engineering has come to be recognized as a learned profession.

The wonderful growth of engineering education is of interest to the young man who is trying to choose a lifework; but it is of vastly greater importance to the citizen who is interested in the continued growth and prosperity of the country. For the past few years our newspapers and our magazines have had much to say about our rapidly increasing foreign trade, chiefly in the way of recording its marvelous growth, but with little attention to the factors that make such success possible. Of course, such a result depends upon many elements, among which are: (1) The peculiarities of our national ancestry, which has peopled this country with the brightest minds of all nations; (2) our political constitutions, which make it possible for the humblest to rise to the highest position; (3) the fact that we are a great nation, speaking one language, with no barriers in the way of the freest social and commercial intercourse; (4) our great and varied natural resources of mine, forest, and soil; (5) the high price of labor, which stimulates the introduction of labor-saving machinery; and (6) the general dissemination of education, which made possible the effective use of labor-saving machinery and permitted the nation to profit by the capable and ambitious workers of all classes.

But we have recently entered upon a new phase of national and industrial life. Until now we have been engaged in subduing the great West, in establishing homes, in founding cities, in building railroads. By legislation we barred out foreign competition and preserved the home market for our own products; but now the new land in the West is occupied and there is no longer an outlet in that quarter for our surplus labor, and our industries have outgrown the home market. If prosperity is to continue in the future as in the past, we must have new markets; and in these markets we must meet the competition of the world. What are the conditions necessary for success in that field? The recent commercial history of Germany and Great Britain is significant.

For many generations Great Britain was preeminent in manufactures and in commerce. In 1870 she did one quarter of the world's business, and the English believed that their industrial supremacy was secure; in a single generation they have awakened to the fact that they are rapidly losing ground and in some respects are already third in the race. With Germany the almost exact reverse is true. Thirty years ago she had a comparatively unimportant place in the commercial world, but in a single generation all this has been changed. The power employed in manufacture has increased four times as rapidly as the population, and the tonnage of the ships engaged in foreign trade has increased ten-fold. From 1870 to 1895 German foreign trade increased 42 per cent, while the English increased only 13 per cent; and from 1895 to 1900 German foreign trade increased $200,000,000, while England's increased only $30,000,000. Why is it that Germany, with one of the poorest seaboards in the world, with a poor soil and with a dangerous military position, has been able in a single generation to outstrip England — the mistress of the sea and the foremost manufacturing nation of the world?

The recent marvelous industrial development of Germany was coincident with, and dependent upon, the development of industrial education. About 30 years ago Germany reorganized and strengthened her technical schools and established many new ones, until now the provision for technical education is the wonder and admiration of all who know the facts. In the number and equipment of her technical schools Germany leads the world. She is fully alive to the commercial importance of scientific investigation and technical education.

England a few years ago, confident in the superiority of her own manufactures, passed a law that all foreign-made goods should be labeled with the name of the country from which they came. This stamp was intended to be a mark of inferiority; but, to the surprise of the British, the label "Made in Germany" appeared on the highest grade of goods, which the Englishman had assumed to be of home manufacture. England received another shock when she found her street railroads being supplied with electrical apparatus made in America, and when she discovered that her manufacturers were importing American machine tools, and when America obtained the contract for bridges in her African and Indian colonies. After vainly endeavoring to convince herself to the contrary, England is ready to admit that she is being distanced in the industrial and commercial race, because she has not kept alive to the intimate relation between science and industry, and that in neglecting the technical education of her people she has failed to train her industrial army. In these days of sharp competition and small margins, when the entire world is in the market, the nation that most carefully trains its industrial army will gain industrial supremacy. Of course, there are other factors, as wages, labor unions, and tariff; but not one of them is of such transcendent importance as that training of the individual which enables him to produce the most in the least time and at the smallest cost.

What is the lesson for the United States? It is, that if this country is to extend or maintain its foreign trade it must look carefully to higher education. We already have a goodly number of technical colleges, but in number and equipment they are inferior to those of Germany, although in method they are better adapted to American conditions than would be the German type. Most of our technical schools are in need of additional equipment and more instructors. Technical education in this country was inaugurated about 30 years ago, and the engineering education given now is vastly better than that of 25 years ago; but there is still opportunity for improvement. The one thing necessary is adequate financial support. Technical education, especially engineering education, is very expensive. A large and costly equipment is required, and machines and apparatus wear out or become antiquated and must be replaced by new. Our technical schools need a more generous support, so that they may add to their facilities and extend their courses. Any money given for this purpose is wisely expended, for experience has abundantly proven that money given to technical education is returned many fold in the increased productiveness of the nation's industries.

To be most effective, technical education must be practically free. Unless it is so many will be debarred from its privileges, and society will be dependent upon a few workers from a favored class. One of the main reasons why the United States has been so prosperous in the past is that education has been free, and consequently the higher ranks have been continually recruited from the lower. The way should be open that the humblest may rise from the lowest to the very highest rank. Education should not be bestowed as a charity, nor as a means for helping the recipient to earn a livelihood, but because the proper education of the people is the only basis for social security, economic prosperity, and the highest national development. The conclusion almost certainly follows that only the government has the ability to make provision for the adequate technical education of the people. The Federal government and the States, particularly the North Central ones, have made magnificent provisions for technical education; but the numbers seeking it require increased equipment and the change in industrial life demands a higher grade of work.

At present the engineering college is engaged chiefly in giving the rudiments of an engineering education, but it should do more than simply impart elementary instruction. There are numerous scientific and practical subjects that are very much in need of investigation. The practising engineer frequently encounters problems which ought to be investigated experimentally, but it is seldom that he can command the necessary laboratory equipment or find the time for such work. There should be some place where such problems could be sent for solution; and where is a better place than a research laboratory established in connection with a technical school? Much of the equipment required in the work of instruction could also be used in research work. The professors now do more or less such work, but they are usually, and rightly, employed because of their ability to teach, and the impartation of instruction consumes so much of their time and energy that they can not do much in the way of investigation. There should be trained corps of men engaged in original research in matters relating to engineering and manufactures, much as is the case with agricultural experiments and investigations now being carried on at most agricultural colleges. Many such investigations are returning to the public each year benefits equal to more than a hundred times their cost. Of these a few are: the breeding of cotton and of corn, the prevention of smut in oats, and the spraying of apple trees for the destruction of harmful insects. Why should not similar aid be given to our manufacturing interests?

The following are the words of a prominent practising engineer: "The cost of duplicating the land, buildings, equipment, and endowment of the largest and most complete technical school in the United States, training more than 1,500 young men, is little more than half the cost of one of the latest battleships, and the running expenses of one of the largest technical schools are about the same as for keeping a battleship in commission. The technical school has a use no less important than the battleship in the 'first line of national defense.' The time has already come when the commonwealth and the nation should contribute more liberally to the burden of its support and help it to ever broader usefulness. The demonstration of its great value to the prosperity of the state is already complete. With the increasing numbers of students and with the rapidly increasing cost of laboratory facilities needed for the best training, the need of funds is greater than private munificence can be relied upon to meet. In the reawakening of the old spirit of commercial adventure in foreign lands, we must to-day base our hope of success on superior excellence and economy of manufacture and in the calling of our engineers to foreign lands. The growth of our cities is laying a burden of new and larger problems on our departments of public works, a burden which only those trained in the schools of engineering can carry wisely and well. The business man, when he comes to see these matters clearly, will urge again and again a generous support to schools of engineering by city, state, and nation when private munificence falls short."

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Education, Higher, in the United States. The beginnings of higher education in the United States are almost coincident with the founding and permanent settlement of the colonies which later became the commonwealths. The General Court of Massachusetts as early as 1630, when the colonists it would seem could have been excused of all concern save for subsistence and safety, agreed to give out of the common treasury £400 "toward a school or college." This worthy purpose and pledge had virtual redemption a few years later when John Harvard's bequest begot other gifts and led to the successful establishment of a college which has kept the primacy through the more than two and a half centuries since. The College of William and Mary was founded as a "place of universal study" before the Virginia colony had a population beyond that of a sizable city in the present century, and while all the tobacco the colonists could raise was needed in the judgment of Crown officials for better purposes. Yale received in 1702 its charter, after several unsuccessful attempts covering nearly a half century had been made to establish a college in the Connecticut colony, and leading for a decade or more a migratory existence along the shores of that colony at last found a permanent home in New Haven. The New Jersey Log College lived long enough to prove the practicability, as well as to reflect the need, of a college in that colony, and it was not long after its end which came with the death of its president, who was its faculty as well, that Princeton University came into being as the College of New Jersey in the year 1748. This famous institution had official offspring in Brown University in the colony of Rhode Island, which was organized in 1764 under the agency and presidency of a Princeton graduate acting for the Philadelphia Baptist Association. Pennsylvania had in 1751 her Academy, established under the incentive of Benjamin Franklin, since become the University of Pennsylvania. And in New York but a little later the work of King's College, now Columbia University, was begun, under a charter granted by George II. in the vestry room of Trinity Church, assisted thereto, as were others, by the proceeds of a "public lottery," and with a faculty which for years did not exceed three. These, with Rutgers and Dartmouth, also established in the pre-Revolutionary period, show how general and how deep was the interest in higher education in those primitive and formative days.

The Revolution interrupted the sessions of all of these save one or two for a time, but the occasion of the suspension gave them added reason for existence. Harvard's halls were yielded for a time to the use of the provincial troops and Washington occupied the president's house as his headquarters; Yale had to resume its migratory life again for a season; Nassau Hall, at Princeton, gave shelter by turn to the British and American troops and bears still the scars of the war; the College of Philadelphia had to suspend its work; Brown's University Hall was used as barracks and hospital; the one building of King's College was also put to the latter use for a time; and Queen's College, now Rutgers, fled to the north branch of the Raritan to escape the scenes of active hostilities. William and Mary and Dartmouth seem alone to have continued undisturbed in their work, but the latter lost its Indian students. They all, however, survived the hardships and distresses of that period and others to the number of 13 were added before the century went out, among them Williams, Bowdoin, Union, and Middlebury.

Though all were organized and maintained as private institutions, most if not all of them had material aid from the colonial or the home government either through direct gift of money from the common treasury, through appropriation of lands to their use and benefit by act of the sovereign or the local legislature, through certain special exemption from some tax or burden, or through the enjoyment of some special privilege, as, for example, the income from a lottery or an excise tax. The entire sum of gifts and privileges now seems exceedingly small. It is estimated by Dexter, in his 'History of Education in the United States,' that the total property of the colleges in existence at the end of the 18th century did not exceed $1,000,000 in value. As there were between 1,000 and 2,000 students in attendance the per capita provision was somewhere between $500 and $1,000. At present with a total over 300 times as great, the per capita amount is nearly $4,000.

The equipment then deemed essential and adequate was very slight. When the State of New Jersey sought to make good the material losses of Princeton during the war in the scattering of its library, the destruction of its apparatus and the damage to its buildings, the appropriation made was £600 a year for three years, and doubtless the destruction of apparatus was but a very small item of this meagre total. Books were about the only accessories the teacher had in his labors of instruction. It was John Harvard's library and the few volumes which, according to tradition, were carried to the conference at Branford, that were the first tangible equipment of Harvard and Yale. Then came the president, the forbear of that species of executive peculiar to this country, who was in those days always a minister. He filled in his own person the offices of dean, registrar, and college preacher as well as president, and was for some years in one or two colleges the entire faculty, teaching all the subjects of the curriculum; and in others he was the major part. When the buildings were provided as bodies for these ardent spirits, they were of the severest, simplest type, and void of adornment. Nassau Hall, the largest building of its time in the colonies, though plain in its present environment, had the distinction in the advertisements of its earlier days as being of "gentle workmanship." Yet relatively slight and simple as it all was by comparison with the present provision — and by comparison with the results — it represented an intenser interest and appreciation of the importance of this higher training that is even now generally felt. So deep was the concern that the teaching in these institutions was watched with jealousy and, as the democratic spirit grew in strength, with a feeling that they were not fully meeting the need of the whole people. This feeling manifested itself in the effort made in several of the commonwealths to bring the colleges immediately under public control. In some instances the legislature vainly sought by gift to secure this control. In three States, at least, the colleges were for a brief period converted into public institutions. But they all soon reverted to their original character. This period of vexation is remembered generally only in the famous case of Dartmouth College, Daniel Webster appearing in defense of this small college and in opposition to its supplanting by a State university. But what the solicitous public could not bring about in institutions already established and of fixed traditions it was able to provide for in the States where private and church benefactions had not yet laid their foundations. The first steps in this direction were taken in the South before the end of the century; and so determined was the purpose of democracy even in those days of penury to insure to all the advantages of the higher education beyond the restriction of any denominational or partisan lines that provision was made in the constitutions of most of the new States for the establishment of State colleges, or "universities," as they came to be called, to be the crown of the public school system. As a result practically every State of the South and every State west of the Alleghany Mountains has its State university supported out of the public treasury and governed by a board of public appointment or election. In 1900 nearly 25 per cent of the total amount expended in support of higher education in the United States was contributed directly by the State, municipal, and Federal governments (Harris), and in 1903 33 States — Alabama, Arkansas, California, Colorado, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, North Carolina, North Dakota, Ohio, Oregon, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming — and three Territories — Arizona, New Mexico, and Oklahoma — maintained State or Territorial universities wholly or in part at public expense (Dexter). The total attendance exceeded 40,000 in 1903, which was nearly half the total number of students in all the colleges and universities of the United States for the same year, excluding colleges for women alone.

Those States which were carved out of the public domain were to be helped to the fulfilment of this high purpose and constitutional pledge by the grants of land that were made or set apart when the States were formed, and about half their number had in 1862 struggling colleges, bearing the name of university as a rule, but doing work that would now be reckoned as hardly beyond that of a secondary school. The Morrill Act of the year just named initiated a new period. This act provided that for each representative and senator in the Federal Congress there should be appropriated in support of a higher institution of learning in each State 30,000 acres of land, and further that at these institutions technical and agricultural branches should be taught. The effect of this generous grant was to stimulate the State universities in their growth and to broaden the scope of the college curriculum. Sixty-five colleges (Harris) enjoyed the benefit of this Federal endowment. In some States new institutions were created of college grade in which the branches named were to be taught. Dexter lists the Universities of California, Illinois, Maine, Minnesota, Nebraska, Nevada, Ohio, West Virginia, and Wyoming as owing their origin to the Morrill Act. In other States agricultural colleges were established, as in Massachusetts, Michigan, and Iowa; and in still others the proceeds of these grants were devoted to the maintenance of departments in connection with existing institutions. Practically every State has now availed of this Federal gift in provision that has amply justified the grant.

The most gratifying outcome has been the development of the State university to which in many States, as noted above, these grants have given either life or succor. The grants themselves were not large compared with the annual appropriations now made by the States, but they afforded a nucleus-fund in some and in others a helpful incentive. Taking these grants and making enthusiastic and praiseworthy supplement, "the newer States had the most comprehensive university foundation the world has ever seen" (Draper). They have been supported with good-will and increasing generosity. The annual appropriations to each of several exceeds $500,000 for current expenses. In some States the proceeds of a permanent "mill-tax" assures a fixed minimum of income. In some of the States no fee is exacted of students coming from within the State; in none is the fee more than nominal except for the professional courses. Occasionally there has been unjustifiable restraint of "academic freedom" or political interference, but happily these instances are rare and with the increasing strength and prestige of these institutions the perils of such restraint or trespass will undoubtedly be lessened. The standards of scholarship of a few are very high and of all probably as high as they would be under private guidance and maintenance. There is doubtless a more ready response in the curricula of these institutions to the demands of the practical, and there seems to be a more widely and deeply pervading sense of the obligation to put the higher training at the service of the public.

Direct Federal aid to higher education is stated in Commissioner Harris's report for 1903 to be but 4 per cent of the total receipts from all sources, though as just stated the grants of land and scrip were effective materially and morally beyond the intrinsic value of such amounts to-day. In addition to such indirect assistance, proffered through the States, the nation maintains its own military and naval colleges, or "academies," as they are called, though organized and conducted on the footing of the best technical colleges here or abroad. The military academy at West Point and the naval academy at Annapolis provide each for the education of one student from each congressional district, Territory, and the District of Columbia, of one each for every senator and 40 upon appointment of the President of the United States.

There is one other type of public college that has illustration in our educational history, the college of municipal maintenance and control under a general State supervision. The most conspicuous and in a sense the only pure example of this type is the College of the City of New York. It was organized as an "Academy or College" in 1847, but has recently been developed into an institution of collegiate standards. The city of New York has within the last few years appropriated nearly $6,000,000 for new buildings, grounds, and equipment, and appropriates annually over $300,000 for its maintenance. The city of Cincinnati partially supports an institution of college grade with which professional schools are associated. This university had its origin and still receives a considerable income from private benefactions.

But while the development of the State colleges or universities has been rapid in the last quarter of a century and they have grown to such proportions as to embrace in their census (those receiving only partial support from the State, as some of the universities of the South being reckoned in this list) nearly half the total student population in our higher institutions of learning, the colleges, and universities of private origin and nourishing have steadily grown in number and endowments throughout the century. Seventy per cent of all higher educational institutions are (Harris, 'Report for 1903') under control of religious denominations and the remaining 30 per cent, that are nonsectarian, are equally divided in their source of support and control between the public and private. Undoubtedly this denominational control is in most instances merely nominal and indicates the origin of the institution rather than the present supervision or support, for many of the institutions of earlier foundation were designed primarily to prepare young men for the ministry but do not now differ from other colleges in their purposes, their curricula, or general clientele. However this may be, the number of private institutions of this higher and highest grade would seem to be 85 per cent of the total number of colleges and unversities, though they have hardly more than half the total number of students. That the interest in the maintenance of private institutions does not wane in spite of the generous public provision is witnessed by the fact that the benefactions of individuals in the decade at the close of the century amounting to $115,500,000 (Harris, 'Report of 1903') were equal to the sum of the estimated value of college grounds, etc., and of all the productive funds in 1890. Two gifts this current year, one of $10,000,000 in endowment of a pension system, and the other of like amount for the direct support of colleges and universities, alone maintain the ratio of increase.

The two classes of institutions have thus developed side by side. The private institution has led the way, advertised and stimulated the need and showed how to meet it. The public college or university has followed, under the compulsion of an appreciation of the vital necessity of such training especially for a self-governing people, and of the obligation of a wider need than was met even by the high motive of private provision, has broadened the scope and emphasized the serviceableness of the higher education, has modified or supplemented the somewhat straitened college curricula, and has given a new and noble function to the State. Each now corrects the shortcomings, the excesses, the errors of the other with the result that the expressions of purpose and methods of governance and teaching grow each more like the other into a common type with one aim. For both are public institutions in motive, in object, and in service, but it cannot be doubted that the more general good has been emphasized through the agency of the public university. The institution endowed by private philanthropy has often greater freedom of experiment, is likely to be less influenced by the whim of the hour good or bad, and is more prone to keep the spirit of altruism in its teaching body. Together they furnish an example and proof of high-mindedness, discernment, and prescience as well as of self-sacrifice which promise well for democracy.

That the provision which has been made from these two sources has not been extravagant is evidenced by the fact that the endowment and equipment of no institution yet exceed the need which confronts it. No college or university, public or private, finds itself fully equipped to meet the demand made upon it. Great as the public gifts and private benefactions have been they have not gone beyond the mark of adequacy. The proportion of university-bred men in the early New England settlements was 1 in every 250 inhabitants. The proportion is not now as high throughout the United States, but in the 30 years 1872–1902 the numbers grew from 1 in 1,694 inhabitants to 1 in 731. This is accounted for in part by the greatly increased number of women students. This total includes, however, only the women in coeducational institutions (somewhat more than 20,000 in 1902). The doors of men's colleges were first opened to women at Oberlin in 1833 and now 72 per cent of the higher educational institutions are coeducational (Harris), including all the State universities save two or three in the South.

The American college was fashioned after the pattern of the English college, but its development has been such as to make it a type of educational institution peculiar to this country. Requiring for admission to its lower class what is now provided by the free public school system in practically all the States of the Union — through an elementary course of eight years and a secondary school course of four usually — it has without important exceptions, until recently, demanded for graduation four years of residence and the completion by all of a uniform prescribed programme of studies of much the same content and scope in all the colleges. Gradually with the increasing knowledges and the diversity of view as to their importance and their relative disciplinary or pedagogical values, students were allowed to make election of some of their subjects, especially in the later years of their courses. So elastic have the requirements now become that in some institutions practically free election is given in all the years of the curriculum, while in many others, in most indeed of the colleges and universities of highest rank, more than half the courses are elective.

And with this elasticity of course there has come an elasticity in time, though this is by no means as prevalent. The requirement at first was residence, there being no uniform requirements of admission. Gradually the latter became fixed, and with term of residence there came to be associated a minimum proficiency test. Now there is a tendency manifest to interpret the requirement not in time but in accomplishment under certain restrictions as to the maximum and minimum amount of work that may be taken in any one term or year. In Harvard University many students now accumulate the credits required for the degree in three years. In Columbia University and a few other institutions the undergraduate course is reduced to three years for those who enter one of the professional schools of the university. It should be noted that the requirements for admission have not only become measurably uniform but they have also been raised far beyond the level of requirements in the early days. This heightened requirement prevents the admission of the student to college as a rule under the age of 18, and since, if he enter a profession, he must spend three or five years in special preparation, he cannot normally take his professional degree under 26 there is continuous and increasing pressure from above to shorten or to condense the college course. There are some indications of fission at the end of the sophomore year, corresponding to that which has been made in the German school system, the advanced high schools or «institutes» carrying to that point and the university admitted with that preparation to the graduate or professional school. If this tendency were to become general it would destroy the integrity of the American college and its function as maintained in the past and perhaps eliminate the bachelor's degree.

The development of our universities after the pattern of the continental universities gives some ground for the fear or hope, as the case may be, of this reclassification. Until 25 or 30 years ago little graduate work was offered in this country. In the early seventies there were not more than 200 or 300 graduate students and they were doubtless on their way to the more modest second degree and not to the doctorate. The degree Ph.D. had been conferred in but few instances up to that date. There were a quarter of a century later, in 1900–1, over 6,000 graduate students and over 250 doctorates were conferred at the end of that year. These were all in the courses of academic character.

A comparison with the continental European universities reveals the lack in most of ours of the theological faculty, the comparatively undeveloped state of the philosophical faculty (the latter dividing its time between graduates and undergraduates), and the dominance here of the professional and technical school (Perry). The absence of the first faculty, so conspicuous in the old European universities, is due of course to the divorcement in this country of church and state. That the graduate schools are only now coming into strength, and even yet lack as a rule that character which can only come from the creation of a faculty devoting its full energies to graduates exclusively, is due to our youth and immaturity. The rapid development of professional and technical schools has had its motive in the pressing need of the practitioner.

Concerning the professional and technical schools, it is possible to say here but a word. Law schools did not exist in any number until the middle of the century; there are now approximately 100 such schools, with an attendance of between 10,000 and 15,000 students. The requirements for admission vary from a common school education to a college degree, and the range in length from one year to four years. Medical schools were of much earlier organization, two such having been established in the 18th century in connection with colleges. Their number is now about 150 and the total attendance over 25,000. There is as wide variance in the requirements for admission as in the law schools, but there is practical uniformity in the length of course, four years being required in practically all. Nearly 50 colleges and universities have established and maintain theological faculties. The total number of theological schools in 1902 was 150 (Dexter), and the number of students 7,343, a decrease, as compared with the attendance of 1900. Nearly half require a college degree for admission, and the length of course in a great majority is three years. In addition to these professional schools, there are over 50 schools of dentistry, with over 8,000 students, 60 schools of pharmacy, with about 4,500 students, and, of comparatively recent establishment, training schools for nurses (Dexter).

The latter half of the 19th century has witnessed also the development of the school of applied science. Most of these schools, whether agricultural or technological, require four years of residence, and grant degrees of like time-value with the baccalaureate degrees granted by the classical institutions. As stated above, the schools of this type had distinct stimulus from the grants of the Morrill Act.

There remain of the institutions within the higher educational group the schools for the training of teachers.

Nearly 150 normal schools are in existence, but in only a few of the States are the requirements for admission such as to permit the inclusion of these institutions in this class. Besides these there are over 100 private normal schools with nearly 25,000 students; training schools for teachers maintained by several cities; pedagogical departments now organized in many universities and colleges; and a few teachers' colleges.

Higher educational provision in the United States is creditable to a people of so brief a history and under such material obligation and temptation. The college and university, public opinion supporting, have increased their demands quantitatively in spite of the pressure of the «practical,» though they have made concessions to the latter. They have enlarged their field of service from preparing at first chiefly for the ministry and then for the learned professions only, until now they include all high human activities in the contemplation of their curricula. They reflect the high purposes of a democratic people; but they are in a good measure responsible for those purposes.

I have been aided in the preparation of this sketch chiefly by Commissioner Harris' reports, Edwin Grant Dexter's 'History of Education in the United States,' and President Butler's 'Education in the United States.'

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Education — the Development of the Office of School Superintendent. Supervision of schools by educational experts is an American idea. In ancient Athens, it is true, the teachers were to some extent under the supervision of the State. Overseers were appointed to enforce the laws respecting morality. The State, however, exercised but little supervision over the qualifications of tutors or their methods of teaching. Charlemagne visited the school of the palace and placed the schools for the education of the clergy under the care of the bishops and the parish schools under the care of the priests. They had so many other duties that they could not exercise a close oversight over the teaching in the schools which were thus placed under their care. Luther and Melanchthon visited schools and churches under the direction of the

Elector of Saxony, but their time and strength were devoted to duties other than those of supervision. When the King of England and the nobility made liberal subscriptions for the establishment of a system of charity schools, in which the German children of Pennsylvania might be taught English, and thus through the instrumentality of language be attached to the English Crown, Rev. Michael Schlatter was in 1754 made superintendent of those schools at an annual salary of £100. He was succeeded by Dr. William Smith, who was outspoken in his loyalty to the British government. The former was a missionary of the Reformed Church, and the latter was provost of the university. Hence neither of them could devote much time to the work of supervising the schools under their care.

City Supervision.— The idea of appointing a person who was to devote all his time to school supervision first took shape in Buffalo, N. Y., and Louisville, Ky. In the winter of 1836–7 a law was passed by the legislature of New York authorizing the appointment of a superintendent of common schools in Buffalo. R. W. Haskins received notice of his appointment on Jan. 10, 1837. He accepted the office, but finding the law defective, he resigned before the expiration of the year, and was succeeded by Oliver G. Steele, who has always been known as the father of the public schools of Buffalo.

The city of Louisville, Ky., appointed a superintendent of schools in 1837. He was called Agent of the Board of School Visitors and began his work in the month of September. Two years later Saint Louis, Mo., and Providence, R. I., appointed superintendents. The last of the great cities to create the office of superintendent was Philadelphia.

State Administration and Supervision.— New York also led the way at a still earlier date in provisions for State administration and supervision of schools. The law of 1795, which appropriated for school purposes $100,000 each year for five years, provided for the annual election of not less than three, nor more than seven, commissioners in each town who were to supervise and direct the schools. By the act of 1787 the regents were empowered to charter colleges and incorporate academies, and to exercise supervision over them, being authorized and required to visit and inspect them, to examine into the condition of education and discipline in them, and to make an annual report thereof to the legislature.

On 14 Jan. 1813 Gideon Hawley was elected superintendent of common schools of New York and retained the office until 22 Feb. 1821, meanwhile having been appointed secretary of the board of regents, 25 March 1814, and continuing in that capacity until 1841. When he was removed by the "Counsel of Appointment" just prior to the expiration of its own life, as provided by the Constitution of 1821, public indignation rose to such a pitch that the legislature promptly abolished the office of superintendent and devolved the duties upon the secretary of state. But the office has been continuous from 1812 to the present time and has been held by several of the most distinguished men of the State.

Maryland had a State superintendent in 1825, and Vermont in 1827, but in neither was the office continuous. In Pennsylvania the duties of State school administration were, in imitation of New York, devolved upon the secretary of the commonwealth, and Thomas H. Burrows achieved lasting fame by his work for the common schools while serving as secretary of the commonwealth. Most of the time, however, the function of school administration was assigned to a clerk or deputy until 1857 when the office became independent of and co-ordinate with the other departments of the State government. Michigan created the office in 1836, and Massachusetts in 1837 with Horace Mann under the title of secretary of the state board of education. Kentucky came next (also in 1837), and then Connecticut with Henry Barnard under the same title as that adopted in Massachusetts. His office was abolished in 1842, but resumed by himself in 1849. Since that time the establishment of the office has been rapid, and in the newer States the office dates from the beginning of their organization, either as a Territory or as a State.

County and Local Supervision.— In 1841 New York passed a law for the appointment, by the board of supervisors of each county, of a deputy state superintendent of common schools for the county, except that in counties having more than 200 school districts they were to appoint two deputies. These deputies came to be known very soon as county superintendents, and the arrangement lasted until 1847. In 1843 provision was made for the election of town superintendents and this lasted till 1856. In 1854 a State Department of Public Instruction was again established, and the office of superintendent of public instruction was created. In 1904 the Department of Public Instruction and the Board of Regents were consolidated, and at the head was placed a state commissioner of education. The powers lodged in this department of the State government have been surprisingly large. Its decisions can not be questioned and reviewed in any court or in any other place. Thus school disputes can be settled promptly and without much expense.

In Massachusetts there have been several great epochs in the development of the policy of school supervision. The ordinance of 1647 obliged all towns of a given number of householders to provide and support schools. The law of 1789 authorized the employment of a school committee to look after the schools. In 1826 such oversight was made obligatory by law. The people of Massachusetts have always been jealous of their rights and correspondingly slow to delegate power to persons in office. The high-water mark of democracy and the low-water mark of the Massachusetts school system was reached when prudential committees and district committees began to be in collision or collusion. The law of evolution under which the people gradually demand the best in education for their children brought on the period of supervision by experts. At first school committees appointed one of their own number to inspect the schools. The school committee of Cambridge in 1836 and of Gloucester in 1850 delegated to one of their members certain supervisory duties and designated him superintendent of schools. The first instance of the appointment of a superintendent other than that of a member of the school committee in Massachusetts was in Springfield in 1840. He remained in office but two years. The first permanent appointment of such an official was made in Boston in 1851. The experiment was successful, and in 1854 a law was passed (amended in 1857 and 1860) authorizing towns and city councils to require the school committee to appoint a superintendent who should have the care and supervision of the public schools. The cities and large towns, one after another, adopted the plan until in 1879, 25 years after the permissive bill was passed, 35 cities and towns employed superintendents for full or nearly full time. In 1888 a law was passed permitting the employment of a superintendent by two or more towns, the expense therefor being largely borne by the State. Permissive measures were followed by mandatory laws, and the legislature of 1900 passed an act obliging the school committees of all towns and cities to employ a superintendent of schools after 1 July 1902, the towns having a valuation of less than $2,500,000 to be governed by the law under which two or more districts could join in the employment of a superintendent. New York and Massachusetts are typical States, and their example was followed elsewhere, especially in the Northwestern States and in Pennsylvania. In the latter State the office of county superintendent was created in 1854. Popular indignation rose to so high a pitch over the creation of so many new offices that it helped to defeat Governor Bigler when he came up for re-election. But his successor, Governor Pollock, took a bold stand in favor of school supervision, and the superintendent of schools whom he appointed, Henry C. Hickok, made it his chief aim to show the people that they would get more in return for their school taxes if the schools were placed under the supervision of men fitted for the office by literary and professional qualifications. The law in Pennsylvania has always been a schoolmaster of public opinion, and in no long time the advantages of school supervision were recognized, and the policy of electing county superintendents at a triennial convention of school directors specially called for the purpose has remained unchanged to the present time. The requirement that the superintendent must possess literary and professional qualifications in order to fill the office has been adopted in other States.

Salary.— The higher compensation which the superintendent receives, as compared with the teachers under him, has raised in the public mind the question: "How does the superintendent earn his salary?" To answer the question the school system may be likened to a manufacturing establishment whose operating expenses exceed the income by $20,000. The deficit caused the stockholders to employ a more efficient superintendent, who by organizing the workmen, rearranging the work, and saving the waste of raw material not only prevented this loss but made a profit of $50.000 by the end of next year. Did the new superintendent earn the $5,000 salary which he received? To ask the question is to answer it. But in school work there is waste far more serious than the waste of raw material. The most valuable asset of a commonwealth is brains, and this goes to waste through inefficient teaching. The time and effort of pupils is too valuable to be wasted during the most plastic period of human life. It is the function of the superintendent so to organize and oversee the work at school that the people may get the largest return for the taxes gathered for educational purposes. The results of school supervision have established in public favor the office of superintendent and the policy of school supervision in every State of the Union.

Duties of the Superintendent.— Various functions are assigned to the superintendent. If he is to be held responsible for the efficiency of the schools he must have a voice in the selection, suspension, and dismissal of teachers, the promotion of pupils, the making of the course of study, the selection of the text-books, the purchase of apparatus, and the location, erection, and condemnation of school houses. In smaller towns difficult cases of discipline are referred to him for adjustment; in the cities and larger towns such cases go to the principal who then assumes many of the functions of a supervisor. Where a superintendent's powers are based upon statute it is easy for him to exercise these functions. When he must exercise them through committees the situation becomes very complex and requires the greatest tact and personal force.

Methods of Teaching.— The superintendent is everywhere expected to improve the methods of teaching. Hence he is charged with the duty of conducting teachers' meetings, and in some States he has charge of the annual teachers' institute. He makes reports to the board of education, stands between the schools and the newspaper reporter bent on mischief, between the teacher and the unreasonable parent, as well as between the schools and the ill-advised reformer. It is also the duty of the supervisor to protect the child from over-pressure in school work and from other unreasonable demands on the part of the teacher. He may, by ill-advised and too frequent examinations, ruin the methods of teaching and unnecessarily worry the minds of teachers and pupils. It is now recognized that children have rights as well as duties, that one of these rights is the right to be happy at school, that children can not be happy unless the teachers are happy in their work, and that no teacher can be happy if he or she is constantly annoyed by rude or unreasonable demands from the superintendent. Hence the educational leaders of America have insisted that the superintendent shall be courteous in manner, always pleasant to parents, teachers, and pupils, and capable of sending them away satisfied, even when he must refuse their requests.

Assistant Supervisors.— Where the administration of schools absorbs most of the time of a superintendent it has become imperative to appoint supervisors who take charge of special lines of work, like drawing, music, manual training, primary instruction. In the selection of these assistants it is important to get experts who can get things done. Mere inspection for the purpose of reporting what is done falls far short of the real purposes of school supervision.

From the nature of the case, county superintendents can not exercise as close supervision as is possible in cities and towns. Various duties have been assigned to them in different States, namely, to examine teachers, issue certificates, visit schools, conduct the annual institute, make reports to the Department of Public Instruction, see that the schools are kept according to law, that the State school appropriation and other school funds are wisely expended, and that school houses unfit for use are replaced by modern structures. The preparation of questions for the examination of teachers and the employment of talent for the annual institutes has in many States been delegated to the State superintendent and his assistants.

The Selection of Superintendents and Public Opinion.— Of the various plans for the selection of State or county superintendents, that by popular vote is least satisfactory. Nominating conventions are apt to select candidates for geographical reasons or political services, and not on the basis of fitness for the duties of the office. This may be prevented by public opinion. The superintendent has no duty more important than that of creating educational sentiment. The schools can not be made better than the people want them to be, nor will they be allowed to lag far behind the demands of public opinion. See SCHOOL SUPERVISION. NATHAN C. SCHAEFFER,
Superintendent Department of Public Instruction, State of Pennsylvania.

Education, Indian. See INDIAN, EDUCATION OF.

Education, Industrial. The history of industrial education in the United States dates from 1835, when the Rensselaer Polytechnic Institute was established at Troy, N. Y., for the purpose of training young men in the art of civil engineering. Yale followed this example, in 1847, by the institution of the Sheffield Scientific School, and Harvard, in 1848, by the establishment of the Lawrence Scientific School. (See EDUCATION, ENGINEERING.) In 1855 an agricultural school was organized at Cleveland, Ohio (see AGRICULTURAL EDUCATION), and, since 1862, when the land grants voted by Congress for agriculture were also extended to technical schools, the growth of such institutions has been so general that there are now in the United States more than 190 special schools of this class, in which, by the simple systems of manual training, pupils are instructed in the various useful trades. (See TRADE AND MANUAL TRAINING SCHOOLS and TECHNICAL EDUCATION.) In 1896 Massachusetts passed a law requiring every city of 20,000 inhabitants to incorporate manual training into its high school courses of study, and similar results have been attained, either through private beneficence or by legislative action in almost every portion of the country.

Education, Kindergarten. See KINDERGARTEN EDUCATION.

Education, Medical. See MEDICAL EDUCATION.

Education, National Systems of. All of the nations laying claim to any part in the civilization of the world sustain some kind of a system of common instruction. This is not only true now but it has been true as far back as history runs. Even the pagan nations which have consistently defied civilization have held and exemplified certain ethical principles, various classes of knowledge, and many interesting and expert accomplishments which they have taught to their young. Some of the nations which we would not quickly classify as civilized maintain not only schools, but schools of differing grades and in some cases they are related together in systems of very considerable organized efficiency. The civilized nations have all developed, either under public or private control, institutions comprising school systems, often extending from the kindergarten to the university, and in many cases they have added elaborately equipped and purposeful educational systems going far beyond the functions of schools. The monarchial governments have educated a favored class more or less exclusively, giving but the rudiments of knowledge to the masses. The democratic governments have opened schools and other educative instrumentalities more and more to all the people. We are to present here, in a necessarily general way, the salient features of these different national systems of education, and will begin with those of the simplest form and the least international pretentions, and later take up those which are more ambitious and more elaborately and expensively organized. The order of presentation, however, must not be taken to indicate any close or deliberate arrangement of these different systems in the order of their excellence. It is not practicable to present all, or to present any very completely, and the order of arrangement is not to be taken as significant of merit beyond the general fact that we begin with the simpler and proceed to the more complex forms of organization and administration.

China.— China has undoubtedly maintained a system of instruction for the children of the higher classes and propagated certain very definite philosophical theories for thousands of years. The Imperial government provides a system of examinations, but leaves the training to parents or guardians. Schools are mainly supported by private subscriptions. The rich employ tutors for their sons. The girls count for little. The conditions of the masses are hard. Some classes maintain clan schools for their own children. Charity schools, supported by philanthropy, exist here and there. The best schools are conducted by the missionaries. The greater number of children are mainly without education. In recent years the Imperial government has established a university, a normal school, and a school of languages, and some of the provincial governments have opened colleges and military and naval academies. One province is attempting a system of graded schools. The whole school system is inchoate. Control by parents and filial regard for parents are national fetiches, regardless of the fitness of the parent for the exercise of control or for worship, and no duty of the State to the ignorant child of the masses is anywhere asserted.

Spain.— Spain has a system of primary schools. It is supported by local funds. The municipalities are by law charged with maintaining schools but the obligatory provisions do not seem to be much enforced. Worse than all, there is apparently but little educational sentiment. It seems strange that a people with such a long and, in some regards, an heroic history — almost conquering the world at one time — and a people with so much artistic feeling and so many polite accomplishments should have so little educational initiative. But it is so little that in the absence of government support and compulsion the schools are disjointed and often superficial. So far as the scheme of the educational laws goes it seems well enough, but it fails in the vital points of application and compulsion. Primary instruction is divided into three classes, viz.: first, instruction for infants between three and six years, elementary instruction between six and nine, and superior instruction for children between nine and 12. The work covers the ordinary primary subjects familiar in America. Some advanced schools are being developed and in many of the provinces there are normal schools for training teachers. The teachers' salaries seem to be determined somewhat by the size of the towns and vary from $150 to $900 per year. In addition to the absence of educational sentiment and initiative there is the no less notable absence of higher institutions to give zest and guidance to elementary schools. A census taken in 1860 shows that 20 per cent. of the population could read and write, that 4.6 per cent. could read only and that 73.3 per cent. could neither read nor write; a census taken in 1889 shows that 28.5 per cent. could read and write, that 3.4 per cent. could read only, and that 68.1 per cent. could neither read nor write; the last census, taken in 1900, shows that out of a total population of 18,607,674 there were 11,869,486, or 63 per cent. who could neither read nor write. Here is an ancient empire with history and traditions, conspicuous position and great resources, with extraordinary culture of a kind, and with varied refined accomplishments, and yet the masses are in sodden ignorance. It is not because of the lack of laws nor because there are no schools. It is because the laws are meaningless, because of false views of life, because Spanish history, with all of its valor, has not made for true civilization.

Italy.— In Italy at least one lower grade school is required to be maintained in every commune. Communes of more than 4,000 inhabitants must establish a high school. Classical instruction is provided in about a thousand institutions and technical instruction in about 400 advanced technical schools. There are many universities, of more or less importance. The leading libraries and art galleries are extremely rich in their possessions. These institutions exert a very considerable influence upon the intellectual life of the kingdom, as they certainly do upon the culture of the world.

Attendance upon the elementary schools seems to be enforced, but it does not extend beyond the ninth year. The elementary schools are supported by municipalities. The character of the schools is looked after by government school inspectors. Religious instruction is no longer obligatory. Many schools are supported by the Church, in which, of course, religion is taught. There are also many private schools established to serve one or another special end. In all of these the government requirements, which are not onerous, have to be observed. Education is practically free up to the university. Illiteracy is growing less. It is now about 35 per cent. and has decreased by about half in the present generation. There are many schools for special purposes, such as art, agriculture, mining, business methods, etc. There are 150 training schools for teachers, with 20,000 attendants. The government does much for musical training. The growth of religious toleration in the kingdom and the added intermingling with other peoples are clearly aiding the progress of Italian education.

Japan.— Japan presents probably the most conspicuous illustration in the world of the quick formation and the rapid evolution of a national system of education. In 40 years the Japanese people have passed from a chaotic educational situation to one very definitely, very completely, and very systematically and philosophically organized and administered. Where so much has been done in so short a time there is undue tendency to exaggerate statement and commendation, but there can be no doubt about the spirit and purpose and plan and determination which have accomplished so much, being entitled to the most enthusiastic admiration and approval, even though we distinguish the fact that the things accomplished could not, in so short a time and under such conditions, come abreast of the educational progress of some of the older and more democratic nations.

The elementary school system is practically universal, there being 27,000 schools in 1902–3. The attendance of children between six and 14 is compulsory, and the people in Japan seem to be in the habit of doing as the law directs. In 1902–3 the attendance of both boys and girls was more than 90 per cent. of the school population. Comparing this with the situation before the Japan-China war of 1893–4, an increase of 33 per cent. in attendance in less than 10 years is apparent. The attendance of girls is nearly equal to that of boys. The number of teachers is over 90,000. The schools above the elementary grade seem to consist of a half-dozen secondary schools whose function is to prepare students for the Imperial Universities at Tokio and Kioto and for various art and industrial schools. The universities embrace faculties of law, medicine, engineering, literature, science, and agriculture. In 1903 the number of resident instructors in the University of Tokio was 222 and the number of students 2,880. There are many libraries and museums. Education seems not only to be pervasive but very intensive in Japan. The observation of other peoples by the Japanese is wide and keen, and they quickly adapt to their own ends whatever attracts their attention in other lands. The government has been accustomed to send the most prominent young men to European and American universities to be educated, but this hardly seems necessary any longer. However, the diplomatic representatives of Japan are exceedingly and uniformly alert in observing and reporting everything which may prove advantageous to the intellectual progress of the empire, and many special commissioners are sent abroad to study subjects of particular interest to the educational, military, and industrial activities of the empire.

Perhaps it ought to be observed here that in Japan, as in all governments where the form of government is so extremely monarchial and classes among the people are well defined, some education may be pretty nearly universal while all education is not so. This is much, very much, better than nothing, but it is not all. The system does not open the higher schools to the masses, or at least it does not encourage the child of the masses to seek their advantages. So much is ordinarily true of all nations where classes are distinctly differentiated. But it must be said that the educational system of Japan has at once come to be remarkably balanced and diversified. It expresses the traits and promotes the progress of a people with marked characteristics. The elementary part of the school system is not only universal but, better still, the mighty and conclusive power of the government is exercised to have the elementary schools provide the beginnings of learning to all the children, boys and girls alike. Since 1900 tuition in the elementary schools has been free. The training of the teachers is thorough, the discipline of the teaching force excellent, and the supervision is close and under immediate government control. The methods for enforcing attendance are effective and apparently there is no thought of evasion. This is surely putting monarchial government to its best uses and it is not for us to say that such a form of government exercised for such ends, over such a people, is not quite as suitable as any other.

Great Britain and Ireland.— In England, Scotland, and Ireland we have our conspicuous illustration of a people who could set the limits to the power of the king, and establish government by the suffrage and under a constitution, without marked or general educational progress. From the beginnings of English history a small number of high grade universities with a few tributary fitting schools have trained the sons of the nobility, while the elementary education of the masses has been meagre, precarious, and lethargic. There has never been before the present generation — if indeed it may be said that there is now — any common school system in England. There have been elementary schools, upon one footing or another, nearly or quite everywhere, and the habit of sending children to school has been general, but these schools have not been under popular control, and they have not led up to higher institutions. They have lacked in self-activity, spontaneity, and aggressiveness. As a consequence the masses have the rudiments of learning, and this, with the strength and balance of the native character, means very much. But the fact remains that because the elementary schools have really had no connection with the schools above, the children of the masses are without educational opportunity and the educational system lacks in national coherency, strength, and elasticity.

Why is this so among such a great people who have done so much for freedom and constitutionalism? No doubt the answer is found in the prevalence of ecclesiasticism, in the measure of control which the Established Church exerts over the learning of the kingdom, and in the stubborn opposition of churchmen to forms of educational activity which are not at one with the fixed thought, plans, and ends, not of religion but of church organizations. Parliament has been struggling with this subject for generations. As democracy slowly advances to larger power in the parliament house and as the advantages of a free and articulated school system in other countries, and particularly in the United States, become obvious, more and more ground is gained — but the process is a slow one.

In England an act of Parliament passed in 1870 established school boards chosen at popular elections. The independence of these boards was very considerable and, therefore, their adaptability to particular conditions was marked. But by legislation in 1902–3 the local administration of schools of all grades was given over to the county, or county borough, council. Again the application of so much unification as this implies has been relaxed by excepting noncounty boroughs with a population of over 10,000 and urban district councils with a population of over 20,000, which the act declares to be entitled to control their elementary education. In 1891 an act was passed giving to every parent the right of obtaining free elementary education for his children between the ages of three and 15 and as certain schools still continue to charge fees, the school boards are often put to their resources and ingenuity to find free instruction for all who demand it. Church schools are numerous. The conflict of interests between church schools and board schools, and between the adherents and supporters of each, are frequent, and the whole subject is a continuing source of acrimonious discussion and of unceasing educational uncertainty.

Beyond the elementary schools there are institutions of all kinds and grades. There is no organized system of secondary schools. As of yore the fitting schools for Cambridge and Oxford continue. The overwhelming, if not the fatal, defect in the English school system has grown out of English thought and history. It is that the universities and preparatory schools are to serve the aristocracy, and that any extension of these instrumentalities to the masses will unsettle and unfit them for service to the aristocracy. Accordingly, there is not only no settled and universal school system for elementary instruction, but there is no organic connection between such elementary schools as there are, and such secondary and university institutions as there are above them.

But this has not interfered with, perhaps it has promoted, the development of business and trade and technological institutions. The defeat of British industrial interests in the competitions at world's fairs in the present generation has undoubtedly served as an impetus to the progress of instruction bearing upon the nation's industries.

A word as to the compulsory features of the English elementary school system should be said. By an act passed in 1876 attendance was first made compulsory and subsequent acts have made the compulsory provisions more stringent. As a general rule it is now obligatory for children from the age of five to the age of 12 to attend school, and they must attend from 12 to 14 unless they are excused wholly or in part by reason of having passed prescribed examinations, or having attended with marked regularity before the age of 12. In 1893 the attendance of blind and deaf children between seven and 16, and in 1899 the attendance of defective and epileptic children between the same ages, were made compulsory. Parents and guardians are made responsible for the attendance of children within the compulsory ages and are fined for delinquency, and employers who give work to children who are bound to be in school are fined heavily. The attendance laws seem to be very well enforced. Illiteracy is low. Exact data are not obtainable. In recent years only about one man in 40 and one woman in 40 have been unable to sign their marriage certificates.

No word of commendation bearing upon the historic English art and literary institutions, outside of the schools, which culture thought and give even added substance and warmer color to English character in general, and particularly to the classes liberally educated, is needed here. They are many and great — a good part of the intellectual instrumentalities of the world.

The Scottish school system comes nearer to that of the United States than that of England does. It has come down from the times of John Knox. It undertook to establish a school under a qualified master in every parish and made the maintenance of the same a charge upon the land revenues of the district. The influence of the Scotch education department upon all educational activities in Scotland is very considerable. This is the government department which administers government grants in favor of education, which prescribes the general lines of organization, and fixes educational values. It acts through inspectors or others charged with particular duties. The primary schools are general and they seem more often to carry their work into what we call the secondary schools, than is common in England. Coeducation in all grades is common in Scotland and has been for a long time. The universities are strong and the Scotch character is strong. Many enter the universities from all walks of life. Scotch history supplies the reasons why democracy seems to be freer in Scotland than in England, and the results are obvious enough in the educational system. Still it must be said that the lack of organic connection — of the continuous road — between the elementary and the advanced institutions is obvious enough also, and it is of much moment from the American point of view.

Attendance upon the elementary schools from five to 14 years of age is exacted, but some exemptions are granted after 12 years of age. The responsibility is placed upon the parents, and the penalties include both fines and imprisonment. In 1890 the attendance of blind or deaf mutes was made compulsory. The sentiment of the people combines with the efficiency of the government to make attendance general, and the percentage of illiteracy is low.

As to education in Ireland there is not a very great deal to be said, but so much as may be said is exceedingly hopeful. There are some Americans who do not realize what great institutions and what fine educational instrumentalities may be found in Ireland. These of course appear in the principal cities and they minister to the higher classes. The poverty of many in the country, particularly in the southern part of the island, is a great hindrance to the universality of the elementary schools. Yet the government grants have become relatively liberal, and the determination to enforce the organization of and compel attendance upon the schools has become decisive in the last decade. The Irish Education Act of 1892 exacted the attendance of children over six and under 14 years of age, but some exemptions are granted to certain children over 11 years of age. It was said with authority in 1902 that the compulsory provisions of the act were being satisfactorily enforced by committees in 131 different places. The general average of attendance is low but steadily improving. The government grant for primary education in Ireland for the financial year ending 31 March 1904 was £1,000,000 sterling. It may be said rather confidently that whatever work is done is as a rule very well done, and that the sentiment of the people touching education is steadily improving and highly promising.

If this article laid any claim to being a history, or even a very exact description of national systems of education, it would be necessary to go into an examination of the British influence upon the intellectual life of the colonies and dependencies of the nation. It would be a profitable and perhaps a fascinating study. In several directions, particularly in Canada, Australia, and India, it would have a somewhat significant bearing upon world education. It is obviously impossible to enter this broad field at this time. But it must be said that wherever the flag of Britain has been raised, there schools have quickly resulted, and there order and system have led speedily to the generation of intellectual energy and to the diffusion of learning. Kipling's virile verse is not without sufficient reason:

> They terribly carpet the earth with dead
> And before their cannon cool
> They walk unarmed by twos and threes
> To call the living to school.

France.— There is a very completely organized and a well-nigh universal system of education in France. It has developed with marvelous rapidity since the Franco-Prussian War in 1871. It is hardly too much to say that it resulted from that war. In a great measure it did, but other contributing causes must not be lost sight of. It is an autocratic and in some ways a mechanical system, but it is autocratic and mechanical because of the necessities of the situation. It is a system which knows much of the history and philosophy of education and which puts to its uses the courses and the processes which the most enlightened educationists believe to be of the most worth in raising the level of a nation's intellectual and industrial capacity. It is not free from the incumbrances and hindrances peculiar to the political and religious history of the French Republic, but it seems to be freeing itself with truly spontaneous energy and elasticity, and the process has already gone so far that the danger of arrest or of retrogression has been practically eliminated.

The educational system of France has been marked by exactness, and the work it does is characterized by completeness. The State controls all. The Minister of Education is the autocrat of all things in the French schools. The differentiation of schools into primary, secondary, and higher is not only rigid but desirable. Next to the Minister there is a director over each of these subdivisions of the school system. These officers are aided by inspectors. The educational policies result very largely from a higher council, a dignified body of leading educators, which meets twice a year under the presidency of the Minister of Education. The members of the Council are appointed for four years. There are 60 members. Thirty are professors and representatives of the advanced schools. Six are chosen by officers of primary education. Four, who represent private instruction, are appointed by the President of the Republic on the recommendation of the Minister of Education. Five are elected by the *Institut de France* from its own membership. Nine councilors appointed by the President of the Republic and six designated by the Minister of Education constitute the "permanent section," which meets once a week. With some appropriate division of authority and responsibility, these bodies lay out the educational plans of the Republic and exercise very decisive control over the satisfactory and complete enforcement of those plans.

The teachers in the public schools must be of French birth and must meet the requirements fixed by law. The private schools are subject to government inspection and direction. A naturalized citizen may be authorized by the Minister to teach in a private school, but the exclusion of foreigners from even the private schools seems severe. There are more than 100 normal schools for training teachers, which practically supply all the teachers needed, and the system for examining and certificating teachers is elaborate and exacting.

The inspection of the schools is systematic and close. There are general and local inspectors in large numbers. The average is something like one inspector for 200 teachers, but by the increase in inspectors the number of teachers to an inspector is growing smaller. The inspection districts vary in size. The supervision of the normal and technical schools, of the manual training, and of gymnastics and military exercise is somewhat accentuated.

Coming to the schools themselves, it may be said that they exist everywhere. They are classified about as follows: (1) the mothers' schools for children from two to six years old, (2) the lower primary schools for children from six to thirteen, (3) the upper primary schools and complementary courses annexed to the lower primary schools for children who have completed the work in the latter schools, (4) the manual training schools, with courses at least three years long, which receive pupils from the primary schools and develop technical aptitude. They complete the instruction of the elementary schools for pupils apparently destined for industrial life, (5) classes for adults and apprentices where the instruction has practical reference to the trades.

The elementary schools are free, even the books, paper, pencils, ink, etc., being generally gratuitous. Even more, food and clothing are sometimes provided. The expenditure for elementary schools is very large.

The work is generally excellent. It rests upon a philosophic basis and relates very decisively to the artistic tendencies which are always liberally present in the French people, and to manual dexterity. All the usual branches are well covered, with apparent emphasis upon drawing, work requiring the use of tools, the household arts, and music. Of course the outcroppings of militarism are often manifest. The branches which are simply culturing without manual labor are not neglected. The equipment of the schools, particularly in the cities, in apparatus and implements seems to be very abundant, and it is said that much of this is made by the pupils.

The aids to the life of the schools are very many. Libraries, art museums, musical institutions, are numbered by the thousands, and mutual aid societies, asylums for the unfortunate, and reform schools are too numerous to be treated with any detail.

The secondary school system is apparently attaining rapid development, but it is yet immature. The universities are many, strong, and yet growing stronger. So far as the writer can see, there is lack of articulation between the lower and the upper schools. It seems to be closer between the lower and the middle schools. Certainly the greatest emphasis is thrown upon the primary schools.

Primary instruction is obligatory upon all children between six and thirteen years old, unless in a particular case a child who is over 11 years of age is exempted by reason of his proficiency duly established. The instruction may be in a public or private school or in the family, but apparently the fact and quality of it must be indubitably established. Complete lists of children are continually maintained, and all upon the lists have to be accounted for. People in France are compelled to do things and they have got in the habit of it. Fifteen days before the opening of the school term the parent or guardian must notify the mayor of the commune whether his children of the attendance age will go to the public school, or to a private school, or be instructed at home. If the notice is not given the child is enrolled in the public school and the parent advised. Then the public school authorities must report on him. The only excuses accepted for absence are the sickness of the child, a death in the family, and some accidental and temporary break in communication. The penalties run against the parent or guardian, are sufficient, and the procedure is regular and as a matter of course. The percentage of illiteracy is not unreasonable and is improving. It is about one in 16, which, in view of the really recent origin of the French school system as now rated, is not unsatisfactory.

The criticism which will occur to an American concerning the school system of France will relate to its *rigidity*. It seems to be the idea that the same thing must be done everywhere, and at the same time, and in the same way. There is lack of allowance for differences in local conditions. All children seem to be put through the same processes. The teachers are trained under a system which is exactly uniform. The freedom of the universities does not act upon the elementary schools. There is little local color through local freedom in organization and administration. The people themselves are without the advantage of administering their own schools. There are doubtless some advantages and some disadvantages in this. It is not a matter of election. It is a matter of history, of habit, of accepted understandings, and of outlook. The French system presents an extreme. Another extreme is presented in some of our American States. Very likely the golden mean is between the extremes.

Switzerland.— There can be no treatment of the educational system of Switzerland, which is both brief and exact. The country determined upon a universal system of primary schools nearly a century before England took that step. The obstacle to a brief description is in the fact that each of the 25 cantons has its own organization, and there is not much legislation of general application to the whole country. The Confederation makes free primary education compulsory, but leaves the limits and details to the cantons. The Constitution forbids the employment of children in factories before they are 14 years old, with the further provision that in the 15th and 16th years the time given to work, to the "continuation schools" and to religious instruction shall, taken together, not exceed 11 hours per day. This is important in view of the continuation and evening schools, at the latter of which attendance is often compulsory. The Federal Constitution also requires all boys between 10 and 15 years of age to be instructed in military drill and attendant exercises.

The primary schools are non-sectarian. The different cantons are somewhat distinguished by differences in national descent and in church tendencies. Both the Evangelical-Reformed Church and the Roman Catholic Church are recognized by the State, but the instruction in the primary schools is secular.

There are six universities, at Basel, Zurich, Geneva, Freiburg, Bern, and Lausanne, with foundations from 1460 to 1832. There are excellent academies at Freiburg and Neuchatel, and a strong polytechnic school at Zurich. The country is not at all lacking in libraries, art museums, and other stimulating incentives to learning. The different parts of the educational system seem to be correlated. The republican form of government gives an air of freedom to the whole which is not common in Europe.

The system for insuring the attendance of all children within the general ages from six to sixteen, with immaterial variations in the different cantons, is substantial and effective. The sentiment of the country supports the schools with remarkable universality. Illiteracy is practically unknown. Switzerland furnishes an excellent example to Europe of what a small republic can do for law and order and self-enlightenment as a people, and for individual opportunity, industry, and happiness.

Netherlands.— The Dutch educational system seems to have maintained a very uniform growth from the dark days in the latter part of the 16th century, when the nation set up not only common schools but universities in celebration of the military victories over the Spanish in the first really great and prolonged war for religious freedom, which almost unconsciously led into political freedom as well. The system now embraces schools of every kind and grade, including good secondary, technical, and normal schools, and four State universities, which are ancient in origin and much regarded. Since 1857, and particularly since 1878, the instruction in the primary schools has been undenominational. Attendance has been obligatory since 1900, and the people who cannot read or write are about one in forty of the population. The expense and management of the schools are divided between the general and the State governments. Institutions bearing upon the agricultural and mechanical industries are by no means lacking, and fine libraries, museums, and architecture, evidence, while they aid, a substantial and assiduous people.

Denmark.— The educational system of Denmark diffuses throughout the kingdom a grade of learning very well suited to such a people. Primary schools are common but not free, except to the poor. Attendance is compulsory between the ages of seven and fourteen. Illiteracy is almost a negligible quantity. The established religion is Lutheran and it embraces almost the entire people, but other denominations are tolerated. Denmark seems to excel in secondary schools. Technical and professional schools are common. The country is essentially agricultural, and the fact is plainly discernible in the strong points of the educational system. At the head of the system stands the University of Copenhagen. The Royal Library at Copenhagen has 500,000 volumes and is exceptionally rich in original manuscripts. There are two other public libraries in the city. Matters are managed very exclusively by the State, and the level of intelligence and thrift seems high.

Norway.— The primary school system of Norway seems to reach all of the people effectively. It embraces a seven-year course suited to children from seven to fourteen years old. It is a national system; is free, and attendance is compulsory. The distinguishing feature of the elementary school system seems to be a class of "ambulatory schools," which are moved about from place to place in the thinly-settled districts. Beyond the primary schools the towns have superior schools of all grades and kinds. There are six teachers' seminaries. At the head of all is the Royal University at Christiania, founded in 1811. The State religion is Lutheran, but all denominations are tolerated.

Sweden.— There is practically no illiteracy in Sweden. The statistics show less than one illiterate in a thousand of population, and so much is said to arise from a few Finns in the extreme north. Of the conscripts in the army in 1900, 60.8 per cent. could read "fluently," and 30.2 per cent. "fairly well." This tells the story of the national system of education. Probably no country in the world gives more exact and persistent attention to education than Sweden is now giving. The Common School Statute of 1897 requires at least one primary school in every district. Where large enough, at least two grades of instruction are maintained, viz., an infant school for beginners and a common school proper for the more advanced pupils. In the former the instruction is arranged for two, and in the latter for four years. Attendance is, of course, compulsory. It must be from seven to fourteen years of age. The responsibility is upon parents and guardians, and the school board is by law bound to see that the obligation is fulfilled. If children are deficient of the required knowledge after passing the ordinary time in school, they must continue until they can meet the State's requirements. No obstacle — not the sickness or poverty of parents, not even the need of their labor to earn the family bread — is allowed to come in the way of every child being required to possess the elements of learning. If necessary, the child is given to the care of others and the expense forced from the parent or guardian.

The State pays exceptional attention to the defectives — the deaf, and dumb, and blind. This training is compulsory, also. Deaf and dumb schools are established on a large scale, and the State bears the expense. This extends not only to the defectives, but also to the disabled.

The trend of education in the country seems toward training every boy and girl to read and write, to attend to household duties, and then to make useful things with his or her hands. The obligatory subjects of instruction are religion, the Swedish language, arithmetic, geometry, geography, history, natural science, drawing, gymnastics, gardening. The expenses are borne by national grants and local taxes.

Secondary schools also form a part of the public school system, and a national university at Upsala exercises a very considerable influence upon the whole. The system is ancient, substantial, and comprehensive.

Germany.— For the long established, territorially extended, philosophically organized, capably directed, thoroughly accepted, and notably efficient, national system of education in Europe we must go to Germany. And if we were to undertake the exact study of any one system of German schools we must go to that great leader which embraces much more than half of the territory and population of the 26 German States which comprise the German Empire, established by the peace with France in 1871 — *Prussia.* This is not saying that the Prussian school system is better than any other in Germany; only that it is the oldest, the largest, the most comprehensive, and, therefore, the subject of the most interesting study.

The laws of the Empire provide for primary schools in every city, town, and village. As a result there are something like 60,000 of these primary schools, with 125,000 teachers and over 8,010,000 pupils. These schools are supported by some local rates and by much government aid. Parents are compelled to send their children from six to fourteen years of age to a primary school. One of the strongest points in German life is the very nearly universal and thoroughly established habit of sending the children to school. Compulsory attendance has been in operation for 63 years in Prussia. It is much for a mighty people to assume by common understanding that none but an imperative cause is to keep a child from school a single day when he ought to be there, and that nothing whatever is to be allowed to rob him of his right to an elementary education. This is apparently the case in Germany, and as a consequence the rate of illiteracy is diminished almost to the vanishing point.

Kindergartens are common in Germany, but are ordinarily if not invariably carried on by private enterprise.

"Continuation schools" are provided for the children of the working classes who want to do more work than is provided in the primary schools. They provide courses for two and three years and their work runs into trade instruction.

The regulations touching primary schoolhouses in Prussia illustrate the national estimate of the importance of educational details. Of course there are many buildings which were erected before the modern regulations were deemed necessary, and such regulations are not always enforced in Prussia, but they are quite suggestive enough. The building is to be erected in a sunny and dry open space, away from the most-used streets. In the cities the interior of the block is preferred. Quiet is imperative. Good water is sought. Playgrounds are demanded. If the building has more than one story the youngest children have the ground floor. In building anew, provision must be made for enlargement. Every detail of construction is specifically treated. Use of new buildings is prohibited until thoroughly dry; in stone and brick buildings six months is allowed. The size of rooms is regulated; even the shape of rooms is regarded. So, too, is the size, form, and location of doors and windows. Heating and ventilation are specifically treated. The width and length of halls and the width and height of stairs are specified. The form and situation of desks; the height, width, and depth of the platform upon which the teacher's desk stands, and the need of hooks and pegs for hats and coats are all set forth.

Of course a national system which regards all these small matters touching the school accommodations, with reference to the health, eyesight, and convenience of teacher and pupils, cannot neglect the details of the courses pursued or the sufficiency of the instruction; and it does not.

Secondary schools are found everywhere. Their work is varied but leans toward the classical, the culturing, the professional, and their line of cleavage is quite clearly a social one. Provision is made for the secondary education of girls as well as of boys.

Then follows a large variety of advanced special schools, such as schools for defectives, academies of forestry, polytechnics, schools of agriculture, of mining, of architecture, of art, and of music. There are more than 250 normal schools for training teachers.

Above all the rest there are 21 universities, some of them with just reputations which have attracted students from all parts of the educational world. In 1900 there were 2,800 teachers and 34,000 students in these universities.

The fundamental and distinguishing characteristics of this mighty system of education may perhaps be enumerated as follows: (a) the full and regular attendance of children of school age; (b) the habit of uniform obedience to the State's authority; (c) official exactness concerning the quantity of the work to be done in each grade of schools; (d) uniformity in the work of each grade, with 42 to 45 weeks of work in a year; (e) the fact that each grade of school leads to something beyond, to work as much as to higher schools; (f) that the "something beyond" is suited to whatever manner of life the child is likely to lead; (g) the adequate preparation of the teachers, the exclusion of immature or unprepared teachers, the certain tenure of teachers, and the consequent dignity of the teacher and his work; (h) the inspection of private teaching and the assumption of entire responsibility for the education of the country by the government; (i) the apparently open opportunity for all, accompanied by a marked contentment with one's situation and a readiness to do what is reasonably within the reach of one's station in life; (j) a very considerable evenness of educational instrumentalities and opportunities in all parts of the Empire; (k) very many heights of scholarship which are not outranked by any in the world; (l) deep and common civic responsibility for the character of the schools.

In the work of the German schools the ordinary work in American schools is included, but special emphasis is laid upon physical exercise and militarism, upon drawing and manual skill, upon needlework and other domestic arts, and upon music. Everything is done to nourish love for the Fatherland. The portrait of the Emperor is required to be displayed in every schoolroom. The national songs are sung often and well. The accomplishments of the nation are well told. Everything is done for contentment, for scientific scholarship, for industrial productivity, for military efficiency, for the happiness, oneness, strength, and greatness of the German Empire.

Mention of the important fact that religion is a vital part of the primary school curriculum of Germany must not be omitted. Whether the child goes to a public school or a private school, or is instructed in the family, the State demands that he be instructed religiously. If the school be one of Protestants, Roman Catholics, or Jews, the master must see that the religious instruction conforms to the religious preferences, and whoever gives any instruction, including the religious, must have the authority of the government behind him. If the schools are mixed religiously, the instruction must accord with the beliefs of the greater number; perhaps in some cases the dogma and doctrine are somewhat mixed, too; more likely the religion is not so theological as some would make it. The clergymen are in a sense representatives of the State. The greater number receive a considerable part of their salaries directly from the State. They have been educated in the different grades of the schools, including the divinity schools of the universities, and are easily adaptable to the needs of German religious education.

In view of the purely non-sectarian character of American public schools and of the frequent discussion of religious training in this country, it is interesting to notice how the German law treats the matter. The following are among its provisions: The character of the religious instruction is determined by the father. Where the father and mother are of different denominations an agreement made before marriage to train the children in the religion of the mother has no legal effect. On the death of the father the instruction must continue in his faith and no death-bed conversions to a different faith are recognized. On the death of the father the court must attend to the matter. Children born out of wedlock must receive religious instruction in the faith of the mother. After 14 years old children may decide for themselves as to the denomination they will affiliate with. Before 14 no denomination is allowed to receive a child or permit a confession of faith other than that to which the child belongs by law.

The reader needs no assurance that a people doing so much for schools of every grade from the kindergarten to the university has accumulated many and great aids to information and culture outside of the schools. We know it would be so and that it is so. The libraries, museums, art galleries, architecture, palaces mausoleums, and monuments of the Germans fittingly augment and round out their system of education, but obviously we cannot enter upon even a partial description of them here.

Comparisons with the United States.— The extended treatment which has been given to various phases of the American educational system in this department makes any general presentation of our own system unnecessary in this place. But I cannot forbear observing that it is clear enough that there are some advantages and some disadvantages with us when we come to compare ours with other systems. Such comparison may be hazardous, but I shall venture to express the thought that in regard for details and in a commonly exercised and accepted power to regulate them; in the appreciation of the necessity of universal and regular attendance of all children within fixed ages; in training for specific industries and common employments and in promoting contentment; in realization of the bearing of the work of the advanced schools upon the lower ones; in providing for the philosophical and exact preparation of teachers; in dignifying the teacher's position; in fixing educational values and in avoiding erroneous estimates of scholarship and culture in the affairs of the people, and particularly in determining the policies of the government of the nation, there are foreign systems of education which have claims superior to the corresponding claims which may be made on behalf of the American system.

On the other hand, it seems to me that in the adaptability of schools to agricultural, and particularly to pioneer, conditions; in such general inclusion of high schools, and now of State universities in the public educational system; in the steady correlation and solidification which is going on between all grades and kinds of institutions; in the continuous road from the lowest to the highest, and the encouragement which is given every ambitious child of the people to follow it; in balancing State and local control and in developing so much and such efficient local supervision; in the cheerful generosity by which the public schools are supported, and the monumental munificence with which private schools are established and maintained; in the fullness of religious toleration and the cordiality with which all classes from all peoples are working together for learning; in the elasticity and flexibility of the whole system, the freedom of its opportunity, the aggressiveness of its spirit, the grandeur of its outlook, and the measure of its accomplishments and of its confident expectancy; in the ripeness of its scholarship at many points and the tendency to diffuse and absorb scholarship at all points; in the growing regard for the implements and results of scholarship and the unlimited determination to have whatever will aid learning; and particularly in the popular administration of the system, the universal sense of proprietorship, and the retroactive influence of this upon the buoyant intellectual and moral sense of the nation, we have educational advantages which are hardly enjoyed by any other people.

The political theories which developed very early and very strongly in the pioneer life of America and which have become the universal policy and almost the passion of the country in its maturer life, have had a controlling influence upon the scheme and the scope of our educational system. They lead us to hold up some ideals and undertake many ends which other nations, even the best of them, never think of or never attempt. We must give every American child an equal chance. The equal chance means that each must have legal and actual right to all the learning that he has the time, the preparation, and the strength of purpose to get. The system which provides this widely diversified instruction must necessarily be adaptable to widely diversified conditions, to city and country, to old states and new ones, to all conditions of climate, of geographical situation, of means, of experience, and of learning. About the only constant and uniform factor in it all is the universal American spirit. Beyond this is the weighty fact that the American educational system has to be organized and administered through the helpful agencies of the State but through the actual management of the people themselves. The centralized and arbitrary administration which accomplishes so much within fixed and commonly exclusive limits in many other lands is repugnant to our fundamental political philosophy. The result doubtless is that undertaking so much, for everybody, and through extreme forms of decentralized and popular government, we do not accomplish all we undertake as completely as some other nations accomplish the more aristocratic and autocratic, the less democratic and less ambitious, ends which they undertake. For example, it is clearly true that there are several other nations where the percentage of people who cannot read and write is considerably lower than in America, but it is highly probable that there is no other nation with a higher general level of scholarship, of resourcefulness, of ambitious and educated purpose, and of disposition to use all of the means that can actually promote the higher enlightenment of all the people. The American people are steadily gaining in disposition to do, and in ways and means of doing, by doing things for themselves. Fresh from this review of other great national systems of education, and admitting some things that we are not doing at all or not doing as well as they, we falter not in the belief — rather we are strengthened in it — that our political system and our resultant educational system are fraught with more good to all the people, to all the higher interest of the world, than any other, because it is moving on, steadily and forcefully, to more distinct and decisive and uniformly important culminations.

Andrew S. Draper,
Commissioner of Education, State of New York.

Education, Negro. See Negro, Education of.

Education, Professional, in America. At the time of the Declaration of Independence there were only two professional schools in the United States, the Medical College of Philadelphia (1765), now the medical department of the University of Pennsylvania, and the medical department of King's College (1768), now Columbia University.

The following statistics for the year 1904, as prepared by the commissioner of education, show a remarkable growth in this particular phase of education in the United States:

Class of School	Schools	Instr't'rs	Students	Graduates
Theological	153	1,055	7,392	1,620
Law	95	1,167	14,306	3,288
Medical	152	5,252	26,949	5,702
Dental	54	1,191	7,325	2,192
Pharmaceutical	63	611	4,457	1,308
Veterinary	11	165	795	198
Totals	528	9,441	61,224	14,308

In 1904, the total amount of property controlled by these schools was estimated at $33,027,675. The income of these institutions amounts to $3,279,358, and the number of volumes in the school libraries is 2,286,980.

Among the 153 theological schools are 28 Roman Catholic institutions, 18 Presbyterian, 2 United Presbyterian, 2 Reformed Presbyterian, 1 Cumberland Presbyterian, 10 Baptist, 1 Seventh Day Baptist, 2 Free Will Baptist, 3 Lutheran, 17 Evangelical Lutheran, 1 German Lutheran, 10 Congregational, 12 Protestant Episcopal, 13 Methodist Episcopal, 4 Methodist Protestant, 7 Reformed (Dutch) Church, 2 Jewish, 4 Christian, 3 Universalist, 3 Non-Sectarian, 1 Moravian, 1 Unitarian, and 8 others.

There is no national authority in the United States that can prescribe standards for degrees or for license to practise the professions. Each State makes its own professional laws. As a result there are almost as many standards as there are political divisions. The desirability of uniform standards throughout the country for admission to professional practice is recognized generally, but varying conditions as to density of population, educational advantages, and general development make it impracticable to hope for the attainment of this end for some time to come. In 1850 the public had little protection from incompetency in professional practice. The bar is said to have been at its lowest ebb. Medical laws were crude and largely inoperative. In several States only were there any acts designed to control the practice of pharmacy and dentistry. There was no law whatever restricting the practice of veterinary medicine. There has been extraordinary progress, especially in the last decade, in restrictive professional legislation, and in the admission and graduation requirements of professional schools throughout the United States. In New York State a preliminary general education equivalent to graduation from a four years' high school course after a completed eight years' elementary course is prescribed by statute as the minimum standard for license to practise medicine. This standard approximates that required in continental Europe. New Hampshire has similar requirements, but they are not as rigidly enforced. The statutes of Delaware, Maryland, New Jersey, and Pennsylvania prescribe a "common school education." Louisiana demands "a fair primary education." The rules in Vermont prescribe a high school course; in Illinois and Iowa less than one year of high school work; in Virginia, "evidence of a preliminary education." In remaining political divisions laws and rules are either silent in this respect or so indefinite as to be of little value.

In New York and Illinois a preliminary general education equivalent to a three years' high school course is required for admission to the bar. Connecticut demands a high school education or an indefinite preliminary examination. The minimum requirement in Michigan (in case of examination) is less than two years of high school work, in Colorado it is one year of high school work, in Minnesota (in case of examination) it is less than one year, in Ohio it is a common school education. If anything is demanded in other political divisions the requirement is not sufficiently established (excepting a few local cases) to find a place either in statutes or court rules.

The New York law exacts a full high school course as one of the requirements for license to practise dentistry. New Jersey demands by statute "a preliminary education equal to that furnished by the common schools," Pennsylvania "a competent common school education," Virginia a "fair academic education." In other political divisions there is no such requirement. Louisiana, Michigan, South Dakota, Wisconsin, and, in case of examination, California and Texas are the only political divisions which mention in their rules preliminary general education as a requirement for license to practise pharmacy. An elementary education only is prescribed. The completion of a full high school course or its equivalent is one of the statutory requirements for license to practise veterinary medicine in New York. Pennsylvania demands "a competent common school education." There is no such requirement in any other State.

In New York, high standards in preliminary general education are demanded both for degrees and for licenses, and in each case the question of attainments is determined by a central authority, the University of the State of New York. As a rule in other States the professional schools conduct their own entrance examinations, and the tests are often mere matters of form, even though the standards may appear satisfactory on paper.

Entrance Requirements.— In 4 theological schools there are no entrance requirements; in 24 schools they are indefinite; 19 demand a grammar school education; 1, 6, and 19 require respectively one, two, and three years of high school work; 18, 3, and 71 demand respectively one, three, and four years of college work.

In 16 law schools there are apparently no entrance requirements whatever; in 8 schools they are so indefinite as to be practically worthless; 26 schools demand a grammar school education; 8, 11, 12, and 3 require respectively one, two, three, and four years of high school work. Harvard demands an education equivalent to that required for admission to the senior class. The Columbia Law School is maintained as a graduate department after 1903.

In 2 medical schools the requirements are indefinite; 29 demand a grammar school education; 97, 12, 3, and 12 require respectively one, two, three, and four years of high school work. Johns Hopkins and Harvard require a college course.

In 3 dental schools the requirements are indefinite; 18 demand a grammar school education; 18, 11, and 6 require respectively one, two, and three years of high school work.

In 6 schools of pharmacy there are no entrance requirements; in 4 schools they are indefinite; 24 demand a grammar school education; 11, 6, and 1 require respectively one, two, and three years of high school work.

In 1 veterinary medical school the requirements are indefinite; 9 demand a grammar school education; 1, 5, and 1 require respectively one, two, and three years of high school work.

Courses in theology, law, and medicine are naturally graduate courses and will eventually be maintained as such by leading universities. It is believed, however, that it would not be advisable or even desirable for the State to make graduation from college the minimum requirement in general education for degrees even in these faculties. High school graduation is sufficient for the minimum State requirement.

University Supervision.— As long as the public had practically no protection from incompetency in professional practice independent proprietary schools flourished. With proper restrictive legislation such institutions will either die or fall under university supervision.

Many professional schools not under university supervision show a self-sacrificing zeal for high standards and an absence of the commercial spirit that might well be emulated by all institutions connected with colleges or universities. Nevertheless independent institutions are realizing more than ever before the disadvantages of working without university privileges and tend more and more toward university connections or university relations.

Scholarships.— Theological seminaries, when not endowed, are supported by funds from the denominations they represent. Tuition is generally free, and in many cases board and lodging are furnished. Additional help is given usually when needed, and generous scholarships are the rule. In other professional schools scholarships are comparatively rare. The latest United States education report gives 40 law school scholarships and 295 medical school scholarships. The largest, offered by College of Physicians and Surgeons, New York, pays $700 a year and is bestowed to promote the discovery of new facts in medical science.

An examination of 82 law school catalogues shows that 48 scholarships are offered definitely. Tuition is free at the law department of Howard University, the law departments of the universities of Kansas, Texas, and West Virginia. The Harvard law school and the Boston University law school offer a "limited number of free scholarships." Law students may compete for the 150 State scholarships and the 18 university scholarships offered annually at Cornell and for the 50 city scholarships offered by the University of Pennsylvania. The law department of Centre College offers free tuition to sons of ministers and to all young men of limited means and good character. Three schools give fellowships annually as follows: New York Law School, 1 at $500 a year, good for from one to three years; law department University of Pennsylvania, 1 at $300, good for one year; Pittsburg Law School, 1 at $250, good for one year. Thirty-two schools offer cash prizes amounting to $3,010 and law and reference books as other prizes.

One hundred and fifty-one medical school catalogues report definitely only 152 scholarships and 11 fellowships. These are offered by 31 schools. Five other schools refer indefinitely to scholarships. At Cornell and the University of Pennsylvania medical students may compete for State and university, or city scholarships on an equal footing with those who would enter other departments. Tuition is free at the Army

Medical School, the medical department of the University of Texas, and the medical preparatory school of the University of Kansas. Nineteen schools give cash prizes amounting to $5,685; 57 offer hospital appointments as prizes; 47 give gold medals, surgical instruments, and other prizes.

Fifty-six dental school catalogues show that 7 schools offer 58 scholarships. The dental department of the University of Maryland deducts one half from tuition fees of one student from each State on recommendation of his State dental society. The Baltimore College of Dental Surgery had similar beneficiary scholarships till 1898 when they were abolished. Eighteen schools offer prizes but their value is not great.

Fifty-two catalogues of schools of pharmacy show that 5 schools offer 12 scholarships and 2 fellowships. Tuition is free at the schools of pharmacy connected with the Alabama Polytechnic Institute, Washington Agricultural College, Purdue University, and the universities of Kansas, Ohio, Oklahoma, Texas, Washington, and Wisconsin. Fifteen schools offer prizes, usually medals or pharmaceutic instruments. Five of these 15 schools give cash prizes amounting to $620. The committee on revision of the 'United States Pharmacopœia' has instituted fellowships in the University of Michigan and the University of Wisconsin for the discovery of new facts in pharmacy.

Sixteen veterinary school catalogues show that 19 scholarships are offered at 5 schools, that 1 school gives a fellowship and that 6 schools offer prizes. Tuition is free at the veterinary departments of Cornell and Ohio universities, and of Washington Agricultural College. Cornell opens to competition by veterinary students 18 scholarships and to veterinary graduates a fellowship of an annual value of $500. Veterinary matriculates are eligible for 50 city scholarships offered by the University of Pennsylvania. The veterinary department of Ohio State University offers a scholarship in each county in which the agricultural scholarship is not taken.

Fees.— Tuition is free in 132 theological schools. Only 8 have matriculation fees, 33 a course fee, and 34 other fees. The average matriculation fee is $5.38, the average course fee $91.61, the average of other fees $22.06.

Tuition is free in 4 law schools; 23 have matriculation fees (average $14), 83 have course fees (average $69.80), 59 have other fees (average $10.86).

Tuition is free in 3 medical schools; 119 have matriculation fees (average $10.68), 153 have course fees (average $82.39), 129 have other fees (average $49.47).

Tuition is not free in any dental school; 40 have matriculation fees (average $8.62), 56 have course fees (average $94.32), 5 have other fees (average $33.48).

Tuition is free in 9 schools of pharmacy; 28 have matriculation fees (average $8.07); 43 have course fees (average $58.90), 50 have other fees (average $37.90).

Tuition is free in 3 veterinary medical schools; 7 have matriculation fees (average $7.85), 14 have course fees (average $81.28), 12 have other fees (average $43.50).

Libraries.— In 1904 the United States commissioner of education reported 1,534,486 volumes in libraries of theological schools, 473,771 in libraries of law schools, 220,822 in libraries of medical schools, 9,171 in libraries of dental schools, 44,705 in schools of pharmacy libraries.

Endowments.— The report (1904) of the commissioner of education gives the following figures:

Class of School	Endowment funds	Benefactions received during the year
Theological	$21,422,322	$1,092,645
Law	1,447,300	13,550
Medical	1,665,416	376,755
Dental	....	1,000
Pharmaceutical	23,279	8,021
Veterinary	....	103,000

Value of Grounds and Buildings.— In 1904 the following figures were given, showing the value of grounds and buildings of professional schools:

Theological	$14,304,414
Law	2,461,500
Medical	13,989,263
Dental	1,250,256
Pharmaceutical	852,742
Veterinary	166,500

The following report the greatest values in grounds and buildings.

Theology	
General Theological Seminary, Protestant Episcopal	$1,742,000
St. Joseph's Seminary, Roman Catholic	1,000,000
McCormick Theological Seminary, Presbyterian	1,000,000
Law	
University of Pennsylvania, law department	$500,000
University of Chicago, law department	320,000
Boston University Law School	250,000
Medicine	
Cornell University, Medical College	$1,100,000
Hahnemann Medical College, Philadelphia	1,000,000
Jefferson Medical College	600,000
University of Pennsylvania, Department of Medicine	540,656
University of Illinois, College of Physicians and Surgeons	520,000
University and Bellevue Medical College, New York	518,852
Washington University, medical department	500,000
Cooper Medical College	500,000
George Washington University, Department of Medicine	403,195
Dentistry	
Baltimore Medical College, dental department	200,000
Tufts College Dental School	200,000
Philadelphia Dental College	130,000
New York College of Dentistry	120,000
Pharmacy	
Philadelphia College of Pharmacy	250,000
New York College of Pharmacy	204,242

When grounds and buildings are used for several departments, as for example the Columbia Law School which is in the library building, values are not always reported.

Receipts and Expenditures.— The latest reports available for 1903-4 give only a partial report of income as follows:

Class of School	No. of Schools	Income
Theological	153	$1,069,690
Law	95	364,618
Medical	152	1,318,570
Dental	54	205,956
Pharmaceutical	63	182,437
Veterinary	11	48,087
Totals	528	$3,279,35[illegible]

Women as Professional Students.— The 1901 United States education report shows that women now appear as students in professional schools of each class except those in veterinary medicine. In nursing they are of course in a large majority, 10,292 as compared with 1,307 men. In the other professions they are reported as follows: Theology, 181, law 170, medicine 1,219, dentistry 166, pharmacy 206. The proportion of women in regular medical schools is much smaller than in homœopathic, eclectic, and physiomedical schools, showing that women prefer the medical sects.

See Dentistry; Education; Law; Medicine; Nurses, *Trained*; Pharmacy; Theology; Veterinary; Women, Education of.

Power to Confer Degrees.— Low standards in many professional schools are due to a failure to subject the degree-conferring power to strict State supervision. In New York and Pennsylvania the laws now prevent an abuse of the power to confer degrees. In Massachusetts and Vermont bodies formed under the general corporation acts are prohibited from conferring degrees. In Ohio and Nebraska the statutes require only the nominal endowment of $5,000 for a degree-conferring institution. In other States and Territories as a rule any body of men may form an educational corporation with power to confer degrees "without any guaranty whatever that the privilege will not be abused." This matter has been under discussion recently in various educational bodies and there is a strong sentiment in favor of a strict supervision by the State of the degree-conferring power.

Bibliography.— It is impossible to give more than a brief outline of professional education in the United States. For detailed information touching laws, regulations, location of schools, and courses of study the reader is referred to 'Professional Education in the United States,' published by the University of the State of New York. Of the many authorities the following are most helpful: United States education reports; Eliot, 'Educational Reform'; United States census reports; Briggs, 'Theological Education, and Its Needs'; Dyer, 'Theological Education in America'; Jessup, 'Legal Education in New York'; Wellman, 'Admission to the Bar'; Hammond, 'American Law Schools, Past and Future'; reports of the American Bar Association; Toner, 'Annals of Medical Progress in the United States'; Davis, 'Medical Education and Medical Institutions in the United States'; Journal American Medical Association; Shepard, 'Inaugural Address at the World's Columbian Dental Congress'; 'Proceedings of the American Pharmaceutical Association.'

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Education, Roman Catholic, in America. The educational work conducted under the auspices of the Roman Catholic church in the United States embraces all grades of institutions, from the kindergarten to the university. The official figures for the year 1903 show 4,001 parishes with parochial schools, 646 academies and high schools for girls, 179 colleges for boys, and 7 universities. At least four of these universities, by reason of their collegiate and professional courses, deserve to rank as universities, in the proper acceptation of the term. At the head of the Catholic school system is the Catholic University of America, Washington, D. C., established canonically by Pope Leo XIII., 10 April 1887, and incorporated the same year under the laws of the District of Columbia, with Rt. Rev. John J. Keane, S. T. D., as rector.

About one hundred religious teaching orders of men and women and select bodies of the diocesan clergy conduct this work, with a variety of methods and courses of study, but with a unity of purpose to impart a thorough Christian education to the Catholic youth of the country. In the secular studies, the curricula of schools, academies, colleges, and universities do not differ materially from those that obtain in other American schools. In many instances they are recognized by city or state departments of public instruction, and prepare the students for entrance into the higher public institutions of learning. Throughout all schools and grades the study and practice of the Catholic religion are made important; indeed, it is this solicitude of the church for the influence of Christian faith and morals upon the conscience and character of youth that has called forth and maintains, at immense cost and sacrifice, these thousands of Catholic schools. The Catholic Church considers the Christian religion essentially requisite for shaping the character and regulating the life of her youth, and therefore insists upon its action in her schools, to develop a sense of Christian duty, of obligation, of right and wrong, in conscience and before God. The aim of the church and its attitude toward State schools, wherein the teaching of religion is prohibited, are clearly set forth in the pastoral letter of the American bishops of the Third Plenary Council:

> Reason and experience are forcing all Christian denominations to recognize that the only practical way to secure a Christian people, is to give the youth a Christian education. The avowed enemies of Christianity in some European countries are banishing religion from the schools, in order to eliminate it gradually from among the people. In this they are logical, and we may well profit by the lesson. Hence the cry for Christian education is going up from all religious bodies throughout the land. And this is no narrowness nor "sectarianism" on their part; it is an honest and logical endeavor to preserve Christian truth and morality among the people by fostering religion in the young. Nor is it any antagonism to the State; on the contrary, it is an honest endeavor to give to the State better citizens, by making them better Christians. The friends of Christian education do not condemn the State for not imparting religious instruction in the public schools as they are now organized; because they well know it does not lie within the province of the State to teach religion. They simply follow their conscience by sending their children to denominational schools, where religion can have its rightful place and influence.

Catholic Secondary Schools.—There is no single, organized system of Catholic secondary schools in the United States. Between the parish school system, now fairly well organized in most dioceses with school superintendents, courses of study, grading of classes, etc., and the university at Washington, there is no uniform plan of intermediate studies. Each secondary school and college is a law unto itself respecting entrance requirements, length and character of courses, and standards for graduation, except in so far as these are regulated by the chartering power under which degrees or honors are conferred. Nor are there any free, endowed Catholic secondary schools besides the Boys' Catholic High School, Philadelphia, founded by the late Mr. Cahill, and the Creighton University, Omaha, Neb., founded by John A. Creighton. The secondary schools that do exist are maintained by the teaching orders, mainly through the tuition fees of the students. Living a community life and working without salary, these teachers have been enabled to accomplish much with inadequate resources, and their contribution to the church's educational work in the United States is beyond reckoning. Were it not for their self-sacrifice and devotion to the cause of education, the American Catholic youth would have scarcely any means of prosecuting the higher studies under Catholic auspices. Within the past 10 years efforts have been made with success in several dioceses to secure the foundation of free scholarships for ambitious and deserving graduates of the parish schools.

Academies and High Schools.— Under this heading are included the convent schools for girls, manual and industrial training schools for boys, commercial and high schools for both sexes. The elementary course of eight years is supplemented by a course varying from one to four years, in the higher studies of English, languages, science, mathematics, history, commercial studies, art and music, and Christian ethics. Last year there were 646 academies for girls with an attendance of about 25,000.

The manual and industrial training schools are not so numerous, but with the growing demand for artistic work in the trades, each year marks the opening of new trade schools. The Catholic High School, Philadelphia, and the Papal College Josephinum, Columbus, Ohio, are noted for their excellent work. Commercial schools for boys are found in every large city as preparatory schools for those intending a business career. Many parish schools give post-graduate courses in commercial law, bookkeeping and typewriting, and might properly be classed with secondary schools. For some time there has been a tendency to advance the larger parish schools beyond the studies of the grammar grades. One or more advanced classes are devoted to secondary work. At present there are about 50 of these in the larger cities, with an attendance of 450 boys and 750 girls. These figures are not large but they are significant of a growing demand for the advantages of Catholic secondary education.

Less than half of these Catholic academies have reported statistics to the United States Commissioner of Education. Of the 1835 private secondary schools reporting to the Commissioner, religious denominations control 923. Of the latter, the Catholic Church maintains 369, with 1,946 instructors, and 16,786 students, distributed as follows:

	Schools	Instructors	Students
North Atlantic States....	99	556	5,385
South Atlantic States....	35	163	1,227
South Central States.....	53	268	2,485
North Central States.....	116	675	5,426
Western States	66	284	2,263

History.— One of the first high schools for boys in the United States was the classical school founded in 1682 by the Jesuits, in that part of New York city known as "Bowling Green," near the Battery. It was patronized by Gov. Thomas Dongan and by the best Protestant families of the time. Later it had to be closed owing to attacks of bigotry, rampant in that age, but in 1808, Father Antony Kohlmann, administrator of the diocese, bought ground for a new school, in front of the old cathedral. It was opened with one priest, and four scholastics, and had 35 pupils. A few years after it moved to the site of the present Cathedral, and developed into the diocesan seminary. Among the earliest American academies for girls was the pioneer Ursuline Academy in Canada, founded by Madame de la Peltrie, in 1652. The original building forms the centre of that group which to-day constitutes the Ursuline Convent, Quebec. The first band of Ursulines in the United States reached New Orleans in 1727, and established on August 7, that year, what is probably the first high school for girls in this country. In 1808 Ursulines from Ireland opened an academy in New York city, but failing to receive vocations to the Order, they returned home. In 1820, the historic Ursuline school at Charlestown, Mass., was opened, and at once attracted attention for the excellence of its work. It is said that four fifths of its pupils were from the most distinguished Protestant families of New England. The Visitation Nuns began their educational work in the United States at Georgetown, D. C., in 1799. The saintly Mother Eliza Anne Seton, a convert to the Catholic faith, established in 1809 at Emmetsburg, Md., the Sisters of Charity of Saint Joseph. In 1812, at Nazareth, Ky., a few pious ladies founded the Sisters of Charity of Nazareth, with Mother Catharine Spalding, the first superioress, and in 1818 the Ladies of the Sacred Heart came to the United States, when Madame Duchesne opened a convent at Saint Charles, Mo. Since then other Orders from the old world came here to organize and conduct schools and at least 20 more are original American foundations.

Catholic Colleges.— These may be classified as classical, commercial, and a combination of both. They arose to meet the demand for higher education by those destined for the priesthood, the learned professions, and business careers. The tendency to-day is to eliminate the commercial department from the colleges, and thus make them strictly classical and scientific. The Christian Brothers, who had attained distinction in the teaching of the classics, have returned to their primitive rule which forbade this teaching, and are now making a specialty in their colleges of the modern languages, pedagogy and applied science. Excepting Creighton College, Omaha, Neb., there is no free, endowed Catholic college in the United States. Tuition fees have been the main source of revenue; benefactions and endowments have been a rarity; not one Catholic institution appears on last year's list of notable benefactions to American colleges. Lack of funds has hampered many of the colleges in extending the field of their labors and in undertaking many modern methods and improvements. No uniform, definite standard obtains for entrance. In the East an increasing number conform to the requirements of the Regents of the University of New York, or to the regulations of "The Association of Colleges and Preparatory Schools in the Middle States and Maryland." Under the guidance of Rt. Rev. Mgr. Thomas J. Conaty, D. D., rector of the Catholic University, the representatives of 53 Catholic colleges assembled in Chicago in 1899, and organized "The Association of Catholic Colleges of the United States." The purposes of the association are to study the questions connected with college education, to advance the unification of systems of Catholic education, and to strive toward a larger development of college work. The Association meets at an annual conference, the report of which is published at the Catholic University. Its organization was perhaps the most important step taken in Catholic higher education since the establishment of the Catholic University.

The colleges are conducted chiefly by the religious teaching orders of men, as follows: Augustinians, 2; Benedictines, 18; Capuchins, 2; Carmelites, 1; Order of Charity, 1; Christian Brothers, 6; Franciscans, 5; Franciscan Brothers, 1; Holy Cross, 5; Holy Ghost, 1; Jesuits, 24; Marists, 5; Society of Mary, 4; Precious Blood, 1; Brothers of the Sacred Heart, 4; Saint Viateur, 1; Vincentians, 2; Zaverian Brothers, 3. Not all of these are reported by the United States Commissioner of Education. In the 60 colleges for which statistics are given, there were (1902-3) 1,375 instructors and an attendance of 14,158 students.

Colleges for Women.— The Catholic Church has ever been solicitous to foster the higher education of women, but on lines that will conserve the graces and promote the ideals of true Christian womanhood. The Ursulines and the Ladies of the Sacred Heart conduct several collegiate schools. At Govanstown, Md., the School Sisters of Notre Dame maintain a promising college. Saint Mary's, Notre Dame, Ind., Sisters of the Holy Cross, was founded in 1855 to provide for the highest education as rapidly as means would allow. This is probably the first legally authorized Catholic college for women in the United States, its charter from the Indiana legislature dating back to the year of foundation. The new Collegiate Hall was opened last year. The College of Saint Elizabeth, formerly known as the Academy, Convent Station, N. J., was founded in 1859 and is in charge of the Sisters of Charity. It is chartered under the laws of New Jersey to confer degrees, and is registered by the N. Y. Board of Regents. Its physical and chemical laboratories are splendidly equipped with all modern appliances for advanced work in all the college departments. Saint Mary's-of-the-Woods, Saint Mary's, Ind., was established by the Sisters of Providence, in 1840, and for some years has been empowered to confer academic honors and collegiate degrees. Trinity College, Washington, D. C., in the immediate vicinity of the Catholic University, was organized in 1901 by the Sisters of Notre Dame of Namur, and is strictly a post-graduate college. It is a woman's college of the same grade as Vassar, thus giving Catholic women an opportunity for receiving the highest collegiate instruction.

Universities.— Among the Catholic institutions of highest education are the universities of Georgetown, Notre Dame, Creighton, and the Catholic University of America. Saint John's College, Fordham, N. Y., founded in 1841, announces that it will branch out as a university this year, when a medical college will be opened, affiliated in a clinical way with a new hospital in course of erection near by. The oldest Catholic university in the United States is Georgetown, District of Columbia, founded in 1789. It contains a graduate school, collegiate, law, medical and preparatory departments, and an astronomical observatory. The Jesuit Fathers conduct it. Notre Dame University, Saint Joseph County, Ind., was established 1842 by the Very Rev. Edward Sorin, C. S. C. It has thirteen full collegiate courses, besides excellent courses in art and music. The Creighton University, Omaha, Neb., founded by John A. Creighton and endowed as a free college, was opened in 1879, in charge of the Jesuits. It includes Creighton College, a free, classical day college, and the Creighton Medical College (1892), with a clinic in The Creighton Memorial Saint Joseph's Hospital. The Catholic University of America, Washington, D. C., was established by the American bishops through the munificence of Miss Mary Gwendolin Caldwell. It was solemnly opened 13 Nov. 1889, as the highest seat of learning of the Catholic Church in the United States. By the terms of its Constitutions "the courses of study shall be such in quality and grade as befit a real university." Under the Faculties of theology, philosophy, and law, and the Board of Instruction of Technology are maintained twenty-five departments of university study. The University Colleges, managed by officers under rules laid down by the Board of Trustees, of which His Eminence James Cardinal Gibbons is president, are Divinity College, or Caldwell Hall, and Keane College, named in honor of the University's first Rector, Most Rev. Archbishop John J. Keane, Dubuque, Iowa. Affiliated with the University and grouped about it are Saint Thomas' College (Paulists), Marist College (Society of Mary), Holy Cross College (Fathers of the Holy Cross), College of the Holy Land (Franciscans), Saint Austin's College (Sulpicians), and the Apostolic Mission House (Catholic Missionary Union). Saint Paul's Seminary, Saint Paul, Minn., is also an affiliated college. McMahon Hall, named in honor of the late Mgr. James McMahon, who founded it, contains the chief lecture halls and laboratories. Among the University publications are the 'Catholic University Bulletin,' published quarterly; 'Pittonia,' a series of papers relating to botany; and the 'Year Book,' published annually in April.

Normal Schools.— The religious orders of men and women devoted to educational work prepare their novices at their respective motherhouses, which are normal schools, with more or less full courses in pedagogy. Many of these are distinct buildings, equipped with the best appliances used in modern training schools for teachers. The normal institutes of the Christian Brothers at Amawalk and Ammendale, of the Notre Dame Sisters at Waltham, Mass., and San Jose, Cal., and of the Marist Brothers at Dayton, Ohio, are model institutions. In the United States Commissioner's report are the statistics of twelve others, in which the curriculum of normal studies is followed by 215 students. In 1873 Mother Angela, Sisters of the Holy Cross, Notre Dame, Ind., established Saint Catharine's Normal School, at Baltimore, Md. This was the first Catholic Normal school for women in the United States. Its course of study has always been in accord with the best pedagogic methods. Of late years the Jesuits and the Christian Brothers have conducted special pedagogical departments in most of their colleges. In October 1903, the Catholic University opened in New York city an Institute of Pedagogy, where its professors give graduate courses in psychology, logic and ethics, principles, methods, and history of education, American history, and library work.

Catholic Reading Circles.—The first Catholic reading circle was begun by Warren E. Mosher, in Youngstown, Ohio, in 1889. He also founded and edited the 'Catholic Reading Circle Review,' the monthly organ of the Catholic Educational Union. Under the name of the 'Champlain Educator,' the Review is now the official organ of the Catholic Summer School of America. The same year the Paulist Fathers (N. Y.) established the Columbian Reading Union, with a department in the 'Catholic World Magazine.' Under the Catholic Educational Union, 200 reading circles are organized, with a membership of 6,000; in the Columbian Reading Union are 150 reading circles, with a membership of more than 5,000. The most far-reaching and progressive outgrowth of the movement has been the University extension work through the Catholic Summer and Winter Schools, organized on the well-known Chautauqua plan. The parent Catholic Summer school was established at New London, Conn., in 1892. A year later permanent grounds consisting of 500 acres were secured at Cliff Haven, on the west bank of Lake Champlain. In 1903, 6,000 people were in attendance. The investments of the Catholic Summer School of America represent over $400,000. The lecture courses embrace literature, art, science, pedagogy, history, philosophy, music, physical culture, and ethics. The New York State Department of Public Instruction has established the Summer School as a summer institute for teachers, and the course in pedagogy qualifies for promotion before the Board of Education, New York city. In 1895 a similar organization was effected in the Middle West, at Madison, Wis., where the successful Columbian Catholic Summer School holds its sessions. The Catholics of the South in 1896 opened a Catholic Winter School in New Orleans, where its annual session opens each year after the Mardi Gras celebration. San Francisco also has its Catholic Winter School, and at Emmetsburg, Md., have been held annual sessions of the Maryland Catholic Summer School.

Bibliography.—Shea's 'History of the Catholic Church in United States'; 'Catholic Directory' (1905); 'American Catholic Quarterly Review' (July 1897); 'American Ecclesiastical Review' (June 1896); 'Reports of the Conferences of the Association of Catholic Colleges'; 'Review of Catholic Pedagogy' (1903); 'Report of United States Commissioner of Education' (1902). See PARISH SCHOOLS.

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Education, Scientific and Technical. The opening for the founding of the modern scientific or engineering college was in a large measure made by Archimedes, Galileo, Bacon, Kepler, Newton, and others, whose creation of exact science made possible the study of applied science, and the wonderful growth and development of such schools, in which the applications of scientific discovery might be taught, has practically all been witnessed since the last half of the 19th century.

Industrial and economic conditions had much to do with the founding of such schools in certain localities; for example, the famous School of Mines at Freiburg, and to this same class belong many of the earlier European schools. These schools have been the models after which the schools of the United States have been patterned, but still the individuality and great advances made in the schools of the United States in the direction of scientific and technical education are of great interest to educators throughout the world.

Scientific and technical schools may be divided into three groups: (1) those schools which teach science and technology exclusively, and which are independent of and free from all State or government control and which oftentimes rely for their income upon the endowment of a single person; (2) those schools, not under State or government control, which are affiliated with some college or university, and whose work is largely individualized, often having no separate faculty or organization and sometimes wholly supported by the income derived from separate endowments and their own tuition fees; (3) those schools which derive a large portion of, if not all, their support from State or government.

The organization, courses of study, and degrees conferred by such schools are materially the same; all courses are four years in length, the first two preparatory to the last two, embracing the usual subjects, such as modern languages, mathematics, etc., the junior year generally marking the point at which the differentiation begins; the degree almost universally conferred is B.S., but some few also grant the degrees of C.E., M.E., etc.

The respect for exact scholarship and the regard for scientific truth make schools of engineering and technology more than a means toward riches; they instill into the mind of the student a regard for his duty as a citizen, and cultivate a thorough responsibility and accuracy of judgment as well as disciplined, intellectual, and independent thought. See EDUCATION, ENGINEERING; MANUAL TRAINING; ARMOUR INSTITUTE OF TECHNOLOGY; CASE SCHOOL OF APPLIED SCIENCE; CHANDLER SCHOOL OF SCIENCE; COLUMBIA UNIVERSITY, *School of Mines;* LAWRENCE SCIENTIFIC SCHOOL; LEHIGH UNIVERSITY; MASS. INSTITUTE OF TECHNOLOGY; POLYTECHNIC INSTITUTE OF BROOKLYN; ROSE POLYTECHNIC INSTITUTE; SHEFFIELD SCIENTIFIC SCHOOL; STEVENS INSTITUTE OF TECHNOLOGY; VAN RENSSELAER POLYTECHNIC INSTITUTE; WORCESTER POLYTECHNIC INSTITUTE; and articles on the various State universities, nearly all of which give instruction in applied science.

Education, Secondary, in America. The history of American secondary education presents three stages of development. First, the colonial period, with its Latin grammar schools; secondly, the period extending from the Revolutionary War to the middle of the 19th century, with the "academy" and, thirdly, the period down to the present, chiefly characterized by the growth of public high schools.

The influences which most vitally affected the early development of secondary education in America were the example of the "grammar schools" of England and the rising spirit of democracy, which was largely Calvinistic in its modes of thought, and kept in touch with Calvinistic portions of Europe.

Early in the history of the colony of Virginia, funds were raised and lands set apart for the endowment of a Latin grammar school. But these promising beginnings were swept away by the Indian massacre of 1622, and the school seems never to have been opened. The town of Boston, in the Massachusetts Bay Colony, set up a Latin school in 1635, which has had a continuous existence down to the present time. This school was established by vote of the citizens in a town meeting. It was supported by private donations and by the rent of certain islands in the harbor, designated by the town for that purpose; a town rate seems to have been levied when necessary to make up a salary of $244.50 a year for the master. Other Massachusetts towns followed the example of Boston. School fees were commonly collected. A town rate, which was depended upon at first only to supplement other sources of revenue, gradually came to be the main reliance; and by the middle of the 18th century most of the grammar schools of Massachusetts charged no fee for tuition. Latin schools were early established in Connecticut; one at New Haven in 1641, and one at Hartford not later than 1642. A notable bequest of Edward Hopkins, sometime governor of Connecticut Colony, available soon after the middle of the 17th century, was devoted mostly to the maintenance of Latin grammar schools in Hartford and New Haven, and also in the towns of Hadley and Cambridge in Massachusetts. The Dutch at New Amsterdam opened a Latin school in 1659, continued for some years after the colony passed under English rule. Secondary schools were established in Pennsylvania in the latter part of the 17th century. One of these, the William Penn Charter School at Philadelphia, has continued down to the present day. King William's school at Annapolis was erected by the legislature of Maryland in 1696, and similar schools were established in different sections of the same colony. The 18th century saw schools of like character opened, partly by legislative enactment, partly by private initiative, in these and in the remaining colonies. Some of the number, like the University Grammar School in Rhode Island and the Free School at New York, were forerunners of the accompaniments of colonial colleges. In the organization of colonial systems of secondary education important beginnings were made. In 1647 the colonial legislature of Massachusetts decreed that an elementary school should be maintained in every town of 50 families; and that in every town of 100 families there should be a grammar school, in which students might be fitted for the university. This provision was copied by the colonies of Connecticut and New Hampshire, and in Connecticut the provision was afterward changed to require a grammar school in each county town. These New England colonies maintained and enforced such provisions down to and after the Revolution. Maryland also established by law a system of county grammar schools. When the colonies were transformed into States, after the Declaration of Independence, the systems of schools in the four colonies mentioned were continued with little change, but no other of the 13 States had anything that could be called a system of public instruction.

The chief emphasis in these colonial schools was laid on preparation for the college entrance examination, and the requirements for admission to college determined their course of study. The colonial grammar schools accordingly taught Latin, a little Greek, religion, and little else.

Both grammar schools and colleges were intended especially for the directive and professional classes, and had little connection with such elementary schools as there were. In Massachusetts, towns which maintained grammar schools were not required to maintain reading schools. Sometimes pupils were taught to read in grammar schools. But the grammar school teachers objected to this burden; and the mixing of the two grades of instruction in one school was recognized as an evil. The grammar schools exercised a kind of selective function, discovering latent capacity for the higher studies and starting talented youth on the way to college. Those who showed capacity of a lower grade or of a different sort received little attention or encouragement.

As we approach the Revolutionary period, we find new social conditions giving rise to a new order of schools. With the growth of sectarian differences, there appeared a decided tendency toward the separation of governmental from ecclesiastical affairs, and thus the position of educational institutions was disturbed. This change lessened the prestige of colonial systems of education among the adherents of the religious denominations, and a growing distrust of the colleges appeared among those who were most in accord with the secularizing tendency of the time. The old grammar schools were weakened by these influences, and in their stead there grew up a new type of secondary school, commonly known as the academy.

Both the name and the character of the new institution were suggested by precedents in England, where Dissenters were excluded from grammar schools and universities. In the latter part of the 17th century the non-conformist bodies first established "academies," schools in the main of secondary grade, which, however, undertook to prepare candidates for the non-conformist ministry.

The fame of the English academies seems to have influenced the thought of the American colonists in the matter of public education; first the strong theological bent of their English prototypes reappeared in the new American schools; and then the resemblance was more obvious in the wide range of studies offered, for the English academy had been more practical and technical than the university. But the American academies soon came to have a well-defined character of their own, apart from any conscious imitation of English models.

In 1726, a school for classical and theological studies was established by a Presbyterian minister at Neshaminy, in Pennsylvania. It was commonly known as the "Log College," as its home was a building made of logs. This school in the wilderness was the centre of deep and widespread interest in classical studies as well as in the religious life. It sent out large numbers of zealous pastors and teachers, who established "log colleges" all over the highlands of the middle and southern colonies. The Neshaminy Log College itself was later incorporated with what is now Princeton University.

Through the efforts of Benjamin Franklin, a school was established at Philadelphia, legally incorporated as an academy in 1753, and probably the first institution in America formally designated by that title. It was under the control of a self-perpetuating board of trustees. A fund raised by private subscription for its establishment and maintenance, was supplemented by a grant from the city treasury and by tuition fees, which were remitted in the case of those unable to pay. This academy organized in three departments or schools; namely, the Latin, the English, and the mathematical, put little stress on the theological element and much on English language and literature, and the mathematical sciences. The school ultimately developed into the University of Pennsylvania. Within two or three decades after the founding of this school at Philadelphia, a number of schools somewhat similar in character, and some of them bearing the name academy, were established in the middle and southern colonies. In New England the two Phillips academies, one at Andover in Massachusetts and the other at Exeter in New Hampshire were incorporated in 1780 and in 1781, respectively. The influence of these two schools extended to remote States, especially in the growing West; and they still rank among the strongest and most influential secondary schools.

Soon after the close of the Revolutionary War, new State systems of education began to be established, in which special provision was made for secondary schools. The University of the State of New York, erected in 1784, is a notable example of the strong influence which French thought then exercised in American affairs, as it realized the conception of a university put forth by Diderot and others of the great French writers of the latter half of the 18th century. It embraced the whole provision for secondary and higher education within the State, with the exception of schools of a purely private character. Its control was vested in a board of regents, consisting of the governor and the lieutenant-governor, *ex officio*, and 19 members elected by the State legislature. The reorganization of 1787 accordingly made the board of regents distinct from the board of trustees of Columbia College, with which it had been identical. This "university" exercised great influence on later systems; and in Georgia, by an Act, passed in 1785: "All public schools instituted, or to be supported by funds or public moneys in this State, shall be considered as parts or members of the university"; and in the territory of Michigan, an act was passed in 1817 instituting a university of imposing character. The latter establishment existed mainly on paper, and the act incorporating it was repealed in 1821. The Georgia "university" also never amounted to much. But although the comprehensive type of university organization was not widely adopted, there was a general desire in the early part of the 19th century to establish complete and well-rounded systems of public instruction. The legislature of Tennessee declared in 1817 that, "Institutions of learning, both academies and colleges, should ever be under the fostering care of this legislature, and in their connection with each other form a complete system of education." Even more significant is the provision of the constitution of Indiana, adopted in 1816, that, "It shall be the duty of the general assembly, as soon as circumstances will permit, to provide by law for a general system of education, ascending in regular gradation from township schools to a State university wherein tuition shall be gratis and equally open to all." For the most part, however, actual State agency in secondary education was as yet limited to the subsidizing of privately managed academies. In Massachusetts, the provision for grammar schools under town control was continued after the colony became a State, but the law was so changed that only the larger towns were left subject to this requirement. At the same time academies established by private initiative were endowed by the legislature with grants of public lands. In Kentucky, the State legislature granted 6,000 acres of public lands to an academy in each county. In Pennsylvania, colleges and academies received financial aid from the State for many years, culminating in 1838 in a general State system of educational subsidies. Five years later, such aid was discontinued. In other States, the granting of State subsidies, in money or in lands, to secondary and higher schools, was customary for many years. For the most part, there is but little system or consistency observable in the distribution of such aid; and the State-aided institutions were not subjected to any sort of State control.

The type of secondary school which grew up under these conditions demands closer consideration. The old academies were generally endowed institutions, organized under the control of self-perpetuating boards of trustees or of religious bodies, established to serve the need of a wide constituency and not merely of a single community, and often located in small country places. Many of them made provision for boarders as well as for day pupils. They were not intended in any exclusive sense for the training of future members of the learned professions, although many of them developed into preparatory schools. In the western States preparatory schools attached to colleges were commonly called "academies." But such was not the earlier purpose of the academies, which were largely schools for the middle classes, and answered to a growing desire after learning for its own sake, or for the increased efficiency it would give in other than professional pursuits.

Their training was more "practical" than that of the colleges, wider and more liberal than that of the grammar schools, or of some of the colleges. They laid new stress on the study of the English language, together with grammar, rhetoric, and public speaking. They taught mathematics, often including surveying and navigation; began the study of natural science, especially of natural philosophy (physics), of which astronomy constituted an important division; gave courses in geography, ancient history, English and above all American history, French often and German seldom. Latin and Greek were the substantial core of the instruction offered. In the earlier days, the course of study was not well defined. In English, Latin, and mathematics, a good degree of continuity of work was apparently maintained, but in others, classes were formed at irregular periods, because of the exigencies of rural life which demanded that certain courses be confined to a short winter term not interfering with farm labor. When finally definite courses of study were laid out, they varied in length from three to four or five years. Parallel courses were offered. That including classical studies and covering the required preparation for admission to some college was commonly regarded as the standard course of the school. With this might be found an English course. Afterward a scientific course was often provided.

Many of these schools were established by religious bodies. Catholic secondary schools began to appear in this period, established by the several teaching orders. The Society of Jesus founded institutions of secondary and higher education in the United States after the Revolutionary War; the Brothers of the Christian Schools opened their first school in America at Montreal in 1838; soon after set up establishments within the United States, at Baltimore and New York, and followed these elementary schools with secondary courses; and besides many conventual schools for girls were established, which drew a large clientage from other than Catholic families. The academies established by Protestant bodies usually terminated their formal connection with ecclesiastical societies upon their legal incorporation. The religious instruction which they carried on concerned itself for the most part with the broad underlying principles of Christianity, so that the non-Catholic academies, even such as had arisen from the initiative of religious societies, tended toward the non-sectarian character which has been more fully exemplified in the public schools of later times.

The grammar schools had been exclusively for boys. Such was the case with many of the academies. But others were coeducational, and there grew up also a large number of academies for girls, which were all too often weighed down with the title of «female seminary.» The last two prepared the way for two types in higher education, appearing in the fourth decade of the 19th century, namely, the coeducational college and the college for women exclusively.

The academies broadened the intellectual horizon of families and communities, and reinforced the protest which was arising against the narrow curriculum of the American colleges. In the absence of special schools for the training of teachers, the better elementary schools were for a long time in the hands of academy graduates. Special classes were organized in New York and Pennsylvania academies for instruction in the art of teaching, and a seminary for teachers was opened in connection with the Phillips Academy at Andover. When State normal schools began to be established, in Massachusetts in the year 1839, suggestions for their organization and management were drawn from this seminary and from the current practice of the academies.

In the early part of the 19th century, there appeared a strong demand for schools under the exclusive control of the State. The Calvinistic view of the civil power had apparently prepared the way for State agency in education, and the steadily advancing separation between Church and State kept alive the question as to the relation of the schools to both. The well-established theory that the State should grant charters to colleges, authorizing them to manage their own affairs under close corporations, with incidental aid from the State in the shape of gifts of land or money, was long applied to secondary education as well. The first step in the establishment of public secondary schools was taken by the larger towns and municipalities, under the lead of Boston, where in 1821 was established an «English classical school,» which soon took the name of «English high school,» imitating the style of the Edinburgh High School, from which the new Boston school differed in not including the ancient languages in its curriculum, and in not employing the monitorial method of instruction. Its course was three years, embracing English language and literature, mathematics, navigation and surveying, geography, natural philosophy (including astronomy), history, logic, moral and political philosophy. Latin and modern languages were added afterward and the course extended to four years. Students were received into the high school from the elementary schools of the city, but at first were not prepared for admission to college, that being the function of the Latin school. But with the addition of foreign languages to its course of study, the English high school fitted its students for admission to certain higher institutions.

Other Massachusetts towns followed the lead of Boston in this matter. Philadelphia, in 1838, established the Central High School, under special authorization from the Pennsylvania legislature. Baltimore followed, with the establishment of a «city college.» Providence opened a public high school in 1843. Hartford, in 1847, transformed her old grammar school into a school of the newer type. New York opened a «free academy» in 1848, the name of which was afterward changed to the College of the City of New York. This school was established in accordance with a special act of the State legislature, ratified by vote of the people of the city. Later growth was rapid and widespread, although the movement encountered hostility from those who regarded the academy as the final or best solution of the problem of public secondary education, and from those who were opposed on principle to the recognition of secondary education as a proper field for governmental agency. The legal questions involved in this latter contention were settled by the supreme court of Michigan, in what is commonly known as the «Kalamazoo case,» the decision being: «Neither in our State policy, in our constitution, nor in our laws do we find the primary school districts restricted in the branches of knowledge which their officers may cause to be taught, or the grade of instruction that may be given, if their voters consent, in regular form, to bear the expense and raise the taxes for the purpose.»

As early as 1798, Connecticut authorized the opening of higher schools by the local authorities («school societies»). In Massachusetts, the law requiring grammar schools in the towns was so far weakened, in 1824, that towns having a population of less than 5,000 were allowed to substitute therefor an elementary school. But two years later it was enacted that every town having 500 families should provide a master to give instruction in history of the United States, bookkeeping, geometry, surveying, and algebra; and every town having 4,000 inhabitants, a master capable of giving instruction in Latin and Greek, history, rhetoric, and logic. Iowa adopted a provision in 1849 expressly permitting the adding of higher grades to the public schools; and in 1858 authorized the establishment of country high schools. In New York, systematic grading of the schools went steadily forward; and the "academic departments" of these schools corresponding to the high schools of other States, formed a part of the University of the State of New York and received financial aid from the literature fund. In Maryland, the county academies, which had displaced the grammar schools of colonial days, continued for many years to receive financial aid from the State. Even when the high schools had begun to prepare their more favored students for college, the connection between the secondary and the higher institutions was not so close as was desired, because of the inherent differences between the college and the secondary system, especially in the East where few universities were under State control. For a long time the most powerful single agency affecting the course and the methods of instruction in the better high schools, as in the academies, was the entrance examinations of the several colleges.

Thus the college examination became the chief end and aim of much of the work in secondary schools, and there appeared a marked tendency to substitute a cramming process for real educational procedure. The attempt to correct this evil has taken several different directions. One of the earliest and most noteworthy attempts at its solution is the so-called accrediting system, introduced by the University of Michigan in 1871. Under this system the university admits to its freshman class, without examination, such graduates of approved secondary schools as are especially recommended for that purpose by the principals of those schools. It depends upon a purely voluntary agreement between the secondary schools and the higher institutions, so that the school rather than the individual is examined; and the inquiry relates chiefly to the vitality, intelligence, and general effectiveness of the instruction. The highest grade of efficiency in university inspection is found in such a system as that maintained by the University of California, where the accrediting of schools is in the charge of a committee of the academic senate, some of whose members visit every year all secondary schools within the State which apply for accrediting.

The disadvantages of the system are that it tends to foster a disposition to evade all tests of accurate scholarship in the shape of definite examinations; that it entails a heavy burden upon the higher institution; and demands large expenditures of money and of the time of university instructors. In the University of California, the actual cost in money for the traveling expenses of the inspectors is about equal to the salary of an assistant professor and the aggregate of the time required each year by all departments for the purposes of examination of schools is not far from three full academic years. Several institutions accordingly have appointed special examiners of high schools. Yet the plan of having inspection carried on by actual university instructors has not been wholly abandoned even in these instances. The examiners of high schools give instruction during a portion of the year in the university departments of education, and some inspection by representatives of other departments of instruction is still carried on. In 1901 the North Central Association of Colleges and Secondary Schools appointed a commission on accredited schools to unify and perfect the system of accrediting throughout the States of the Northwest. The commission appoints a board of inspection consisting chiefly of the inspectors of high schools of leading universities. Following the appointment of this commission the State of Ohio had the public high schools classified by the State Commissioner with reference to their ability to prepare students for admission to professional schools; and in Iowa the leading colleges have taken concerted action looking to the unification of their several systems of accrediting.

Though begun as a Western movement, the accrediting system has been adopted in one form or another by many Eastern institutions. A significant stage in the development of this system in the East was the establishment in May 1902 of the New England entrance certificate board. This board, consisting of one delegate from each of the co-operating colleges, examines the application of schools which desire the privilege of sending their graduates to college without entrance examination, and the list of such schools approved by the board becomes the accredited schools list of each of the colleges represented. The board does not inspect schools directly, but bases its reports on the statements of the school authorities, and the performance of the graduates.

Parallel with the development of the accrediting system, there have grown up important voluntary associations of instructors, in which representatives of the colleges meet with representatives of the secondary schools for the discussion of topics of comon interest. The parent society of this sort is the New England Association of Colleges and Preparatory Schools organized at Boston in 1885. This organization prompted the establishment of the commission of colleges in New England on admission examinations.

The Association of Colleges and Preparatory Schools in the Middle States and Maryland came into existence in 1892. The North Central Association of Colleges and Secondary Schools was formed at Evanston, Ill., in 1895; and the Association of Colleges and Preparatory Schools of the Southern States, at Atlanta, Ga., in the same year. State organizations somewhat similar in character are found in a number of the States, as in New York, Ohio, Tennessee, Colorado, Michigan, and both Dakotas.

But the chief landmark in the recent history of this grade of school is the work of the Committee on Secondary School Studies, appointed by the National Educational Association in 1892, and commonly known as the "Committee of Ten." This committee was the outcome of a movement within the national association in the direction of uniformity of college entrance requirements. Not limiting itself to the mechanical adjustment of relations between the high school and the college, this committee proceeded to consider the problem of secondary education from an educational point of view. Nine sub-committees of 10 members each were appointed to prepare reports on the several ordinary departments of secondary school instruction, namely, Latin, Greek, English, other modern languages, mathematics, physics (with astronomy and chemistry), natural history (biology, including botany, zoology, and physiology), history (with civil government and political economy), and geography (physical geography, geology, and meteorology). The Committee of Ten, having secured carefully prepared reports from its sub-committees, and having examined a large number of the courses in actual use in secondary schools, drew up a report which was published by the United States government in December 1893, together with the reports of the several sub-committees. Great stress was laid on the correlation of studies in secondary schools, the unifying of many subjects into a well-knit course of instruction, through the recognition of their numerous inter-relations. The committee would have continuous instruction in the four main lines of language, mathematics, history, and natural science. In particular, they recommended that in the first two years of a four-year course, each student should enter all of the principal fields of knowledge, in order that he may fairly "exhibit his quality and discover his tastes"; and urge the postponement of the beginning of Greek to the third year, in order that the student may not find himself at the bifurcation of the course into classical and Latin-scientific courses, before he is ready, or his advisers sufficiently informed as to his capabilities, to make an intelligent choice. The committee would require in each course a maximum of 20 recitation periods a week; but they would have five of these periods devoted to unprepared work; and would reserve double periods for laboratory exercises whenever possible. With reference to requirements for admission to college, the committee rcommend "that the colleges and scientific schools of the country should accept for admission to appropriate courses of their instruction the attainments of any youth who has passed creditably through a good secondary school course, no matter to what group of subjects he may have mainly devoted himself in the secondary school." "A good secondary school course" they describe as consisting of any group of studies from those considered by the sub-committees, "provided that the sum of the studies in each of the four years amounts to 16, or 18, or 20 periods a week,— as may be thought best,— and provided, further, that in each year at least four of the subjects presented shall have been pursued at least three periods a week, and that at least three of the subjects shall have been pursued three years or more."

Since the early days of the academies, it has been customary in many schools to offer alternative courses; one of them classical, the other "modern." Especially within the last 25 years, there has appeared a strong demand that instead of a choice of courses the students be offered a wide range of choice in particular subjects. Several influences have combined to bring about this demand. Teachers have objected to close prescription in high schools when freedom is increasing in the higher institutions. The conviction that the secondary schools should not be merely tributary to the colleges is gaining ground, and the independence of the secondary school carries with it independent responsibility for the supply of the actual educational needs of the youth attending such a school. It is urged that, since no two students have exactly the same aptitudes, so far as possible, every student should pursue a different course of instruction from every other student. This doctrine substitutes a quantitative for a qualitative consideration of the curriculum. A high school curriculum, under this system, would consist of a fixed number of units of study, to be chosen at will from the whole number of studies taught in the school. Certain utterances of the Committee of Ten have tended to strengthen this quantitative view of the curriculum. In the attempt to reduce this doctrine to practice, certain modifications necessarily enter. The choice of studies cannot be left simply to the immature pupil. Even if other subjects may be given over to absolute freedom of election, studies in English are found to be indispensable in every course. Little by little, other subjects are acknowledged to be essential; until it appears that there is little difference in practical working between a system of parallel courses rendered flexible by the allowing of occasional substitutions, and an adequately supervised elective system.

The latest attempt at an adjustment of the relations of secondary schools and colleges, to the educational advantage of both, is contained in the report of the Committee on College Entrance Requirements, appointed in 1895 by the National Educational Association, and consisting of 14 members, representing the high schools and universities of different sections of the country, under the chairmanship of the superintendent of high schools of the city of Chicago. The first important service rendered by the committee was the preparation and publication of a table showing the actual entrance requirements of 67 representative colleges, universities, and higher technical schools in the United States. The committee's final report, presented at the meeting of the National Educational Association in July 1899, is mainly devoted to the attempt to establish "national units, or norms," in the several subjects taught in the secondary schools as preparatory to the college course. The fundamental problem "is to formulate courses of study in each of the several subjects of the curriculum which shall be substantially equal in value, the measure of value being both quantity and quality of work done." In the determination of these norms, the committee received assistance from several bodies of expert scholars in the several branches of instruction. The American Philological Association proposed courses of study in Latin and Greek; The Modern Language Association of America rendered a like service with reference to the French and German languages; the American Historical Association and the Chicago section of the American Mathematical Society reported on courses in history and mathematics; and the Department of Natural Science Instruction of the National Educational Association presented recommendations relating to physical geography, chemistry, botany, zoology, and physics. These several supplemental papers are published in connection with the committee's report. The committee adopted 14 resolutions, of which the following are of the greatest general significance:

1. That the principle of election be recognized in secondary schools.

4. That we favor a unified six-year high school course of study beginning with the seventh grade.

6. That while the committee recognizes as suitable for recommendation by the colleges for admission the several studies enumerated in this report, and while it also recognizes the principle of large liberty to the students in secondary schools, it does not believe in unlimited election, but especially emphasizes the importance of a certain number of constants in all secondary schools and in all requirements for admission to college.

12. That we recommend that any piece of work comprehended within the studies included in this report that has covered at least one year of four periods a week in a well-equipped secondary school, under competent instruction, should be considered worthy to count toward admission to college.

Actual courses of study in our secondary schools show great diversity, as this matter is generally left to the discretion of municipal or district boards of education. Owing to the extensive circulation of all sorts of educational publications, however, and the frequent meeting of teachers one with another in educational conventions, there is a surprising approach toward uniformity in the educational provisions found in all parts of the country. Sigh schools may be found having courses ranging all the way from one to six years in length; but the four-year course is the generally recognized standard, and the classical course is regarded as the standard, from which the other courses pursued in the same school are looked upon as variants.

The differentiation which appears everywhere in our secondary education appears in the erection of special schools for special classes of students. There is separate schooling of boys and girls, in many instances. Another special type of school, the evening high school, has been established in a number of our larger cities. These schools have offered very elastic courses of study, suited to the varied needs of their clientage; and have been a great boon to many who have been obliged to work by day after the completion of an elementary school course. In the Southern States there is further separation between white and colored children, although the latter class of course do not bulk largely in secondary education.

As to manual training, the United States report for 1904 showed a total of 195 manual training schools, 98 of which were of high school grade. The majority of these are under private control, but in 1879 St. Louis established such a school in connection with Washington University, and since then similar schools have been established in Baltimore, Chicago, San Francisco, New York, Brooklyn, Philadelphia, Boston, and other large cities, while a number of smaller cities have added manual training courses to the regular high school curriculum. In these schools and courses, the idea of manual training for the purposes of general culture was usually uppermost, their projectors disclaiming any intention of establishing schools for the teaching of trades. Trade schools have been established in the largest cities, but for the most part under private initiative and control. Alabama, however, began in 1896 the establishment of one agricultural school of secondary grade in each of the nine Congressional districts of the State; and Wisconsin began in 1901 the establishment of county schools of agriculture and domestic economy. The commercial spirit of this country finds expression in the frequent appearance of such subjects as bookkeeping and commercial arithmetic in general courses of study. Special schools for distinctly commercial training are usually private ventures. These are found in great numbers in all parts of the country, generally going by the name of "commercial college" or "business college." There is a growing tendency, however, to establish public commercial schools; and probably no special development of the public schools has received more marked consideration within recent years than these commercial schools. The first Commercial High School now in existence was established by the city of Pittsburg, Penn., in 1872; the next was the Business High School of Washington, D. C., established in 1890; Los Angeles, Cal., came third in 1895. Since 1898 Louisville, Ky., San Francisco, Cal., Philadelphia, Pa., and Syracuse, Brooklyn, and New York City, N. Y., have established commercial high schools, of which the largest and most important is the New York High School of Commerce, opened in 1902; the Philadelphia Commercial High School is for girls only. See COMMERCIAL EDUCATION.

One movement should be mentioned which is part cause and part result of the increased attention which is now paid to problems of secondary education, in themselves considered. Reference is made to the study of the several aspects of adolescence, as a stage in the mental development of individuals. Secondary education being essentially the education of adolescents, whatever throws light upon the peculiar psychology and natural history of this period of youth is of value to the educator. Many studies of particular phases of adolescence development have been made within the past few years, under the stimulus of investigations begun at Clark University.

Methods of instruction in all secondary school subjects have been profoundly influenced of late from the side of the natural sciences. Laboratories have become common in high schools and academies. College entrance requirements have been extended to include laboratory work in physics, and, in some instances, in chemistry or in the biological sciences. In these laboratories, students perform representative experiments in the science they are pursuing, under the guidance and subject to the criticism of the instructor. These experiments are commonly regarded as illustrative of or preparatory to the statement of principles in a text-book. The "method of re-discovery" has influenced the practice of the schools; yet there are probably few school laboratories in which the students are expected to re-discover on their own account the laws of physics or chemistry, or of any other of the sciences. A fine blending of discovery, verification, and correction seems to be the ideal of our best teachers of natural science. Much stress is laid on the accurate recording of observations and experiments. The students' note-books serve as one of the chief tests of the excellence of their work. This is a great advance upon the prevailing method of a generation ago, when the text-book was the main reliance in school instruction, even for classes in the natural sciences. A like change appears in the treatment of other branches than the natural sciences. The attempt is now made to put the student in touch with first-hand materials of knowledge; and to guide and stimulate him to the end of making over these crude facts into real knowledge for himself. This procedure seeks to give full recognition to both the ideal and the sensuous elements in knowledge, and indicates some appreciation of the fact that the ideal element to be truly ideal must be supplied by the active agency of the student's own thought, exercised upon the products of his own experience. In the practice of the schools, we find these principles applied, for example, to the teaching of history. Although text-books are not dispensed with, the effort is made to give the student some acquaintance with the sources of historical knowledge. In the study of literature, less attention is paid to historical summaries than was formerly the case, and more time is devoted to the study of literary masterpieces. In grammar and rhetoric, the study of principles is closely connected with the study of passages from literature which embody those principles in living forms; and with composition exercises upon topics which invite free expression. In modern languages, facility in conversation is not commonly sought, but the ability to read the languages readily and with understanding, and to enter into an appreciation of their literatures, is the end chiefly striven for, and grammar is studied, on the whole, less abstractly than formerly, and more in its actual embodiment in literature. Greater effort is made now than a generation ago to secure a reading knowledge of the ancient classics. There is much difference of opinion among leading teachers as to the proportionate attention to be paid to «sight reading»; and as to the value of the inductive method in the mastery of grammatical principles: but actual practice seems to be tending slowly toward a middle course, which retains much of the old-time thorough discipline in Latin and Greek grammar, but brings this training into more vital connection with the study of classic literature. The question of approaching Attic through modern Greek has been warmly discussed, but the proposed change finds little, if any, acceptance in actual practice. In mathematics, much stress is laid upon the original demonstration of theorems, particularly in plane and solid geometry. Much stress is put upon the use of accurate language in mathematical demonstrations, and, more generally, on the need of more careful and accurate English expression in all school exercises. The attempt to teach English expression, oral and written, wholly through the medium of instruction in other branches does not promise well; but there is a growing recognition of the fact that all teachers must have at least some share in the responsibility for such instruction.

The moral influence of secondary schools is undoubtedly the most important topic to be considered in this paper, but it is at the same time the most difficult to reduce to accurate statement. The religious background of moral instruction has already been referred to. It should be added that even in public high schools, from which all instruction in sectarian dogmas is strictly excluded, there is not uncommonly found a pervasive religious atmosphere, an influence emanating from the personal character of the instructors. In many of these schools, it is still customary to open the daily session with the reading of a passage from the Bible or the repetition of the Lord's prayer; or with the singing of a devotional or patriotic hymn. In some schools, elementary ethics is taught, but this is unusual, and moral force depends mainly on the personal influence of the teachers, on the government of the school, and on the relations of the students one with another.

Some subjects of instruction offer especial advantages as regards the formation of high ideals of conduct. The teaching of literature, and particularly the literature of the mother tongue, is found to be of great value in this respect — the more so, doubtless, when untimely moralizing is dispensed with, and noble sentiments are permitted to make their appeal through the charm of their artistic presentation. Choice works of plastic and pictorial art are rapidly finding their way into our school rooms, and are expected to accomplish their mission by their mere presence; or to reinforce the æsthetic side of instruction in literature and in drawing. History is probably, on the whole, the most neglected of the main lines of study in secondary schools; and the moral loss resulting from such neglect is serious. Greek and Roman history is commonly taught, at least in classical courses; but too often in a scrappy and inadequate fashion. Later European history receives some attention. The history of the United States is, perhaps, the most seriously slighted of all. The reason for this seems to be that the history of our own country is studied in the grammar schools; and it is only beginning to be emphasized by the colleges as an admission subject.

In the government of our best secondary schools, the relations of teachers and students are comparatively informal, and there is little consciousness of official or artificial barriers between them.

Some interesting and successful experiments have been made in the organization of regular systems of self-government among students. Under any system of government, the social life of the school is the chief teacher of morals. The fact that tuition in these schools is free to all, helps to bring about this result. It is unnecessary to point out the numberless bearings of this democratic spirit in the schools upon the pupils who are subject to its influence. There is undoubtedly a growing disposition among families of wealth and high social position, to send their children to private schools. This disposition is, however, by no means universal.

The social organization of the students in high schools and academies is much alike. The instinct of association is strong and finds expression in clubs, leagues, societies, and fraternities. The several classes are commonly organized, with class officers, and have occasional gatherings of a social character. The offices of the highest class in school are sought for with keen competition. Athletic associations, foot-ball and base-ball clubs, and the like, are usually maintained, and several schools often join in an athletic league. Debating clubs and other literary societies are maintained with much interest. Contests in debate with neighboring schools call forth a spirit of emulation like that displayed in athletic struggles. Musical organizations are among the most pleasing of school societies. Annual publications by successive classes present a record of the varied interests of the larger schools. Besides Greek-letter societies, formed after the fashion of the colleges, there are sometimes voluntary associations for religious culture and observance maintained by the students. All of these organizations are commonly under the immediate control of the students themselves. The completion of the course of study in a secondary school is celebrated in public with "graduation" exercises and the conferring of diplomas upon the members of the class. The graduates of a flourishing school usually organize in an alumni association.

A committee of the National Educational Association — the so-called Committee of Fifteen on elementary education — reported in 1895, among other topics, on the training of teachers for secondary schools. This committee declared that, "The degree of scholarship required for secondary teachers is by common consent fixed at a collegiate education." They proposed a course of special training for such teachers, consisting of instruction during the senior year of the college course in psychology, methodology, school systems, and the history, philosophy, and art of education; and a graduate year of practice in teaching, under close supervision, supplemented by advanced studies in educational theory. This proposal is far in advance of common practice or requirement. Very few of the American States make any specific requirement for the high school teacher's certificate beyond that for a license to teach in the elementary schools. But in many secondary schools teachers rarely obtain employment unless they are college graduates; and there are large sections of the country in which common usage is rapidly tending in this direction. The most of the leading universities and some of the higher normal schools are devoting especial attention to the professional training of teachers for schools of this grade. A Massachusetts report for the year 1897 shows that one per cent of the high school teachers then employed in that State were graduates of scientific schools, 13 per cent of normal schools, and 66 per cent of colleges. In the State of New York, in 1898, 32 per cent of the teachers in secondary schools (not including principals) were college graduates, 39 per cent were normal school graduates, and 19 per cent were high school graduates. Of the principals, 51 per cent were college graduates, 35 per cent normal school graduates, and 8 per cent high school graduates. These figures include private academies as well as public high schools. They include also one-year, two-year, and three-year schools, as well as fully developed high schools and academies. An inquiry into the preparation of teachers in the secondary schools of California, in October 1897, showed that of the teachers then employed in the public high schools of the State 59 per cent were college graduates.

The several States have been slow to organize general systems of secondary schools. But a few have made considerable progress. The early history of secondary schools in Massachusetts has already been told. This State is the foremost in the Union in the universality of its provision for secondary education. Every "town" (township) in the State is required by law to provide free high school tuition for all students who are prepared for that grade of instruction. Inasmuch as the whole State is divided into towns, this means that free secondary education is offered to every child in the commonwealth. Of the 353 towns in the State, 185 are required by law to maintain high schools; 70 others maintain high schools, though not required to do so; and those not maintaining such high schools are required to pay the tuition fees of qualified students within their limits who go elsewhere for high school instruction. The poorer towns receive help from the State in paying for tuition in outside schools. The high schools must offer a four-year course, of 40 weeks a year, and they must prepare pupils for the State normal schools, and for higher scientific schools and colleges. The organization of the University of the State of New York has been mentioned. It presents the most thoroughly organized State system of secondary education yet developed on American soil. All incorporated secondary schools in the State and all other secondary schools which may, after official inspection, be admitted to membership by the regents, are institutions of the university. Of the six departments into which the work of the regents is divided the college and the high school departments are under one department director, assisted by nine inspectors of schools and by a large staff of examiners. The regents distributed in 1898 a total of $209,250.48 in State funds to the secondary schools of the State. The method of distribution is as follows: (a) $100 is allotted to each school approved by the regents, without regard to its size or special attainments. (b) One cent is allowed for each day's attendance of each student in such schools; provided that each student so counted must hold a "regent's preliminary certificate" for admission to the school, or the school must be approved by two university inspectors, as having a higher entrance requirement than the minimum prescribed for the preliminary certificate. (c) The State duplicates the amount raised by the schools for the purchase of approved books and apparatus up to the sum of $500 a year for any one school. (d) Grants are made on the basis of credentials obtained by pupils in the school who pass the regents' examinations — a method of "payment by results." In 1898, of the money distributed by the regents to secondary schools, about 25 per cent came under item (a); 22 per cent under item (b); 19 per cent under item (c); and 34 per cent under item (d). The regents' examinations are held three times a year. The diplomas issued by the regents to graduates of secondary schools are accepted by Cornell University and by other institutions of higher education in the State, in lieu of entrance examinations in the subjects which they cover. A syllabus is issued by the regents for the guidance of instruction in university institutions. There is free consultation between the officers of the university and the instructors in the schools with reference to the contents of this syllabus. An annual university convocation, in which the representatives of all divisions of the university meet for public discussion, forms one of the notable educational gatherings of the country.

In Maryland, a law of the year 1865 swept away the old academy system, and substituted for it a system of county high schools. This radical change was followed by a reaction. Later legislation took a middle course. A law enacted in 1872 provided for the establishment of high schools in the several counties, to be under the control of the boards of county school commissioners, or of district boards appointed by them. Each of these high schools must be "visited and examined annually by the principal of the State normal school, or a professor thereof," and must also be visited once in each term by the county examiner. The support of these high schools is provided for by the county school commissioners, who set apart for that purpose a portion of the ordinary school funds received from the State and the county. About 20 academies continue to receive direct donations from the treasury of the State.

In Indiana there is virtually a system of university accrediting of high schools, the administration of which has been turned over to the State Board of Education. In July 1873 the board of trustees of Indiana University adopted a resolution to the effect that a certificate "from certain high schools" should entitle the bearer to admission to the freshman class. In August of the same year, the State Board of Education adopted plans under which the high schools which were worthy of such recognition should be designated and commissioned. In 1888 the following order was passed: "That hereafter no high school commission be granted except on a favorable report in writing, to be made to the State Board of Education, by some member of the State Board, who shall visit the high school in question as a committee of the State Board for that purpose. That all the high schools now in commission be visited by committees of the board as soon as may be, and that the present list be modified by the reports from such visitation. That in case of change of superintendent in any commissioned high school, the commission then existing shall be in force until a visitation shall be made by a committee of the State Board." By such simple means and without specific legal enactment, an important system of high schools has been built up. They are supported in the same manner as the elementary schools.

Minnesota may be taken as another type of secondary school control as that State has maintained a State system of high schools since 1881. At the head of this system stands the State high school board, which appoints a high school inspector and a graded school inspector. Any public high school in the State may become a State high school, and is then entitled to receive from the State the sum of $800 annually. To be a State high school, it must admit students of either sex from any part of the State without charge for tuition, must provide a course of study covering the requirements for admission to the University of Minnesota, and must be subject to the State rules and open to inspection. The State high school board conducts a written examination of classes in the schools twice a year. Students who successfully pass such examinations receive certificates for the subjects so covered; and these certificates are accepted by the university and the normal schools of the State in lieu of entrance examinations in the subjects specified. The taking of this State examination is ordinarily optional with the school; but the State board may require a school to take an examination as a part of the annual inspection. Perhaps the most significant thing about the Minnesota system is the encouragement it gives to high schools in the smaller towns. Communities all over the State tax themselves freely to supplement the bounty distributed by the State board.

Several other States have made marked advance within the past few years in the direction of improved systems of secondary schools, improvements gained through the untiring efforts of devoted friends of education.

Elmer Ellsworth Brown,
United States Commissioner of Education.

Education, Supplemental. To define clearly the nature and relations of this type of educational work, the three main divisions of the whole field of education may be indicated as follows:

First.—Fundamental education, or that which prepares one by general or professional training for entrance upon his life work. This is the particular service of the schools proper conducting their work for the professionally student class.

Second.— Incidental education, or the education of experience. This is acquired as one meets the problems and performs the duties of his daily life and work.

Third.— Supplemental education, or that which makes up the deficiencies in one's fundamental education, or furnishes the necessary complement to one's incidental education. It gives that for which one has present need but has failed to get in the schools and is now failing to get in active life. This is the particular work of educational movements other than the schools proper and serves most largely those who are professionally something else than students. Supplemental education is not an imitation of fundamental, nor a substitute for incidental education, but it presumes under the stress of age and working conditions unfavorable to the most efficient intellectual life to give an individual from a life standpoint that educational help which he needs most next.

Features.— Among the most feasible and fruitful agencies of supplemental education are Reading Rooms, with attention given to the suggestion and direction of reading; Museum Exhibits, with descriptive bulletins inducing intelligent observation, conversation and reference reading; Libraries, special, rather than general in nature, so selected and placed as to make them accessible and helpful in connection with one's daily life and work; Reading Courses, furnishing incentive to wisely selected, consecutive and progressive reading and study; Instruction by Correspondence, setting educational tasks for detached and irregular students, and projecting for their aid the encouragement, instruction and counsel of the teacher; Directed Conversations or Practical Talks, bringing together for conference parties of large experience and ability to advise on practical life subjects and those who need such advice; Educational Lectures, making accessible in attractive and instructive form the results of the extended studies, or special observations of advanced scholars and practical experts; Educational Clubs, ranging from the temporary round-table to the permanent association or guild, calculated to encourage and facilitate co-operative reading, investigation and discussion; Tutoring, providing unusual opportunities for rapid study, or the meeting of peculiar needs under abnormal conditions; Educational Classes, furnishing direct instruction, adapted to meet as immediately as possible the students' current interests and needs, being conducted most largely in the evenings, and at other times and under conditions not common in the schools proper. The necessity for this variety of features arises from the widely varying needs and educational inclinations of the constituencies which they serve. While many of these features are commonly used as extensions of school work, or auxiliaries thereto, in the field of supplemental education they become prime agents in awakening and guiding the intellectual life of the people, without special regard to making their influence tributary to any institution for fundamental education.

Purposes.—The educational purposes wrought out by supplemental educational work may be indicated as follows:

First.— Awakening one to a sense of his intellectual needs and cultivating his appreciation of intellectual living and culture.

Second.—Enabling one to investigate his special interests, discover his natural bent and measure his capacities.

Third.— Providing facilities for making up delinquencies in one's elementary education.

Fourth.— Giving special fitting for improved service or advancement in the line of one's present employment.

Fifth.—Fitting one unfortunately situated through the educational occupation of his leisure hours for successful entrance into lines of activity for which he is better adapted.

Sixth.— Enabling one whose activities tend to restrict or distort his intellectual life, to regain or to maintain a good mental balance.

Seventh.— Keeping intellectually awake one now detached from liberal educational opportunities to which he has been accustomed and who tends consequently to lapse into mental stupor and inactivity.

Eighth.— Giving effectual encouragement and guidance to one's individual or private reading and study.

Ninth.— Making practically useful the training and culture of one liberally educated through his rendering educational service to those less privileged.

Tenth.— Through the educational occupation of leisure hours adding to one's mental equipment, perhaps already sufficient to meet the demands of a workaday life, those cultural elements that broaden one's interests and sympathies beyond the limits of his own work.

Principles.— Any supplemental educational movement must incorporate as fundamental principles in the conduct of its work, the following:

First.— It must deal with two rather distinct classes: (a) students proper — constituting the small minority who seek with definite student purpose, but under unusual conditions, a general education; (b) non-students — constituting the large majority, who seek by suggestion or adapted instruction, educational help in the solution of some present problem or fitting for some special service.

Second.— The scheme of educational work offered must make the various features elective to a maximum degree.

Third.— The work must be flexible enough in adaptation to meet individual, special and even transient needs and conditions, without unnecessarily violating popularly recognized educational forms.

Fourth.— The features must be presented in small and varied units.

Fifth.—The various units of work must be so scheduled that sequential arrangement in courses is possible when desired, and even encouraged.

Sixth.— All forms of work must glow with the recreative element, both in subject matter and treatment.

Seventh.— In many of its rudimentary forms the work must aim at suggestion and inspiration, rather than complete or thorough training.

Eighth.— The work must seek primarily the increase of one's capacity to live efficiently and largely, rather than the accumulation of knowledge or the development of scholastic ability.

Ninth.— Much stress must be laid on teaching, leading and co-operating in study as important means of education to those rendering such service.

Tenth.— The work must have its own distinct ideals, methods and estimates of value, basing them upon the current conditions and individual needs of the non-student class rather than on regular school standards, applicable primarily to the student class.

Administration.— Adaptation: The methods of administration of supplemental educational features must be adapted to meet the peculiar conditions and personal attitudes of those to be served. The desirable locations for such work are in the natural assembling places of working people, especially during their leisure hours, as largely as possible making the educational effort in which they participate a natural adjunct to their everyday life instead of making it a separate and distinct enterprise. This consideration causes the placing of libraries, reading rooms, talks, lectures, and even club and class work in stores, factories, athletic, social and religious centres instead of congesting all these features in distinct places set apart in the community as strictly educational centres. Advantage is also gained by offering the educational features in connection with other privileges, physical or social, the continued interest of many people being attendant upon identification with an associated group of varied privileges, offering not only self-improvement but recreation. This combination of educational opportunities with other privileges also serves another purpose in the reducing of embarrassment which many feel at having to be instructed after passing the usual school age. Because of the extreme self-consciousness of the mature non-school class when endeavoring to make up their deficiencies or working on unusual lines of effort, there arises the necessity for careful shaping of administrative plans to avoid in advertising, reports and current conduct of the work, making the party conspicuous as a delinquent or as a belated or emergency student.

Independence: As a practical expediency in the promotion of both fundamental educational institutions and supplemental educational movements it is usually wise in matters of administration to keep the two separate and distinct. This provides against the necessarily irregular, special and frequently uncredited work of the supplemental movement discounting or handicapping the conduct of the necessarily systematic, aggressive and credited work of the educational institution; while on the other hand it protects the supplemental work from being restricted in its liberty of adaptation and converted into a mere auxiliary feeder to some school. It has been found equally expedient that such movements intended for the employees of commercial and industrial concerns shall not be dominated by the employers and advanced by compulsory or coercive means to contribute to the economic advantage of the concerns.

Support: The administration of supplemental work, since it must meet the students' individual needs in a manner most economical of their time and means, must be non-mercenary. The genius and true spirit of supplemental education is lost as soon as the interests of the management of the educational enterprise take precedence over the interests of those intended to be served by it. While there is a general willingness on the part of those enjoying supplemental educational advantages to meet the actual current expense incurred by such work, pioneering in the establishment of features in new locations, and the expense of special equipment and general supervision must usually be met by private gifts or income from endowment. Many commercial and industrial concerns, as well as private individuals, are liberal givers for the support of such work, and in some cases municipal and governmental assistance is also given. Increasingly in America and Europe, endowments are being established for the extension, equipment and supervision of supplemental educational movements.

Supervision: In order to maintain the closest possible working contact with the employed classes it is common to have in the leadership of supplemental educational movements a large number of individuals, representative of the various classes of people in the community to be served, and also representative of the various walks of life. The active participation of these representatives in the guidance of the features insures that the movement shall be constantly attuned to current conditions and needs and saved from becoming either distorted in the hands of extreme faddists, or crystallized into an arbitrary educational system entirely dominated by professional schoolmasters. In addition to this safeguard and because most supplemental educational movements must be launched and maintained by sheer force of inducement and personal leadership, the work being practically injected into situations which reveal no conscious or intelligent demand, there is need, as in perhaps no other form of educational work, for liberally trained, energetic and tactful supervision. The supervisor of such movements must be thoroughly sympathetic with the purposes and activities of fundamental educational institutions working especially for the student class, but must also be keenly sensitive to the educational needs and possibilities of the great non-school population. He must give attention, not alone to the determination of educational forms and methods to be pursued, but must engage himself as a strategist in setting up educational campaigns, and in enlisting both paid and volunteer workers in carrying out the desired enterprises. In short he must be a promoter and counsellor in natural life movements, rather than the professional superintendent of an educational institution.

Credits: Since supplemental educational movements deal mainly with a different class and with different objects in view from the schools proper, it is found expedient that not only courses of study, and frequently the methods of treatment, be distinctive, but that in features where formal recognition or credits are given for work done, these credits shall also be distinctive, the forms of certificates being sufficiently specific and in detail to avoid any misjudgment of value, or confusion with the credits for systematic student work in fundamental educational institutions. Such specific credits are, however, readily convertible into equivalents in school credits, and are received for entrance requirements and advanced standing in many schools and colleges. The majority of those engaged in supplemental educational work give little thought to formal credits, being satisfied with the personal returns from the privileges enjoyed.

Types.— Some of the notable types of supplemental educational movements are to be found in the Continuation, or Supplementary, Schools of Germany, the Polytechnic Institute in London, and in America, aside from public libraries, night schools and lecture courses under municipal direction, the Chautauqua movement, University Extension, vacation schools, certain of the correspondence schools, special schools of instruction allied with commercial and industrial concerns, and the educational departments of institutional churches, social settlements, and of the Young Men's and Young Women's Christian Associations. Probably the most comprehensive movement of the distinctly supplemental educational type has been developed in connection with the Young Men's Christian Associations in North America, the records for the year 1903-4, after a single decade of systematic promotion, showing, exclusive of religious and Bible study lectures, clubs and classes, the conduct in 1,005 different associations of 661 reading rooms with 32,403 periodicals; 707 libraries with 578,382 volumes; 3,267 educational lectures and talks; 618 educational clubs and 376 groups of educational classes; covering a very wide range of subjects and enrolling 32,821 different men, taught by 1,516 employed teachers.

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Education in Latin-America. The peculiar nature of the problems in the field of education which the Latin-American republics have been called upon to solve may be shown most conveniently if we consider, (1) the experience of Mexico, and (2) that of Brazil. Characteristic differences in the educational systems of other Latin-American countries are mentioned where the context serves to explain them — that is, in the articles dealing generally with the history and institutions of those countries. In Mexico, subsequent to colonial legislation the first law on the subject of education, in 1823, was based upon liberal principles and contained an excellent plan of study for use in public schools; it provoked a revolution, however, by appropriating some real estate belonging to the Church, suppressing the clerical university, and exempting public education from the control of the clergy. The clerical party succeeded in re-establishing the university under direction of the clergy and restoring to the Church its confiscated property. Wars, civil and foreign, and the undetermined relation of the States to the central government, stopped or hindered educational progress, but in 1843 the government established uniform methods of teaching and a graded system of classes in schools. An effort was made in the same year to centralize the management of the educational system in the city of Mexico. Three years afterward the States resumed their proper share of authority in this matter. Between this time and 1857 the country was distressed by revolutions, dictatorships, and the war with the United States which resulted in the loss of more than two fifths of the Mexican territory; but when the constitutional government was established (1857) the educational law of 1843 was restored. In 1861 Ramirez, minister of justice, secured the passage of another law on this subject, liberal in spirit like that of 1833. War with France (1862–7) made it impossible to carry out the provisions of that law; in December 1867, however, the establishments for secondary instruction were reopened, and an effort was made to improve the primary schools and to bring the methods of teaching into harmony with republican principles. The privileges of education were, by the law of 15 May 1869, extended to all social classes, and primary instruction was made obligatory in the federal district and territories. Thus we find that the triumph of liberal theories was preceded by a contest which lasted for 36 years, at least. "The results of this triumph," as Mr. Hilder well says, "have been the complete separation of church and state, universal religious toleration, a constitution based on the broadest republican opinions, a free press, and free schools." Meantime the great mass of the people had remained ignorant and untrained. The task of the government was therefore exceedingly difficult. A plan hopefully formulated in 1873 could not be carried out; in fact, the practical device for producing an impression upon the millions of utterly indifferent common people appears first in a law of 1888 requiring all persons having control of minors to *prove* that the children in their care had received the necessary primary education; the penalty for violation or neglect of this order being a fine (10 cents to $10) and imprisonment for not more than 10 days. In 1889 Baranda, minister of justice and education, called a convention of prominent educators and representatives of the different States of the republic. The convention met in the city of Mexico 28 November, and its sessions continued until 31 March 1890. A second educational convention met 1 Dec. 1890 and remained in session until March 1891. The conclusions reached in these pedagogic congresses were embodied in the law of 21 March 1891, which provides that instruction in the public schools shall be secular and gratuitous, and that primary elementary instruction (obligatory for children of both sexes from 6 to 12 years of age) may be obtained in any public or private school, or from private tutors. In the federal district and territories committees have been formed to see that the law in respect to compulsory education is complied with; in the States, however, "and particularly the less populous ones, and where the Indians predominate, compulsory attendance, although recognized by law," it is said, "can not yet be enforced." For the uncivilized Indians of remote districts special schools are provided in which the teachers are young members of the same tribes, trained in normal colleges. The government has organized many schools and colleges in which higher education and scientific training may be obtained. The principal institutions are: National College of Engineers and Mining (all classes open to the public, and no fee required either on entrance or at the time of receiving degree or diploma); Medical College; National Medical Institute (established by the government 1888–90, for the study of the flora, fauna, climatology, and geography of the country, and their practical application to the science of medicine); National College of Agriculture and Veterinary Surgery; Commercial College; National School of Fine Arts; National Conservatory of Music; National Law School; National Military College; normal schools for training male and female teachers; National School of Arts and Trades for Men (manual training and a higher education for workingmen); the same for women (founded by President Juarez 1871, for the purpose of improving the social condition of workingwomen and affording them an opportunity to fit themselves for good business positions); National School for the Blind; a school for deaf-mutes; industrial school for orphan boys; La Paz College (for women); Correctional School of Trades and Professions (for the reformation of boys under 18); and the National Library, containing 170,000 volumes, the nucleus of the collection being formed by the books and documents which came into the government's possession through the suppression of ecclesiastical colleges. There are museums in nearly every State, supported by the local (State) governments. The principal cities, Toluca, Morelia, Guadalajara, Guanajuato, Puebla, Merida, and others, have literary and scientific associations, and a score of such societies exist in the federal district. Of these the most influential is El Liceo Hidalgo, which has for its aim the encouragement of native talent. President Diaz stated in his message of 1 April 1895 that there were about 8,000 public schools for primary education in the republic, with 500,000 scholars; that the amount appropriated by the government for educational purposes was about $3,500,000 per annum; and that in the federal district there were 62 private free schools, and 195 private schools in which pupils paid for their education. The influence of the government's educational policy since 1857 has been very marked, in spite of the difficulties we have mentioned; and the good results are seen especially in the improved intellectual status of women. Mr. Hilder says that "there is now a very large and influential middle class, composed of both Indian and mixed races, which is every year, by the spread of education, gaining accessions from the humbler class" — the latter making good progress under the new order of things.

Brazil was notably unprogressive during the three centuries of her existence as a colony, while her intercourse with the outside world was controlled by Portugal, though an interest in art and letters awoke when the Portuguese court was transferred to South America (see

BRAZIL). King John introduced printing-presses, established schools, and promoted arts and sciences; the country was visited by large numbers of foreigners, including distinguished writers and scholars, and all this tended to improve the manners and enlarge the ideas of the people. Moreover, when the Cortes of Portugal recalled the king (1821), he left his historical library, which became the nucleus of the great public library at Rio de Janeiro. Independence was declared 7 Sept. 1822, and by a decree in October 1823 any citizen was authorized to establish a primary school without obtaining a special license — a radical departure from the old custom of entrusting elementary education to the clergy alone. In 1827 a law was passed authorizing the establishment of public primary schools in all the cities and towns, but little progress was made until 1854, when a thorough reorganization of the school system was effected. During the second half of the century a development has taken place which is certainly admirable; and no one will be disposed to withhold his commendation who reflects that the country was obliged at the same time to deal with such problems as the Paraguayan war, the emancipation of the slaves, and the change in the form of government from monarchy to republic. Under the constitution the instruction given in public institutions is secular, gratuitous (in primary schools), and at the charge of the various States and municipalities. In some of the States primary instruction is compulsory. An excellent standard has been established in primary schools (except those of remote districts, which are decidedly inferior). Pupils are admitted to the first-grade schools from 7 to 13 years of age, and to the second-grade schools from 13 to 15 years of age. There are separate schools for girls, who are admitted to the first grade at the age of 8 years. The course of study in the first grade is: reading, writing, the Portuguese language, arithmetic as far as the rule of three, metric system, elements of geography and history (especially of Brazil), introductory lessons in physical science and natural history, moral and civic instruction, drawing, elements of music, gymnastics and military exercises, manual training for boys and needle-work for girls, and practical lessons in surveying. The number of primary schools in the republic was recently stated to be 7,017, and the number of pupils about 300,000. There are several hundred private schools. Secondary education is provided in the Gymnasio Nacional (two establishments thus named in the capital; course of study seven years). National institutions for higher education are: two law schools (those of São Paulo and Pernambuco); two schools of medicine and pharmacy (at Rio de Janeiro and Bahia); the polytechnic school at Rio de Janeiro; the school of mines at Ouro Prieto in the State of Minas Geraes; military and naval schools; the National Academy of Fine Arts, Institute of Music, and Museum; and finally the National Library, containing an immense collection of books and maps, manuscripts, prints, and coins.

Consult: 'Education in Mexico and Central America,' by F. F. Hilder, in report of secretary of interior on education (1896), Vol. V., Part I., Washington, Government Printing Office, 1897; also 'Education in Brazil,' same, in reports of department of interior, Commissioner of Education (1898), Vol. I., Washington, 1899.

MARRION WILCOX.

Education of Defectives. See DEFECTIVES, EDUCATION OF; BLIND; DEAF; DUMB; FEEBLE-MINDED, etc.

Education of Women. The changes during the 19th century include none more significant than those in the history of education for women. So swift has been the transition that it is difficult to realize that until after the Revolution practically the only opportunities for a girl's education were found in the so-called "Dame Schools," where she was taught to read and sew, the 'New England Primer' being the chief text-book. Even the art of writing was not universal, as is shown by the number of wills, left by women of property, which were signed with a cross. The grammar schools, providing instruction sufficient to prepare young men for college, only occasionally admitted girls until the beginning of the 19th century. The exceptions were less than 12 in the first century of our colonial history, as shown by the records of nearly 200 towns in New England. The town of Medford, Mass., voted in 1766 that "The Committee have power to agree with the School Master to instruct girls two hours in a day after the boys are dismissed"; Dorchester in 1784 voted "that such girls as can read the psalter be allowed to attend the grammar school from the first day of June to the first day of October," and Gloucester in 1790 passed the following resolution: "And also that the master be directed to begin his school from the first day of April to the last day of September at 8 o'clock in the morning and close at 6 o'clock in the afternoon, or any 8 hours in the 24 as shall be thought the most convenient, but that two hours, or a proportionable part of that time, be devoted to the instruction of females — as they are a tender and interesting branch of the Community, but have been much neglected in the Public Schools of this town."

In Norwich, Conn., they were admitted "from 5-7 A.M.," and Nathan Hale, school-master in New London in 1774, writes, "I have kept during the summer, a morning school between the hours of 5 and 7, of about 20 young ladies: for which I have received 20 shillings a scholar by the quarter." This admission of girls at times during the day and year, when the schools were not needed for the boys, seems to have been common during the last years of the 18th century. Northampton, which had voted in 1788 "not to be at any expense for schooling girls," four years later voted "by a large majority to admit girls between the ages of 8 and 15 to the schools from May 1st to October 31st," and Boston, in 1790, opened the schools to girls during the summer months, when there were not enough boys to fill them.

One of the first advocates of education for girls was a graduate of Yale College in 1780, William Woodbridge, who took for the subject of his graduating essay, "Improvement in Female Education," and afterward opened an evening school for them in which he dared to teach such abstruse subjects as grammar, geography, and the art of composition. The founding of academies, to which girls as well as boys were admitted, is another evidence that in the latter part of the 18th century and the early part of the 19th, there was a new sentiment concerning their education. The first quarter of the 19th century might well be called the "Academy Age," since the most distinctive advance was in the founding of these institutions. The first one was at South Byfield, founded by bequest of a certain William Dummer, who died in 1761. Leicester, incorporated in 1784, Westford (1793), Bradford (1803), Monson (1804), were all coeducational at the beginning, although Bradford later excluded boys and has been for many years a school for girls. The so-called Academy at Medford, Mass., founded in 1789, is said to have been the first in New England for girls only, but was followed by others which became more famous, such as Adams Academy in Derry, N. H. (1823), Ipswich Academy, in Massachusetts (1828), and Abbot Academy in Andover (1829).

There were other efforts for the education of girls before the close of the 18th century in other parts of the country; by the Friends in Rhode Island, by the Friends and Moravians in Pennsylvania, the latter founding a school in Nazareth, before the middle of the century, and as far south as Lexington, Ky. None of these institutions, however, aimed to give higher education to women; the academies prepared boys for college, but 200 years after the founding of Harvard College there was not a college for women in the country.

A movement for the higher education of women began about 1820. The Rev. Joseph Emerson, principal of the Academy at Byfield, had become noted for his championship of the cause and had attracted to the Academy women like Zilpah Grant and Mary Lyon, whom he inspired with zeal for learning as a preparation for service. In 1820 Emma Willard's 'Plan for Improving Women's Education' attracted the attention of Governor Clinton of New York, who secured the passage of two acts, one the incorporation of a proposed seminary at Waterford, and the other, "To give female academies a share of the literary fund," probably the first law passed by any legislature, expressly favoring women's education. The seminary was opened in 1821, not at Waterford, but at Troy, N. Y., as the Troy Female Seminary, later known as the Emma Willard School.

In 1822 Catharine Beecher opened a seminary at Hartford, Conn., in the upper room of a store. Beginning with 7 pupils, it soon grew to more than 150, and attracted students from all the States, but after 10 years was discontinued on account of Miss Beecher's removal to Cincinnati. Her interest in education was thus transferred to the Middle West, where for a generation she helped to mould public opinion on the subject.

From 1830–9 several institutions for the education of women were established, most of them in the South, the Wesleyan Female College at Macon, Ga., being authorized to grant degrees. In 1835 Wheaton Seminary in Norton, Mass., was founded by Judge Wheaton in memory of his daughter. His daughter-in-law, Mrs. Eliza Wheaton, instrumental in the founding of the school, lived until June 1905, its constant benefactor and a significant figure, as representing the last of the little group who, in the thirties, were laying the foundations of higher education for women.

Adviser and helper in the founding of this school was the woman who holds a foremost place among pioneers of higher education. Mary Lyon's reputation as student and teacher had already been won in the academies at Byfield, Amherst, Ashfield, and Derry, and with Miss Grant in the seminary at Ipswich, but her chief work was in the founding of Mt. Holyoke Seminary. Incorporated in 1836, and opened in 1837, in the town of South Hadley, Mass., the seminary realized the ideal for which the founder had been working for years, that of a permanent institution for women which should furnish "every advantage that the state of education in the country will allow." The first curriculum, including the natural sciences, higher mathematics, logic, moral philosophy, ancient and modern history, evidences of Christianity and Butler's 'Analogy,' shows a decided advance since the days when Mr. Woodbridge was considered eccentric because he believed that women should be allowed to study grammar, geography, and composition. It marks an era in higher education, in the establishment of a permanent, endowed institution, which should furnish to women, at moderate rates, as good educational opportunities as the colleges for men then offered. Its founding is not less significant in its influence as the "mother of schools." Among the institutions established on the same plan, with its graduates as principals and teachers, are the Western College at Oxford, Lake Erie College at Painesville, Ohio, and Mills College in California. Michigan Seminary at Kalamazoo and the Cherokee Seminary, in what is now Indian Territory, were also Mount Holyoke schools, while across the water they were founded in Persia by Fidelia Fisk; in Turkey at Marsovan and at Bitlis; in South Africa, where the Huguenot Seminary at Wellington, Cape Colony, is the most famous; and in Spain, in the form of the International Institute of Madrid, founded at San Sebastian, by Alice Gordon Gulick. Miss Lyon's influence is seen also in the establishment of Wellesley College, for its founder was a strong friend of Mount Holyoke and included many of its features in his own institution.

The intervening period before the Civil War saw the rise of numerous schools for the education of women, but only two of full collegiate rank to-day, Rockford College in Rockford, Ill., opened as a seminary in 1849 and chartered as a college in 1892, and Elmira College in Elmira, N. Y., founded in 1855 and authorized from the beginning to confer degrees. It is interesting to notice that most of these institutions were in the Southern States, a development cut short by the war, the Randolf-Macon Women's College at Lynchburg, Va., opened in 1893, being the only separate college of importance established since that time.

The last 35 years of the 19th century were marked by an advance movement in women's education such as the world had never before seen. During this period three types of institution were developed; —

1. The separate women's college.

2. The women's college affiliated with the university.

3. Coeducation in the universities for men.

The first and second types are characteristic of the East and the third of the West, although the distribution is not entirely along sectional lines.

The Separate Women's College.— The conviction of Matthew Vassar, that "woman, having received from her Creator the same intellectual constitution as man, has the same right as man to intellectual culture and development," led in 1861 to the incorporation of Vassar College, opened in Poughkeepsie (1865) with more than 300 students, the first of the distinctive colleges for women authorized to confer degrees, with curriculum and endowment sufficient to realize its ideal of collegiate work. In 1875 two other colleges for women followed, Wellesley College at Wellesley, Mass., founded by Mr. and Mrs. Henry F. Durant, in memory of their son, and Smith College at Northampton, founded by Sophia Smith of Hatfield.

Within another 10 years a fourth college was established, Bryn Mawr at Bryn Mawr, Pa., founded by Joseph W. Taylor, and opening its doors to students in 1885. In 1888 Mount Holyoke Seminary was incorporated as Mount Holyoke Seminary and College, and in 1893 became Mount Holyoke College, the seminary course being withdrawn. The development of these colleges for women has been phenomenal. Each one has a beautiful campus, with fine academic buildings and residence halls, is well equipped, and offers a wide choice of elective courses, in addition to the required work, which varies somewhat in the different institutions. The faculty of each includes both men and women, with the latter in the majority. Two, Smith and Vassar, have had only men for presidents, one administration covering the entire history of the former college; two, Wellesley and Mount Holyoke, have had only women; and one, Bryn Mawr, had a man for the first president and a woman, the present executive, for the second holder of the office. The large number of applicants for admission has made it possible for these colleges to maintain a high standard of entrance requirements. Only one, Bryn Mawr, refuses to accept certificates from accredited schools, but all accept the results of the College Entrance Examination Board, and all, except Smith, are members of that board. The total number of undergraduate students in 1904–5 was 4,117, and in graduate work 106, of whom 73 were at Bryn Mawr.

Other colleges in the East, somewhat smaller, but of high collegiate rank, are the Woman's College of Baltimore, founded in 1888 as a Methodist institution, and Wells College in Aurora, N. Y., beginning as a seminary in 1868, but chartered as a college in 1870. The Western College at Oxford, Ohio, Lake Erie College at Painesville, Ohio, and Mills College in California, all beginning as seminaries but later chartered as colleges, are doing good collegiate work, although their numbers are small, as might be expected in sections of the country where coeducation is almost universally accepted.

The Women's College Affiliated with the University.— The college for women affiliated with the university, although the latest development, holds a place midway between the college on a separate foundation and coeducation. There are five well known institutions of this class, three in the Eastern and one each in the North Central and South Central divisions.

The first to be established (1886) was the H. Sophie Newcomb Memorial College for Women, affiliated with Tulane University in New Orleans. Under the same Board of Trustees as the university, its buildings are in a different part of the city, its productive funds are in part separate, and it has a distinct faculty, including the president. The graduate department of the university has been entirely open to women since 1890.

The Women's College of Western Reserve University, Cleveland, is the outgrowth of an informal system of coeducation, established at Adelbert College, the undergraduate department of the university, in 1872. Sixteen years later women were excluded from Adelbert College, and provision made for them by the establishment of the Women's College. The fine buildings of the college, although separate, are near the other university buildings, and some of the laboratories of the men's college are open to women. The faculty, with the exception of the president, is distinct, but the university confers the degrees and opens all its graduate work to women.

Barnard College, affiliated with Columbia University, was opened in 1889, although 10 years before that President Barnard had urged the adoption of coeducation at Columbia College. As a result of his efforts and of a large popular petition in 1883, asking for the admission of women to Columbia College on the same terms as men, a system was inaugurated known as the "Collegiate Course for Women," which proposed to grant degrees to those who passed the college examination, but made no provision for instruction. The unsatisfactory character of this arrangement led to the establishment of the college, which, with a separate charter and an administrative autonomy, received Columbia degrees, took the university examinations and had university instructors, or those approved by the president. In 1900 another change was made by which Barnard bears the same relation to Columbia University as Columbia College, having its own faculty, endowments, and examinations, but receiving the university degree and being represented on the university council.

In 1891 the corporation of Brown University voted to admit women to the university examinations, but made no provision for instruction and took no action concerning the conferring of degrees. Unofficial instruction, however, was given by some of the faculty of the university during the first year and at least one woman was admitted to the regular classroom, a beginning which resulted in a vote of the corporation in June 1892 opening the degrees and all graduate courses to women. At the beginning of the second year a dean was appointed and a building for recitation purposes secured, where regular undergraduate classes were conducted by members of the university staff under the name of "The Women's College in connection with Brown University." The numbers had largely increased and four classes were graduated before the corporation formally recognized the college by constituting it in 1897 a department of the university. The affiliation is a close one, since the faculty is com posed of members of the university faculty, and the requirements, courses, examinations, and degrees are the same, thus carrying out the plan of the founder, President Andrews, who designed it not as an «Annex,» but as «part and parcel» of the university.

Radcliffe College, in affiliation with Harvard University, although of the five colleges of this class, the last chartered to confer degrees (1894) was one of the first to make some provision other than coeducation for the admission of women to university privileges. Following the precedent of the English universities at Cambridge and Oxford, in 1879 the «Society for the Collegiate Instruction of Women» was organized in Cambridge, Mass., «for the purpose of providing systematic instruction for women by professors and other instructors in Harvard University.» The students who completed the course received not a degree, but a certificate stating that the holder «has pursued a course of study equivalent in amount and quality to that for which the degree of Bachelor of Arts is conferred in Harvard College, and has passed in a satisfactory manner examinations on that course corresponding to the college examinations.» There was no official relation with the university until 1894, when the society commonly known as «Harvard Annex,» was incorporated as Radcliffe College and authorized to confer Bachelor's and Master's degrees, subject to the approval of the president and fellows of Harvard College. The president and fellows constitute the Board of Visitors having the general administration of the college, but the immediate government is in the hands of a council and an academic board, chosen mainly by the associates, who form the corporation. Thus its management is, in general, distinct from that of Harvard, although its instructors are entirely from the university staff.

The affiliated colleges show certain differences in the character of their connection with the university. The chief administrative is generally the dean, only Radcliffe and the H. Sophie Newcomb Memorial College having a president distinct from the president of the university. All these universities open their graduate courses to women, and all, with the exception of Harvard, grant degrees on the completion of that work. In their development much has been accomplished by advisory boards or councils of women, who have collected funds for endowments, erected buildings, acted as advisers, and in many ways promoted their interests.

Coeducation in the Universities for Men.— To Oberlin College, Oberlin, Ohio, belongs the honor of being the first institution of collegiate rank to admit women. Opened in 1833 as Oberlin Collegiate Institute, it was coeducational from the start, although at first women entered the so-called «Ladies' Course,» and were not candidates for degrees until 1837. The new departure aroused less comment, since «from the outset the new institution stood for so many unpopular ideas, social and theological, that the mere fact of the admission of both sexes attracted little attention.» Its example was not followed for two decades, the second institution in this pioneer work being also in Ohio, Antioch College at Yellow Springs, founded by Horace Mann in 1853, and coeducational from the beginning. The movement, however, did not gain before the period of the Civil War, various reasons have been suggested for its rapid development since that time, such as the growth of the public school system, generally coeducational, and thus influencing public opinion in favor of the same policy in higher education, and the rise of the factory, relieving the home of many duties and leaving women more free for other interests. Throughout the country the demand for «practical education» was felt and the passage of the Land Grant Act in 1862, appropriating 10,000,000 acres for the endowment of colleges «to teach such branches of learning as are related to agriculture and the mechanic arts» is most significant in its influence upon women's education, since it was interpreted as providing for them as well as for men.

The West and the State Universities have been the leaders in coeducation, only three of the latter, Virginia, Georgia, and Louisiana, being still closed to women, but the East is not without representation in this class. When Cornell University was opened at Ithaca, N. Y., in 1868, the interest of Mr. Cornell and President White in favor of giving equal advantages to young women resulted in the offer from Henry W. Sage of a generous endowment on condition that «instruction shall be offered to the young women by the Cornell University as broad and thorough as that now offered to young men.» In 1872 this offer was accepted and Cornell became coeducational.

The movement, however, had spread further east than the state of New York. In 1868 Boston University was opened, welcoming young women on precisely the same conditions as young men, the first institution in Massachusetts to take this step, and according to the report of the president, «the first in the world to open the entire circle of post-graduate professional schools to men and women alike.»

Several of the colleges in the East are coeducational, such as Swarthmore College in Pennsylvania, Wesleyan University in Middletown, Conn., Tufts College in Massachusetts, and Colby College in Waterville, Me., although in the last named there is an approach to the plan of the affiliated college. It is interesting to notice that the four colleges named are all sectarian, belonging respectively to the Society of Friends, the Methodists, Universalists, and Baptists.

The opening of the University of Chicago in 1892 added another endowed institution of rank to coeducation, but in 1902, by the so-called «segregation» policy, which means separate instruction for women during the first two years of their undergraduate course, the university provision for them comes partially under the head of the affiliated college. This action, together with the limitation of the number of women admitted to undergraduate work at Leland Stanford Jr. University in California and at Northwestern University, Evanston, Ill., might be interpreted as a certain reaction in the West against coeducation were these policies not explained by the institutions themselves as efforts simply to preserve a proportionate relation in the undergraduate body. In the light of statistics the fear that the women students may outnumber the men is not unfounded. The report of the Commissioner of Education for 1903 states that of 455 universities and colleges men only are admitted to the undergraduate department of 132, while 323 are open both to men and women, and of 43 schools of technology women are in the undergraduate departments of 26.

The comparatively large number of women in technical schools, over 1,000, as indicated in the last report of the Commissioner of Education, suggests the question whether the choice of subjects is determined by sex or by the individual. The curricula of the colleges for women show large departments in the natural sciences, mathematics, political economy, and sociology, as well as in the classics, literature, history, and philosophy. An interesting comparison made between the electives of the men and women in the senior classes of the universities of California and Wisconsin, in 1902, is shown in the following table:

University of California.— Proportion of women in: Letters, 54 per cent; social science, 68 per cent; natural sciences, 66 per cent; chemistry, 20 per cent; commercial course, 0 per cent; engineering, 0 per cent.

University of Wisconsin.— English, 34 per cent; modern classics, 75 per cent; civics and history, 27 per cent; general science, 18 per cent; philosophy, 39 per cent; ancient classics, 49 per cent.

The choice of electives by undergraduates is not conclusive, since the strength of varying departments in different colleges, and certain fluctuations in their popularity, a "drift" impossible to predict or account for, as well as the question of preparation for future work, must all be taken into consideration. The degrees conferred in 1902 afford some comparison as to the courses taken, but not an exact one, as in many institutions only the B.A. is granted for a scientific as well as for a classical course.

	Women	Men
Bachelor of Arts	3,061	5,614
Bachelor of Science	520	2,801
Bachelor of Philosophy	351	729
Bachelor of Letters	713	205
Bachelor of Agriculture	0	27
Bachelor of Music	174	6
Bachelor of Pedagogy	48	27
Master of Arts	287	1,111
Master of Science	6	179
Master of Letters	14	14
Master of Philosophy	5	12
Civil Engineering	0	260
Mechanical Engineering	0	305
Electrical Engineering	0	76

In general, the position seems well taken that the practical consideration affects women as well as men and that indisposition to elect courses leading to a degree in engineering, for example, is due in part to the fact that the profession of engineering is not generally available for them. Even here the question is not entirely one of sex, for there are women more interested in mathematics than in literature, as there are men of whom the reverse is true. There is evidence for the same conclusion in the electives in education in the universities referred to, 67 per cent being women.

The tendency toward the utilitarian is more marked in the coeducational institutions than in the separate women's colleges, a difference easily explained, since the step is a natural one, from the opening of a work-shop for the men students to the establishment of courses in domestic science for the women. The universities endowed by the land grant were the first to introduce the last named subject and now form the majority of the institutions which include it in their curricula.

Early specialization is also more common in the coeducational college, the separate college placing greater emphasis in its undergraduate course upon liberal culture. The general tendency to-day, however, is away from unrestricted elective toward more required work, a "group system," or a system of "majors," by which the student may have in her undergraduate course something more than a purely technical and hence one-sided training.

The results of education for women are shown in the large increase of numbers in the professions, the census of 1890 giving the number of women in professional service as 311,689, and that of 1900 as 430,576, an increase of 38 per cent. One of the chief reasons urged by the early champions of the movement was that they might be better qualified to become teachers and to-day their representation in that profession outranks all others. In 1902 there were 327,614 women teachers and college professors, 7,387 physicians, 3,373 ministers, and 1,010 lawyers. The ratio to the entire body of teachers was as follows:

	Per cent
Public secondary schools	51
Private secondary schools	58
Colleges and seminaries for women	72
Coeducational colleges—	
Preparatory departments	29
College departments	10

In the last few years there has been a large increase in the number and variety of employments which they enter. College women are not only teachers and physicians, but also nurses, superintendents of hospitals, secretaries, registrars and keepers of records, librarians, social workers, in settlements and associated charities, professional housekeepers, assayers, and poultry-raisers. They have opened laboratory kitchens, laundries, and greenhouses, have engaged in scientific and historical research, published books, become musicians and artists, deans and presidents of colleges. Nor has their interest been confined to the professions by which they might earn a living. A recent writer says that "between the two broad oceans there is hardly any significant movement outside of trade and politics which is not aided by unpaid women who work purely out of ideal motives." Educated women are interesting themselves in the problems of the cities in which they live, serving on boards of education and of sanitation, making possible public playgrounds and vacation schools, agitating the questions of improved tenements, pure water supply, and clean streets. The experiment of college training for women has already justified itself by what they have accomplished in promoting public health and morals.

The fear that academic training would unfit women physically and divert them from the home by the attraction of other careers has proved unfounded. The women's colleges and many of the coeducational institutions provide gymnasiums and regular physical training, require out-of-door exercise, and have careful physical examination. These provisions, together with the regular hours and systematic life of the college, mean a better physical condition than in the case of the average non-college woman.

To those who know the college woman in her home the question concerning her fitness for it is not debatable. The supreme result of the college training is the development of character, and the cultivation of self-control, of consideration for others, and of a more rational outlook, means preparation for the home as well as for the profession.

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M. E. Woolley,
President Mount Holyoke College.

Education, The State Universities. See State Universities.

Education, United States Bureau of. The Bureau of Education was originally established as an independent department by act of Congress, approved by President Johnson on 2 March 1867. The bill had been introduced into the House of Representatives the previous year by Gen. Garfield, accompanied with a memorial signed in behalf of the National Association of State and City School Superintendents (later merged into a department of the National Educational Association) by E. E. White (State Commissioner of Common Schools of Ohio), Newton Bateman (State Superintendent of Public Instruction, Illinois), and J. S. Adams (Secretary of State Board of Education, Vermont), which memorial strongly urged the creation of such a government agency.

The need of this measure was emphasized at the moment by many conditions. All through the South schools and colleges had been closed or hopelessly crippled by the Civil War. The proportion of illiterates in our population, as shown by the census of 1860, was alarming, and was being rapidly increased by immigration, while "the gloomy total" was swelled, as Gen. Garfield noted in his speech supporting his bill, "by the 4,000,000 slaves admitted to citizenship by the events of the war." The general government had been lavish in its gifts of lands for education, without holding any one responsible for the carrying out of its intent. "No member of this House or the Senate, no executive officer of the government," said Gen. Garfield, "now knows, and no man ever did know, what disposition has been made of this immense bounty." At that time 17 States could show fairly complete school statistics; the Congressional Library was searched in vain for school reports from any one of the remaining 19. The nation had indeed no means of estimating its educational forces or of comparing itself in this respect with other nations.

The general purpose of the new department was defined by the law as follows: "to collect such statistics and facts as shall show the condition and progress of education in the several States and Territories and to diffuse such information respecting the organization and management of schools and school systems, and methods of teaching, as shall aid the people of the United States in the establishment and maintenance of efficient school systems and otherwise promote the cause of education throughout the country."

The law provided that the President, acting in advice with the Senate, should appoint a commissioner of education, and left large discretion to this officer with respect to the management of the department, including the appointment of three clerks allowed him by the law. The commissioner was, however, expressly directed "to present annually to Congress a report embodying the results of his investigations and labors, together with the statement of such facts and recommendations as will in his judgment subserve the purpose for which the department was established." Thus the annual report has become the exponent of the operations of the office.

The first commissioner, Dr. Henry Barnard, served only three years, from 16 March 1867 to 16 March 1870, and, on account of the uncertain fortunes of the office at this initiatory stage, he had little chance to shape a definite policy. He published during the time a report on education in the District of Columbia, ordered by joint resolution of the House and Senate.

By an act of Congress which took effect 1 July 1869, the Department of Education was changed to an office or bureau in the Interior Department, but without change in the scope of its duties, and shortly after this event Dr. Barnard resigned.

The second commissioner, Gen. John Eaton, appointed by President Grant 16 March 1870, understood well the problems in which the help of the Bureau was needed at the moment—problems growing out of the awakened sense among us of the importance of free public schools, and the conviction agitating the minds of thoughtful men that the national government should assume some responsibility for the education of the freedmen in the South. With these interests clearly in mind, Gen. Eaton addressed himself to the question of pressing importance, namely, that of the actual provision for education in the United States. His first report, covering the year 1870, presented a survey of the whole country, surprisingly complete in respect to the main particulars of State systems of education. By 1873 the inquiry forms for collecting statistical data, drawn up in advice with the leading representatives of institutions and systems of education, were completed, substantially as they have been maintained to the present time. This device of a method for bringing the Bureau into vital relation with all local agencies of education and securing their co-operation in its work, was the most important outcome of Gen. Eaton's service. The schedules thus formulated furnish the basis of the annual report required by Congress, and have had great effect in unifying the local reports of education throughout the country.

In 1886, after a service of 16 years, Gen. Eaton resigned. Under his successor, Hon. N. H. R. Dawson, of Alabama, the relations of the Bureau with the higher institutions of the country were strengthened through the arrangement for publication by the Bureau of a series of monographs on the history of higher education in the several States. The work was placed under the editorial charge of the late Dr. Herbert B. Adams, of Johns Hopkins University, who selected a specialist in each State to prepare the subject-matter. Thirty-six monographs of the series have been published to date, all of which have been well received.

With the resignation of Mr. Dawson the formative period of the Bureau ended. The whole educational provision of the United States had been brought within the scope of its inquiries, cordial relations had been established with the directors of institutions and with all State and city superintendents of education, and everywhere educators were beginning to look to the Bureau for helpful suggestion in respect to their professional problems. President Harrison appointed Dr. W. T. Harris, who directed the office 12 Sept. 1889–1906, when Elmer E. Brown assumed charge.

Under this commissioner the stress of effort in the preparation of the annual report is to interpret the data collected and to present them in such a way as to enlighten every one who has to deal with the problems of education as they arise, either in the schoolroom or in the broader administrative fields. In this way alone can the highest function of the Bureau, as a force stimulating local self-direction, be realized.

The purpose is promoted by Dr. Harris's discussions of educational movements in his introductory statements to the annual reports, and is strikingly illustrated by the statistical method introduced under his direction. By means of comparative statistics the record of past years is organically related to that of the current year, so that a single table comprised in a page suffices to show the development of the public school systems of the country from 1869–70 to the present time; in a few pages the comparison is extended to the geographical sections and individual States of the Union. The record thus presented is impressive by reason of the magnitude of the work disclosed — a work affecting at present above 16,000,000 pupils, at an annual expenditure of $251,458,000 — and by its emphasis upon significant particulars. It offers to each community and institution the means of measuring its progress by that of all others and of discovering the points at which new effort is needed. The survey reveals, also, movements of national significance; it proves the increasing faith of our people in the value of free schools, manifested by increased appropriations for their support and by the almost phenomenal growth of public high schools (increased in 13 years from 2,526 schools, with an enrolment of 203,000 pupils, to 6,800 schools with an enrolment of 592,213). The growing appreciation of the highest means of training and culture is also manifested by the larger proportion of youth in attendance upon colleges and higher technical schools. Whereas in 1872 the proportion of such students was 590 to each 1,000,000 inhabitants, in 1904 it had risen to 1,477.

The exposition of foreign systems of education, which has become a feature of the annual reports, reveals the means by which each nation seeks to develop through its schools its own type of national character, and at the same time shows the movement in all democratic nations for freeing secular education from ecclesiastical control and sustaining it upon the common basis of civic necessity.

In addition to this broad survey of education the annual reports of the Bureau comprise the results of special investigations and discussions of topics of timely interest. A typical example of the former is a paper in Gen. Eaton's report for 1870, embodying the results of a special inquiry into the relations of education and labor. It followed the lines of the far-famed presentation of the same subject in Horace Mann's fifth report, but is even more convincing as to the effect of common school education in increasing the earning power of the laborer.

The thorough manner in which subjects of current interest are treated in the reports may be best indicated by a few special references:

The character and scope of State school systems, as illustrated by the methods of administration and support, and the obligatory studies of the public schools, are shown from time to time by digests of school laws prepared by experts. The latest appears in the report for 1904 (270 pp.).

A chapter on the laws relating to city school boards in 23 typical cities of the United States answers a general demand for helpful suggestions as to the means of meeting the conditions of rapid urban growth. (Report for 1895–6, 71 pp.)

The present status of the certification of teachers in the United States is set forth in the report for 1903 (56 pp.). The data have been carefully collected, critically revised by State superintendents, and reduced to tabular form convenient for reference. Combined with the results of an extensive inquiry into the actual tenure of teachers now in service, prepared for the commissioner's forthcoming report, the certificate requirements indicate very clearly the conditions that are making for the professional character of the teaching service of the common schools and the difficulties in the way of maintaining that character.

The reports of the Bureau have been of great service to the cause of higher education by disclosing fully the scope of the curricula and the standards maintained in the colleges and universities of the United States, and thereby correcting false impressions, both at home and abroad, arising from the varied uses in different countries of the same terms of classification. The presentations under this head include: tabular view of the complete course of study for 100 colleges (137 pages, report for 1888–9); requirements for admission to 475 colleges and higher technical schools (156 pages, report for 1896–7); length and organization of typical college curricula (21 pages, report for 1902).

The liberal policy of the nation in the endowment of the agricultural and mechanical land-grant colleges, and the manner in which the several States have supplemented and guarded the bounty, is set forth in a digest of the general and State laws relating to these institutions. The matter, which was comprised originally in two chapters — published respectively in the commissioner's reports for 1902 and 1903 — has been brought together in a single monograph to meet special demands for this information.

As indicating the wide range of interest stimulated by the report may be mentioned the "Regulations relating to pensions and insurance in all German universities" (report for 1904), and an installment in the same report of the interesting "notices of some early English writers on education" from the pen of the well-known specialist, Prof. Foster Watson, of University College, Wales. These notes, covering the period 1578–1603, throw light on the state of education in England in the century preceding the English colonial settlement in America.

Statistics relating to libraries are published at intervals of about five years in the commissioner's report. The latest compilation (report for 1903, 258 pp.) gives the statistics of 6,869 libraries having each 1,000 volumes or over, an increase above the number reported in 1900 of 1,486. The number of volumes in libraries of this class is 54,419,002, an increase since 1900 of 9,827,151, or 22 per cent. The presentation includes public, society, and school libraries, showing in detail the duration, size, sources of income, etc., of each. The statistics of 2,242 libraries of less than 1,000 but more than 300 volumes completes the tabular view.

The periodical recurrence to this subject is in line with investigations suggested by Dr. Barnard and culminating during Gen. Eaton's administration with the celebrated report on libraries, issued in the centennial year.

To the functions of the Bureau designated in the original law certain others have been added under subsequent acts of Congress. The entire management of the government schools in Alaska, outside of incorporated towns, which was committed to the secretary of the interior in 1884, was lodged at that time in the Bureau of Education. The following year, Dr. Sheldon Jackson, who had had seven years' experience in the field as agent of the Presbyterian Board of Home Missions, was appointed general agent to take charge of the government schools under the direction of the commissioner of education, a position which he still retains. The two special features of the work thus inaugurated are the association of the schools with the mission stations and the use of the reindeer in the scheme of industrial education. The government bears all the expenses of the secular schools and appoints their teachers, but by the location of the schools at what Dr. Harris has termed "the strategical points for influence upon the natives," their work is reinforced by all the wholesome influences of the mission centres.

The plan of industrial education matured since the introduction of the reindeer in 1891 aims at two objects: the training of the natives as herders and teamsters and their education in thrift, so that they will preserve and augment the increase of the deer loaned them. In the carrying out of this plan, also, the mission stations have been indispensable aids; "the missionary," says Dr. Harris, "discovers the individuals that are tractable — those that show capacity for learning our industries and spreading our language. These furnish hopeful apprentices for reindeer herders and teamsters." Through this training the natives are enabled to take the long step from the nomadic habits of the fisherman and hunters to that of dwellers in villages with permanent employments profitable to themselves and of inestimable value to the white population that is steadily pouring into the Territory. (See Report of Commissioner Harris, 1896–7, Vol. I., pp. 39–42.)

For the maintenance of the government schools for the fiscal year ending 30 June 1906, Congress appropriated $50,000, and for the reindeer fund $15,000.

The commissioner of education is also charged by the secretary of the interior with a limited administration of the fund appropriated by Congress by act of 30 Aug. 1890, for the further endowment and maintenance of the agricultural and mechanical colleges established under the Morrill Act of 1862.

The reports of the treasurers of the several institutions showing that the disbursement of the funds previously received has been in accordance with the specific requirements of the law, are received and audited in the Bureau, and, upon the approval of the respective accounts by the commissioner of education, each State and Territory is duly certified by the secretary of the interior to the secretary of the treasury as entitled to its installment of the fund for the next succeeding year. The amount thus allotted for the year 1905 was $1,200,000, or $25,000 to each of the 48 States and Territories.

Apart from the organized functions of the Bureau of Education, it is called upon for important service growing out of the common interests of the leading nations in the processes and results of education. Since the Franco-Prussian war, which greatly stimulated democratic tendencies in Europe, the attention of foreign governments has been more and more directed to the educational policies of the United States. Their interest is manifested by the presence among us of foreign experts and commissions charged with a mission to study our institutions, and by constant requests for information on special points transmitted to our government through diplomatic channels, and eventually referred to the Bureau for consideration. The inquiries are generally of such a nature as to demand the attention of the chief specialists of the office and the careful selection of printed documents or the preparation of extended written statements covering the desired information. The service which the Bureau thus performs as a medium of international exchange realizes an anticipation of its founders; their prevision in this respect is emphasized by the recent organization of special divisions for similar service in the education departments of England and of France.

The Bureau, whose operations have been thus briefly summarized, has published since 1869 33 annual reports and 10 special reports.

besides many monographs, and has prepared exhibits for 12 expositions, of which 8 were international.

The present force under the direction of the commissioner comprises, beside a chief clerk, 6 specialists, 29 clerks, 3 assistants to the general agent of education in Alaska, and 7 laborers. The clerical force is organized in four divisions, as follows: statistics, correspondence and records, research and editorial, library and museum.

The library of the Bureau contains 84,023 volumes and 104,500 pamphlets, forming a professional collection of great value. It is a working library whose necessary growth threatens to seriously overcrowd the rented building which the office occupies.

In the preparation of the annual report, 20,000 schedules, comprising 73 items, are tabulated, and a vast number of educational reports, catalogues, and manuals of law are examined and digests of the same prepared for use as circumstances require.

The mail matter received during the year ending 30 June 1904 included 14,210 letters, 91,147 documents from the government printing office, and 167,752 pieces of printed matter. During the same year the mail matter sent out by the office included 12,410 letters and 97,064 documents.

For the present fiscal year the appropriation for the current work of the office, in which printing is not included, amounted to $58,390.

ANNA TOLMAN SMITH,
United States Bureau of Education.

Educational Athletics. At the outset it must be borne well in mind that athletics in an educational institution is not an end but a means to an end. The end in view is to furnish a healthy habitation for a healthy mind, for without a sound body to carry out its work, the mind certainly cannot do what nature intended it to do. Certain minds incorporated in crippled bodies, it is true, have risen to remarkable heights in the various fields of human activity, but not on account of deformities, but in spite of them. Perhaps there is nothing so detrimental to a good healthy body — not even the use of stimulants — as excessive sedentary pursuits. When a young man is bent on winning scholastic honors, he unconsciously falls into this excess. Of course the natural result follows. Good rich blood is denied the parts; they become starved, and in a short time degeneration sets in throughout the entire body. Then it is that we have a terrible spectacle of a strong intellect unable to do even ordinary work on account of a pain-racked body.

It is to counteract this tendency to starve the body in order to feed the mind, that school authorities have encouraged physical as well as mental training among students. Thus we see that to-day the gymnasium is as important a part in a group of school buildings as a hall of science or of arts.

Although educational athletics is found at its best in the university, and there is little difference between the systems employed in our leading institutions of learning, the question is far from settled as to the best way of exercising the boy in the elementary and high school. It is a generally accepted fact that the kind of exercise — we can hardly dignify it by the name "athletics" — in the elementary school, is the one which, apparently, has the least system about it. For instance, let a boy exercise for the pleasure he gets out of it, and he will be immeasurably better off than if he exercises because it is prescribed in a school's work. The question of exercise in the country schools is easily solved. Where there is plenty of space and fresh air, no supervision is needed. The growing boy will find enough games to give him sufficient exercise to keep him healthy. However, in large cities, where there are few or no play grounds; where because of the congestion on all sides, tainted air is the best to be had, a real problem presents itself. A boy must have action; he must move about. A lad of 10 or 12 years is too young to differentiate clearly between good and bad, and if he does, he cares very little, as long as he finds a means of action. As a result, if he finds an outlet for his youthful spirits in a corner gang, he joins it, and we have the beginning of, if not an undesirable citizen — at least an undermined human body. On the other hand, give him pure air, and a play ground in which to romp, and we have a healthy boy. In short, play grounds will solve the problems of exercise in the elementary schools of large cities. Of course, it is impossible to furnish play grounds in many cases, so calisthenics have been introduced. Naturally, this is not as good as a game into which a boy goes with a zest, yet it does a great and an important work.

Athletics reduced to a system is for the first time found in the high school. The games played are much the same as in the college, namely, baseball, football, track sports, tennis, and basketball, while in some of the high schools of the Middle West we find in-door baseball. As a rule all interscholastic competition is under the control of the school principal, or a member of the teaching force appointed by the principal. There is much to be said pro and con as to the good that boys get out of their sports. Many educators and physical trainers agree that the high school lad exercises too strenuously. They say that the boy's body is not matured, and he therefore lays himself open to grave injury. Furthermore it is maintained that the undeveloped mind of the school boy is inclined to give athletics too important a place in his school work. Then again in many of the larger high schools professional coaches are often employed. In many instances a coach is more bent on a team's victory than on the health of his charges. However, in spite of all the objection that can be raised on this score there is little doubt that high school athletics has done much good.

All over the country there are interscholastic associations made up of high schools in adjacent counties. The winners in the respective meets compete in larger meets under the auspices of the athletic associations of some nearby university. In many of the western States, State high school track meets are held annually by the various State universities. Beside the rivalry between high schools located in the same section, there have been contests between the champion football teams of the Middle West and those of the East, and strange to say, in all of these intersectional meetings, the western schools have come out with flying colors.

Possibly the great fault to be found with athletics in high schools, and this is true of the universities as well, is that not enough boys get an opportunity to take part in the games. In other words, the majority of the pupils, and perhaps those who need it the most, get no exercise at all outside of calisthenics. If some system could be thought out whereby the whole school could take part in games, a finer lot of men, physically, would enter and graduate from our colleges. The solution of this difficulty probably lies in introducing a sufficient number of new games, so that every one can find some game that suits his temperament and needs. But it is with athletics in the university that we treat more especially, for athletics should come to their fruition there. The main object of the department of physical training in the university, is to preserve and improve the bodily health of the students by careful physical examinations, and rational prescriptions of exercises; by correcting physical deformities, and imperfect development; by teaching proper methods of living; and by encouraging proper intercollegiate sports.

Generally speaking, every university in the United States has the same routine. Each student is required to undergo a physical examination, so that a correct knowledge of his bodily condition is obtained and proper exercises prescribed. Regular classes are formed for drill in ordinary arm, body, leg, and wand calisthenics, and then on the various gymnasium appliances and apparatuses. During the freshman year at least, gymnasium work is compulsory. Exceptions, however, are made in the cases of those who make athletic teams. Besides the exercises themselves, lectures are given on personal hygiene. If the college is a co-educational institution, the female students take physical training under a competent woman instructor. In several institutions young women have taken part in basketball, and in rarer cases in track athletics, and on several occasions have made enviable records.

All competitive athletic games are given under direct faculty supervision, and examination is required to show that the membership on any team will not cause injury to the student, but will tend to improve his physical condition. No student, whose class work is unsatisfactory, is allowed to play on a university team. No student is permitted to play on an athletic team more than four years. All those who take part in collegiate sports must be amateurs.

Of all intercollegiate sports the most popular and the one most distinctively a college sport, is football. The football season begins in the middle of September and ends with Thanksgiving day. Intercollegiate contests begin about the first of October, since the last half of September is taken up with the training and conditioning of the players. The schedules are usually arranged so that the first games are easy to win, but they gradually become harder, until Thanksgiving, when rival teams trained to the minute meet each other in the supreme contests.

Football, as it is played in colleges to-day, is a modification of the Rugby game. This country first saw it at Harvard in 1875. A match was arranged with Yale that year, and the latter was beaten. However, the lesson seemed to have been a good one, for since then Harvard's victories over Yale have been few and far between. To Walter Camp, Yale 1880, sometimes called "the father of football" do we owe much for football as it is played to-day. It was due principally to Mr. Camp's efforts that the number of players on a team, and positions were fixed in their present condition. Without going into a discussion, on the roughness of the game, let it be considered that what is rough — nay, brutal — for a man in no condition to play, is merely a trial of strength, courage, and cleverness, in which all unnecessary roughness is eliminated, for the trained athlete.

For years Yale and Harvard had the leading football teams of the country. Then its spirit forced Princeton to the front. A few years later, Woodruff, a great Yale athlete, was employed as a coach at the University of Pennsylvania. Mr. Woodruff had very original ideas, and perfected what was known as the guards back play. With good material, and the guards back play, Pennsylvania became a contender for championship honors, and soon Yale, Harvard, Princeton, and Pennsylvania were known as the "Big Four" in football. In late years, other colleges have become prominent in this branch of sport, notably, Cornell, Columbia, West Point, Dartmouth, and Annapolis.

In the Middle West, seven State universities, the University of Chicago, and Northwestern University have entered into athletic relations, and are known as the Conference Universities, or the "Big Nine." Before 1890 there was practically no football played except in the East. The strides that football has made in the Middle West since then is little short of marvelous. The men who have raised the standard of play in the West are Alonzo A. Stagg, a former Yale athlete; Phil King, the Princeton quarter-back; and Fielding Yost, who learned the game at Lafayette, and Dr. Williams of Yale. Two different years King coached championship teams at the University of Wisconsin, and during the other years of his tutelage, Wisconsin was always one of the leaders. For almost a decade Stagg's teams at the University of Chicago have held good positions in the western football world, and in 1899, Chicago tied with Iowa for the championship of the Middle West. The latter team was coached by Knipe, of Pennsylvania, a former pupil of Woodruff, and he introduced in the West the guard's back play.

It was left for Yost to revolutionize the football of not only the West, but that of the country. Mr. Yost is a coach, none of whose teams have ever lost a game. His work has stood out most prominently at the University of Michigan. In the four years that he has coached there, the teams have won every game played, except one in 1903, a tie with the team of Minnesota, coached by Dr. Williams, a colleague of Stagg at Yale. Unfortunately, of late years there have been no intersectional contests between the elevens representing Eastern universities and those of the Middle West. The easterners claim that their teams are the better and the westerners make as strong a claim for theirs. Of course the question of superiority can never be settled until the leaders in the respective sections meet. To the calm observer it seems that each section could learn something from the other. In the East, the system of training is more methodical. The team is worked up in such a way that it is at its best when it goes against its strongest rival for the last game of the season. As the season is somewhat longer and there are more games to play in the West, the teams cannot be coached in this way, and what is lacking in method is made up in greater variety of play and dash.

All the western teams employ eastern coaches, with the exception of those at the universities of Illinois and Wisconsin, where a graduate system is in vogue. However, at the latter institution the system did not prove a success, and Phil King will again coach the team. Although Mr. Stagg got his training in the East, the system that is being built up at Chicago is that with the graduate in charge. West of the Rockies, both Leland Stanford and the University of California, the two leading seats of learning on the Pacific coast, employ graduates to coach their athletic teams.

After the football season is over, beside work in the gymnasium, there is nothing done in the way of exercise until after the holiday vacation, when the various indoor or gymnasium sports are taken up. The principal winter sport is basket ball and gymnasium work. It is very important, among other things, in that it brings out a part of the student body which takes no part in the other branches of sport. Gymnasium teams practice in tumbling, trapeze, horse, and bar work. Many of the students also take special interest in wrestling, fencing, and boxing. Although there is none or little intercollegiate competition in handball, this beneficial exercise is the principal mode of recreation for a great many of the student body.

Although it is long before the season of competition, the training season of both the baseball and track teams start immediately after the Christmas holidays. Baseball brings out more candidates than any other branch of sport, and the reason for this may readily be seen. Although there are many boys in college who have never played football, or sprinted, there is hardly one, physically able, who has not played the national game. The indoor work in this branch consists of batting, throwing, picking up grounders, and pitching. The squad, which in some instances numbers more than a hundred men, is gradually cut down, so that when they are able to play out of doors, in March, there remains probably enough men to make up two teams, beside the men who are trying for pitching positions.

The strongest football teams in the country are the college teams; the strongest baseball teams are of course the professional organizations. However, the strongest amateur teams in the country are the college teams. There is something about a college game of baseball which one never sees in a game between professional nines. That is, the college man plays the game with more earnestness and spirit than the player on the professional team. The college player receives no pay outside of victory. The game itself is everything to him, while he is playing it, and as a result he plays at top form every minute of the game. This much cannot be said for the professional player.

Now and then there is a player who is really superior to most professional players, and it is not an unusual thing to see college players drift into professional baseball. It is not a very lofty position for a college-bred man. Certainly, playing professional ball does him no good. In some instances, however, it has done the game good by driving out the rowdyism.

In the East, Brown, Yale, Harvard, Princeton, Georgetown, and Holy Cross have always been among the leading schools in baseball. The baseball squads in almost all of these colleges are coached by professional players. In the West, Illinois and Michigan have divided all the diamond honors in recent years. In 1902, the Illinois baseball team made an invasion of the East and defeated Yale, Princeton, Pennsylvania, and West Point, and was defeated by Harvard by a score of 2 to 1.

Training for a track team starts in the winter. Almost every university gymnasium is fitted up with a running track. There, day after day, the candidates for the team get out and run under the eye of the trainer. Intercollegiate indoor track matches begin as early as February. They take place in the gymnasium, and consist of short dashes, hurdle races, middle and long distance runs, shot put, pole vault, and high jump. To this list is often added a relay race. As soon as the weather is warm enough the track candidates are taken out on the athletic field. During the spring, dual meets are held, and in June, at the end of the collegiate year, a meet is held to which all the track teams of the colleges of a section are invited to compete.

Harvard, Pennsylvania, Yale and Georgetown do the best work on the track in the field among the eastern colleges. In the West Michigan and Chicago usually fight it out for leadership. In a dual meet held in 1904, in Chicago, Princeton won over Chicago by a margin of one point. Taken all in all, the average run of track athletes in the East are a trifle better than those in the West, though the West has turned out several record holders.

The following are the best records made in the respective events by the college track athletes of the country in collegiate meets:

100 yards—9⅗ s.—A. F. Duffey, Georgetown.
220 yards—21⅕ s.—B. J. Wefers, Georgetown.
One-fourth mile—41¾ s.—W. Baker, Harvard.
One-half mile—1 m. 53⅖ s.—C. J. Kilpatrick, Union.
One mile run—4 m. 23⅖ s.—G. W. Orton, Pennsylvania.
Two mile run—9 m. 40 s.—W. E. Schutt, Cornell.
120 yard hurdles — 15⅖ s.—S. Chase, Dartmouth; A. C. Kraenzlein, Pennsylvania.
220 yard hurdles—23⅗ s.—A. C. Kraenzlein, Pennsylvania.
Running high jump—6 ft. 4 in.—W. B. Page, Pennsylvania.
Running broad jump—24 ft. 4½ in.—A. C. Kraenzlein, Pennsylvania.
Pole vault—12 ft. 1 32-100 in.—Norman Dole, Leland Stanford.
Throwing 16 lb. hammer—166 ft. 5 in.—J. R. De Witt, Princeton.
Putting 16 lb. shot—47 ft. 8½ in.—Ralph Rose, Michigan.
Discus throw—125 ft. 3¼ in.—Ralph Rose, Michigan.

Besides the sports already mentioned, rowing takes an important place in the athletic catalogue of many universities. Perhaps a man has to train longer and more strenuously to make a college crew than if he went into any other branch of sport. Often the man on the crew starts to work in September and continues throughout the entire college year. The swimming tank in the gymnasium leads to many water games, such as racing, diving, water polo, etc., all of which tend to mould a man along healthful lines. Lawn tennis occupies a very important place in college athletics. It is one of the most beneficial sports we have, but as it is not a game which is very interesting to spectators, it will never rank with football, baseball, rowing or track athletics as an intercollegiate sport. Golf is being taken up more and more by the colleges and this most excellent game will increase in popularity, and we will hear of many intercollegiate matches where now there are but few.

The good of athletics in institutions of learning is incalculable. Between classes and lectures, when there is nothing to take up the student's mind, the temptations are manifold. If he is of a studious disposition, there is the danger of excessive sedentary life. If he is not studiously bent, there are many temptations to attract the idle. If he is of a weak constitution, disease and its consequences soon follow; if he is robust, although he may stave them off longer, the consequences are the same. Then again, the athletic field is a place where all classes of students can meet on a common ground. It is the place where they can get rid of a superabundance of youthful enthusiasm. As a result, the town and gown riots, which formerly characterized every college town, are things of the past. One is thus inclined to agree with an eminent college president when he said, "the athletic field does more toward keeping order in the student body than all our rules and regulations combined."

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Educational Land Grants. See Colleges, Land Grants.

Educational Military System. The system of military education that is provided in the United States is materially different from that which prevails in other countries. The foundation of this system is supplied by the United States Military Academy at West Point, but the practical education of the soldier, according to the American system, has only just begun when he obtains his certificate of graduation from the military school. The various posts have their officers' schools for instruction in theory and practice and these are attended by such graduates as may not have been assigned to one of the special service schools of application. These are the artillery school at Fort Monroe; the school for engineers at the Washington, D. C., barracks; the special school for cavalry men and infantry men at Fort Riley, Kan.; the institution for instruction in submarine defense at Fort Totten, N. Y.; and the army medical and dental schools at Washington, D. C. The courses at each of these schools is one or two years, and, as far as possible in that length of time, the students are trained by methods of practical application in the special work that distinctively applies to their particular branch of the service. In addition to these schools, however, there is the General Service and Staff College at Leavenworth, Kan., all under the direction of experienced army officers, and the War College at Washington, another institution organized to fit officers for service on the general staff.

A general supervision over all the different military schools is maintained by the War College Board, and the recognition of the value of the citizen-soldier in time of war has led the War Department to declare that all officers' schools at the military posts as well as the General Service and Staff College at Leavenworth, shall be open to National Guard and volunteer officers as well as to those who have graduated from the recognized military academies and colleges. See Military Academy, United States; Military Schools.

Educational Organization and Administration. The first white settlers who came to America were from the more civilized European peoples, who had already made some progress in the direction of popular education. The most potent influences upon American civic institutions were English and Dutch. English colleges and fitting schools were maintained for the training of young men of noble birth for places under the government and in the government church, but there were no common schools for all. The Dutch had gone farther than the English; they had just waged a war for civil and religious liberty which had enlarged their freedom and quickened their activities; they had become the greatest sailors and the foremost manufacturers in the world; and they had established the government policy of maintaining not only colleges, but common schools for all. English and Dutch each brought their national educational ideas with them. The English colony in Massachusetts followed the English educational policy; and set up a college to train their aristocracy for places in the state and the church. The Dutch, more dependent upon their government over the sea, at once set up elementary schools at public cost and common to all. In a few years the English overthrew the little Dutch government and almost obliterated the elementary schools. For a century the English royal governors and the Dutch colonial legislatures struggled over the matter of common schools. The government was too strong for the humble people; little educational progress was made. Near the close of that century the government established King's College to educate sons of noble birth and prevent the spread of republican ideas. The Revolution of 1776 changed all. In fighting together for national independence the different peoples assimilated and became Americans in the new sense. They realized that education must be encouraged, and, so far as practicable, made universal under a democracy in which the rights of opportunity were to be equal. But they began to be interested in education because they saw that schools would help the individual and so promote virtue and extend religion. It did not occur to them at first that the safety of the new form of government was associated with the diffusion of learning, for the suffrage was not universal at the beginning of independent government in America. Therefore, it was understood to be the function of parents to provide education for their children. Schools were partnership affairs between people who had children in their care. They apportioned the expense among themselves. But it was soon seen that many who had children to educate would neglect them to avoid contributing to the support of the school. Besides the schools were very indifferent affairs. If they were to be of any account they must have recognition and encouragement from government. Encouragement was given by official and legislative declarations in their behalf and by authorizing townships to use various surplus funds for the benefit of the schools. It was a greater step for the townships to require parents and guardians to maintain schools, and a still greater one to adopt the principle that every child was entitled to an elementary education, that this was for the safety of the state, that therefore the state was bound to see that schools were provided for all, and that all the property of all the people should contribute alike to their support. Perhaps it was even a greater step to provide secondary and collegiate, and in many cases professional and technical, training at the public cost.

Although there was no educational system in the United States at the beginning of the 19th century, there is now one throughout the country, free and flexible, adaptable to local conditions, and with the elements of a complete and symmetrical system. The parts of this system may be designated as follows:

(a) Free public elementary schools in reach of every home in the land.

(b) Free public high schools, or secondary schools, in every considerable town.

(c) Free land grant colleges, with special reference to the agricultural and mechanical arts, in all the States.

(d) Free State universities in practically all of the southern States and all the States west of Pennsylvania.

(e) Free normal schools, or training schools for teachers, in practically every State.

(f) Free schools for defectives, in substantially all of the States.

(g) National academies for training officers for the army and navy.

(h) A vast number of private kindergartens, music and art schools, commercial schools, industrial schools, professional schools, denominational colleges, with a half dozen leading and privately endowed universities.

This educational system is held in the control of the people, and so far as practicable in the control of local assemblages. In spite of modern tendencies toward centralization of management, the conspicuous characteristic of the system has always been that elementary and secondary schools are largely controlled and directed by each community.

The School District.— The «school district» is the oldest and the most primary form of school organization, and the smallest civil division of our political system. It resulted from the disposition of neighboring families to associate for the maintenance of a school. Later it was recognized by law. It ordinarily accommodates but a few families, and is better adapted to the country than to town or city. The «district system» is in operation in most of the States; in New York there are more than 11,000 and in Illinois more than 12,000 school districts. Their government is the most simple and democratic that can be imagined. It is controlled by school meetings held annually or oftener and composed of resident legal voters, in many of the States including women, especially of property holders. These meetings vote repairs and appliances for the school, erect new schoolhouses, and elect officers, one or more, commonly called trustees or directors, who are required to employ the teacher and have general oversight of the school. Although much has been said against the district system, it cannot be denied that the system has had much to commend it, for it suits the conditions of country life; makes schools adapted to the thought and wants of the people; educates the people themselves in civic spirit and patriotism: and affords a meeting-place for the people. The district school ordinarily has been as good as a free and primitive people would sustain or could profit by. The teachers have generally been young and inexperienced, but never mere mechanical automatons, and as a rule they have proved makers of opinion and leaders of action upon a considerable field. Certainly the work has lacked system, continuity and progressiveness, but the pupils have not suffered seriously, in comparison with the children living in the towns. The district system has sufficed well for them and it is to be spoken of with respect, for it has exerted a marked influence upon our citizenship, and has given strong and wholesome impulses in all the affairs of the nation.

The Township System. — In the first half of the last century the general educational purpose was to perfect the district system; the tendency in the latter half was unmistakably to merge it into an organization covering a larger area, and capable of larger undertakings. The cause of this has been the desire for larger schools, taught by teachers better prepared, and capable of broader and better work, and a purpose to distribute educational advantages more evenly. Accordingly, in most of the States the township system has already supplanted the district organization. The township system makes the township the unit of school government. It is administered by officers chosen at annual town meetings, or sometimes by central boards, the members of which are chosen by the electors of different sub-districts. In any event, the board has charge of all the elementary schools of the township, and of the township high school, if there is one. The board provides buildings and cares for them, supplies the furnishings and appliances, employs teachers, and regulates the general operations of the schools. Of course the township system is much less formally democratic and much more centralized than the district system. It has doubtless produced better schools and schools of more uniform excellence. One of its most beneficent influences is the multiplication of township high schools.

It has many advantages over the district system for a people who are ready for it, and it is a step toward that general centralization in management and greater uniformity of method so manifest throughout the school system of the United States.

The County System.— The southern States, for the most part, have a county system of school administration. This has resulted from the general system of county government prevalent in the southern States and easily traceable to historic causes.

The county system is not constituted identically in all of the southern States of the Union. In Georgia, for example, the grand jury of each county selects from the freeholders five persons to comprise the county board of education; in North Carolina the justices of the peace and county commissioners of each county appoint such a county board of education; in Florida such a board is elected by the people biennially; and elsewhere a county commissioner or superintendent of schools is the responsible authority for managing the schools of the county. In any case the unit of territory for the administration of the schools is the county, and county officials locate sites, provide buildings, select text-books, prescribe the course of work, examine and appoint teachers, and do all the things which are within the functions of district or township trustees or city boards of education in the northern States.

The City School Systems.— In cities where it is difficult for people to meet to fix the policies and manage the business of the schools, or to choose officers to manage the schools, the State legislatures make special laws for city schools. In some States these laws are uniform for all cities of a certain population, but more often each city has gone to the legislature and procured the enactment of such statutes as seemed suited to the immediate circumstances, so that there is no uniform or general system of public school administration in the American cities. But in nearly every case there is a board of education charged with the management of the schools; these boards differ in constitution and in legal functions in different cities. Usually boards of education are elected by the people, on a general city ticket, or by wards or sub-districts; and either at a general or municipal election, or at special elections. But in the larger cities, the board is appointed by the mayor, or by mayor and city council. In a few instances it is appointed by the city councils. It must be said that there has been much dissatisfaction with the way school affairs have been managed in the larger cities, where there have been many and serious complaints of misuse of funds, of neglect of property, of appointment of unfit teachers, and of general incapacity, or worse, on the part of the boards. All this has come from the amounts of money that are involved and the number of appointments that are constantly to be made. More than $100,000,000 is paid annually for teachers' wages alone in the United States. People who are needy have sought positions as teachers without much reference to preparation, and the kindly disposed have aided them without any apparent appreciation of the injury they were doing to the highest interests of their neighbors. Men engaged in managing the organizations of the different political parties have undertaken to control appointments in the interests of their party machines. And downright scoundrels have infested the school organization in some places for the sake of plunder. As cities have grown in size and multiplied in numbers the more scandal there has been. But so has the determination of the people strengthened to remedy difficulties.

Especially important is a report of the Committee of Fifteen of the National Educational Association, which closes with the following suggestions:

First. The affairs of the school should not be mixed up with partisan contests or municipal business.

Second. There should be a sharp distinction between legislative functions and executive duties.

Third. Legislative functions should be clearly fixed by statute and be exercised by a comparatively small board, each member of which is representative of the whole city. This board, within statutory limitations, should determine the policy of the system, levy taxes, and control the expenditures. It should make no appointments. Every act should be by a recorded resolution. It seems preferable that this board be created by appointment rather than election, and that it be constituted of two branches acting against each other.

Fourth. Administration should be separated into two great independent departments, one of which manages the business interests and the other of which supervises the instruction. Each of these should be wholly directed by a single official who is vested with ample authority and charged with full responsibility for sound administration.

Fifth. The chief executive officer on the business side should be charged with the care of all property and with the duty of keeping it in suitable condition: he should provide all necessary furnishings and appliances: he should make all agreements and see that they are properly performed: he should appoint all assistants, janitors, and workmen. In a word, he should do all that the law contemplates and all that the board authorizes, concerning the business affairs of the school system, and when anything goes wrong he should answer for it. He may be appointed by the board, but it is preferable that he be chosen in the same manner as the members of the board and be given a veto upon the acts of the board.

Sixth. The chief executive officer of the department of instruction should be given a long term and may be appointed by the board. If the board is constituted of two branches, he should be nominated by the business executive and confirmed by the legislative branch. Once appointed he should be independent. He should appoint all authorized assistants and teachers from an eligible list to be constituted as provided by law. He should assign to duties and discontinue services for cause, at his discretion. He should determine all matters relating to instruction. He should be charged with the responsibility of developing a professional and enthusiastic teaching force, and of making all the teaching scientific and forceful. He must perfect the organization of his department and make and carry out plans to accomplish this. If he cannot do this in a reasonable time he should be superseded by one who can.

In the present scheme the powers of the city boards of education are very broad, almost without limits as to the management of the schools. They do everything but decide the amount of money which shall be raised for the schools, and sometimes do that. Of course these independent and large prerogatives are exceedingly advantageous to educational progress when exercised by good men; but it is not to be disguised that in some of the foremost cities they have fallen into hands which are corrupt, but more often into the hands of men who do not see the importance of applying pedagogical principles to instruction, and who are used by designing persons for partisan, selfish or corrupt purposes. But notwithstanding all hindrances, the issue is being joined and the battle will be fought out to a successful result. There can be but one outcome. The forces of decency and progress always prevail in the end.

The demands of the friends of popular education in our great cities are for a plan of organization separating legislative and executive functions, putting the interests of teachers upon the merit basis and leaving them free to apply pedagogical principles to the instruction, giving large authority to officers and teachers, but locating responsibility and ousting the incompetent or corrupt.

The States and the Schools.— Since the American school system is supported wholly by taxation, it depends upon the exercise of a sovereign power. The provision and supervision of schools is a power lodged in the State, and the school system has a legal organization peculiar to each State. This dependence upon State authority has developed a system which tends toward the equalization of school privileges within each State. Of the improvement brought about by intervention on the part of the State in local control, there can be no doubt. In many cases State school funds have been created, or large sums are raised by general levy each year, which are distributed so as to give the most aid to the sections which are poorest and most need it. In the State of New York, for example, the cities pay more than $500,000 every year to the support of the schools in the country districts. Moreover, excellent normal schools and, in the South and West, great State universities are sustained as parts of the State school systems. In 10 universities of the north-central division of States there are more than 20,000 in college and professional courses, and the work is of as high grade and of as broad range as in the oldest universities of the country. These things exert strong influences upon the sentiment of the people and increase their respect for the State authority over schools. The application of State authority to all schools supported by public moneys of course makes them better and more alike. Whims of local settlements disappear. Schoolhouses are better. More is done for the preparation of teachers, and more uniform exactions are put upon candidates for the teaching service. The courses of study are more quickly and symmetrically improved. There is criticism and stimulus from a common centre for all of the educational work of the State. The different States have gone to very different lengths in exercising their authority. The State government has, of course, not been disposed to go farther than the people were willing, for all government is by the people. The thought of the people in the different States has been somewhat influenced by considerations which arise out of their early history, but doubtless in most cases it is predicated upon their later experiences.

All State constitutions now contain provisions relating to popular education. This was not true of the original constitutions of the older States, for when they were adopted the maintenance of schools was looked upon as a personal or local rather than a State concern. But later amendments introduced such provisions into all older State constitutions. And all newer ones contained strong and elaborate sections, making it a fundamental duty of the government they establish to encourage education and provide schools for all. All the States have legislated much in reference to schools, and there is scarcely a session of one of the State legislatures in which they do not receive considerable attention. In all the States there is some sort of a State school organization established by law. In practically all there is an officer known as State superintendent of public instruction, or State school commissioner. In some there is a State Board of Education. In New York there is a State Board of Regents in charge of private academies, in some measure of public secondary schools, and of all higher institutions; and also a State Superintendent of Public Instruction, with authority over the elementary schools and in a large measure over the public high schools. The officer last referred to is probably vested with larger authority than any other one educational official in the country. He apportions the State school funds; determines the conditions of admission, the courses of work, and the employment of teachers; audits accounts of the 12 normal schools of the State; has unlimited authority over the examination and certification of teachers; regulates the official action of the school commissioners in all of the assembly districts of the State; appoints teachers' institutes, arranges the work, names the instructors, and pays the bills; determines the boundaries of school districts; and provides schools for the defective classes and for the seven Indian reservations yet remaining in the State. Besides he may condemn schoolhouses and require new ones to be built; and may direct new furnishings to be provided. He is a member of the State Board of Regents and of the board of trustees of Cornell University. He may entertain appeals by any person conceiving himself aggrieved from any order or proceeding of local school officials, determine the practice therein, and make final disposition of the matter in dispute, and his decision cannot be "called in question in any court or in any other place." All this, with the splendid organization of the State Board of Regents, provides New York with a more complete and elaborate educational organization than any other American State. Some think it more elaborate and authoritative than necessary. Certainly it is exceptional among the States, for most of them undertake to regulate school affairs very little, and usually the State Board of Education only controls the purely State educational institutions, and the principal functions of the leading educational official of the State are to inspire action, gather statistics, and disseminate information. However, there can be no doubt that the general tendency is toward greater centralization. The overwhelming current of legislation and of the decisions of the courts is making it imperative, being practically in accord, and to the effect that in each State the school system is not local, but general; not individual schools controlled by separate communities, but a closely related system of schools which has become a State system and is entirely under State authority; and holding local school officials as agents of the State for the administration of a State system of education. The granting of aid by the State implies the right of the State to name the conditions upon which the aid shall be received, and the duty to see that the exercise of such powers shall result in equal advantages to all. Despite of differences all the States appreciate the fact that a constitutional self-governing state exists for the moral and intellectual advantage of every citizen. They have employed and will continued to employ different methods; but all have the highest authority and the supreme responsibility in the matter. And it is the purpose of the people and the law of most of the States not only that such educational opportunities shall be provided for every American child, but that every one shall be required to take advantage of them. Compulsory attendance laws have been enacted in most of the States. These are not as carefully framed as a good knowledge of educational administration might very easily lead them to be, and they are not as completely enforced as the true interests of many unfortunate children require. The right of compulsory education on the part of the State has met with considerable opposition and is still a much disputed question.

General Government and Education.— The Federal government has never exercised any control over the public educational work of the country. But it has never been indifferent thereto. It has shown its interest at different times by generous gifts to education and by the organization of a bureau of education to gather and disseminate the fullest information from all the States, and from foreign nations. The gifts of the United States to the several States to encourage schools have been in the form of land grants from the public domain. In the sale of public lands the practice of reserving one lot in every township "for the maintenance of public schools within the township" has uniformly been followed. In 1786 officers of the Revolutionary army petitioned Congress for the right to settle territory north and west of the Ohio River. A committee reported a bill in favor of granting the request, which provided that one section in each township should be reserved for common schools, one section for the support of religion, and four townships for the support of a university. This was modified so as to give one section for the support of religion, one for common schools, and two townships for the support of a "literary institution to be applied to the intended object by the legislature of the State." This provision, coupled with the splendid declaration that "religion, morality, and knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall forever be encouraged," foreshadowed the general disposition and policy of the central government and made the "Ordinance of 1787 for the government of the Northwest Territory" famous. The precedent here established became national policy, and after the year 1800 each State admitted to the Union, with the exception of Maine, Texas, and West Virginia, received two or more townships of land for the founding of a university. In 1836 Congress passed an act distributing to the several States the surplus funds in the treasury. In all $28,101,645 was so distributed, and in a number of the States this was devoted to educational uses. But the most noble, timely, and carefully guarded gift of the Federal government was embodied in the Land Grant Act of 1862 for colleges of agriculture and the mechanic arts, which gave to each State 30,000 acres of land for each senator and representative in Congress to which the State was entitled under the census of 1860, for the purpose of founding "at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States shall respectively prescribe, in order to promote the liberal education of the industrial classes in the several pursuits and professions of life." This act has been added to by other congressional enactments and the proceeds of the sales of lands have been generously supplemented by the State legislatures until great peoples' colleges and universities have arisen in all of the States.

The work of the United States Bureau of Education is a most exact, stimulating, and beneficent one. Without exercising any authority, it is untiring and scientific in gathering data, in the philosophic treatment of educational subjects, and in furnishing the fullest information upon every conceivable phase of educational activity to whomsoever would accept it. It has become the great educational clearing-house of the world. Its commissioners have been eminent men and great educational leaders.

Private Institutions.— Besides public schools there is a large number of other schools which comprise an important part of the educational system of the country and are of course subject to its laws. Any statement concerning American school organization and administration, even of the most general character, would be incomplete which did not cover these. In the first half of the last century many private "academies" or "seminaries" sprang up where the country had become at all settled. This was in response to a demand from people who could not get what they wanted in the common schools. A teacher with a little more than ordinary gifts could open one of these private schools and soon have an abundance of pupils and a profitable income. But most of these schools served their purpose and gave way to new public high schools. Some remain and continue to meet the desires of certain families who prefer their somewhat exclusive ways. A considerable number have been adopted by their States and developed into State normal schools, and not a few have by their own natural force grown into literary colleges. In recent years innumerable schools have arisen out of private enterprise. Every conceivable interest, professional, technical, industrial, and commercial, has produced a school to promote its own ends.

All such schools operate independently of the States in which they exist. The States do not interfere with them, as they ask no public support. Some of them hold charters granted by the legislature, and more secure recognized standing by organizing under general corporation laws enacted to cover all such enterprises. In some cases the States distribute public moneys to some of these institutions by way of encouragement, and perhaps impose certain conditions upon which they shall be eligible to share in such distributions. But ordinarily a State does no more than protect its own good name against occasional impostors. New York, for example, has prohibited the use of the name "college" or "university" except when the requirements of the State Board of Regents are met. All reputable institutions desire reasonable supervision, for it certifies their respectability and constitutes them a part of the public educational system of the State.

Expert Supervision.— From the beginning the laws have provided methods for certificating persons deemed to be qualified to teach in the schools. This has ordinarily been among the functions of State, city, and county superintendents or commissioners. Sometimes boards of examiners have been created whose only duty was to examine and certificate teachers. The function of certificating and that of employing teachers have, for obvious reasons, not commonly been lodged in the same officials. Superintendents began to be provided for by law in the early part of the 19th century. The first State superintendency was established by New York in 1812. Other States took similar action in the next 30 years. Town, city, and county superintendencies came along rapidly, and by or soon after the middle of the century had been set in operation in most parts of the then settled country. The main duty of these officials in the earlier days was to examine candidates for teaching, report statistics, and make addresses on educational occasions. In later years, however, they are held in considerable measure responsible for the quality of the teaching. In country districts superintendents hold institutes, visit schools, commend and criticise the teaching, and exert every effort to promote the efficiency of schools, so that a discreet and active county superintendent comes to exert almost a controlling influence over the school affairs of his county. In the cities, and particularly the larger ones, the problem is much more difficult. Because of the greater number of teachers, the task of securing uniform excellence is much enlarged. The schools are less homogeneous and instruction less easy. Frequently the superintendent cannot know the personal qualities of each teacher, or even visit all of the schools. Yet a system must be organized which, through the aid of assistants, will advise the superintendent's office fully of the work of every teacher. All teachers must be upon the merit basis, the most deserving must be advanced in rank and pay as rapidly as practicable, and the weak must be helped and trained into efficiency or removed from their positions. The laws are coming to recognize the responsibilities and difficulties of the superintendent's position, and are continually throwing about that officer additional safeguards and giving him larger powers and greater freedom of action. And the good cause of education against political manipulation is making substantial progress. The law books of all of the States show provisions recognizing the professional school superintendent; in many of the States they contain provisions directing and protecting his work: and in some they confer upon him entire authority over the appointment, assignment and removal of teachers, and impose upon him entire responsibility for the quality of the teaching. It is this professional supervision which has given the American schools their peculiar spirit. As the people have come to know the worth of good teaching they have favored closer supervision over the teaching. All this is yearly becoming more and more apparent in the laws, and it is advancing the great body of American teachers along philosophical lines more steadily and rapidly than any other great body of teachers in the world is advancing.

In conclusion a few facts touching the great school system, the legal organization of which we have briefly tried to sketch, and which has produced that organization and in turn has in part been produced by it, will be of interest. The enrolment of pupils in the State common schools alone in 1899–1900 was nearly 15,350,000. These schools were kept open an average of 140.5 days in the year. The number of teachers employed was more than 420,000, and the running expenses for the year about $213,000,000. Laws making attendance at school compulsory have been enacted in 32 States and Territories.

The United States Bureau of Education, to which I am indebted for the foregoing figures and much other information, is aided by a corps of 15,000 voluntary correspondents who furnish printed reports and catalogues and cheerfully answer the bureau's inquiries upon every phase of educational work.

It is of course difficult for one not familiar with American institutions and American ways to understand or appreciate the American school system. To him it seems anything but a system. It is a product of conditions in a new land, and it is adapted to those conditions. It is at once expressive of the American spirit and it is energizing, culturing and ennobling that spirit. It is settling down to an orderly and symmetrical institution, it is becoming scientific, and it is doing its work efficiently. It exerts a telling influence upon every person in the land, and is proving that it is supplying an education broad enough and of a kind to support free institutions.

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Edward the Elder, king of England: b. about 870; d. Farndon, Northamptonshire, 925. He was a son of Alfred the Great, and succeeded his father in 901. Ethelwald, the son of his father's elder brother, claimed the crown; and an insurrection took place in his favor, but it ended with the death of Ethelwald in battle. The reign of Edward was further distinguished by successes over the Anglicized and foreign Danes. He fortified many inland towns, acquired dominion over Northumbria and East Anglia, and subdued several of the Welsh tribes.

Edward (surnamed the «MARTYR»), king of England: b. about 963; d. Corfe Castle 18 March 979. He was a son of Edgar, and succeeded his father in 975. His stepmother, Elfrida, wished to raise her own son, Ethelred, to the throne, but was opposed by Dunstan, through whose exertions Edward was peaceably crowned. His short reign was chiefly distinguished by the disputes between Dunstan and the foreign monks on one side, and the secular clergy on the other. Hunting one day in Dorsetshire he was separated from his attendants, and repaired to Corfe Castle, where Elfrida resided. He requested a glass of liquor, and as he was drinking on horseback one of Elfrida's servants gave him a deep stab behind. He immediately set spurs to his horse, but, fainting from loss of blood, was dragged in the stirrup until he died. The pity caused by his innocence and misfortune induced the people to regard him as a martyr.

Edward (surnamed the "CONFESSOR"), king of England: b. Islip, Oxfordshire, about 1004; d. 5 Jan. 1066. He was a younger son of Ethelred II. On the death of his maternal brother, Hardicanute the Dane, in 1041, he was called to the throne, and thus renewed the Saxon line. He was not the immediate heir, as his brother, Edmund Ironside, had left sons; but as he received the support of Godwin, earl of Kent, on condition of marrying his daughter, Editha, his claim was established. Edward was a mild and virtuous prince, who acquired the love of his subjects by his sanctity and care in the administration of justice. Having been educated in Normandy he introduced so many natives of that country to his court that the French language and manners became prevalent in England to the great disgust of Earl Godwin and his sons. A rebellion took place, and Edward was forced to dismiss his foreign favorites. Perceiving that the youth and weakness of his chosen heir, Edgar Atheling (q.v.), would not secure the succession against the power and ability of Harold, the son of Godwin, he turned his eyes upon his kinsman, William of Normandy, in whose favor it has been asserted that he executed a will. He died leaving the point of the succession undetermined; and with him ended the Saxon line of kings. He caused a body of laws to be compiled from those of Ethelbert, Ina, and Alfred, which is the supposed source of the common law of England. He was canonized by Alexander III. in 1166.

Edward I., king of England: b. Westminster 17 or 18 June 1239; d. Burgh-le-Sands, near Carlisle, England, 7 July, 1307. He was a son of Henry III., and the contests between his father and the barons called him early into active life, and he finally quelled all resistance to the royal authority by the decisive defeat of Leicester, at the battle of Evesham, in 1265. He then proceeded to Palestine, where he inspired so much terror that an assassin was employed to despatch him, from whom he received a wound in the arm, which, as tradition reports, being supposed to be from a poisoned weapon, was sucked by his faithful consort, Eleanor of Castile. On assuming the government he acted with great vigor in the repression of the lawlessness of the nobles and the corruption in the administration of justice; but often evinced an arbitrary and grasping disposition. In 1274, and again in 1276, he summoned Llewellyn, prince of Wales, to do him homage, and upon his refusal, except on certain conditions, began the war which ended in the annexation of that principality to the English crown in 1283. Edward then spent some time abroad in mediating a peace between the crowns of France and Aragon, and on his return commenced his attempts to destroy the independence of Scotland. After his return from the Scottish expedition in 1296, which terminated in the capture of Baliol, he became involved in a quarrel with his clergy, who, supported by the Pope, refused to submit to a tax which he had imposed on them. Edward forced their compliance by placing them out of the protection of the law. His frequent expedients to raise money at length produced great discontent among the nobles and people also, which obliged him to confirm the great charter and charter of forests, and also to give other securities in favor of public liberty. He then made a campaign in Flanders against France, which terminated with the recovery of Guienne and his second marriage with Margaret, the sister of King Philip. Meantime new commotions took place in Scotland under the guidance of the celebrated William Wallace. These transactions recalled Edward from Flanders, who hastened to the border with an army of 100,000 men. The ignominious execution of the brave Wallace, in 1305, as a traitor, forms a blot in the character of Edward. Neither did it avail, since Robert Bruce was able, in 1306, to place himself at the head of a new confederacy. Indignant at this determined spirit of resistance Edward vowed revenge against the whole Scottish nation, and, assembling another army, was on the point of passing the border when he was arrested by sickness and death. Few princes have exhibited more vigor in action, or policy in council, than Edward I. His enterprises were directed to permanent advantages rather than to mere personal ambition and temporary splendor. Nor was he less intent upon the internal improvement of his kingdom than its external importance. The laws of the realm obtained so much additional order and precision during his reign that he has been called the "English Justinian." He passed an act of mortmain, protected and encouraged commerce; and in his reign first originated the society of merchant adventurers. The manners of this able sovereign were courteous, and his person majestic, although the disproportionate length of his legs gave him the popular surname of "Longshanks." He left a son and three daughters by his first wife, Eleanor, who died in 1290, and two sons by his second wife, Margaret of France. See Stubbs, 'The Early Plantagenets' (1877); Tout, 'Edward I.' (1893).

Edward II., king of England: b. Caernarvon Castle in 1284; d. Berkeley Castle 21 Sept. 1327. He was the first English Prince of Wales and succeeded his father, Edward I., in 1307. He was of an agreeable figure and mild disposition, but indolent and fond of pleasure. His first step was to recall Piers Gaveston, a young Gascon, whom his father had banished, and whom he created Earl of Cornwall, and married to his niece. He then went to France to espouse the Princess Isabella, to whom he had been contracted by his father, leaving Gaveston guardian of the realm. Soon after his return the barons associated against the favorite, whom they more than once obliged the king to send away. He was, however, as constantly recalled when the immediate danger was over, until an open rebellion took place; and the person of Gaveston being captured, he was executed as a public enemy. In 1314 Edward assembled an immense army to check the progress of Robert Bruce, but was completely defeated at Bannockburn. After the death of Gaveston he selected another favorite, Hugh le Despenser, upon whom he lavished favors of every kind, until the barons again rebelled, and the Parliament dooming Despenser and his father to exile, the king was obliged to confirm the sentence. Edward, however, on this occasion, in concert with the Despensers, contrived to raise troops and attack the barons, at the head of whom was his cousin, the Earl of Lancaster, who, being taken prisoner, was executed at Pomfret. Edward subsequently made another fruitless attempt against

Scotland, which ended in the conclusion of a truce of thirteen years. In 1324 Queen Isabella went to France, and while there entered into a correspondence with several English fugitives, in whose hatred to the Despensers she participated. Among these was Roger Mortimer, a young baron of the Welsh marches, between whom and Isabella a criminal intercourse followed, in consequence of which the queen was still more determined upon the ruin of her weak and unhappy husband. Having formed an association with all the English malcontents, and aided with a force by the Count of Hainault, she embarked for England in September, 1326, and landed in Suffolk. Her forces seized the Tower of London and other fortresses, captured and executed both the Despensers without trial, and at length took the king prisoner. Edward was confined in Kenilworth Castle, and in January 1327, his deposition was unanimously voted in Parliament, on the ground of incapacity and misgovernment. A resignation of the crown was soon after extorted from him, and he was transferred to Berkeley Castle, where Mortimer despatched two ruffians, who murdered him, in the 20th year of his reign and 43d of his age.

Edward II., an historical tragedy by Christopher Marlowe (1598). It follows history closely in its main lines and is a drama as powerful as it is painful.

Edward III., king of England: b. Windsor 13 Nov. 1312; d. Richmond, Surrey, 21 June 1377. He was a son of Edward II., and on his father's deposition in 1327, was proclaimed king under council of regency, while his mother's paramour, Mortimer, really possessed the principal power in the state. The pride and oppression of Mortimer now became so intolerable that a general confederacy was formed against him. The result was the seizure of Mortimer, who was tried and condemned by a parliament at Westminster, and was executed 29 Nov. 1330. The queen, although treated with outward respect, never again during the remaining 28 years of her life recovered any degree of authority. Edward now turned his attention to Scotland. Assisted by some principal English nobles, Edward Baliol, son of the John Baliol to whom the crown had been awarded by Edward I., raised a force, and defeating the Scots in a great battle, set aside David Bruce, then a minor, and was crowned at Scone in 1332. Baliol being driven away on the departure of his English auxiliaries, applied to Edward, who defeated the regent, Douglas, at the famous battle of Halidon Hill, in July 1333. This victory produced the restoration of Baliol, who was, however, again expelled, and again restored, until the ambition of Edward was called off by a still more splendid object. The crown of France, by the Salic law, having devolved to Philip de Valois, cousin-german to the deceased king Charles the Fair, Edward was induced to claim it in right of his mother, that monarch's sister. Edward, in order to obtain supplies, made concessions to Parliament which he never intended to keep; and finding his territory of Guienne threatened, sent over a force for its defense, and quickly followed himself, accompanied by his son Edward, the famous Black Prince, all his chief nobility, and 30,000 men. The memorable battle of Crécy followed, 25 Aug. 1346, succeeded by the siege of Calais. In the meantime, David Bruce, having recovered the throne of Scotland, made an incursion, at the head of a large army, into England; but being met at Durham by a much inferior force, raised by Queen Philippa, and headed by Lord Percy, was totally defeated and taken prisoner, with many of his principal nobles. Philippa went over to her husband at Calais, and, by her interference prevented the barbarous execution of Eustache de St. Pierre and five other citizens, whom Edward, on the capitulation of the place, had determined to execute, in revenge for his long detention in the siege. In 1348 a truce was concluded with France. The year 1349 was distinguished by the institution of the order of the Garter, which soon became one of the most illustrious orders of knighthood in Europe. Philip, king of France, dying in 1350, was succeeded by his son John, the commencement of whose reign abounded with intestine commotion, and in 1355 Edward again invaded France on the side of Calais, while the Black Prince at the same time led a large army from Gascony. Both these expeditions were attended with much plunder and devastation; and Edward, being recalled home by a Scottish inroad, soon repelled it, and retaliated by carrying fire and sword from Berwick to Edinburgh. During this time the Prince of Wales had penetrated from Guienne to the heart of France, where he was opposed by King John, at the head of an army nearly five times more numerous than that of the English. The famous battle of Poictiers ensued, in which the French monarch being taken prisoner, Edward held at the same time in captivity the kings of France and Scotland, the most dangerous of his enemies. John was taken to England and treated with the greatest respect; and David was soon after liberated upon ransom. A truce had been made with France after the battle of Poictiers, at the expiration of which, in 1359, Edward once more passed over to Calais with a large army, but at length consented to a peace. Besides the stipulation of a large ransom for King John, several provinces and districts in the southwest of France and neighborhood of Calais were yielded to Edward, who in turn resigned his title to the crown of France and duchy of Normandy. The successor of John, Charles V., invaded the provinces entrusted to Prince Edward, then in the last stage of declining health, and Edward had the mortification of witnessing the gradual loss of all his French possessions, except Bordeaux and Bayonne, and of all his conquests except Calais. See Longman, 'Life and Times of Edward III.' (1869); Mackinnon, 'History of Edward III.' (1900).

Edward IV., king of England: b. Rouen, France, 29 April 1441; d. 9 April 1483. His father, Richard, Duke of York, was grandson of Edward, Earl of Cambridge, and Duke of York, fourth son of Edward III., while the Lancaster branch descended from John of Gaunt, the third son. The York line had intermarried with the female descendants of Lionel, the second son, which gave it the preferable right to the crown. Edward, on the defeat and death of his father at the battle of Wakefield, assumed his title, and having entered London after his victory over the Lancastrians at Mortimer's Cross, in February 1461 was declared king by acclamation. Soon after his accession he had to fight for his crown against an army of 60,000 Lancastrians, assembled in Yorkshire; and the field of Towton confirmed his title by a decisive victory. Although the high-spirited Margaret was enabled by the aid of Louis XI. of France again to take the field, the result of the battle of Hexham, in May 1464, obliged her to return to Flanders, and leave her husband, the imbecile Henry VI., a prisoner in the hands of his enemies. By a marriage with Elizabeth Woodville, widow of Sir John Grey of Groby, a Lancastrian, Edward plunged himself into very serious difficulties, since at the same time he had despatched the Earl of Warwick to negotiate a marriage for him with Bona, sister to the Queen of France; so that he at once offended two royal houses and his powerful friend Warwick. Aided by France, Warwick, who had contracted his daughter to the Lancastrian Prince Edward, landed with Clarence and some other lords at Dartmouth; and quickly saw himself at the head of 60,000 men, with whom he marched to encounter Edward. The king left Warwick in full possession of his kingdom, 11 days after he had set his foot in it. Henry's title was again recognized by Parliament, and Warwick and Clarence were declared regents of the kingdom. Edward subsequently landed at Ravenspur, in Yorkshire. Here his forces were reinforced by partisans from all quarters, and he was soon enabled to march to London, where he obtained entrance as king, and the unfortunate Henry again became prisoner. Warwick advanced against him as far as Barnet, where, on 4 April 1471, another great battle was fought, which ended in the death of Warwick, and a decisive victory on the part of Edward. On the same day Queen Margaret and her son landed at Weymouth, and marched into Gloucestershire, where she was met by the victorious Edward, who totally defeated her at Tewkesbury. The queen and her son Edward being taken prisoners and brought into the presence of the victor, Edward asked the latter how he dared to invade his dominions. On receiving a spirited answer he basely struck the captive prince on the face with his gauntlet — the signal for immediate massacre by the king's brothers and other nobles attendant. Margaret was thrown into the Tower, where Henry VI. soon after died, but whether by violence or by disease is uncertain. The latter part of his reign was disturbed by his jealousy of his brother Clarence, whom he put to death, it is said, by drowning in a butt of Malmsey wine.

Edward V., king of England: b. Westminster 2 or 3 Nov. 1470; d. London 1483. He was the eldest son of Edward IV., and was in his thirteenth year when he succeeded his father in 1483. He fell into the hands of his uncle, the Duke of Gloucester, the regent who caused the young king and his brother to be sent to the Tower, and, it is said, had them smothered by ruffians. Two bodies, answering their description, being found buried at the foot of the stairs of their apartment, in the reign of Charles II., were taken up by that king's order, and deposited in Westminster Abbey.

Edward VI., king of England: b. Hampton Court, England, 12 Oct. 1537; d. Greenwich 6 July 1553. He was the son of Henry VIII. by Jane Seymour. At his father's death he was only 10 years of age, and as he did not live to attain majority, the public acts of his reign are to be deemed those of his counselors. His education was entrusted to men of the first character for learning, among whom was Sir John Cheke. He was studious, somewhat retiring, devout, and showed a decided preference for the reformed doctrines, and antipathy to those of the Roman Catholic Church. After his father's death his maternal uncle, the Duke of Somerset, became protector, but his administration raised up such powerful enemies that he was brought to the scaffold with the king's consent (1552). After his death Dudley, Duke of Northumberland, became all-powerful, and through his influence Edward, in a declining state of health, was induced to set aside the succession of both his sisters, and to settle the crown upon Lady Jane Grey, claiming through his father's youngest sister, the Duchess of Suffolk.

Edward VII., king of Great Britain and Ireland, and Emperor of India: b. Buckingham Palace 9 Nov. 1841, and baptized as Albert Edward. He is the eldest son and the second child of the late Queen Victoria and the prince consort, Prince Albert of Saxe-Coburg. On 14 December in the year of his birth he was, as heir-apparent, created Prince of Wales. After receiving a careful education under private tutors he studied at the universities of Edinburgh, Oxford, and Cambridge. In the summer of 1860 he visited Canada, where he was enthusiastically received, and by special invitation of President Buchanan extended his visit to the United States, where his reception was no less cordial. He was appointed a brevet-colonel in the army in 1858, and three years later was attached to the Curragh Camp in Ireland. In October 1861, he was made a bencher of the Middle Temple. In 1862 he was promoted to the rank of general, and in the spring of that year he set out on a visit to Egypt, Palestine, Syria, and Athens in company with the Rev. Arthur Penrhyn Stanley, afterward Dean of Westminster. After the Prince's return from the East he was introduced at the privy council, in 1863 he took his seat in the House of Lords, and about the same time formally gave up his right to succeed to the Duchy of Saxe-Coburg-Gotha. On March 10, 1863, at St. George's Chapel, Windsor Castle, he was married to the Princess Alexandra, eldest daughter of the King of Denmark. From this time onward the Prince discharged many important public ceremonial functions in various parts of the United Kingdom. Near the end of 1871 he was attacked by typhoid fever, and for a time it seemed as if his death were imminent, but he had completely recovered early in 1872. On 27 February of that year his recovery was made the occasion of a special thanksgiving service in St. Paul's Cathedral. In October 1875 he sailed from Dover on his journey to India. He arrived at Bombay in November, and between that date and his departure for England in March 1876 he visited the chief provinces, states, and cities of the Indian Empire, being everywhere received with the utmost cordiality and respect. With the Princess he made an extended tour through Ireland in 1885, and in 1888 his silver wedding was celebrated. The establishment of the Im-

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perial Institute as a memorial of the jubilee of the late queen (in 1887) was mainly due to his suggestion and exertions. In 1893 he sat on the Poor Law Commission, and in 1896 he was appointed chancellor of the newly created University of Wales. In the diamond jubilee year (1897) he established the Prince of Wales Hospital Fund for the better financial support of the London hospitals. At the great naval review of that year he represented Queen Victoria. By the death of his mother on 22 Jan. 1901, he became King of Great Britain and Ireland, and Emperor of India, and has elected to be known as Edward VII. On 14 February he and Queen Alexandra opened Parliament in state. To him and Queen Alexandra have been born: Albert Victor Christian Edward, Duke of Clarence and Avondale, b. 8 Jan. 1864, d. 14 Jan. 1892; George Frederick Ernest Albert, Duke of Cornwall and York, now heir-apparent, b. 3 June 1865, married 6 July 1893, to the Princess Victoria Mary of Teck; Princess Louise Victoria Alexandra Dagmar, b. 20 Feb. 1867, married 27 July 1889, to the Duke of Fife; Princess Victoria Alexandra Olga Mary, b. 6 July 1868; and Princess Maud Charlotte Mary Victoria, b. 26 Nov. 1869, married 22 July 1896, to Prince Charles, second son of the Crown Prince of Denmark.

Elaborate national and international preparations for the coronation ceremonies in Westminster Abbey were made for 26 June 1902; but on 24 June all festivities and ceremonies were suspended in consequence of a sudden illness requiring an immediate surgical operation. Owing to his fine natural constitution, the king fully recovered, and the coronation in a greatly modified form was accomplished 9 August. See 'The Private Life of King Edward VII.' (1901); 'Life of the King' by "One of His Majesty's Servants" (1901); 'From Cradle to Crown' (1902).

Edward, Prince of Wales, surnamed the Black Prince, English prince: b. Woodstock 15 June 1330; d. Westminster 8 June 1376. He was the eldest son of Edward III. and Philippa of Hainault, and at the age of 15 accompanied his father in his invasion of France, and received from him the honor of knighthood. The victory of Crécy, 26 Aug. 1346, which King Edward left principally to the exertions of the force under his son's command, to use that warlike king's language, "showed that he merited his spurs." It was on this occasion that he assumed the motto of *Ich dien* (I serve), used by all succeeding princes of Wales, and derived, it is said, from the crest of the King of Bohemia, slain in that battle, which tradition, however, later antiquaries seem disposed to discredit. In 1355 he commanded the army which invaded France from Gascony, and the next year fought the great battle of Poictiers, and distinguished himself by the courtesy with which he treated his prisoner, King John. By the Peace of Bretigny his father had obtained the provinces of Poictou, Saintonge, Périgord, Limousin, etc., which he annexed to Guienne and formed into a sovereignty for his son, under the title of the Principality of Aquitaine. There the prince took up his residence; and at his court Pedro the Cruel sought refuge, when driven from his throne by his natural brother, Henry of Trastamare. Edward undertook the re-establishment of this tyrant, which he accomplished. Disappointed, by the perfidy of Pedro, of the stipulated reimbursements, the taxes he was obliged to levy on his new subjects rendered his government unpopular; and an appeal was made to the king of France, as his liege lord, who summoned him as his vassal to appear at Paris. "I will come," replied the angry prince, "but it shall be at the head of 60,000 men." His health, however, was too far declined to enable him to take the field, when the king of France invaded his dominions; and having suffered the mortification of seeing his generals defeated, he withdrew into England, and after lingering some time died in his 46th year, leaving an only son, afterward Richard II. He was buried in Canterbury Cathedral, where portions of his armor are still suspended above his tomb.

Edward, Thomas, Scottish naturalist: b. Gosport 1814; d. 27 April 1886. As the apprentice of a shoemaker he spent the early part of his life in Aberdeen, and in 1837 married and settled in Banff. Here he struggled for 40 years in a ceaseless effort to acquire a close knowledge of natural history, while at the same time he supported his wife and 11 children on wages that never exceeded 15 shillings a week. Apart from his laborious work as a shoemaker he collected, described, and exhibited numerous specimens of natural history. A biography of Edward, written by Samuel Smiles (q.v.), appeared in 1876, 'Life of a Scotch Naturalist,' and being thus prominently brought before the public, a pension of £50 a year was conferred upon him by the Queen.

Edwards, Alfred Shenstone, Socialist propagandist: b. Birmingham, England, 23 Oct. 1849. Since 1867 he has resided in the United States and has been an active worker in labor and social reform organizations since 1887. He edited 'The Coming Nation' (1895–8), and later 'The Social Democratic Herald,' and has written extensively under the pen-name "Sevenoaks."

Edwards, Amelia Blandford, English Egyptologist and novelist: b. London 1831; d. Weston-super-Mare, Somerset, 15 April 1892. Her novels include: 'My Brother's Wife' (1855); 'Hand and Glove' (1859); 'Half a Million of Money' (1865); 'Lord Brackenbury' (1880); 'Barbara's History,' and 'In the Days of My Youth' (1873). Later she achieved great celebrity through her writings and lectures in Europe and the United States on the antiquities of Egypt; her best-known works in this field are: 'A Thousand Miles Up the Nile' (1877); and 'Pharaohs, Fellahs, and Explorers' (1891). She also translated Maspero's work on 'Egyptian Archæology,' and was secretary of the Egyptian Exploration Fund.

Edwards, Bela Bates, American Congregational clergyman: b. Southampton, Mass., 4 July 1802; d. Athens, Ga., 20 April 1852. He was graduated at Amherst College in 1824, was appointed tutor there in 1826, and was assistant secretary of the American Education Society, 1828–33. He edited the 'American Quarterly Register' 1828–42; founded the 'American Quarterly Observer' in 1833, and edited it after consolidation with the 'Biblical Repository' in 1835–8; edited the 'Bibliotheca Sacra' (1844–52). In 1837 he became professor of Hebrew at

Andover Theological Seminary, and in 1848 professor of biblical literature there, which posts he held till his death.

Edwards, Mrs. **Bennett,** English novelist. She has published 'A Tantalus Cup'; 'In Sheep's Clothing'; 'Pharisees'; 'The Unwritten Law'; 'Saint Monica'; 'His Story and Hers'; 'A Woman in Spectacles.'

Edwards, Bryan, English historian of the West Indies: b. Westbury, Wiltshire, 21 May 1743; d. Southampton 15 July 1800. On the death of his father he was taken under the care of an uncle in Jamaica, who left him a large fortune. After a successful mercantile career he returned to England, and in 1796 took his seat for the borough of Grampound, which he represented until his death. He is remembered for his 'History, Civil and Commercial, of the British Colonies in the West Indies' (1793). A new edition of this work (1801) includes a history of San Domingo. He also published 'Proceedings of the Governor and Assembly of Jamaica in regard to the Maroon Negroes' (1796).

Edwards, Charles Lincoln, American scientist: b. Oquawka, Ill., 8 Dec. 1863. He was graduated at Lombard University in 1884; Indiana University, 1886; and the University of Leipsic 1890. He was assistant professor of biology in Clark University 1892–3; associate professor of biology in the University of Texas, 1893–4; professor of biology in the University of Cincinnati 1894–1900; and professor of natural history in Trinity College after 1900. He was president of the American Folk-Lore Society in 1899. He has published 'Bahama Songs and Stories' (1895), and many papers and monographs on subjects in biology, embryology, folk-lore, etc.

Edwards, Clarence Ransom, American military officer: b. Cleveland, Ohio, 1 Jan. 1860. He was graduated at West Point in 1883; professor of military science and tactics at St. John's College, Fordham, 1890–3. Commissioned first lieutenant, 1891; captain, 1898; lieutenant-colonel of volunteers, 1899. Served on the staff of Gen. Lawton in the Philippines, and was recommended for brevets of major, lieutenant-colonel, and colonel in the regular establishment, and brigadier-general of volunteers. Accompanied Gen. Lawton's body to the United States. Chief of the division of insular affairs, War Department, 1900–2. Commissioned colonel, 1 July 1902, and chief of the bureau of insular affairs since that time and director of its publications.

Edwards, Edward, English librarian: b. London 1812; d. Niton, Isle of Wight, 10 Feb. 1886. He published 'Memoirs of Libraries' (1859); 'Lives of the Founders of the British Museum' (1870); 'Sir Walter Raleigh' (1885).

Edwards, Elisha Jay, American journalist: b. Norwich, Conn., 10 Nov. 1847. He was graduated at Yale in 1870, and at Yale Law School in 1873, and has been in newspaper work since 1870. He was Washington correspondent of the New York *Sun*, 1880–4, and editor of the New York *Evening Sun* 1887–9. Since 1889 he has contributed the daily "Holland" letters to several papers in the larger cities. In 1894 his charges against the sugar trust called forth an investigation by the United States Senate and the prosecution of the president of the sugar trust and others. He contributed a series of political biographies to 'McClure's Magazine' in 1893–4, and has published other magazine articles.

Edwards, George, English sociologist: b. 1752; d. London 17 Feb. 1823. Possessed of the conviction that he held the precious secret of the relief to man's estate, he wrote some 50 books to disseminate the information, among which is one with the long title: 'The Practical System of Human Economy, or the New Era at Length Fully Ascertained, Whereby We are Able in One Immediate Simple Undertaking to Remove the Distress, Burdens, and Grievances of the Times, and to Bring All our Interests, Public, Private, and Commercial, to their Intended Perfection' (1816).

Edwards, George Wharton, American artist and author: b. Fairhaven, Conn., 1859. He was educated in Antwerp and Paris, and has received many medals and honors for his work at American and European exhibitions. His watercolors are particularly praiseworthy and his magazine illustration is well-known and of a high quality. He has published 'Thumbnail Sketches' (1886); 'P'tit Matinic and Other Monotones' (1887); 'The Rivalries of Long and Short Codiac' (1888); 'Break o' Day, and Other Stories' (1889); he has illustrated Oliver Wendell Holmes' 'Last Leaf' (1885); Austin Dobson's 'Sun Dial' (1892); Spenser's 'Epithalamion' (1895); 'Old English Love-Songs' (1896); 'Old English Ballads' (1897).

Edwards, Harry Stillwell, American journalist and novelist: b. Macon, Ga., 23 April 1854. He was graduated from the law department of Mercer University, and practised law, but in 1871 entered journalism in his native city. He is well-known as a writer of dialect stories. Among his works are: 'Two Runaways, and Other Stories' (1889); 'Sons and Fathers': 'The Marbeau Cousins'; 'His Defense, and Other Stories.'

Edwards, Henri Milne-. See Milne-Edwards.

Edwards, Henry Sutherland, English author: b. London 1828. He traveled and studied in Russia, Turkey, and central Europe, acting as newspaper correspondent. He has written 'The Polish Captivity' (1863); 'Life of Rossini' (1869); 'The Germans in France' (1874); 'The Slavonian Provinces of Turkey' (1876); 'The Prima Donna: Her History and Surroundings from the 17th to the 19th Century' (1888); 'Dutiful Daughters' (1890), a tale of London life; 'Personal Recollections' (1900).

Edwards, James Thomas, American educator: b. Barnegat, N. J., 6 Jan. 1838. He was graduated at Wesleyan University in 1860. He served in the national army in the Civil War, was afterward principal of several schools, and in 1892–3 was field-secretary of the Chautauqua System of Education. He was a senator in the Rhode Island legislature, 1865–9, and a member of the New York legislature, 1892–3; was chairman of the committee on education of both bodies, and was the author of the University bill and Library and Traveling Library bills. He was a trustee and director of the departments of physics and chemistry of the

Chautauqua summer schools 1883–93, and has been prominently identified with other educational movements. He has published 'The Grass Family' (1872); 'The Silva of Chautauqua Lake' (1892); 'Addresses — Educational, Political, Scientific, Religious' (1896); 'Pen and Picture' (1896); 'Rhymes from a Reclining Chair' (1902); and has contributed articles to various periodicals.

Edwards, John, American poet: b. near the river Twrch, Wales (whence known as Eos-Glan-Twrch, or "the nightingale of the Twrch"), 15 April 1806; d. near Rome, N. Y., 20 Jan. 1887. He did much to promote the publication in America of Welsh periodicals. His published poems include 'The Crucifixion' (1853) and 'The Omnipresence of God' (1859).

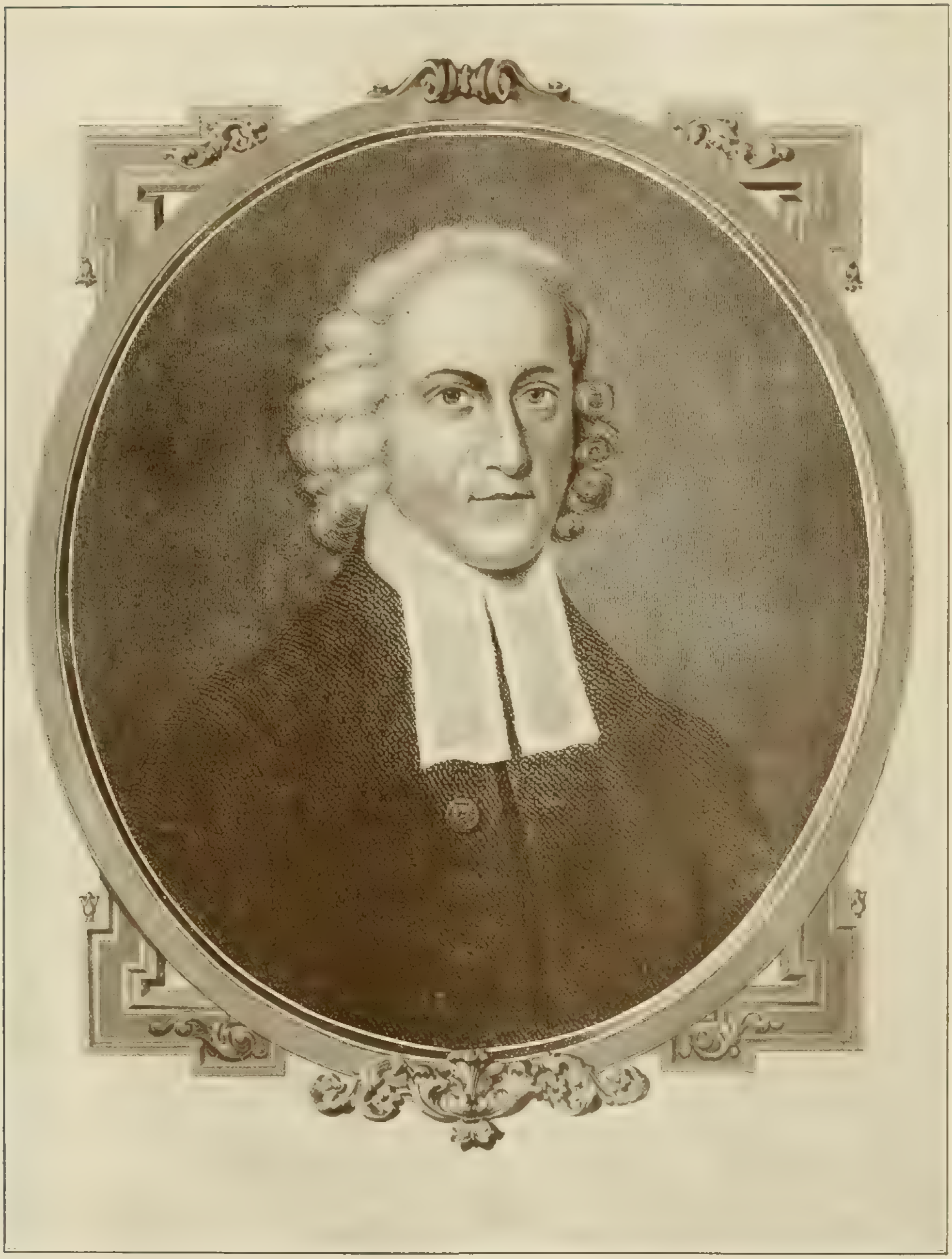
Edwards, Jonathan, American theologian: b. in South (then East) Windsor, Conn., 5 Oct. 1703, a year before the death of Locke, his first great inspiration in philosophy, and about two years before the birth of Franklin, with whom he shares the distinction of supreme intellectual eminence among his American contemporaries; d. Princeton, N. J., 22 March 1758. His father, the Rev. Timothy Edwards, a graduate of Harvard, was parish minister at Windsor for nearly 60 years. His mother, Esther Stoddard, a daughter of the Rev. Solomon Stoddard, minister in Northampton, Mass., is celebrated for force of character and native vigor of intelligence. There were ten other children in the family, all girls. Jonathan, the fifth child, was brought up with his sisters in an environment peculiarly adapted to his development. The quiet beauty of the landscape about Windsor and the outward simplicity of the life in the village and the home, where the interests of recognized supremacy were those of the spirit and the mind, exerted congenial influence on a character preëminently disposed to reflection and to the feeling and practical acknowledgment of things invisible. Religion, both in its experimental and in its theoretical aspects, early became his absorbing preoccupation. The precocity of his intellectual development is shown in his first essays, a metaphysical tract on the nature of the soul, written when he was ten, and a paper, remarkable for accuracy of observation and acuteness and breadth of reasoning, on the habits of the "flying spider," written some two years later. At thirteen he entered the Collegiate School at Saybrook, afterwards Yale College, from which he graduated at New Haven, with the valedictory in a class of ten, shortly before his seventeenth birthday (1720). The event of greatest intellectual significance for Edwards, and one which may even be said to mark a turning-point in the history of philosophy in America, was his reading, in his sophomore year in college, of Locke's 'Essay on the Human Understanding.' The book made on him a profound impression. He read it, he tells us, with a pleasure far higher than that of the greediest miser gathering up handfuls of silver and gold from some newly discovered treasure. He began now, or shortly afterwards, a series of notes designed as material for an exhaustive treatise on the mind. He also wrote a series of notes with a view to a corresponding treatise on natural science. These notes, some of which probably belong to the years immediately following his graduation, though some of the most important almost certainly go back to an earlier date, throw a flood of light on the whole subsequent development of his thinking, as well as on the character and workings of his mind at the period of their composition. The notes on natural science, indeed, valuable as they are as evidence of his genius, express in their main contents only an incident in his thinking. But the psychology and philosophy of both series of notes, especially the notes on the mind, are intimately connected with his theological interests. Here the influence of Locke is marked, but more striking still the originality of the writer's response to it. Edwards accepts Locke's empiricism only in part. He makes all our ideas "begin from" sensation; he recognizes distinctly the fundamental importance of the mechanism of association and the part played by "images" in the higher intellectual processes. But he is very far from regarding mind as constituted of passively received impressions and their copies. He emphasizes rather the intellectualistic elements in Locke's doctrine; his tendency is towards Kant rather than towards Hume. The mind is, in his view, essentially active, in pleasure and pain, in sentiment and emotion, as well as in judgment and choice. In its intellectual constructions, moreover, the mind is guided by intuitively certain principles (being, cause, finality, etc.) and is capable, by reflection, of rising above all things sensible to the contemplation of things spiritual and eternal. Universals are not all of pragmatic origin and merely nominal import; the most considerable species have their foundation in "the order of the world." The most noteworthy metaphysical advance beyond Locke lies in the idealistic theory of matter. The general conception was not new; already in the 18th century, before the earliest of these notes were written, Norris, Collier, and Berkeley had propounded similar views. Edwards may have heard of their writings, but it is doubtful if he had read any, and practically certain that he had not then read Berkeley. However suggested, the doctrine is worked out in a thoroughly independent fashion and the expression of it is wholly original; the true substance of the material universe is declared to be God and its *esse,* not *percipi,* but an "infinitely exact and precise divine Idea, together with an answerable, perfectly exact and stable Will, with respect to correspondent communications to created minds, and effects on their minds." In a later note in his diary he desires as clear a conception of the relation to God of finite minds. In one of the notes on the mind, he rejects Locke's notion that personal identity consists in identity of consciousness. The whole trend of his metaphysics pointed to another solution. With him the fundamental ontological verity is "that God and Real Existence are the same," "that God is," and that "there is none else." Created spirits are "emanations" or "communications" of his Being. What other conception then for him is possible, but that they, too, like material things, consist in God's distinguishing Thought and stable Will?

Edwards seems to have had no occasion to refer in his later writings to the idealistic theory of matter so pronounced in these notes of his youth. But there is no reason for thinking that he abandoned a view so congruous with his general philosophical position. Other of his most distinctive teachings are here already expressed or indicated. Here, for example, is the doctrine that the will, which is regarded as identical with inclination so far as the latter has respect to the mind's immediate actions, is always determined by motives inherent in the mind's apprehension of the greatest apparent good. Here, too, are the doctrines that «excellency» consists in «the consent of being to being»; that virtue, or the excellency of minds, consists in «love to being»; that the type of this excellency is God's mutual love of himself in the eternal process of the Trinity; that God's love to himself «includes in it, or rather is the same as, a love to everything, as they are all communications of himself»; and that, since God is «universal Being,» true virtue in finite minds consists in love to him. These are the positions elaborated in the treatises on the 'Will' and on the 'Nature of True Virtue' and in the recently (1903) published essay on the 'Trinity.' And the most speculative of Edwards' works, the treatise on 'God's End in Creation,' is essentially but an application to a special problem of the conceptions here advanced concerning the nature of God as «universal Being» and as «Love,» of finite spirits as «emanations,» «communications» or «creations» in his likeness, and of the sensible world as in its order and harmony, a «shadow» of his excellency.

After graduating, Edwards remained two years in New Haven studying for the ministry. He then preached for several months to a small Presbyterian church in New York. But he again returned to New Haven, took his master's degree, and for two years (1724–6) was tutor in the college. He had declined several invitations to a settlement in the ministry, and seemed definitely committed to the academic career, for which by training and intellectual gifts he was eminently qualified, when the call came to him from the church in Northampton, Mass., to become the colleague of the venerable Solomon Stoddard, his grandfather. He was installed at Northampton, 15 Feb. 1727. A few months later he married Sarah Pierrepont, of New Haven, then seventeen, of whom four years before he had written an admiring description, celebrated as one of the most perfect and charming of its kind in literature.

The moral and religious development of Edwards up to this period was as remarkable for richness of experience and intensity of spiritual energy as was his intellectual development for originality, acuteness and speculative power. In a «narrative of personal experience,» written for his own use, we have the intimate record of his religious life from its early beginnings, when as a boy he built with other boys a booth in a swamp for daily prayer and had other places for his own devotions besides, through its decline and revival — his «conversion,» it has been called, though, as he notes with some misgiving in his diary, he was never converted in the manner traditionally expected — to its culmination in a state of settled conviction, with great inward delight in the truth and beauty of the objects of religious faith, including at times marked exaltation of sentiment and something akin to ecstasy. His diary, in which, after the fashion of the time, he watches, with almost morbid intensity, the daily fluctuations of his spiritual estate, tells the same story for a part of the period. And in his seventy 'Resolutions' we have a most striking expression of the lofty moral purposes of his life and of the ideas which actually governed it. For example: «To live with all my might while I do live»; «when I think of any theorem in divinity to be solved, immediately to do what I can towards solving it, if circumstances do not hinder»; «never, henceforward, till I die, to act as if I were any way my own, but entirely and altogether God's»; «on the supposition that there never was to be but one individual in the world, at any one time, who was properly a complete Christian, in all respects of a right stamp, having Christianity always shining in its true lustre, and appearing excellent and lovely, from whatever part and under whatever character viewed: resolved, to act just as I would do, if I strove with all my might to be that one, who should live in my time.» It is the combination of this rare emotional susceptibility, this high reverence and moral enthusiasm, this strict, unrelaxing conscientiousness, with extraordinary subtlety and perspicacity of intellect and an unrivaled capacity for logical analysis and abstract reasoning that gives to Edwards his distinction and is the secret of his power.

On the death of Mr. Stoddard in 1729, Edwards, then 25, became sole pastor of the church in Northampton, which was reputed the largest and wealthiest in the colony outside of Boston. In 1731 he preached in the «public lecture» in Boston the sermon, «God Glorified in Man's Dependance,» with which he achieved a notable success. The sermon is an eloquent and impressive proclamation of one of the most fundamental articles of his creed, the doctrine of God's «absolute sovereignty» in the work of salvation: it was a prophet's call to the Puritan churches to return to the old high Calvinistic faith. The counterpart to it is the sermon, published in 1734, on the 'Reality of Spiritual Light,' which proclaims the mystical principle of a supernatural illumination directly imparted and experienced. The emphasis on religious experience becomes still more pronounced in the two great revivals with which the fame of Edwards as a preacher is especially associated. He wrote the story of the earlier revival, that of 1735 in Northampton, in his 'Narrative of Surprising Conversions' (1736), with confident, even exultant, assurance; the excesses of the «Great Awakening» of 1740–2, more extensive and tumultuous, led him to reflect on the difference between a genuine and a false experience ('Distinguishing Marks of a Work of the Spirit of God,' 1741), and then to an apologetic defense of the movement against the objections of its opponents ('Thoughts on the Revival,' 1742). It was in the height of the excitement that he preached in Enfield, Conn., his sermon on 'Sinners in the Hands of an Angry God' (1741), the extreme representative of a type not uncommon with him, indeed, yet not the most common nor the most representative even in his revival preaching (see, for example, the sermons, 'Justification by Faith,' etc., 1738). More noteworthy and far more original was the



JONATHAN EDWARDS.

treatise on the 'Religious Affections' (1746), in which the distinctively new note in Edwards, the new emphasis on subjective experience, receives its fullest systematic expression.

In the reaction which followed the revival, a case of discipline arose in his parish — many of the young people being charged with reading and circulating immoral books — the unfortunate management of which caused strong resentment and permanently undermined his influence. This was in 1744. Four years later, on his attempt to set aside the established custom — an extension of the old "Half-way Covenant" of which Mr. Stoddard had been the chief advocate — and require for full communion a credible profession of godliness, the disaffection became a bitter and determined opposition. The controversy ended finally in his dismissal, 22 June 1750, after a ministry of twenty-three years, perhaps the most laborious and distinguished in the annals of the American churches. His 'Farewell Sermon,' the greatest of his discourses, is a noble expression of his character and the dignified "apologia" of his ministerial life. Early in the following year he removed with his family to Stockbridge, Mass., then a settlement on the frontier, to do the double work of pastor of the village church and missionary to the Indians. It was while thus engaged that he wrote, during the seven years of his residence in Stockbridge, the theological treatises and essays which are the solid foundations of his fame. In the autumn of 1727 he accepted, with some misgivings, a call to the presidency of the college in Princeton, N. J., made vacant by the death of his son-in-law, the elder Aaron Burr. He had scarcely entered on the duties of this office when he fell a victim of inoculation for smallpox, 22 March 1758.

The least episodical of thinkers, Edwards wrote no system of philosophy or body of divinity. The connected scheme of his ideas has to be gathered from the large proportions of his various writings on special topics, mainly controversial. The professed aim of the major part of these writings is to defend the distinctive doctrines of Calvinism against the rising tide of Arminianism in the churches inheriting the Calvinistic tradition. He brought to this task a power of keen and relentless dialectic that left no loophole of escape to one who accepted his premises and that fairly wearied and overwhelmed the opponent with the multitudinous array of the argument. He brought also, what more contributed to the originality of his thought, the spirit and profound insights of the speculative philosopher, seeking to ground his theology in metaphysics. Finally, he brought the solid character and the rich religious experience which gave the system for him perpetual practical verification and which certainly, with his moral enthusiasm and vivid imagination, gave it, in his hands, much of its vitality. The central conception about which all his thinking moves is the conception of the absolute sovereignty of God. Metaphysically, God is the sole Reality. Neither Parmenides in ancient, nor Spinoza in modern philosophy, is more emphatic in the assertion of the One Absolute Reality than Edwards. He, however, does not stop here. God, the Absolute Reality, is with him — it is easy to see that the tradition here blends with his metaphysics — spiritual, personal — tripersonal — and supremely excellent. In his 'Essay on the Trinity' (1903) he develops the doctrine that the Father is the Deity in prime subsistence, the Son the Deity subsisting in the act of God's Knowledge of himself, and the Holy Ghost the Deity subsisting in the act of God's infinite Love and delight in himself. This Love of God, which is thus his consummating, essential Excellency, is primarily the love of complacency in the perfection of his Being; but it may be viewed also as benevolent, so far, namely, as it embraces the complete content of the divine Idea in God's Knowledge of himself, and so far as that Idea includes within itself the creative plan of the world and the evolution of its history. Now it is the profound thought of Edwards' dissertation on the 'End for Which God Created the World' (written 1755), the most speculatively philosophical treatise of the 18th century, that such is, in truth, the fact. God finds in himself a *disposition* to produce an emanation from himself in which to reflect his glory and express outwardly his delight in his own excellency. The final end of creation is, therefore, the manifestation of the divine glory in a perfect spiritual society. In his 'History of Redemption,' Edwards endeavors with, to be sure, very inadequate knowledge and, for us, impossible dogmatic assumptions, but with a genuine philosophical purpose, to trace the process through which this end is realized in time. The "emanation," or passage into time, of the eternal world-plan, he represents, in his essay on 'Decrees and Election,' as an act of divine Will, the preservation of the world being a perpetual and continued creation. Beyond this indication of a nexus in the divine Will between the world-plan in idea and in process of realization, Edwards does not go; he develops no theory of the metaphysical relation of the temporal and eternal. He is very clear, however, in teaching that the divine Decree conforms to, indeed is determined by the divine Wisdom — what must evidently be taken into account in interpreting the many passages in his writings in which he speaks of God's "arbitrary" Will and of his "mere good pleasure." Edwards' early idealism with respect to matter is in thorough agreement with this doctrine of creation, but is not now in question. His whole concern now is with the divine plan relative to man. The problem of supreme interest here, of course, is the problem of moral evil. No one has depicted the nature, extent and consequences of sin in stronger language than Edwards. Sin is with him literally a guilty disposition inherent since the Fall in man's very constitution, as that even infants, that seem innocent to us, "are in God's sight young vipers," so that the whole race merits and, in the absence of "special" grace, which is bestowed only on the definite number of the elect, inevitably tends to horrible and everlasting destruction. Notwithstanding that all this is held to be included in the creative plan, Edwards nevertheless strongly insists on the sinner's responsibility. In his treatise on 'Original Sin' (1758), he brushes aside the legal fictions with which that doctrine was commonly invested, and boldly advances to the Augustinian position that the whole race was really present and really participated in Adam's transgression — a notion which involves him in curious and intricate speculations concerning personal identity. The most celebrated of his writings, the treatise on 'Freedom of the Will' (1754), discusses from other points of view the same general problem of the relation of the creative Decree to the moral life of man. His object in this work was to refute the notion that the will in choosing is so undetermined with respect to its motives as to be able to initiate acts really contingent and, therefore, incapable of being included in God's determinate foreknowledge and decree. He does not deny the fact of choice; "faculty of choice," indeed, in his definition of will. But he contends that this faculty is always determined in its preferences by the strongest motive, "is always as the greatest good is." The connection of such motive and choice is necessary. But the necessity of this connection is quite consistent, in his view, with the liberty to do as one pleases, without hindrance or impediment. He modifies, indeed, the usual Calvinistic doctrine, declaring in one of his letters that man now, even after the Fall, has all the liberty that he ever had. His chief attack is against the notion that will is self-determined, that is, that it determines itself to will, a notion which, thus stated, leads, as he shows, to the infinite regress. But there is nothing in his contention to preclude the idea that it is the whole concrete nature of a self which determines the act of choice. His whole argument, in fact, is based on the thorough-going application of the law of sufficient reason. Each act of will has its reason, or, as Edwards, suggesting a naturalistic interpretation not intended, says, its "cause," from which it follows with "logical" or "moral" necessity. God's Will even is no exception. Human responsibility for sin is not dependent on the way the volition is motived, but on the evil nature of the disposition. The *ultimate* ground or reason of all volition is the divine Idea, comprehending the world-plan, within which every finite being has his place, and the realization of which is the effect of the divine decree. God is thus, in a sense, the author of sin, yet not so, as in the case of the human will, that his Will is evil, but so that he, being sovereignly good and perfect, and creating the world for a supremely good end, permissively decreed the evil foreseen as comprehended in this purpose.

Thus Edwards, absolutist in metaphysics, ever comes back in his theology to the conception of God as sovereign Power, Wisdom and Love, whose "decrees," determining that the world-plan shall be realized, are the foundation of an all-inclusive optimism. Had he developed his thought as a pure philosopher, his system would doubtless have assumed a very different character in details and in some of its main conclusions. As it was, he blended his philosophy with his theology and his theology with his philosophy and both with a conception and interpretation of scripture that modern criticism regards as untenable. And although the sharp antitheses in which his system abounds are all reconciled in his thought of God's goodness and eternal decrees, as he lacked the mediating conceptions with which some more modern doctrines have made us familiar, this reconciliation is apt to appear to us as one of faith rather than of reason. These defects, however, will not blind the sympathetic student of opinion to the essential strength and largeness of his general scheme of thought. His historical influence extended mainly in two directions. On the one hand, the speculative and logical power with which he worked out his fundamental conception made him the chief of a school of theologians in New England — Hopkins, Emmons, the younger Edwards, Dwight, etc.— who, with less logical acumen and less speculative ability, sought to carry out his principles, and particularly to so formulate the Calvinistic system as to make it appear better accordant with popular notions of the goodness of God and human responsibility. On the other hand, by his doctrine of "spiritual light" and by the emphasis he put on conversion and the religious affections, he powerfully furthered the movement which, laying special stress on religious experience, tends to discard dogmatic assumptions altogether and to seek the solution of the religious problem in the consciousness of this experience itself.

Bibliography.—The first American edition of Edwards' 'Works' was published at Worcester in 8 vols. (1809). Dr. S. E. Dwight published an edition with much new matter and a memoir in 10 vols. (1829–30). Other editions are mainly reprints. There is one in 2 vols. (London 1840), another in 4 vols. (New York 1858), another in 1 vol. (the Bohn edition, London 1865). Many of the Edwards' manuscripts have never been published, and a new and definitive edition of his 'Works' is a desideratum. The 'Observations Concerning the Scripture Economy of the Trinity,' edited by E. C. Smyth (1880), and the 'Essay on the Trinity,' edited, with an introduction on Edwards' theology, by G. P. Fisher (1903), are not included in the published editions. Dwight's 'Memoir' is the fullest for the biography; A. V. G. Allen's 'Jonathan Edwards' (Boston 1889) is the most valuable single work on the theologian from a modern point of view.

HARRY NORMAN GARDINER,
Professor of Philosophy, Smith College.

Edwards, Jonathan (the younger), American theologian: b. Northampton, Mass., 26 May 1745; d. Schenectady, N. Y., 1 Aug. 1801. At the age of six years he went with the family of his parents to Stockbridge, where there was but one school, and that common to the children of both the Indians and white inhabitants, of the latter of whom there were so few that he was in danger of forgetting the English tongue. He so thoroughly learned the language of the Stockbridge Indians, that, as he tells us, all his thoughts ran in their dialect. This knowledge of their language he retained through life. In 1761 he entered the college at Princeton, N. J., where he was graduated in 1765. After leaving college he studied divinity, and in 1776 was licensed as a preacher of the gospel. In 1769 he was ordained as pastor of the church in White Haven, in the town of New Haven, Conn., where he continued till May 1795. Resigning this charge, mainly on account of difference in doctrinal views between himself and some of his people, he was settled in 1796 as pastor of the church in Colebrook 1796–9, where, in addition to professional duties, his time was devoted to his favorite studies, and to an extensive correspondence which he had long carried on with learned men both in this country and in Europe. In May 1799 he became president of Union College, Schenectady, which office he filled at the time of his death. He was the author of a treatise on 'Liberty and Necessity' (1797); and 'Discourses on the Atonement' (1785). See life by Tryon Edwards.

Edwards, Julian, American composer: b. Manchester, England, 17 Dec. 1855. His opera, 'Victorian,' its libretto adapted from Longfellow's 'Spanish Student,' was produced in London in 1884. Since coming to New York in 1888 he has composed the operas: 'Jupiter' (1892); 'Friend Fritz' (1893); 'King René's Daughter' (1893); 'Madeline' (1894); 'Brian Boru' (1896); 'The Wedding Day' (1897), and various other music.

Edwards, Justin, D.D., American Congregational clergyman: b. Westhampton, Mass., 25 April 1787; d. Virginia Springs 23 July 1853. He was graduated at Williams College in 1810, settled in the ministry at Andover in 1812, removed thence to the Salem Street Church, Boston, in 1828, and in 1829 resigned this charge to become secretary of the American Temperance Society, in the service of which he was engaged for seven years. After this, he was for six years president of the Andover Theological Seminary. He was the author of several tracts on moral and religious subjects, some of which had a wide circulation. Of his 'Temperance Manual,' some 20,000, and of the different parts of his 'Sabbath Manual,' nearly 2,000,000 copies have been published.

Edwards, Matilda Barbara Betham-. See BETHAM-EDWARDS, MATILDA.

Edwards, Ninian, American political leader: b. Montgomery County, Md., March 1775; d. Belleville, Ill., 20 July 1833. He was graduated at Dickinson College; moved to the Green River district, Ky., studied law and was admitted to the bar in Kentucky and in Tennessee. He rose rapidly in his profession, was judge of the general court of Kentucky, of the circuit court and of the court of appeals, and chief justice of the State supreme court. In 1809 he was appointed governor of the newly organized territory of Illinois, and held that office till Illinois was admitted as a State. During his administration he organized companies of volunteer rangers and built a line of stockade forts which were of special value in the border wars with the Indians and in the War of 1812. In 1816 he was one of three commissioners appointed to treat with the Indian tribes. In 1818 he was elected to the United States Senate from Illinois and served six years; and in 1826 he was elected governor of the State, holding that office till 1830. Consult Edwards, 'History of Illinois and Life of Ninian Edwards' (1870).

Edwards, Osman, English lecturer and dramatic critic: b. Liverpool 18 Feb. 1864. He has published 'Short Studies of Theatrical Life' from the French of Daudet (1892); 'A Gauntlet' from the Norwegian of Björnson (1894); 'Residential Rhymes' (1899); 'Japanese Plays and Playfellows' (1901).

Edwards, Richard, English dramatist: b. Somersetshire 1523; d. 31 Oct. 1566. He was educated at Oxford, where he obtained distinction for scholarship, and became under Elizabeth one of the gentlemen of the queen's chapel, and had charge with others of the theatrical representations before the children there. His 'Damon and Pythias' was the first English tragedy on a classical subject, and was acted before the queen at Oxford in 1566. Though esteemed among the best writers of interludes and rude comedies of the time, all his other dramas are lost. He wrote several minor poems, one of which, entitled 'Amantium Iræ,' has been often reprinted in modern collections.

Edwards, William, American inventor: b. Elizabeth, N. J., 11 Nov. 1770; d. Brooklyn, N. Y., 1 Dec. 1851. After receiving a common school education he learned the tanning trade, and built his own tannery at Northampton, Mass., but eventually settled in Hunter, Greene County, N. Y. Here he opened a model tannery, with improvements in manufacturing appliances originated by himself. His principal invention was a leather-rolling machine, which saved the labor of hammering. He invented other machines, and utilized water-power to such an extent as practically to revolutionize the tanning business in the United States, improve the quality of shoe-leather and cheapen its cost.

Edwards, William Henry, American naturalist: b. Hunter, Greene County, N. Y., 15 March 1822. He was graduated at Williams College 1842, and was admitted to the bar 1847. In 1846 he traveled in South America, going up the Amazon River and making a natural history collection. He has published: 'Voyage up the Amazon' (1847); 'The Butterflies of North America' (1879, 1884 and 1897); 'Shaksper, not Shakespeare' (1900); and contributed over 150 papers on Lepidoptera to the 'Canadian Entomologist.'

Edwardsville, Ill., city, county-seat of Madison County; on the Illinois Terminal, the T., St. L. & K. C., and the Wabash R.R.'s, about 70 miles southwest of Springfield, and 20 miles northeast of Saint Louis, Mo. It is the centre of a coal mining and agricultural region. The industries are such as are adapted to the country, including several plants for the manufacture of tools and other hardware. Pop. 4,212.

Edwin, king of Northumbria: b. about 585; d. 633. He was the son of Ella, who seems to have ruled that kingdom from 559 to 589. Being an infant at his father's death the crown was seized by Ethelfrith of Bernicia. The young prince was sent for protection to the court of Redwald, king of East Anglia, by whose aid he was eventually put upon the throne (617). He married Ethelburga, daughter of Ethelbert of Kent, and by her influence and that of Paulinus, a Roman missionary, whom she had brought from her father's court, was led to embrace Christianity, and make it the religion of his people. He was baptized in 627 at York, where he built the first church of wood. The Mercians, under Penda, revolted against the supremacy claimed by the Northumbrians; and the war which ensued was closed by a battle at Heathfield, or Hatfield, in Yorkshire, in which Edwin was defeated and slain.

Edwin Drood. See MYSTERY OF EDWIN DROOD.

Edwy, king of England: b. about 938; d. 958. He was son of Edmund I., and succeeded his uncle Edred in 955. Taking part with the secular clergy against the monks, he incurred the confirmed enmity of the latter. Having called Dunstan to account for his share in the administration in the preceding reign, the latter refused to attend the summons, and was in consequence banished. His party was, however, so strong that a rebellion was excited, and Edwy driven from the throne, to make way for his brother Edgar.

Eeckhout, ĕk'howt, or **Eckhout, Gerbrand van den,** Dutch painter: b. Amsterdam 19 Aug. 1621; d. there 22 July 1674. He was one of the pupils of Rembrandt, and in some measure successful in imitating his manner, especially in the early part of his life. He excelled chiefly in painting portraits, and these as well as his historical pictures abound in the best collections of Holland, while several of them are to be found in Germany. His most esteemed work represents Christ among the doctors.

Eecloo, ā-klō', Belgium, town in province of East Flanders, 11 miles northwest from Ghent, near the Liève. The manufactures are chiefly woolens, cottons, hats, tobacco, chocolate, soap, and starch; and it has breweries, distilleries, salt-refineries, dye-works, and oil-mills; and an active trade in grain, linen, cattle, and timber. Pop. 13,200.

Eekhoud, ĕk'howt, **Georges,** Belgian novelist and poet: b. Antwerp 27 May 1854. He first published two volumes of poetry, 'Myrtles and Cypresses' (1876); and 'Poetic Zig-Zags' (1877); then became a newspaper literary critic in Brussels, and wrote several short stories. His first considerable novel, 'The Militia of St. Francis' (1886), is a masterly portrayal of Flemish peasant life, especially its naïve mystic religiousness. His masterpiece, 'New Carthage' (1888), paints Antwerp life in its naked actuality. Still other works of his are: 'The Fusillades at Mechlin' (1890), a story of the peasants' uprising against the French in 1798; and 'La faneuse d'amour' (1900). In poetry he has developed from romanticism to pronounced realism.

Eel, the general name given to a variety of teleostomous fishes of diverse structure and resembling one another chiefly in their elongated form, soft rayed fins, and the tendency for the paired fins to become reduced in size. Although their seclusive habits render the eel-like fishes liable to be overlooked, and it is evident that many remain undiscovered, the number and diversity of those already known are very considerable. Ichthyologists have arranged them in numerous families and several orders, which Prof. Cope regarded as forming a series degenerate in respect to the gradual loss of the paired fins, and certain ossifications of the skull, and in the simplification of the gill arches. According to the classification of Jordan and Evermann, most of the eels fall within the order Apodes, the others chiefly within the *Plectospondyli, Symbranchia,* and *Carenchelyi.* The common eel or fresh-water eel (*Anguilla chryspa,* but also described under a number of other names) belongs to the first order and the family Anguillidæ. It is doubtfully distinct from the European fresh-water eel (*Anguilla anguilla*). Both species are characterized — in addition to the serpent-like elongated body, the absence of ventral fins, and the continuity of the dorsal and anal fins round the extremity of the tail — by the wide interval between the dorsal fin and the head, the projecting lower jaw, well developed pectoral fins, well ossified jaws and gill covers and nearly perfect gill arches. Contrary to the common belief eels are not scaleless but numerous small scales are embedded in the skin. The life history of the eel is very remarkable and in some respects unique. During the spring and early summer multitudes of young eels several inches long migrate up the rivers from the sea and distribute themselves throughout every accessible body of water, whatever its size or character, frequently traveling overland to reach these. Here they remain concealed in the mud or beneath stones and feed on all kinds of animal matter, living and dead, in the pursuit of which they are relentless. Many eels appear never to leave the fresh waters in which they have developed, but most of them after several years return to the sea and enter comparatively deep waters, where sexual maturity and spawning takes place. From the egg a peculiar, compressed, transparent, pelagic larva (*Leptocephalus brevirostris*) is produced, which in due time generally metamorphoses into the young eel which in turn leaves the sea. Some individuals, however, appear to remain permanently in salt as others do in fresh water.

Both in America and in Europe eels are an important and very excellent food fish, and great quantities are caught in a variety of ways. In the United States use is made of hand and set lines, eel spears, eel pots, and weirs. The last is the most efficacious method, but owing to its serious destructiveness of shad and other fishes its use is frequently prohibited by law. A V-shaped fence or net is arranged across the stream with a basket placed in a small opening at the apex, into which the eels are guided by the leads and from which they are unable to extricate themselves. In England river eels are caught in great numbers by means of eelbucks, or eel-pots, traps consisting of a kind of basket with a funnel-shaped entrance composed of willow rods converging toward a point, so that the eels can easily force their way in but cannot return. A stocking or tube of coarse cloth hanging from an aperture of a box down into the interior is also used. A kind of trident, called an eel-spear, is used also for taking them. A fisherman wades to the shallows, and, striking his spear in the mud in every direction around him, the eels reposing on the bottom are caught between the prongs. Except a few other species of the same genus as the common eel all eels are strictly marine and are especially numerous in tropical seas where, in the interstices of coral reefs, as also in the deep sea, some very remarkable kinds occur. For an account of the species consult Jordan and Davis, Report U. S. Fish Commission for 1888; Jordan and Evermann, Bulletin U. S. National Museum, No. 47, Pt. I.; and Goode and Bean, 'Oceanic Ichthyology.' See also articles: CONGER EEL; ELECTRIC EEL; SNIPE EEL; MORAY; PELICAN FISH; SNAKE EEL, etc.

Eel-grass, or **Grass-wrack,** a common name for a marine grass, *Zostera marina,* of the pondweed family (*Naiadaceæ*). The leaves are narrow and ribbon-like, blunt at the end, sometimes six feet in length. The flowers are crowded in a spadix. It is found in bays or streams along the Atlantic coast from Greenland to Florida, and on the Pacific from Alaska to California, also on the shores of Europe and Asia. The genus *Zostera* (from the Greek, referring to the ribbon-like leaves), comprises six genera, of which two besides the eel-grass are found in America. They are all marine plants, and are found on the coasts in the north temperate zone.

Eel-pout, the name of various fishes. It is applied in the United States to the burbot or ling of the Great Lakes and to the muttonfish; in Great Britain to the burbot (q.v.), and in northern Africa to the electric catfish (*Malapterurus*).

Eells, Myron, American Congregational clergyman: b. Walker's Prairie, Wash., 7 Oct. 1843. He was graduated at Pacific University, Ore., 1866, and at Hartford Theological Seminary 1871. He was pastor at Boise City, Idaho, 1872–74, later serving as missionary to the Indians at Skohomish, Wash., where he filled the pulpit of the Congregational Church 1876. Among his works are: 'History of Congregational Association of Washington and Oregon' (1881); 'History of the Indian Missions on the Pacific Coast' (1882); 'Ten years at Skohomish' (1886); 'Father Eells' (1894).

Eelworm, or Vinegar Eel (*Anguillula aceti*), a small *Nematoda* (q.v.) worm of the family *Anguillulidæ*, often found in immense numbers in good cider vinegar or in sour paste, where it feeds on the mucilage and organic fluids. It is just visible to the naked eye and wriggles very actively. Like many related species it is very resistant to dessication and other influences ordinarily destructive to animal life. A vast number of similar species live in the earth and feed on decaying organic matter, others are parasitic on plants, in which they are at least the partial causes of certain very serious diseases; thus *Tylenchus devastatrix* causes the "clover disease" and *Heterodera schachtii* the still more destructive "beet sickness," which sometimes devastates the sugar beet crop of Germany.

Effen'di, a title of respect among the Turks, bestowed on civil officials, and on educated persons generally, in contradistinction to the military title of *aga*. It is nearly equivalent to the French *Monsieur*, but is suffixed to the personal name.

Ef'figy, formerly **Effigie,** (1) a copy or imitation of an object, an image or likeness; in sculpture frequently applied to the figures on sepulchral monuments; (2) to execute or degrade, as the execution or degradation of a condemned criminal, when he cannot be personally apprehended, by subjecting his image to the formalities of an execution; for instance, affixing the image with a rope round the neck to the gallows (hanging in effigy). This practice is not altogether extinct in Prussia, and in other countries; but in England it has become merely a mode in which the populace expresses its feelings respecting an obnoxious personage; such as the English custom of parading and burning the effigy of Guy Fawkes on 5 Nov.

Ef'fingham, Ill., city, county-seat of Effingham County; on a branch of the Wabash River, about 240 miles south by west of Chicago, and on the Illinois C., the Wabash, and Vandalia R.R.'s. The city is the trading point of an agricultural region, and has some small manufactories. It contains Austin College and a large photographic school. Pop. 3,825.

Effores'cence, a term applied to crystals, which, on exposure to the air, lose water of crystallization and crumble down into a powder. The most familiar instance is that presented by the glassy crystals of washing soda, which become white and pulverulent in the air. The same phenomenon is also presented by phosphate of sodium, borax, and other compounds. Another application of the word is to the fine white, feathery crystallization of sulphate and carbonate of sodium which appears on walls, or similar crystallizations on the surface of the earth, in decomposing rocks, etc. Efflorescence is in some respects the opposite of deliquescence, and the difference is shown by placing an efflorescent and deliquescent body under a bell-jar. The former gives up its water, which the latter absorbs, becoming thereby fluid. See CRYSTALS.

Effu'sion (Lat. "to pour out"), in physics and chemistry, the escape of a gas into a vacuum, through a small opening (such as a pin-hole) in a thin partition. So long as the temperature of the gas is constant, the velocity of effusion is independent of the pressure. For the same gas at two different temperatures (but at the same density), the velocity of effusion varies directly as the square root of the absolute temperature. The velocities of effusion of two different gases (both at the same constant temperature) are inversely proportional to the square roots of the densities of the gases; the densities being determined by comparison under convenient but identical conditions of temperature and pressure.

Eft, a name given to several species of newts, especially to the common smooth newt (*Lissotriton punctatus*). The eft has a slightly free tongue, double longitudinal series of palatal teeth, and nailless toes, four before and five behind. The skin is smooth; the dorsal and caudal crests are continuous; there are two patches of glandular pores on the head, and none on the back or sides. The color in the male is brownish gray above, passing into yellowish beneath, which in the spring becomes bright orange; there are numerous round dark spots of unequal size, and two longitudinal streaks on the head; the crest in spring is often tipped with red or violet. The female is light yellowish brown, or buff with brown dots, plainer below. The total length is about 3½ inches, of which the tail is nearly one half. It is very common in the ditches and ponds of Europe, especially where the water is clear. Its food consists principally of aquatic insects, larvæ, worms, and mollusks. The reproduction and metamorphosis are almost identical with those of the newts. Though usually spending most of their time in the water, the young in June, and the adults in summer and autumn, become terrestrial; they appear to attain their full size the first year. Their bite is perfectly harmless. They are eaten by the larger amphibians, by fishes, and by various reptiles, birds, and small mammals.

E'gan, Maurice Francis, American author: b. Philadelphia 24 May 1852. He was graduated at La Salle College; and was subsequently professor of English literature in the University of Notre Dame, Ind., and professor of English language and literature in the Catholic University of America. In 1907 he became minister to Denmark. He wrote 'That Girl of Mine' (1879); 'Preludes' (1880), a book of poems; 'Songs and Sonnets' (1885); 'The Theater and Christian Parents' (1885); 'Stories of Duty' (1885); 'A Garden of Roses' (1886); 'The Life Around Us' (1886); 'Studies in Literature'; 'The Watson Girls'; etc.

Egan, Patrick, American politician: b. County Longford, Ireland, 1841. He became identified with the Nationalists and the Home Rule Movement in 1871, and was one of the organizers of the Irish Land League. He was tried in Dublin in 1880 for conspiracy and sedition, going to Paris upon his acquittal. He came to the United States in 1883, and was president of the Irish National Land League of America 1884-86. He testified before the Parliamentary Commission 1889, and was instrumental in securing the failure of the case of the London *Times* against Parnell. He was appointed minister plenipotentiary to Chile as a reward for his speeches in the campaign of 1888. In Chile he espoused the cause of Balmaceda, the Liberal Dictator. Later he left the Republican party, becoming what was termed a Free Silver Democrat, and taking part in the subsequent campaigns in favor of that issue.

Egan, Pierce (the Elder), English sporting writer: b. London 1772; d. there 3 Aug. 1849. A prolific "historian of the ring" and kindred institutions, he wrote 'Boxiana' (1818); and the widely popular 'Life in London' (1821); which was illustrated by Cruikshank.

Egan, Pierce (the Younger), English novelist: b. London 1814; d. there 6 July 1880. He was a son of the preceding. At first an artist, he turned to fiction, winning fame with 'Robin Hood' (1840); 'Wat Tyler' (1841), and similarly conceived romances; while his later and more sensational tales, 'Imogen'; 'Fair Lilias'; and others, appeared for the most part as serials only.

Egaña, Juan, hoo-än' ā-gä'ña, Chilean author and statesman: b. Lima 1769; d. Santiago, Chile, 13 April 1836. He took an active part in the revolution, was a member of the first Chilean Congress, was captured and imprisoned on Juan Fernandez Island, but was liberated in 1817, and was again a member of Congress until elected president of the Republic in 1823. He was a voluminous writer, both of poetry and prose, his works including several educational text-books. He exercised great influence in shaping the character of the people and the policy of Chile.

Egbert, king of Wessex: b. about 775; d. 837. On the death of Alcmund, the former king, Brihtric, a powerful noble, succeeded in ousting Egbert, who had the best claim to the throne, and was compelled to take refuge first in the court of Offa of Mercia, then in that of Charlemagne. On the death of Brihtric he succeeded him as king of Wessex, in 800. He reduced the other kingdoms, and rendered them dependent on him, in 827, and is thus considered the first king of all England.

Egbert, Harry C., American military officer: b. Pennsylvania 3 Jan. 1839; d. 4 March 1899. He entered the army as first lieutenant in September 1861; was promoted captain in 1865; major in 1890; and colonel on 1 July 1898. In October of the latter year he was commissioner brigadier-general of volunteers. When the war with Spain broke out he commanded the 6th Infantry, of which he was lieutenant-colonel. In the Santiago campaign, while leading a charge at El Caney, 1 July 1898, he was shot through the body. He had scarcely recovered from his wound when he applied for service in the Philippines. He arrived at Manila with his regiment 4 March 1899, and was killed while storming Malinta, on the 26th.

Egbert, James Chidester, Roman archæologist and epigraphist: b. New York 1859. He was graduated at Columbia University in 1881, and held a prize fellowship (1882–85). He began to teach in the University in 1885 and was adjunct professor of Latin 1885–90. In 1890 he was appointed professor of Roman archæology and epigraphy in Columbia, and while he has done much to promote the study of these special subjects, and has published: 'Introduction to the Study of Latin Inscriptions,' he has also edited 'Cicero de Senectute'; and written 'Macmillan's Shorter Latin Course.'

Egede, Hans, hänts ā'gĕ-dĕ, Danish missionary, termed the apostle of Greenland: b. Harstad, Norway, 1686; d. Falster, Denmark, 1758. In 1707 he became a preacher at Wogen. Having heard that Christianity had been once established in Greenland, but had become extinct in the country for want of teachers, he resolved to visit the country, and to preach the gospel to the inhabitants. Having received from the Danish government the title of royal missionary to Greenland, with a small pension and three ships, he sailed on 21 May 1721 with 46 persons under his command. Egede landed on 4 June, and the conversion of the Greenlanders was now undertaken, but offered great difficulties. Egede took up his residence, with his two sons, among the natives, in order to learn their language, and so be able to carry out his project of conversion. He carefully noted down every word of which he discovered the meaning; often performed long journeys, at the peril of his life, to visit the remotest Greenlanders, for the purpose of gaining their confidence, in which he succeeded by a thousand acts of kindness. After spending fifteen years in Greenland, amid innumerable discouragements, he returned in 1736 to Copenhagen, to make new exertions for the support of Christianity in that country. The government appointed him director of the Greenland missions, and established his son Paul in the office of missionary there. His writings are in Danish, and relate to the natural history of Greenland, and his sufferings and adventures there.

Egede, Paul, Danish missionary: b. 1708; d. Copenhagen 1789. He was a son of Hans Egede and was his assistant from the time he was 12 years old. Notwithstanding a strong inclination for the naval service, he submitted to the wishes of his father, studied divinity, joined the mission in Greenland in 1734, and remained there till 1740. He then returned to Copenhagen, and afterwards was appointed

Bishop of Greenland. We have from him an ‘Account of Greenland,’ extracted from a journal kept from 1721–88; ‘Dictionarium Grœnlandicum’; ‘Grammatica Grœnlandica’; and translation of the Gospels, the ‘Imitation of Christ,’ etc., in the Greenland tongue.

Egelhaaf, ā'gĕl-häf, **Gottlob**, German historian: b. Gerabronn, Würtemberg, 1 March 1848. He has published: ‘A History of Germany During the Reformation’ (3d ed. 1893); ‘Emperor William’ (3d ed. 1888); ‘A History of Germany During the Sixteenth Century until the Peace of Augsburg’ (1888–92); and other works.

Eger, ā'gĕr, Bohemia, town in the northwest, on a rocky eminence above the Eger, 91 miles west of Prague. It was once an important fortress, founded in the 12th century. Six lines of railroads converge at Eger. There are various industries, including machinery, wool, cotton, and leather manufactures, and a flourishing trade. The celebrated Wallenstein was assassinated here (1634). Franzensbad, a watering place, is connected with Eger by an avenue three miles long. Pop., of the commune, 24,200.

Eger, a river which rises in Bavaria, in the Fichtelgebirge, 12 miles northwest of the town of Eger, flows first southeast, then takes a northeasterly direction into the Elbe, near Leitmeritz, in Bohemia, after a course of about 190 miles.

Egeria, ē-jē'rĭ-a, (1) a nymph who received divine honors among the Romans. Numa is said to have had secret conversations with her, and to have received from her the laws which he gave to the Romans. Some say Egeria was the wife of Numa. (2) a genus of spider crabs of the family *Maiidæ*; (3) a genus of bivalve shells of the family *Donacidæ*; (4) in astronomy, the thirteenth planetoid, discovered by De Gasparis, at Naples (1850).

Egerton, ĕj'ėr-tón, **George** (pseudonym of Mrs. Mary Chavelita Dunne Melville Clairmonte Bright), English novelist: b. Australia 14 Dec. 1860. She was married in 1888 to H. Melville, who died in 1889; in 1891 to Egerton Clairmonte, who died in 1901; and in 1901 to R. G. Bright. She has traveled extensively, visiting the United States four times. She has published: ‘Key-notes’ (1893); ‘Discords’ (1894); ‘Young Ofeg's Ditties’ (1895); ‘Symphonies’ (1897); ‘Fantasias’ (1898); ‘The Wheel of God’ (1898); ‘Rosa Amorosa’ (1901); ‘The Hazard of the Ill’ (1902).

Egg, Augustus Leopold, English painter: b. London 2 May 1816; d. Algiers, Algeria, 26 March 1863. He became a contributor to the Academy exhibition in 1838, and was elected a member of the Royal Academy in 1860. He painted a great number of pictures illustrative of humorous scenes from Shakespeare, Le Sage, and Walter Scott.

Egg. A cell (ovum) developed in the female reproductive organ (ovary) of any metazoic animal, which, when joined with a male cell (spermatozoön) develops under suitable conditions into an organism like the parents. For the structure of the egg, which differs from other cells only in its germinative property, see Cell; and for its processes of development, see Embryology.

Animals in which the egg passes out of the body before it is hatched, that is, before the maturity and escape of the embryo, are said to «lay eggs,» or to be «oviparous»; those in which the egg remains inside the body to hatch are called «ovoviviparous»; those whose eggs are retained in connection with the parent by means of a placenta and an umbilical cord, so that the young are brought forth alive are called «viviparous.» These distinctions, and especially the first two, are of secondary importance, and in some cases it is difficult to classify an animal according to them; or varying conditions may lead to change in the same species or individual at different times. A few lowly mammals (the *Monotremes*, q.v.), all birds, and most other animals, «lay» their eggs. The ovoviviparous ones are to be found chiefly among reptiles and fishes.

As in all the higher animals the development of the egg is prolonged, and the young animal must reach a comparatively perfect state of development before it leaves the egg; provision for its nutrition during embryonic development must be made by the storage of food in the egg to be gradually absorbed by the growing embryo; also room for growth, and therefore such eggs are always relatively large. The food is primarily the yolk, which is distinctly yellow in the eggs of birds, reptiles and amphibians, and consists of granules of albuminous and fatty matter perfectly adapted to the nutrition of the young. It lies in concentric layers about the whitish germinal vesicle or «tread» of the egg, which is the protoplasmic part where alone development proceeds. This vesicle floats on the surface of the food-yolk, and remains on top, by reason of its lightness, no matter how the egg is turned. The eggs of many of the lower animals contain food-yolk, but it is usually colorless. The egg of a hen or other bird is further furnished with layers of albumen (the «white») placed upon it in the narrow upper part of the oviduct. Outside of this there is next deposited upon the albumen a fibrous membrane of double thickness (the «egg-pod»), the splitting of which later forms the «air-chamber» at that end of the egg where the head of the chick lies. In a further stage of descent along the oviduct there is deposited in and upon the egg-pod an external covering, or «shell,» which may be gelatinous as in the amphibians, or chitinous as among insects, or parchment-like as in reptiles, or calcareous in various degrees, as is familiar in birds' eggs. This shell is porous, so as to admit air to the embryo, which also exposes it to bacteria, so that eggs are liable to quick decay as soon as living influences cease to operate upon it; and preservative methods are directed toward excluding air and germs by closing the pores of the shell. The evil odor of decayed eggs is due to the liberation of sulphuretted hydrogen and certain sulphur proteids, sulphur having a large part in the composition and color of food-yolk. The shells of eggs are often oddly and elegantly shaped, differ greatly in texture and ornamentation, those of insects especially being often exquisitely chased, or studded with projections, and are otherwise beautiful objects under the microscope. Kirby and Spence describe in detail an extraordinary variety, including many which have hinged lids so that the embryo may escape when ready without breaking its way out (see Egg-tooth), as do birds and reptiles. The eggs of a great variety of birds are further ornamented by a uniform tinting or by spottings in diverse patterns and colors, which consist of peculiar pigments, derived from the blood and laid on at the time of the formation of the shell. These color-markings are characteristic of groups to a great extent, and are mainly combinations of yellow, red-brown and greenish-blue. Vast and valuable collections of the nests and eggs of birds exist in museums; and form the topic of the special science oölogy.

Considering the vast variety of animals, and the world-wide diversity of circumstances under which eggs are laid and of conditions which must be met, the greatest dissimilitude is to be expected. In size their range varies from the microscopic cells produced by most mammals to the huge egg of epyornis (q.v.), with a capacity of 2½ gallons. The human ovum is among the smallest known, being a minute spherical body from 1-120 of an inch in diameter.

While the eggs of the vertebrates are spherical or nearly so (oblong or oval in various degrees), those of invertebrates often take strange polygonal forms, as is seen among the worms, lower crustaceans, and insects, some of which are illustrated on the accompanying plate. Equally diverse are the methods taken for protection of eggs against harm by weather or enemies, and in proportion as these have proved successful the number laid by each individual is decreased. Many marine animals, such as most worms, echinoderms, cœlenterates, bivalve mollusks, and fishes pour out millions of ova, or "spawn," most of which serves only as food for other aquatic animals, probably not a tenth of 1 per cent in many cases ever approaching maturity. Creatures above the rank of the more lowly fishes lay comparatively few eggs — some only one annually. This is also true of certain insects, spiders, crabs, and mollusks, where habits of so hiding or protecting the eggs have been acquired that a large proportion are fertilized and hatched. The methods and adaptations for safety observable among insects are exceedingly varied and effective. Some bury their eggs in the ground, or in dead wood, or living wood, or even in the bodies of dead or living animals; some drop them loose into water, or fasten them to a support under its surface; they hide them in all sorts of crannies, glue them firmly to plants, twigs, rocks, or the skin and hairs of other animals. In the majority of cases this protection must withstand the test of resisting prolonged unfavorable conditions, for most species are preserved from year to year only by the hibernation or estivation of their eggs. Among aquatic animals the encasement of the eggs in a gelatinous envelope, as is so common with frogs, newts, and other amphibians; or a tough capsule, as among the cephalopod and many gasteropod mollusks (for example, Muret, Natica, Fusus) is a common method of protection. These egg-cases are often most curious in form and location.

Economical Value of Eggs.— The eggs of birds, especially of fowls, and of some reptiles, as turtles, are commonly used for food. Boiled eggs are less nutritious because the hardened albumen is with difficulty digested. A hen's egg of good size weighs about 1,000 grains, of which the white constitutes 600, the yolk 300, and the shell 100. There are generally 10.7 parts shell, 11.9 parts albumen, 12.8 parts fat, .7 parts salt, and 63.9 water. According to Leppig, the specific gravity of fresh eggs is not less than 1.06 grams, and loses 0.0017 grams a day when kept in the open air; so if an egg sinks in a salt solution of 1.05 specific gravity, the egg is fresh. Besides their use as a food, hen's eggs are used in the technical arts, the albumen in which they are so rich being serviceable in dyeing, manufacture of leather, and for various other purposes.

To preserve eggs for any length of time, they must be kept from the air. They may be rubbed over with butter, lard, gum-water, etc., set on the small end upon a perforated board, or, which is still better, they are placed in layers, upon the small end, in very dry ashes, in dry salt, etc., enclosed in tubs and boxes, and put in a dry place, protected from severe cold in winter, but at the same time not too warm.

Eggs are of great importance in a commercial point of view. In England vast quantities are brought from the country to the large towns, but not in sufficient numbers for the demand, and they are largely imported from the Continent, chiefly from France, Germany, Russia, Belgium, and Denmark, also from Canada, the United States, Egypt, Morocco, and other countries. The value of eggs imported into the United Kingdom is more than $25,000,000 annually.

In the United States the egg industry has grown during recent years to vast proportions. Formerly this country relied largely upon importation for its supply of eggs, but now it exports far more of them than it obtains from foreign parts. The increasing use of incubators has led to a large increase in the number of eggs laid by native fowls, which need "no longer waste their time in hatching them, but may devote it to the more profitable labor of producing them." It is said by experts in this branch of American industry that although the number of fowls kept in this country is now relatively smaller than formerly, yet by the adoption of labor- and time-saving machines the lesser number has been able to produce a constantly increasing output of eggs.

The production of poultry and eggs is one of the most profitable industries. A statistician of authority estimates that a hen may realize 400 per cent profit for her owner. In 33 States and Territories the value of eggs exceeds the value of the poultry product. The egg product in the United States amounts to more, when measured by dollars and cents, than the combined gold and silver production. Prices have not fallen with the introduction of the incubator.

The value of the annual output of eggs is now $145,000,000. In their production Iowa leads the States, its yearly product being 100,000,000 dozen. Ohio comes next with 91,000,000 dozen; Illinois third, 86,000,000 dozen; and Missouri fourth, 85,000,000 dozen. With the exception of Alaska and Hawaii, Montana pays the highest price for eggs, the average price being 20 cents a dozen. They are cheapest in Texas, where the average price in 1902 was 7½ cents a dozen. The average price for the 16,000,000,000 eggs which were marketed in the United States that year was 11.15 cents a dozen.

The railroad men of the country have an excellent opportunity to measure the extent of the egg industry in concrete exhibits. The annual output fills 43,127,272 crates holding 30 dozen each. An ordinary refrigerator car, which has

EGGS.

1. Kingfisher
2. Bee-eater
3. Black Woodpecker
4. Spotted Woodpecker
5. Roller
6. Eagle Owl
7. Long-eared Owl
8. Short-eared Owl
9. Pygmy Owl
10. Brown Owl
11. Nightjar
12. Hoopoe
13. Black Martin
14–19. Titmice
20. Nuthatch
21. Tree-creeper
22. Wryneck
23. Wren
24–25. Kinglets
26–28. Swallows
29, 30, 31. Warblers
32. Cuckoo
33. Goshawk
34. Sparrowhawk
35. Kite.
36. Eagle
37. Osprey
38. Peregrine Falcon
39. Kestrel
40. Honey Buzzard
41. Marsh Hawk
42–43. Butcher-birds
44. Crested Titmouse
45. European Robin
46. Persian Nightingale
47. Bluethroat
48. Hedge Sparrow
49–51. Flycatchers
52. Whitethroat
53. Blackcap
54. Stonechat
55. Whinchat
56. Wheatear
57. Starling
58. Oriole
59. Rock Thrush
60. Fieldfare
61. Song Thrush
62. Ring Ouzel
63. Mistle Thrush
64. Carrion Crow
65. Jackdaw
66. Alpine Chough
67. Magpie
68. Jay
69–71. Reed Wrens
72. Garden Warbler
73–74. Pipit Lark
75. Grasshopper-warbler
76–77. Wagtails
78. Skylark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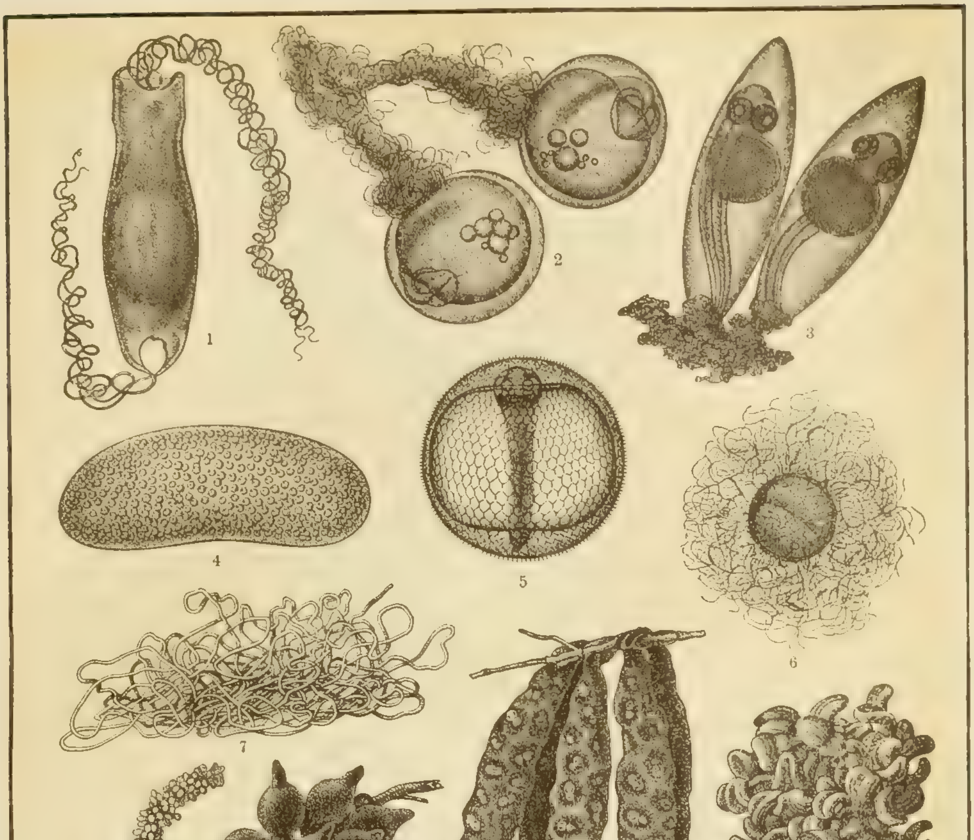
EGGS OF FISHES AND LOWER ANIMALS.



1. Egg of Shark.
2. Egg of Cristiceps.
3. Egg, with embryo of Goby.
4. Spawn of parastic Fierasfer.
5. Egg with embryo of Stargazer.
6. Egg of Garfish.
7. Spawn of a nudibranch.
8. Spawn of Squid.
9. Spawn of Sea-snail.
10. Spawn of Octopus.
11. Egg of Cuttlefish.
12. Egg of a flat-worm.
13. Egg-capsule of Mantis.
14. The same in cross-section.
15. Egg of a butterfly.
16. Egg of Bedbug.
17. Egg of Beetle-mite.
18. Structure of eggshell of a phyllopod crustacean.
19. Egg of branchipod crustacean.

an average length of 42.5 feet, holds 400 crates. It is calculated that a train of these cars sufficient to carry the annual product would be 866 miles long, or long enough to reach from Washington to Chicago, and have several miles to spare. A government expert says: «The majority of the fowls of this country are found in comparatively small numbers on a very large number of farms, where they gather their own subsistence and receive practically no care. The consequence of this is that eggs are produced at little cost. The development of this industry to an extent incredibly larger than it is at the present time is among the easy possibilities.»

Egg, or **Eigg,** ĕg, one of the Hebrides Islands, belonging to Inverness-shire, Scotland. It is south of Skye. Its length is a little less than seven miles.

Egg-bird, or **Sooty Tern** (*Sterna fuliginosa*), a member of the gull family (*Laridæ*) famous for its edible eggs and breeding societies or «wide-awake fairs.» It is found about warm seas throughout the world and abounds in the West Indies. Ascension Island is one of its most frequent breeding places. Occasionally it wanders as far as New England. The adults have beautiful black and white plumage, but the young are of a light, sooty color. The nests are rough excavations in the sand, in which three eggs are usually deposited. They are much valued and the gathering of them in the spring months forms an important West Indian industry. The name egg-bird is also commonly applied to other marine birds of the gull family, as guillemots, murres, etc., whose eggs are of economic value.

Egg Dance, a once popular diversion in England, Scotland, Holland, and some other parts of Europe; now confined chiefly to Spain, among the people of Valencia. A number of eggs were arranged in a prescribed form upon the dancing floor, and among them a blindfolded dancer moved as best he might, to music; the object being to execute an intricate dance without breaking the eggs. The music, like the arrangement of the eggs, was also prescribed.

Egg-eating Snake, the *Dasypeltis scabra,* a tree-climbing species of coluber found in Central and South Africa. It is about two feet in length and is unique in its adaptation to the diet from which it derives its name. While the jaws are almost destitute of teeth and capable of great distention, a substitute for the teeth is found in the elongated hypophyses or ventral processes of several of the cervical vertebræ, which project into the interior of the œsophagus as a series of saw-like teeth tipped with very hard cement substance. This mechanism enables the snake to secure the entire contents of an egg as large as a hen's without losing a drop, for it is swallowed entire and only broken by contact with the œsophageal teeth when safely within the throat, when the contents are swallowed and the shell regurgitated.

Egg-fish, any of various plectognath «globe-fishes,» which swell themselves into the shape of an egg. See PLECTOGNATHI; PUFFER.

Egg-flip, a drink made of warmed beer, flavored with a little sugar, spirit, spices, and eggs beaten with it.

Egg-nog, a drink consisting of the yolk of eggs, beaten up with sugar, to which milk is added, and also usually some kind of spirits. By using the whites of the eggs an agreeable froth is made.

Egg-plant, Guinea Squash, or **Aubergine** (*Solanum melongena*), a plant of the natural order *Solanaceæ.* Its original home is supposed to be the East Indies, where it has long been cultivated and from whence it has been introduced into all tropical countries and many temperate ones for the sake of its egg-like white, yellow, or purple fruits, which are used as a vegetable. In the United States it is cultivated as far north as Long Island and southern Michigan. In the North the plants must be started under glass, and transplanted to the field or garden after danger of frost has passed. They do best upon rich deep loams well exposed to the sun. Their principal insect enemies are practically the same as those of the potato and are combated similarly. (See INSECTICIDE.) Their fungous diseases are few and rarely devastating. The principal ones are a bacterial disease caused by *Bacillus solanacearum,* for which there seems to be no satisfactory remedy; anthracnose (*Glœosporium melongena*), which appears as pink-spotted sunken areas upon the fruits; leaf-spot (*Phyllosticta hortorum*), which turns the affected leaves brown and produces holes in them; and a mold (*Botrytis fascicularis*), which produces soft spots with gray moldy surfaces upon the fruits. Each of these parasites may appear upon any of the green parts, but the parts mentioned are the usual ones. They may all be controlled by timely applications of any standard fungicide.

Egg-tooth, the hard calcareous protuberance at the tip of the beak or snout of a chick or young reptile which is born within an egg having a tough shell, designed to assist the embryo in escaping. It wears a hole through the lining membrane of the egg, and then acts as a file to bore through the outer shell or wedge apart any crack. It is possessed by all birds, and by such reptiles (turtles, lizards, and snakes) as develop in eggs with hard coverings. Soon after the embryo goes free this excrescence falls off; and in this special temporary provision for a special non-recurring exigency, Darwin found an example, in his view, of the results of natural selection.

Egg-urchin, or **Sea-egg,** any of the typical globose sea-urchins, especially those of the genus *Echinus.* Similarly, the flat, bun-shaped echinoderms are called «cake-urchins,» the cockle-shaped (spatangoids) «heart-urchins,» and so on. See ECHINODERMATA; SEA-URCHIN.

Egga, ĕg'a, West Africa, town of Gando, in the Niger Territories, on the Niger. Pottery, iron, gold, and wooden-wares, thick cloth, generally dyed blue, and leather are manufactured, and an active river trade is carried on, especially in ivory. Pop. 12,000.

Eggar-moth. See EGGER-MOTH.

Eg'geling, Julius, English philologist: b. Hecklingen, Germany, 12 July 1842. After studying at Breslau and Berlin, he went to England in 1867 and on account of his knowledge of Sanskrit was appointed secretary and librarian of the Royal Asiatic Society 1869, becoming professor of Sanskrit at University College 1872 and filling the same chair at the University of Edinburgh three years later. Among his publications are 'The Catapatha-Brahmana, Translated according to the Text of the Madhyandina School' (1882–5); 'Catalogue of Buddhist Sanskrit Manuscripts in the Possession of the Royal Asiatic Society' (with Cowell 1875); the article, 'Sanskrit Language and Literature,' in the Encyclopædia Britannica; 'Catalogue of Sanskrit Manuscripts in the Library of the India Office' (1887–9); and editions of 'Vardhamana's Ganaratnamahodadhi' (1879–80); the 'Katantra' (1874–8); and of the 'Kanva Satapatha Brahmana' (1902).

Egger-moth, the name of certain species of moth, of the genus *Lasiocampa* or *Gastropacha,* allied to the silkworm moths. Several species are found in European countries.

Eg'gleston, Edward, American novelist and miscellaneous writer: b. Vevay, Ind., 10 Dec. 1837; d. Joshua's Rock, Lake George, N. Y., 3 Sept. 1902. He entered the ministry of the Methodist Church, and was more or less engaged in pastoral work for a number of years, at the same time contributing to various periodicals, for some of which he acted as editor. From 1874 till 1879 he was engaged in the work of an independent church founded by himself (the Church of Christian Endeavor, Brooklyn), but in the latter year his health failed and he resigned his position as pastor. Subsequently he devoted himself entirely to literary work. Among the most important of his works are: 'The Hoosier Schoolmaster' (1871); 'The End of the World' (1872); 'Mystery of Metropolisville' (1873); 'Schoolmaster's Stories for Boys and Girls' (1873); 'The Circuit-Rider' (1874); 'Christ in Literature' (1875, edited); 'Christ in Art' (1875, edited); 'Roxy' (1878); 'The Hoosier School-boy' (1883); 'The Graysons: a Story of Illinois' (1887); 'History of the United States and Its People' (1888); 'Household History of the United States and Its People' (1888); 'The Faith Doctor' (1891); 'Duffels,' a series of short stories (1893); 'The Beginners of a Nation' (1896); and 'The Transit of Civilization' (1900). His work as an historian possessed much merit, in that it was based upon careful investigation and exhibited sound judgment. Yet is is by his early stories of the Middle West that he will always be best known. These stories gave to those who read them at that time a real delight. They were written without the slightest trace of literary art; but their themes were wholly novel, and the unstudied simplicity of their narrator made them so natural and so life-like as at once to charm and surprise all sorts of readers. 'The Hoosier Schoolmaster' may be regarded as the first of a class of stories of which 'David Harum' and 'Eben Holden' are much later examples. The book, in reality, marked a new departure in our national literature; for it owed absolutely nothing to any model, but was a tale told directly from life, and from American life of a primitive kind which had not before made its way into printed books.

Eggleston, George Cary, American journalist and author: b. Vevay, Ind., 26 Nov. 1839. He is a brother of E. Eggleston (q.v.). During the Civil War he served in the Confederate army. He has long been connected in an editorial capacity with one or another New York newspaper, including the *World,* the *Evening Post,* and the *Commercial Advertiser.* Among his many books are: 'A Man of Honor' (1873); 'A Rebel's Recollections' (1874); 'How to Educate Yourself' (1872); 'How to Make a Living' (1875); 'The Wreck of the Red Bird' (1882); 'Red Eagle'; 'Juggernaut' (with Dolores Marbourg) (1891); 'A Carolina Cavalier' (1901); 'Dorothy South' (1902); 'The Master of Warlock' (1903); 'A Captain in the Ranks' (1904).

Eg'ham, England, village in the County of Surrey, on the Thames, about 21 miles from London. It contains the Royal Indian Engineering College, the Royal Holloway College for Women, and the Holloway Sanatorium. Runnymede, where King John signed Magna Charta, is in Egham parish. Pop. 10,187.

Egil Skallagrimsson, ā'gĭl skäl-lä-grĭmz'-sōn, Icelandic bard or skald of the 10th century. He distinguished himself by his warlike exploits and adventures in Norway, Denmark, and England. Having killed in combat the son of Erik Blódöx, king of Norway, he was doomed to death on being subsequently taken prisoner by that prince in Northumbria, but was allowed to redeem his life by giving a specimen of his powers as an improvisatore. He immediately composed and recited a poem in praise of Erik, known as 'Egil's Ransom,' which procured him his life and liberty. This piece (as well as two others attributed to him) is still extant, and Dr. Percy translated it into English, and printed it in his 'Northern Antiquities.' Egil is said to have been born about 901, and to have died about 980.

Egilsson, Sveinbjörn, svīn'bèrn ā'gĭlz-sōn, Icelandic critic: b. Gullbringasysla 24 Feb. 1791; d. Reikiavik 17 Aug. 1852. He investigated the native antiquities, edited a series of Icelandic historical works, and completed a 'Poetic Lexicon of the Ancient Tongue of the North' (1855–60), published posthumously.

Eginhard, ā'gĭn-härd, or **Einhard,** īn'härd, German historian: b. East Franconia, now the Grand Duchy of Hesse-Darmstadt, about 770; d. Seligenstadt 14 March 840. He was educated in the schools of the abbey of Fulda. When about 25 he entered the service of Charlemagne and thereafter was in all things the confidant of the emperor and one of his principal ministers. One of his great charges was the construction and repair of the public buildings. He was inseparable from the emperor, residing in the palace and accompanying him in all his journeys and expeditions: the only time when they were temporarily separated was when, in 806, the secretary — for such he has always been called — went to Rome to obtain the approval of the Pope of a provision of Charlemagne's testament or will for a division of the empire among his sons after his death. That Eginhard possessed considerable learning appears from his extant writings. During his many years of study at Fulda he acquired all the secular knowledge obtainable in his time, and in the palace of Charlemagne enjoyed the advantage of converse witn the celebrated Alcuin. It was on the advice of the secretary that Charlemagne in 813 made his eldest son, Lewis, his partner in the empire; and when Lewis, on his father's death, became sole emperor, he retained Eginhard in all his high offices and appointed him tutor of his son

Lothair. In 830 he withdrew from the court and retired to his large estates at Mulinheim, where he had erected a splendid basilica and founded various religious institutes, and there passed the remainder of his life. He changed the name of the place to Seligenstadt (City of the Saints, namely, of Saints Marcellinus and Petrus). In this basilica he was entombed, beside his wife, Imma, who died four years before him. According to an old legend Imma was a daughter of Charlemagne, and as time went on the story of their love adventures was added to from the fount of romantic imagination: in fact, Charlemagne had no daughter named Imma, and the lady Imma who was Eginhard's wife was the sister of Bernharius, bishop of Worms. Eginhard's 'Life of Charlemagne' (*Vita Caroli Magni*), written in Latin in a style and on lines imitative of Suetonius' 'Lives of the Cæsars,' is one of the most notable literary monuments of the Middle Ages; it was long used as a manual of school instruction and hence has survived in a multitude of manuscript copies. Another work of his is a history of the Franks, 'Annales Regum Francorum, Pippini, Caroli Magni et Hludowici Imperatoris' (Annals of the Frankish Kings Pippin, Charlemagne, and Lewis the Emperor). There are extant 62 of his 'Letters' (*Epistolæ*), and a narrative of the translation from Rome to Seligenstadt of the relics of Saints Marcellinus and Petrus ('Historia Translationis Beatorum Christi Martyrum Marcellini et Petri'). To the narrative he appends a poem on the same subject.

Eglantine, ĕg'lăn-tĭn or -tīn, the name of the sweet-brier rose (*Rosa rubiginosa*), in the poetry of Chaucer, Spenser, and Shakespeare. The name is common among the English poets; the earlier ones applied it to any wild rose, and Milton seems to confound several different species, among them the honeysuckle, etc. The flower is a native of Europe and Asia, but was easily naturalized in America and, being hardy, it withstood the severe winters, and now grows in profusion in the territory from Nova Scotia to Ontario, south to Tennessee, and east to the shores of Virginia. It is from 4 to 6 feet high, sometimes growing as a long spine-covered wand. The pink or white flowers are a marked feature of the flora of this region, during the months of June and July. A climbing-shrub, native of Asia (*Rosa eglanteria*), with yellow, ill-smelling flowers, is also sometimes called eglantine.

Eglantine Sponge, a rose gall. See Bedegnar.

Egleston, Thomas, American mineralogist: b. New York 9 Dec. 1832; d. there 15 Jan. 1900. He was graduated at Yale College in 1854, and at the School of Mines in Paris in 1860. He returned to the United States in 1861; and soon afterward was appointed director of the mineralogical collection and laboratory of the Smithsonian Institution in Washington. He established the School of Mines as a department of Columbia College, New York; and was professor of mineralogy and metallurgy there 1864–97. He was a United States commissioner to examine the fortifications of the Atlantic coast in 1868; and one of the jurors of the International Exposition at Vienna in 1873. He published: 'The Metallurgy of Gold and Silver in the United States'; 'A Catalogue of Minerals and Their Synonyms'; 'Life of Major-General Paterson, of the Revolutionary Army'; etc.

Egli, Johann Jakob, yō'hän yä'kōb ā'glē, Swiss geographer: b. Uhwiesen-Laufen, canton of Zürich 17 May 1825; d. 1896. He was made professor of geography at the University of Zürich 1883, after teaching in several schools, and did much for the accuracy, precision and uniformity of the nomenclature of geography. Among his earlier works are a thesis on the 'Discovery of the Sources of the Nile'; and a 'Geography of Switzerland.' Later works include 'Nomina Geographica: Versuch einer allgemeinen geographischen Onomatologie'; 'Geschichte der geographischen Namenkunde'; 'Neue Erdkunde'; 'Neue Handelsgeographie'; and 'Der Völkergeist in den geographischen Namen.'

Eg'linton and Winton, Archibald William Montgomerie, Earl of, English politician: b. Palermo, Sicily, 29 Sept. 1812; d. St. Andrews, Scotland, 4 Oct. 1861. He was lord-lieutenant of Ireland in 1852, and 1858–9. He was a well-known patron of the turf and field sports, and his name is associated with a splendid reproduction of a mediæval tournament, which he gave at Eglinton Castle in 1839.

Eg'mont, Justus van, Flemish painter: b. Leyden 1602: d. Antwerp 8 Jan. 1674. He was a pupil of Kaspar Van den Hoeck 1651 and later of Rubens. He established himself at Paris where he became court painter to Louis XIII. and Louis XIV., and was also one of the founders of the Royal Academy of Painting and Sculpture 1648. Among his works are: 'Portrait of Archduke Leopold William'; two 'Portraits of Philip IV. of Spain,' Vienna Museum; 'Maria de Medici,' Schleissheim Gallery; and 'Portrait of Queen Christine.'

Eg'mont, Lamoral, Count, Dutch statesman: b. La Hamaide, Hainault, 18 Nov. 1522; d. Brussels 5 June 1588. He entered the military service, and gained a high reputation under Charles V.; distinguished himself as general of cavalry under Philip II.; and was made stadtholder of the provinces of Flanders and Artois. His connection with the Prince of Orange and his most distinguished adherents made him an object of suspicion to the Spanish court, and Egmont, with Philip of Montmorency, Count Hoorn, became the victims of hate and fanaticism. The Duke of Alva, sent by Philip II. to the Netherlands in 1567 to reduce the insurgents, had Egmont and Hoorn treacherously seized, and caused them both to be executed at Brussels. Egmont died with heroic firmness. He had before written to Philip II., that "he had never joined in any undertaking against the Catholic religion, nor violated his duties as a loyal subject." But the Prince of Orange having taken the field as the champion of his country's wrongs, an example was thought necessary to strike terror into the insurgents. There can be little doubt that the Spanish king unnecessarily dreaded the influence of the gallant soldier but incapable politician. When the troubles in the Netherlands broke out, Egmont, moved by generous sympathy for his injured countrymen, rather than by any fixed principle of action, was found side by side with the Prince of Orange, in the van of the malcontents. But in opposition to the popular movement came his strong feeling of loyalty to Spain, and his still stronger devotion to the Roman Catholic faith. Thus, the opposite forces by which he was impelled neutralized each other, and, ever acting from impulse, he did not calculate the consequences of his conduct. When these consequences came he was not prepared to meet them. See Motley, 'Rise of the Dutch Republic,' Chap. II., part 3 (London 1861); Juste, 'Le Comte d'Egmont et le Comte Hoorn' (1862); Goethe, 'Egmont,' a drama; Brunelle, 'Éloge du Comte Egmont' (1820).

Egoism, ē'go-ĭzm (Fr. *égoisme;* Lat. *ego,* «I»), an ethical term used in the sense of selfishness; it is specially opposed to altruism. The word is sometimes used to denote a metaphysical system of subjective idealism, in which the Ego is the sole reality. See ALTRUISM; ETHICS.

E'goist, The, a novel by George Meredith, published 1879. It describes the experiences of Sir Willoughby Patterne, of Patterne, in selecting a wife.

Egret, ē'grĕt, a name given to those species of white herons which have the feathers of the lower part of the back elongated and their webs disunited owing to the absence of barbules at certain seasons of the year, that they form a soft and flowing train reaching to the tail or beyond it. Their forms are more graceful than those of the common herons. The name is properly applied to two American and two European species. The American egret (*Ardea egretta*) has the plumage white, or partly of a creamy color. The bird is found breeding from Florida to New York, and along the shores of the Mexican Gulf to Texas, but ranges much beyond these limits at other seasons. Its food consists of the smaller quadrupeds, small fishes, frogs, lizards, snakes, and insects, and it breeds like other herons. The long silky filaments of the back are hardly to be seen, except about the love season, which varies from early spring to midsummer according to climate; both sexes possess this train, and many are shot to obtain these feathers for ornamental purposes. The little white egret or snowy heron of America (*A. candidissima*) is much smaller and has a crest on the head which the large species lacks. In habits and distribution it is similar. The European egret (*A. alba*) is about 40 inches long, of a pure white plumage. It is common in southern Europe, but comparatively rare in the northern and central parts. The little egret (*A. garsetta*) is about 22 inches long from bill to end of tail; the plumage is white; from the hinder part of the head spring two narrow feathers four inches long. This species is most abundant in southern Europe and northern Africa; it occasionally wanders as far as England. The Louisiana heron (*A. tricolor*) and the reddish egret (*A. rufescens*) are often given the name, but the latter is white in winter only, and the former is partly colored at all seasons. Both are maritime birds, chiefly of the Gulf States.

Egusquiza, Juan Batista, hoo än' bä-tēs'-tä ā-goos-kē'thä, Paraguayan statesman: b. Asuncion 1845. He was a lieutenant-colonel in the war with Uruguay, Brazil, and the Argentine republic, later being appointed secretary of war, and attaining the rank of general. He was elected president of Paraguay 1894.

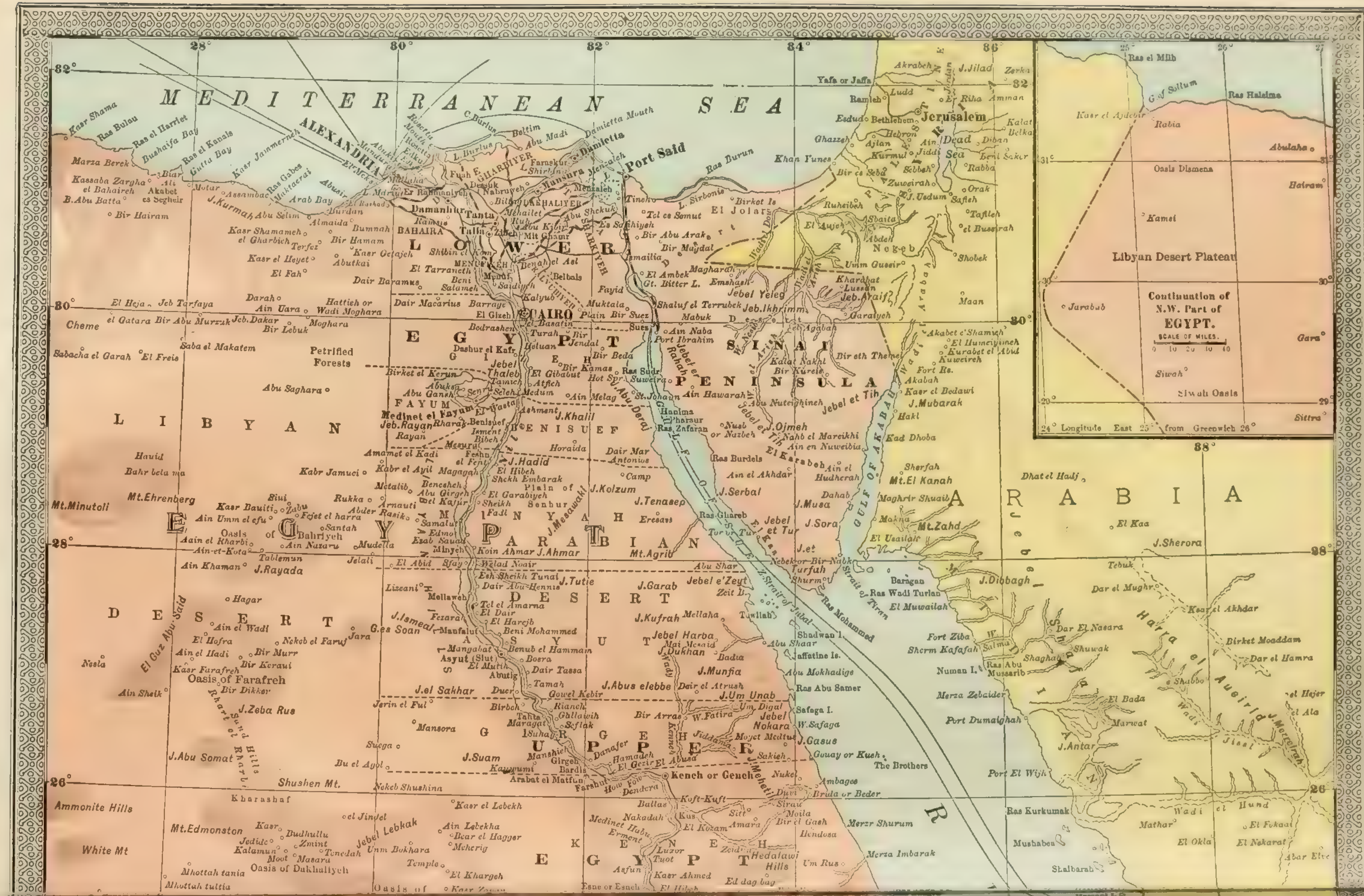
Eguzquiza, ā-gooth-kē'thä, **Rogliode,** Spanish painter: b. Santander 1835. He studied at the Ecole des Beaux Arts, Paris. Among his works are: 'Virgin with Rosary' (1859); 'Discussion Between Don Quixote and the Cure'; 'Michelangelo Beside the Body of Vittoria Colonna'; 'Charles V. at Convent of St. Juste' (1868), reproduced in popular engraving; 'Family Concert'; 'Master-at-Arms'; 'Portrait of Lady' (1878).

Egypt (Greek, **Αἴγυπτος,** *Aiguptos;* Hebrew, **מצרים**, *Mizraïm* or **מצור** *Mazor;* also called **פתרום**, *Pathros* (Is. xi, 11) and **ארץ חם** *Erez-Ham,* «The land of Ham» (Ps. cvi, 22). Assyrian , *Muzri;* Arabic مصر, *Misr* or *Masr.* In Hieroglyphics, , *Kamt*). Its present name is derived from the Greek, *Aiguptos* (meaning obscure). The Hebrew name *Mizraïm,* is the dual form of *Mazor* (a fortified or walled-in place or country), viz., two *Mazors,* «Upper and Lower Egypt.» But its principal name upon the monuments and in the papyri is *Kami* or *Kamt* «Black land», an appropriate name, owing to the black alluvial soil in the Nile Valley, in contradistinction to the reddish soil of the neighboring land on both sides of the Nile.

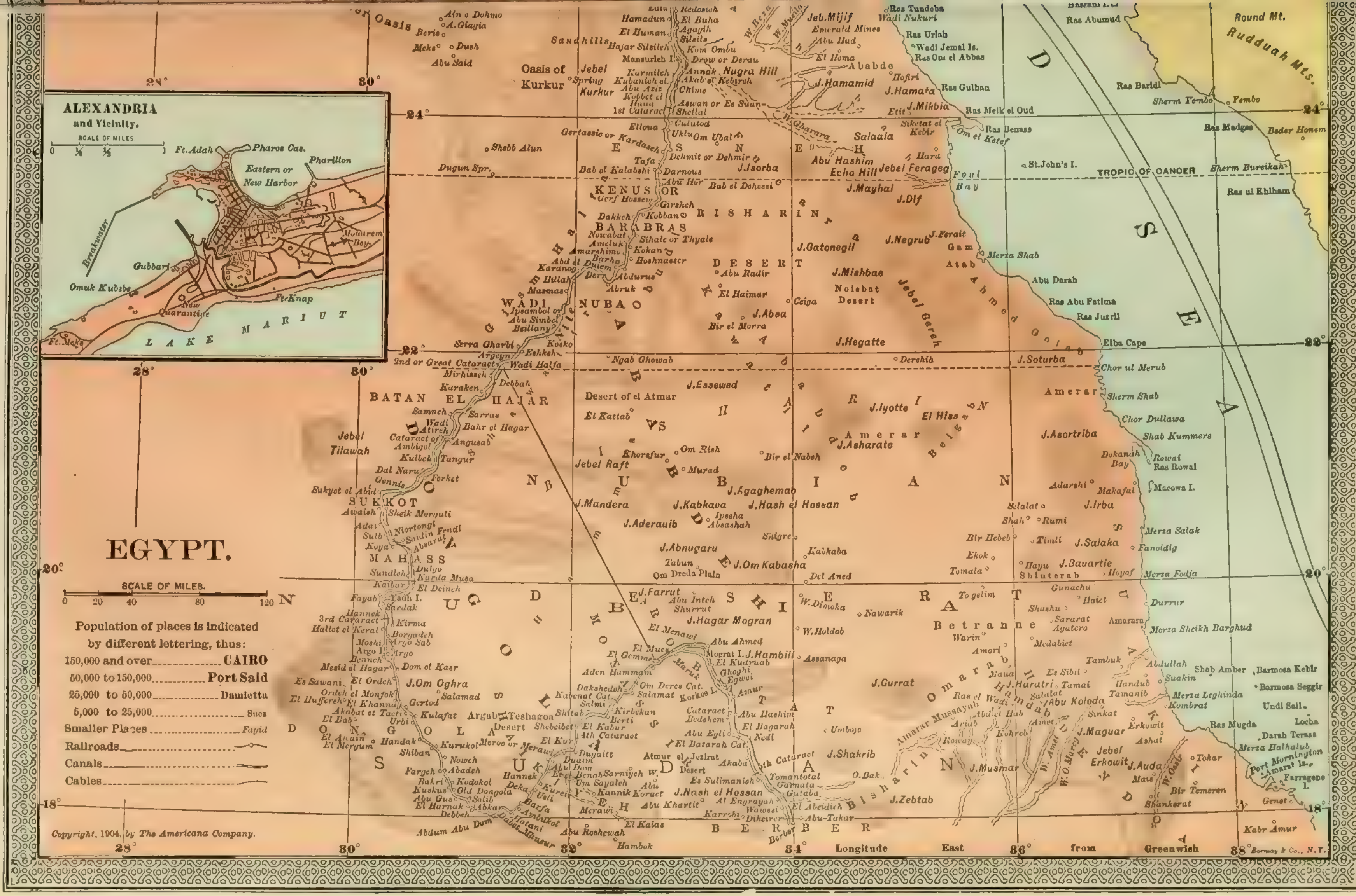
Modern Egypt is a vast country extending from the Mediterranean Sea, lat. 31° 35' to parallel 22° N. l., called Egypt Proper, thence southward to the British possessions in equatorial Africa, which latter region (known as the Egyptian Soudan) is jointly governed by Great Britain and Egypt. The eastern boundary is the Red Sea, and on the extreme northeast, Wady-el-Arish, Syria. The western boundary runs northwest to Tripoli, and thence southeast through the Libyan desert, to a point 200 miles west of Wady-Halfa. The area of Egypt is about 400,000 square miles, the country extending 675 miles north and south, and 500 miles east and west. Its population is about 11,000,000.

Topography.— In ancient as in modern times Egypt was always divided into the Upper and the Lower, or the Southern and Northern countries. At a very early period it was further subdivided into a number of departments, called *nomes,* varying in different ages; 42 was probably the usual number. A third great division, the *Heptanomis,* «seven *nomes,*» preserved in the modern (*Wustani*) «Middle Egypt,» was introduced at the time of the geographer Ptolemy, (first half of the second century A.D.). Each *nome* had a separate local government. In the 5th century A.D., Egypt was divided into six eparchies. Augusta Prima and Secunda on the east, Ægyptiaca on the west, Arcadia (the former Heptanomis), Thebais Proxima as far as Panapolis, and Thebais Supra to Philæ. Under the Mohammedans, the triple division, Misr-el-Bahri (Lower Egypt); el-Wustani (Middle); and es-Said (Upper) has prevailed, but the number of subdivisions has varied. At present there are altogether thirteen provinces.

Egypt is connected with Asia by the Isthmus of Suez, across which runs the great canal, about 100 miles long. The inhabited portion of Egypt is mainly confined to the valley and Delta of the Nile, the widest part of which does not exceed 120 miles, while in many parts of the valley it is only from 3 to 15 miles wide, and at the southern frontier of Egypt proper, only two miles. West of the Nile are several oases. Two ranges of lofty mountains, the Arabian Hills on the East



MEDITERRANEAN SEA
ALEXANDRIA
Port Said
Damietta
CAIRO
LOWER
EGYPT
LIBYAN
DESERT
ARABIAN
DESERT
UPPER
EGYPT
SINAI
PENINSULA
ARABIA
GULF OF AKABAH
Jerusalem
Dead Sea
Yafa or Jaffa
Bethlehem
Hebron
Ghazzeh
Khan Yunes
Ras Burun
El Arish
FAYUM
Medinet el Fayum
BENISUEF
Asyut (Siut)
Kench or Geneh
Luxor
Oasis of Farafreh
Oasis of Dakhuliyeh
Petrified Forests
Port Ibrahim
Suez
Akabah
Maan
The Brothers
Mt. Minutoli
Mt. Ehrenberg
Mt. Edmonston
Ammonite Hills
White Mt
Shushen Mt.
Libyan Desert Plateau
Continuation of N.W. Part of EGYPT.
SCALE OF MILES.
Siwah Oasis
Jarabub
Longitude East 25° from Greenwich 26°


EGYPT.
SCALE OF MILES.
0 20 40 80 120
Population of places is indicated by different lettering, thus:
150,000 and over CAIRO
50,000 to 150,000 Port Said
25,000 to 50,000 Damietta
5,000 to 25,000 Suez
Smaller Places Fayid
Railroads
Canals
Cables
ALEXANDRIA and Vicinity.
SCALE OF MILES
LAKE MARIUT
Eastern or New Harbor
Pharos Cas.
Pharillon
Ft. Adah
Gubbari
Omuk Kubbe
Breakwater
TROPIC OF CANCER
Longitude East from Greenwich
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and the Libyan on the West, enclose this valley. The Delta of the Nile is traversed by a network of primary and secondary channels, and is also intersected by numerous canals.

Seven principal channels or mouths were usually recognized in ancient times, the names of which, going from east to west, were the Pelusiac mouth, the Tanitic, the Mendesian, the Pathmitic, the Sebennytic, the Bolbitine and the Canopic. Now only the Bolbitine (called Rosetta) and the Pathmitic (Damietta), are in existence. The Nile has a current running seaward at the rate of 2½ or 3 miles an hour, and the stream is always deep enough for navigation. The water becomes a reddish brown during the annual overflow; it is esteemed highly salubrious. Near the sea are the Lakes Menzaleh, Birket-el-Mariut and other extensive but shallow lagoons.

The openings or lateral valleys of the hills confining the valley of the Nile are comparatively few, or, being little frequented, are not well known. Those on the east side with which we are best acquainted are the Wady-el Tili, "Valley of the Wanderings" (of the children of Israel), leading from the neighborhood of Cairo to the head of the Gulf of Suez, and that through which passes the road from Koptos to Kosseir on the Red Sea. A short distance west of the Nile and above the Delta is the fertile valley of Fayoum, in the northwest and lowest part of which is the Birket-el-Kerun lake, fed by a canal or branch from the Nile. The level of the lake is now 130 feet below that of the Mediterranean. This lake, formerly known as Lake Moeris, covered a far larger area, and by means of sluices and other works was utilized for irrigation purposes. The deserts on the west bank of the Nile generally present to view plains of gravel or of fine drifting sand; on the east, the scene is varied by rocks and mountains.

Climate.— The atmosphere in Egypt is extremely clear and dry, the temperature regular and hot, though the heat is tempered during the daytime for seven or eight months of the year by the strong wind which blows from the north, and which enables sailing vessels to ascend the river against the stream. The winter months are the most delightful of the year, the air being cool and balmy, and the ground covered with verdure; later, the ground becomes parched and dry, and in spring the suffocating *khamseen,* or samoom, frequently blows into the Nile valley from the desert plains on each side of it, raising lofty clouds of fine sand, and causing great annoyance, until the rising of the river again comes to bless the land. It rains but rarely, except near the seashore. At Memphis the rain falls perhaps three or four times in the course of a year, and in Upper Egypt only once or twice, if at all; showers of hail sometimes reach the borders of Egypt, but the formation of ice is very uncommon. Earthquakes are occasionally felt, and thunder and lightning are neither frequent nor violent. Egypt is not remarkably healthy, especially in the Delta, where ophthalmia, diarrhœa, dysentery, and boils are somewhat prevalent. But many invalids now winter in Egypt, especially in the neighborhood of Cairo, or higher up the river, where the air is dry and pure.

The Nile, Irrigation and Agriculture.— The great historic river Nile, Greek Neilos; Latin Nilus; Heb. Yeor or Shihor, Arabic, En-Neel (black), is 3,400 miles in length, the longest in Africa and one of the great rivers of the world. It divides at lat. 30° 15', just below Cairo into two main streams, the one entering the sea by the Rosetta mouth on the west, the other by the Damietta mouth on the east These two streams carry the bulk of the Nile water to the Mediterranean, and inclose a large portion of the territory known as the delta, from its resemblance to the Greek letter Δ and which owes its existence to the deposits of alluvial matter brought down by the stream. The most remarkable phenomenon connected with the Nile is its annual regular increase, arising from the periodical rains which fall within the equatorial regions and the Abyssinian Mountains. As rain rarely falls in Egypt, the prosperity of the country entirely depends on this overflowing of the river. On the subsiding of the water the land is found to be covered with a brown slimy deposit, which so enriches the soil that with a sufficient inundation, it produces two crops a year, while beyond the limits of the inundation there is no cultivation. The Nile begins to rise about the middle of June, and continues to increase until about the end of September, overflowing the low lands along its course, the water being conveyed to the fields by artificial courses where natural channels fail. After remaining stationary for a short time, the river rises again but subsequently begins to subside, showing a markedly lower level in January, February and March, and reaching its lowest in April, May and early June. The overflow water is now to a great extent managed artificially by means of an extensive system of reservoirs and canals, so that after the river subsides it may be used as required. A certain proportion of the fields, after receiving the overflow and being sown, can ripen the crop without further moisture; but many others always require artificial irrigation. Steam pumps are now largely used in northern Egypt. Latterly the government has tried to make the farmers less and less directly dependent on the inundation and the great barrage of the Nile below Cairo, the largest weir in the world, is one means to this end, the great dam or barrage at Assouan being another.

The native methods of raising water for irrigation are chiefly by the *sakieh,* or water wheel, and the *shádouf.* The first consists of a horizontal wheel turned by one or two oxen, which sets in motion a vertical wheel, around which are hung a number of earthen jars, this wheel being sunk into a reservoir connected with the river. The jars thus scoop up the water and bring it to a trough on a level with the top. Into this trough each jar empties itself in succession, and the water is conducted by an inclined channel into the cultivated ground adjoining, which may have been previously divided into compartments of 1 or 2 yards square by raising the mold into walls or ridges of 5 or 6 inches in height. Into these compartments the cultivator forms an entrance for the water, by depressing a little space in the ridge or wall with the sole of his foot; and this overlooking of the channels of irrigation, and adjustment of the openings from one compartment to the other with the foot, is continued till the cultivator is assured by the growth of the plants that each compartment is daily and duly supplied with its proper quantity of water. The second means of raising water, namely, the *shádouf,* consists of a leathern bucket slung at one end of a pole which has a weight at the other, and sways up and down on a vertical support, a contrivance by which the cultivator is enabled to scoop up the water considerably below his feet, and raise it with comparative ease to the mouth of a channel on a level with his breast. The latter mode of raising water is of great antiquity, and is depicted on the walls of the ancient tombs of Egypt, and also in the sculptures of Nineveh. A sufficient rise of the river (the rise varies at different points) is essential to secure the prosperity of the country; and as the water subsides, the chaplet of buckets on the sakieh is lengthened, or several *shádoufs,* rising one above the other on the river bank, are required. Should the Nile rise above the requisite height it may do great damage; on the other hand if it should not attain the ordinary height, there is a deficiency of crops; but with rare exceptions, the inundations are regular and nearly uniform. See DELTA; IRRIGATION; RIVER.

The Nile Barrage.— One of the greatest wonders of modern times, rivalling the Pyramids of the Ancient is the Nile Barrage. Thanks to Lord Cromer and Lord Kitchener, the stupendous work at Assouan and Asyut of taming the Nile, is an accomplished fact. Egypt is no more subject to the caprices of the Nile. The precious fertilizing fluid coming down from equatorial Africa by way of Bahr-el–Ghazal and Bahr-el-Abyad are halted and stored in an immense reservoir. Millions of acres on both sides of the river are reclaimed. Egypt's prosperity always depended upon the Nile. The «seven year famine» recorded in Scripture was the result of insufficient irrigation, and there is an earlier instance of a similar character recorded in hieroglyphics on the rocks of Assouan. After many centuries of inertness and decay Egypt lifts up her head and promises to become again the storehouse of the East.

Oases.— The fertile spots peculiar to the deserts of Africa are found in Egypt along the hollow region of the Libyan Desert, parallel to the general direction of the valley of the Nile, and above 80 miles west of it. The Great Oasis or Wah-el-Khargeh, lies immediately west of the Thebaid, and has a length of 100 miles. About 50 miles west of the northern extremity of this oasis lies the Wah-el-Dakhileh 24 miles long and 10 miles broad. West by south from the Fayoum the date groves of the Little Oasis, or Wah-el-Baharieh, display their unusual verdure. In this fertile spot artesian wells are numerous, and some of ancient construction have been discovered which have a depth exceeding 400 feet. On the road between this oasis and that of El Dakhileh, inclining to the west, occurs half way the Wah-el-Faráfrah of small extent. West of the Fayoum, and about 200 miles from the Nile, lies the oasis of Siwah. The inhabitants of this secluded spot, though tributary to Egypt, are in language and manners wholly Libyan. The region of the oases terminates toward the north in the desert of the Natron lakes. See OASIS.

Zoology.— Owing to the absence of forests in Egypt there are few wild animals, the principal species being the fox, jackal, hyena, the wild ass, the ibex in the Red Sea hills and several kinds of antelope. The chief domestic animals are camels, horses, asses, horned cattle, and sheep. The hippopotamus is no longer found in Egypt, though it is met with in the Nile above the cataracts, and the crocodile is found in Upper Egypt. Among the birds are three species of vultures (one of which is very large, individuals sometimes measuring eight feet across the wings), eagles, falcons, hawks, buzzards, kites, crows, linnets, larks, sparrows and the beautiful hoopoe, which is regarded with superstitious reverence. Pigeons, quail and various kinds of poultry are very abundant, and numerous aquatic birds, and pelicans. The ostrich is found in the deserts. Among the reptiles are the horned viper (*cerastes*) and the asp (*naja haje*), both poisonous. Fishes abound in the Nile and lakes and furnish a favorite article of food. Water-fowl are plentiful, and were anciently prepared and salted like fish. The sacred ibis is still a regular visitor during the inundation, and the pelican is found in the northern lagoons. Among the countless insects are the sacred beetle, (*Ateuchus sacer*) and the migratory locust. Many of the animals, birds, and reptiles were held sacred by the Ancient Egyptians; whoever killed a sacred animal, an ibis or a hawk, was put to death. If a cat died a natural death every person in the house shaved his eyebrows; if a dog died, the whole body and the head were shaved. The cats were sacred to the goddess Bast and were buried at Bubastis, and the dogs in the vaults of their own cities, field-mice and hawks at Buto, the ibis at Hermopolis, and other animals where they were found lying. Of all animals the sacred bull, Apis, was the most revered. His chief temple was at Memphis. The cow being sacred to Isis, was thrown into the Nile, which was considered sacred; and the Apis bull was buried in the Serapeum near Memphis.

Botany.— The few trees found in Egypt include the date-palm, tamarisk, sycamore, Christ's-thorn, carob, and two species of acacia. Many trees have been planted in recent times, especially about Cairo, such as the lebbek (*Albizzia Lebbek*) and the eucalyptus. The papyrus plant, once so important, is now to be found only in one or two spots. A paper was manufactured from it, which was supplied to all the ancient world. Boats, baskets, cords, and shoes were also made from it. Wine was abundantly produced in ancient Egypt, and the sculptures bear ample testimony to the extent to which the ancient Egyptians indulged in wine and beer or other intoxicating beverages. The vine is still much cultivated, but little or no wine is made, as it can easily be imported. The following plants are sown immediately after the inundation begins to subside, and are harvested three or four months later: wheat, barley, beans, peas, lentils, vetches, lupins, clover, flax, lettuce, hemp, coriander, poppies, tobacco, watermelons and cucumbers. The following plants are raised in summer chiefly by means of artificial irrigation: durra, maize, onions, henna, sugar-cane, cotton, coffee, indigo, and madder. Several varieties of dates, and grapes are the most common, but other fruits such as figs, pomegranates, apricots, peaches, oranges, lemons, citrons, bananas, mulberries and olives are plentiful. The lotus or water-lily is the chief species of flower found in Egypt. There is a high coarse grass called *halfa* and various kinds of reed and canes.

Geology and Mineralogy.— Granite, eocene limestone and sandstone are the principal rock formations found in Egypt. But in the Nile Valley from 25° N. L. to the Fayoum, sandstone predominates. At Syene, the southern extremity of Egypt proper, granite predominates. Its quarries have supplied the materials for the obelisks and many colossal statues of Ancient Egypt. A great extent of the country is covered with moving sands; the soil bordering the Nile, owing to the encroachment of the shifting sands of the desert, consists of an argillaceous earth or loam, more or less mixed with sand. This sedimentary deposit shows no trace of stratification. In addition to those already mentioned, there are various other minerals, which were employed in architecture, sculpture, etc. These include syenite, basalt, alabaster, breccia, and porphyry. Among other valuable products of Ancient Egypt were emeralds, gold from the mines in Upper Egypt, iron from the desert plains of Nubia, and natron from the lakes in the Oasis of Ammon (hence name Ammonia, Latin *sal-ammoniacum*). Bitumen, salt, and sulphur are also among the minerals of Egypt.

Inhabitants.— The peasant class, or Fellahîn, are the most numerous and are indigenous. They are to a certain extent descendants of the Ancient Egyptians, but they have been subjected to crossings and have embraced Mohammedanism. Next in number are the Copts, the descendants of the ancient Egyptians who embraced and still cling to the Christian religion. (See COPTS). Though comparatively few in number (about 600,000), their education and useful talents enable them to hold a respectable position in society, filling the posts of clerks, accountants, etc. With these aboriginal inhabitants are mingled in various proportions, Turks, Arabs (partly Bedouins), Armenians, Berbers, negroes, and a considerable number of Jews, Greeks, and other Europeans. The Turks hold many of the principal offices under the government. The great bulk of the people are Mohammedans, the Christians being only about 7.5 per cent. The Egyptians in the mass are quite illiterate, but under the supervision of the ministry of public instruction progress is being made. In 1902 there were about 10,000 schools with 228,000 pupils. The language in general use is Arabic.

The Fellahin, the most superior type of the Egyptian, are a fine race, handsome, of excellent physique, and courteous in their manners. In northern Egypt they are of a yellowish complexion, growing darker toward the south, until the hue becomes a deep bronze. Mr. Lane, the best authority upon the subject, speaks highly of their mental capacity, and gives them credit for uncommon quickness of apprehension and readiness of wit. They are highly religious, and are generally honest, cheerful, humane, and hospitable. But these are exceptions in a mixed population of Bedouins, negroes, Abyssinians, Turks, Syrians, Greeks, Armenians, Jews, and Europeans. Judging from the language and the physical condition of the mummies of Ancient Egypt, the population must have been of mixed origin, part Asiatic and part Nigritic; and there seems also to have been an aboriginal race of copper color, with rather thin legs, large feet, high cheek-bones, and large lips; both types are represented on the monuments. The statements of Greek writers that a system of castes prevailed in Egypt are erroneous. What they took for castes were really conditions of society, and the different classes not only intermarried, but even, as in the case of priests and soldiers, held both employments. As in all bureaucracies, the sons often obtained the same employments as their fathers.

Government.— The ancient government of Egypt was a monarchy, limited by strict laws and by the influence of powerful hereditary privileged classes of priests and soldiers. The priests were the ruling class. They were restricted to a single wife, and if polygamy was permitted to the rest of the people, it must have been very seldom practised. The marriage of brothers and sisters was permitted. The laws were wise and equitable, and appear to have been rigidly enforced. Murder was punished with death, adultery by bastinadoing the man and by cutting off the nose of the woman, forgery by cutting off the culprit's hands. Imprisonment for debt was not permitted, but a man could pledge to his creditors the mummies of his ancestors, and if he failed in his lifetime to redeem them, he was himself deprived of burial. Women were treated with respect, and the laws and customs seem to have been so favorable to them that their condition in Egypt was much higher than in any other nation of antiquity. The military force of Egypt was a species of hereditary militia, which formed one of the leading classes of society, and in time of peace cultivated the land, of which it held a large portion. The king's guards, some few thousands in number, were the only standing army. The number of soldiers in the military class is stated by Herodotus at 410,000, which probably included all the men of that class able to bear arms. It is improbable that the whole of them ever were or could have been brought into the field at once. Their arms were spears and swords, and they were protected by large shields.

At the present day the government is in the hands of the viceroy or khedive, as supreme ruler, who pays an annual tribute of about $3,000,000 to Turkey, and is assisted by a ministry formed on the model of those of western Europe. The government is carried on under the supervision of Great Britain. After the defeat of Arabi Pasha in 1882 the authority of the khedive was restored by British troops. The British have initiated various reforms in the administration, such as the establishment of new native tribunals. The administration of justice is somewhat complicated. There are besides native tribunals, consular courts, mixed tribunals, and religious courts. The financial condition of Egypt is being slowly improved under British management. The Egyptian army is under the command of an English general, and officered partly by Englishmen and partly by Egyptians; its total strength is 18,100, while the English army of occupation, which, since the rebellion of 1882, has remained in Egypt, has a strength of 5,600.

Commerce and Industry.— Agriculture, manufacture and trade were carried on in Egypt in the very earliest days. Upon the ancient monuments we find representations of the mechanical arts, where we see the blow-pipe, bellows, siphons, press, balance, lever, saw, adze, chisel, forceps, syringe, harpoon, razors; we have also glazed pottery, the potter's wheel, and the kiln; and dated specimens of glass of the time of (Thothmes III. 1445 B.C.). Gold-beating, damascening, engraving, casting, inlaying, enameling, wire drawing, and other processes were practised. Weapons and other instruments of war, shields, cuirasses of quilted leather, helmets, spears, clubs, maces, daggers, bows, battle-axes, pole-axes, hatchets, and falchions are shown. The testudo, ladders, torches, and lanterns were also in use. In agriculture the plow, hoe, sickle, and other implements were employed. The processes of growing and preparing flax, and making it into thread, string, ropes, and cloth, as well as the looms employed, are all depicted. Mats and baskets were beautifully made, either of the halfa grass or palm leaves, or of the outer rind of the papyrus plant, which was used in making paper. Coffins or wooden sarcophagi were chiefly of sycamore or cedar, covered with stucco and richly painted. The ordinary boats of the Nile were of planks of the acacia, and had two rudders or large oars, with a sail of cloth frequently painted or worked in colored patterns. Many of the vessels of burden were of great size. The boats made of papyrus were mostly punts for fishing, or for gliding through the canals of the Delta. Implements for painting, ladles, bells, crucibles, and surgical instruments have also been found. The commerce of the Egyptians with neighboring nations enriched the country with slaves, cattle, gems, metals, rare animals, and objects of curiosity. The Egyptians expended enormous wealth on the tombs and furniture of the dead, and the paintings acquaint us fully with the various ceremonies followed. In embalming they excelled.

To-day the one branch of industry for which Egypt is peculiarly adapted by nature is agriculture, and large quantities of cereals, cotton, and other agricultural produce are raised; yet, generally speaking, agriculture is still in a very low state, the necessary consequence of the wretched condition and extreme poverty of those engaged in it. The Egyptians still adhere to their ancient custom of uniting the followers of each business or profession into a guild, governed by their sheikh, who acts, if need be, as their representative. These guilds are exceedingly numerous, as might be expected among a people whose social organization dates from a remote antiquity.

Among the crops which the Egyptians grow with success, cotton is the most popular and profitable. (See COTTON.) The cotton plant of Egypt differs materially, in one respect at least, from that of other countries. In America it has been found unprofitable to allow the plants to continue in the ground longer than one year. In Egypt, however, the case is different, for the cotton plant yields five, and sometimes six, consecutive crops before replanting is found to be necessary. This being the case, a cotton field once planted is a secure investment for at least five years, and as peasants of the Nile do not love labor, more cotton is grown in Egypt in proportion to the population engaged in agriculture than in any other part of the world. In both Upper and Lower Egypt cotton is therefore the standard crop, and as it is not troubled with worms as in America, and by the method of irrigation the farmer can give it exactly the right portion of moisture and no more, the crop is tolerably reliable. The boats transport the product to Cairo or to Alexandria, the leading cotton markets. The exchange in the former city is located on one of the principal streets, while the market proper is in a public square opposite the great Mosque of Hassan. The time of the river journey to Alexandria is from six days to six months, but, as the Mohammedans say, "God is great, and there is no hurry."

The business of tanning is also one of the industries in which the Egyptians perfectly succeed, by a process peculiar to themselves. They make excellent morocco leather, which is goatskin dressed and dyed in a particular manner. The pottery of Egypt also deserves a word of praise, chiefly for the merit of the bardaks or water-jars. Coarse cotton cloths, and cloths of mixed cotton and wool, are largely made in the country; silk is cultivated to some extent; and the cultivation of the sugar-cane received a great impulse from the viceroy, Ismail, who, at a great expense, erected a number of mills. Goods carried by the Suez Canal do not form part of the commerce of the country, and the transit trade proper is of little importance. The exports of Egypt for 1902 amounted to £19,451,460 and the imports £16,649,145. The public debt (1901) amounts to £103,264,540. The railway system, under government control, embraces 2,173 miles and nearly 2,877 miles of telegraph lines.

Education.—The chief seat of Koranic education is the famous University of El Azhar, founded by Saladin about 1170, and still employing the same methods of instruction that were originally in use. The faculty numbers about 350 moulahs or priests, many having wide reputation for scholarship; the students, some 10,000 or 12,000, are from India, Turkey, Syria, Afghanistan, and other Mohammedan countries. There is no regular university organization, nor arrangement for the endowment of departments or founding of chairs. Anyone who can collect a class is allowed to lecture. Frequently the professors practice law, hold clerkships, or are connected with mosques in Cairo. There is no charge for instruction. Three fourths of the students study theology, though other "ologies" and geography, philosophy, and astronomy are also taught. There are also in Cairo eight colleges and professional schools of excellent grade. The Egyptian ministry of public instruction has under its direction schools for engineering, medicine, law, and agriculture, two technical schools, and two normal training schools for teachers. A military school is under the management of the war office. In addition to the schools under the direction of the ministry of public instruction are 868 other schools under the inspection of the ministry, with 1,364 teachers and 26,831 pupils. The 'Statesman's Year-Book' for 1903 gives a total of about 10,000 schools with 17,000 teachers and 228,000 pupils. There are 187 schools attached to Protestant and Roman Catholic missions, and 43 European private schools. In 1897 the literate native population amounted to but 5.8 per cent.

Justice.—The administration of Egyptian justice is extremely complicated. There are four classes of courts: (1) The *mehkemmehs*, or Mohammedan courts, conducted according to the precepts of the Koran and the principles of the Mohammedan religion, and retaining jurisdiction in matters of personal law only. (2) The so called native tribunals, composed of 46 summary tribunals, 7 central tribunals, and a court of appeals at Cairo. These deal with crimes committed by natives and civil actions between natives. (3) The consular courts, which deal with civil cases between foreigners of the same nationality, and also try criminal cases in which the accused are foreigners, not within the jurisdiction of the mixed tribunals. (4) The mixed tribunals, dating from 1876, which have jurisdiction in all matters civil and commercial between natives and foreigners, or between foreigners of different nationalities. These courts are admittedly successful. A code of laws has been published for the greater systemization of native jurisprudence.

Railways, Telegraphs, and the Post-Office.— On 1 Jan. 1902 there were 2,173 miles of railway, 1,393 miles belonging to the state and 780 to private companies. The private roads are largely narrow-gauge spurs or feeders connecting the sugar-mills and other manufacturing establishments with the public lines. Two thirds of the tracks are in Lower Egypt. The above figures were exclusive of the Cairo suburban line, 16 miles in length, to Helwan, and the Sudan military railway to Khartum. The "Cape to Cairo" line is being gradually extended. At the close of 1902 the telegraphs belonging to the Egyptian government had a total length of 2,877 miles, the length of the wires being 10,874 miles. By concessions, the Eastern Telegraph Company has lines across Egypt from Port Said to Suez and from Alexandria (via Cairo) to Suez. There were 340 post-offices in the towns of Egypt, 254 travelling offices, and 408 localities where rural post had been established.

History.— The history of Egypt, prior to the beginning of the ancient empire 4000 B.C., is entirely mythical. The history divides itself into six great periods: (1) The Pharaohs or native kings; (2) the Persians; (3) the Ptolemies; (4) the Romans; (5) the Arabs; (6) the Turks.

The Pharaohs.— The main sources of its history under the Pharaohs are the Scriptures, the Greek writers Herodotus, Diodorus, and Eratosthenes, fragments of the writings of Manetho (an Egyptian priest in the 3rd century B.C.) From the Scriptures we learn that the Hebrew patriarch Abraham went into Egypt because of a famine that prevailed in Canaan. He found the country ruled by a Pharaoh, Egyptian, *per āa*, meaning "Great house," the Egyptian term for king. The date of Abraham's visit, according to the chronology of the Hebrew text of the Bible, was 1920 B.C.; according to the Septuagint, 2551; while Bunsen fixed it at 2876. Nearly two centuries later Joseph, a descendant of Abraham, was sold into Egypt as a slave to Potiphar, the captain of the guards of another Pharaoh, whose prime minister or grand vizier the young Hebrew eventually became. Joseph's father, Jacob, and his family, to the number of 70, accompanied, as Bunsen conjectures, by 1,000 or 2,000 dependents, followed their fortunate kinsman into Egypt, where they settled in a district called the land of Goshen. There they remained until their numbers had multiplied into two or three millions, when under the lead of Moses they revolted and quitted Egypt to conquer Canaan.

Ptolemaic Period.— When Alexander's army occupied Memphis the numerous Greeks who had settled in Lower Egypt found themselves the ruling class. Egypt became at once a Greek kingdom, and Alexander showed his wisdom in the regulations by which he guarded the prejudices and religion of the Egyptians. He founded Alexandria as the Greek capital, which became the emporium of commerce and centre of learning for several centuries. Ptolemy I. was succeeded by Ptolemy II., Philadelphus. He was successful in his external wars, built the Museum, founded the famous library of Alexandria, purchased the most valuable manuscripts, engaged the most celebrated professors, and had ordered seventy Hebrew sages to translate the Hebrew Scriptures into the Greek language, hence known as the Septuagint, and the Egyptian history to be written by Manetho. His successor Ptolemy III., Euergetes, pushed the southern limits of his empire to Axum. Ptolemy IV., Philopator (221–204 B.C.) warred with Antiochus, persecuted the Jews, and encouraged learning. Ptolemy V., Epiphanes (204–180 B.C.) experienced repeated rebellions, and was succeeded by Ptolemy VII., Philometor (180–145 B.C.) and Euergetes (145–116 B.C.) by Ptolemy X., Soter II. and Cleopatra, till 106 B.C. and by Ptolemy XI., Alexander I. (87 B.C.) under whom Thebes rebelled; then by Cleopatra, Berenice, Ptolemy XII., Alexander II. (80 B.C.), and Ptolemy XIII., Neos Dionysius (51 B.C.), and finally by the celebrated Cleopatra. After the battle of Actium (31 B.C.) Egypt passed into the condition of a province of Rome, governed always by a Roman governor of the equestrian, not senatorial, rank.

The Egyptians have continued building temples and covering them with hieroglyphic inscriptions as of old; but on the spread of Christianity the older religions lost their sway. Then the Christian catechetical school, arose in Alexandria, which produced Clemens and Origen. Monasteries were built all over Egypt; Christian monks took the place of the pagan hermits, and the Bible was translated into Coptic.

On the division of the great Roman empire (337 A.D), in the time of Theodosius, into the Western and Eastern empires, Egypt became a province of the latter, and sank deeper and deeper in barbarism and weakness. It then became the prey of the Saracens, 'Amribu-el asr, their general, under the Caliph Omar, taking Alexandria, the capital, by assault. This happened 641 A.D., when Heraclius was the emperor of the East. As a province of the caliphs, it was under the government of the celebrated Abbassides — 'Harun er-Rashid and Al-Mamon and that of the famous Sultan Saladin. The last dynasty was, however, overthrown by the Mamelukes (1240), and under those formidable despots the last shadow of former greatness and civilization disappeared. Selim, Sultan of the Turks, eventually (1516–17) conquered the last Mameluke sultan, and Egypt became a Turkish province, governed by a pasha. After this it was the theatre of internal wars by the Mameluke beys against the Turkish dominion, which was several times nearly extinguished. Confusion and civil war between the different factions of the Mamelukes continued to prevail till 1798, when the French invasion under Napoleon Bonaparte united their chiefs in self-defense; but the Mameluke army was all but annihilated in the battle of the Pyramids. The French then conquered the whole of Egypt and held it till 1801, when they were driven out by the British under Abercromby and Hutchinson.

On the expulsion of the French the Ottoman Porte effectually urged its claim to sovereignty, and the accession of the Albanian soldier, Mohammed 'Ali to the pashalic in 1805, imparted a galvanic prosperity to Egypt, by the merciless destruction of the turbulent Mamelukes (whom a disastrous British expedition in 1807 vainly sought to restore), the formation of a regular army, the increase of security, the improvement of the irrigation, and the introduction of the elements of European civilization. In 1816 Mohammed 'Ali reduced part of Arabia, brought it under his sway by the generalship of his son, Ibrahim; in 1820 he annexed Nubia and part of the Sudan, and from 1821 to 1828 his troops, under Ibrahim, occupied various points in the Morea and Crete, to aid the Turks in their war with the insurgent Greeks. The Egyptian fleet was annihilated at Navarino, and Ibrahim remained in the Morea till forced to evacuate by the French army, under Maison, in 1828. In 1831 Ibrahim began the conquest of Syria, and in the following year totally routed the Ottoman army at Koniya, after which the Porte ceded Syria to Mohammed 'Ali on condition of tribute. War breaking out again, the victory of Nisib in 1839 would perhaps have elevated him to the throne of Constantinople; but the quadruple alliance in 1840, the fall of St. Jean d'Acre to the British, and the consequent evacuation of Syria, compelled him to limit his ambition to the pashalic of Egypt. In 1848 Mohammed 'Ali became imbecile (he died in 1849), and his son Ibrahim sat on his throne for two months, when he died, and 'Abbâs Pasha, Mohammed Ali's grandson, succeeded him, and was superseded in turn (1854) by Sa'id Pasha, youngest son of Mohammed 'Ali. M. de Lesseps then obtained the coöperation, hitherto withheld, of the Egyptian government in his scheme of the Suez Canal, which was opened in 1869. Sa'id was succeeded (1863) by his nephew, Ismail, son of Ibrahim, who. by a firman purchased from the Sultan, (1866) the hereditary title of Khedive. He obtained the hereditary title of Khedive to the throne of Egypt, direct from father to son, instead of descending, according to Turkish law, to the eldest male of the family, and in 1872 the Sultan granted to the Khedive the rights (withdrawn in 1879) of concluding treaties and of maintaining an army, and virtually gave him sovereign powers. Thus secure on an hereditary throne, Ismail began a series of vast internal reforms, built roads, bridges, lighthouses, railways, and telegraphs, reconstructed the postal service, improved the harbors at Suez, Port Sa'id, and Alexandria, supported education, and introduced mixed courts of law. Extending his dominions southward, he annexed Dar-Fûr in 1874, and in that and the following year further conquests were made. The condition of the finances led to the establishment of "dual control" by Great Britain and France, and in 1879 Ismaîl was forced to abdicate under pressure of the British and French governments, and was replaced by his son, Tewfik. His position was soon threatened by the so-called National party with Arabi Pasha at its head, who aimed at his deposition and at the abolition of European intervention. In May 1882, a rising took place in Alexandria, when many Europeans were killed and their houses pillaged. The Khedive fled from Cairo, where Arabi remained autocrat. The French refusing to interfere, Great Britain determined to act, and on 11 July a British fleet bombarded the forts at Alexandria, causing the rebels to retreat. In August a force under Sir Garnet (afterward Lord) Wolseley landed at Ismailia, and on 13 September Arabi's forces were totally defeated at Tel-el-Kebir, and the rebellion crushed. Arabi and his associates being banished. Before this a rebellion against Egyption rule had broken out in the Sudan under the leadership of Mohammed Ahmed, who professed to be the Mahdi or divinely-sent Mohammedan conqueror. His followers soon became numerous, defeated Egyptian troops that opposed them, and threatened the existence of all the Egyptian garrisons in the Sudan. In 1883 they annihilated an Egyptian force under Hicks Pasha near El Obeid in Kordofan, and in 1884, Osman Digna, as representing the Mahdi, defeated another force under Baker Pasha near Suakim. British troops were now despatched to Suakim, and at El Teb and Tamai severe defeats were inflicted on the Arabs by Gen. Graham. Meantime Gen. Gordon had been sent to Khartum to withdraw the garrisons from the Sudan, but he was shut up in the town for nearly a year, and perished before the relief expedition under Sir Garnet Wolesley could reach him (January 1885). The Sudan was then given up, and the southern boundary of the Egyptian dominions fixed at Wady Halfa.

In 1892 Tewfik died, and was succeeded by his son, Abbas Hilmi, who is the seventh viceroy and third khedive of Egypt. In 1896 an Anglo-Egyptian expedition for the reconquest of the lost provinces was despatched under Sir Herbert (now Lord) Kitchener. Dongola was soon occupied. Abu Hamed was captured in the following year, and (8 April 1898), the insurgents were defeated in a battle near the confluence of the Atbara. Finally (2 Sept. 1898) the forces of the Khalifa, as the Mahdi's successor was called, were defeated with great slaughter at Omdurman, near Khartum. The territory thus reconquered was placed under a governor-general, and was rapidly organized. A subsequent attempt of France to occupy Fashoda and enforce a claim to the Bahr-el-Ghazal "Blue River" valley led to some friction with Great Britain. See ALEXANDRIA; CAIRO; CLEOPATRA; EMIN PASHA; GORDON, GEN. C. G.; KHEDIVE; MAHDI, MOHAMMEDANISM; MOSES; NAPOLEON; PHARAOH; PTOLEMY; SUDAN; SUEZ CANAL; TEWFIK; WADY HALFA.

Religion.— The ancient Egyptian religion was a philosophical pantheism, the various attributes of the Deity being divided among the different gods of the Pantheon. Unlike the Greek, where a god was honored in a separate temple, each Egyptian divinity was accompanied by a *paut*, or "company" of companion-gods. The principal nomes and cities had each a family group of gods, consisting of a parent deity, a wife and sister, and a son. Thus Ptah or Hephaistos, the eponymous and principal god of Memphis, formed a triad with the goddess Sekhet or Bast, and I-em-hetep; at Thebes the triad was Amen-ra, Mut, and Khons; and at Apollinopolis Magna, Har-bahud (Horus), Hathor, and Harpakhrut (Harpocrates). These triads were usually, if not always, accompanied by inferior deities completing the *paut;* and personifications of the elements, passions, and senses were introduced. The worship of some triads, however, became universal — that of Osiris, Isis, and Horus being found all over Egypt at the earliest period. The gods, indeed, are stated by the Greeks to have been divided into three or more orders or systems. The gods of the Memphite order were Ptah, Ra, Shu, Seb, Osiris, Set, or Typhon, and Horus; and Amen, Mentu, Atmu, Shu, Seb, Osiris, Set, Horus, and Sebeq, according to the Theban system. Difficulties arise from the tendency to fuse different gods into one, particularly at a later period; Amen-ra, for example, being identified with Horus; and Horus, Ra, Khnum, Mentu, and Tum being merely considered the sun at different periods of his diurnal course.

A few foreign deities became at the close of the 18th dynasty engrafted upon the religious system — as *Bar*, Baal; *Ashtarata*, Ashtaroth; *Anta*, Anaitis; *Ken*, Kiun; *Reshpu*, Reseph; *Set*, or Sutekh, sometimes identified with Baal. All the gods had human passions and affections, and their mode of action was material; they walked on earth, or sailed through ethereal space in boats. First among the deities comes Ptah, the opener, represented as the creator of the world, the sun, and moon, out of chaos (*ha*) or matter, to whom belong Sekhet, "the lioness," and Bast, Bubastis, lion-headed goddesses presiding over fire, and Nefer-Tum, his son, a god wearing a lotus on his head. Next in the cosmic order is Khnum — worshipped at Elephantine — the ram-headed god of the liquid element, who also created the matter of which the gods were made; and connected with him are the goddesses Heka the Frog, or "primeval formation," Sati, or "sunbeam," and Anuka, alluding to the genesis of the cosmos. The Theban triad comprised Amen-ra, "the hidden" power of the "sun," the Jupiter; *Mut*, the "Mother" goddess of "Matter," the Juno; *Nit*, the "Shuttle," the Minerva; and *Khons*, "Force" is Hercules, a lunar type. A subordinate type of Ammon is Khem or Amsu, "the enshrined," who, as *Harnekht*, or Powerful Horus, unites beginning and end, or cause and effect.

A great variety of abstract principles and even animals and vegetables were, however, worshipped by the multitude, though the doctrine of one God was privately taught by the priests to a select few. To each deity an animal seems to have been held sacred, which was probably regarded as his symbolical representative. Bulls were consecrated to Osiris and cows to Hathor; the sacred bull of Memphis, called Apis, being particularly venerated throughout Egypt. A hawk was the symbol of Horus or Ra, the ibis of Thoth, the crocodile of Sebeq, and the cat of Bast. Of the doctrines of the Egyptian religion little is accurately known. The existence of the spirit after death was believed, and a future state of rewards and punishments inculcated, in which the good dwelt with the gods, while the wicked were consigned to fiery torments amid perpetual darkness. It was believed that after the lapse of ages the spirit would return to the body, which was therefore carefully embalmed.

At the present day about nine tenths of the people in Egypt profess the Sunnite (Mohammedan) faith. About 750,000 are Christians and 25,000 are Hebrews. The Roman Catholics have two churches in Alexandria and two in Cairo. The Armenians also have a church and a bishop at Cairo. There is an American mission in both cities, but the natives are bigoted and exclusive and are not well disposed toward religious beliefs other than their own. See Book of the Dead; Embalming; Mohammedanism; Idolatry; Pantheism.

Literature.— See Egyptian Literature.

Ancient Architecture.— The monuments and traces of a past civilization found in Egypt are of two periods,— those built in the times of the Pharaohs, and those built during the sway of the Greek and Roman rulers of the country. Although the temples of the two periods differ considerably in plan and in other particulars, there is yet sound reason for believing that those built under the Greeks and Romans were constructed after designs, as they certainly occupy the sites of Pharaonic temples still more ancient than any now existing; that they were, in fact, mere restorations of temples built by the earlier Pharaohs.

The leading features of the now existing temples of the time of the Pharaohs are these: First, a gateway or pylon, flanked by two truncated pyramids. These occupy the entire width of the building, and form the entrance to a square court, surrounded by a portico supported by a double or single row of columns. Crossing this court the visitor passes through a second pylon into the inner court, which was likewise surrounded by a portico supported either by columns or by piers, against which were figures of the king. Beyond this second court it would appear the public were not admitted, for the spaces between the front row of columns or piers facing the gateway are occupied by a dwarf wall, which effectually barred entrance excepting at either one or three points where there were gates. This inner court led immediately into the largest chamber of the temple, called the Hall of Columns, the roof of which was always supported by columns representing a grove of papyrus. The centre avenue was higher than the rest of the hall, and consisted usually of 12 columns, the capitals being imitated from the full-blown expanded papyrus, while the columns which sustained the lower roof were in the form of a bud of the same plant. To the Hall of Columns succeeded a series of smaller chambers, the roofs of which were generally supported by six or four columns, imitating the bud of the papyrus, either as a single plant or as several bound together; or else by square piers, or columns with 8, 12, or 16 faces. These apartments frequently surrounded a dark chamber — the most sacred in the temple — the holy of holies. Whether the roof of the portico which surrounded the court was supported by piers or columns, the structural arrangements were always precisely the same. There was first the pier or column, ordinarily made of several pieces of stone solidly united by mortar and wooden cramps; then came the architrave or frieze, of one block, stretching from column to column; and lastly, the blocks forming the cornice, concealing the ends of the roof stones which rested upon the architrave. The bulk of the column, in proportion to the weight it had to sustain, was extremely ample; and the pressure being always perpendicular, these ancient structures have come down to us with their roofs sound, while arched buildings of much less antiquity have been entirely ruined by the lateral pressure which that mode of construction exerts on the walls. The Egyptian gate was peculiarly simple. The lintel was always of one stone, and the door-posts also were very frequently of only one block, while each of the three portions had its appropriate decoration. Above the entrance was sculptured the winged globe or protecting divinity of entrances, with the names of the divinities to whom the temple was dedicated, and of the Pharaoh who built it. The door-posts also bear the name and title of the builder. The surface of each architectural feature was engraved with its particular ornament appropriately colored.

The temples built during the reigns of the Greek and Roman rulers may be thus described. First, the propylon, with its truncated pyramidal towers, which were sometimes adorned with narrow flags on tall poles; then a court surrounded on three sides with a colonnade. At the extremity of the court, and facing the gateway, was an elevated portico of six columns in line, and three or four deep. The uninitiated obviously were not permitted to enter beyond the court, for the columns of the first row of the portico are invariably joined by a dwarf wall, the only opening being between the centre intercolumniation, to which were attached the valves of the gate. To the portico succeeded a series of small chambers, the roofs of which were supported by four or by two columns. The centre chambers were lighted by small square openings in the roof, and those at the side by small openings in the walls; but in no example is there that kind of clerestory perforated with large openings, that occurs in the Hall of Columns of the Pharaonic temples. Besides the foregoing characteristics, there is an elaborate form of capital, representing the papyrus in three stages of growth, in one capital, or sometimes a collection of lotus flowers, or the full-blown papyrus alone; but in no instance do we find the pier with the attached figure, nor the single bud of the papyrus, nor that form of column which represents several buds of the plant joined together. The palm-tree capital, however, belongs to both periods.

Among the most remarkable structures erected by the ancient Egyptians are the great pyramids, erected to serve both as monuments and as tombs. Strong buildings (Mastabas) containing one or more rooms were also erected as tombs, in which food and other articles were deposited for the use of the dead, the inner walls being embellished with inscriptions and representations; statues of the dead being also placed in the interior. Tombs cut in the rock were also common. In connection with architecture should be mentioned the obelisks, the oldest known being erected by Usertesen I. Sphinxes, often forming avenues, were a common accessory of temples, the greatest being that known as *the* Sphinx, a colossal companion of the pyramids of Gizeh. See ARCHITECTURE; OBELISK; PYRAMIDS; SPHINX.

Ancient Sculpture.— In portrait sculpture the Egyptians attained extraordinary perfection at an early date, the skill with which they worked in hard stone, such as diorite and basalt, being surprising. Some of the early statues are of colossal size, but a higher style of art is shown in those of ordinary size, though a certain conventional treatment is always apparent. The most usual kind of mural sculpture, a kind peculiar to the Egyptians, is that known as hollow or sunk relief (*cavo-rilievo*). The general outline of the object intended to be represented is cut into the smooth surface of the stone, while at the same time the minor forms and rotundity are represented within the incised outline. By this contrivance the details of the sculptures are protected. Sometimes the outline is excessively deep, at others the surface of the figures is altogether much lower than the general surface of the wall, and in others the outline is but slightly incised with a corresponding flatness within. Wherever the Egyptians practised the true bas-relief the sculpture is almost invariably in very low relief. The back view of the human figure is never represented in the sculptures excepting in the case of an enemy, and then rarely; the figure is generally represented in profile, and there are but few attempts at delineating the front view of the foot or of the face; however, whether the face be represented in front or side view, a profile eye is never found. The figures of the king in battle-pieces, and of the landed proprietor in domestic scenes, are always on a much larger scale than the other actors in the piece. Statues and reliefs were always painted, and when wall painting is employed it is always as a substitute for sculpture. There is no proper perspective, and certain conventionalities of color are employed. The Egyptians are represented with red and yellow complexions, red ochre for the men and yellow for the women. The hair of the king is frequently painted blue, but that of ordinary men black. In representing the various nations with whom Egypt had intercourse, the artists seem to have endeavored to imitate the complexions peculiar to each. Ammen-Ra, the chief divinity of Thebes, is always painted blue, and he is further distinguished by two high feathers which he wears in his cap. The inferior divinities are not uncommonly of the complexions of mortals. The sky or heavens are invariably indicated by a strip of blue coming downward at the lower side of each extremity, and occasionally having upon it a row of five-pointed stars. Water, seas, and rivers are represented by zigzag lines of a blue or green color. Mountains have a yellow color, with red spots upon it. Egyptian art was at its highest during the period between the fourth and sixth dynasties, and notwithstanding its defects it was superior to that of Nineveh and Babylon. See ART; SCULPTURE.

Archæology.— The attention of the world was drawn to Egypt as a rich field for scientific exploration in the early part of the 19th century. In 1799, M. Boussard, one of Bonaparte's captains, found a large block of black granite in the trenches of Fort Julien near Rosetta; hence the name Rosetta Stone. On this were the remains of three inscriptions in hieroglyphic, demotic, and Greek characters. The stone was given to the British Museum by George III.

The French savant, Emanuel de Rougé, was the first to translate whole Egyptian texts and inscriptions. His influence was felt in France by such men as Mariette, Chabas, Deveria, Pierret, Maspero, and Revillout, the great demotic scholar of France, also by Birch, Le Page-Renouf in England. The practical archæologists of the German school, notably Lepsius, Bunsen, and Brugsch, translated the texts of the Egyptian temples in their relation to history and religion. Ebers introduced his scientific researches in novels. The German Egyptologists mostly devoted themselves to philology, while the French school has made history and archæology its special study since Emanuel de Rougé's death. To Auguste Mariette (Mariette Bey) is due the discovery of the Serapeum of Memphis. He cleared the temples of Edfu, Karnak, Denderah and Abydos. He explored the Nile valley from Tanis to Napata, and his collections of antiquities were removed in 1889 from Boulak to Gizeh.

After Mariette the work of excavation was

TOMB IN THE VALLEY OF EL ASSASSIF, THEBES, EGYPT

carried on by Maspero, Grebaut, De Morgan, and others, the first of whom resumed his post as director-general of antiquities in 1899. There is an archæological mission in Cairo, founded in 1880 by Maspero, who placed at its head successively Lefebure, Grebaut, and Bouriant. Students go every year to Egypt to excavate. The Egyptian Research Account, under Petrie, trains students as explorers. The Egyption Exploration Fund was founded in 1883 by Sir Erasmus Wilson, Prof. R. Stuart Poole, and Miss Amelia B. Edwards, and its American branch, at the close of that year, by the Rev. Dr. William C. Winslow of Boston. In 1883, Edouard Naville of Geneva, Switzerland, cleared the site of ancient Pithom, near the island of Goshen. The work of Naville, Griffith, Gardner, and Newberry resulted in important discoveries at Neucratis, Tanis, Bubastis, Denderah, Deir-el-Bahari, Tel-el-Amarna, etc. See EXPLORATION; NUMISMATICS, etc.

Recent Discoveries.— The last few years have seen wonderful discoveries in Egypt, for the tombs of the kings of Abydos have been opened and the treasures which have been found bring us face to face with archaic history. Among the remarkable finds were a carved slate slab showing King Nār-mer smiting his enemy, an ebony table, a bar of gold, gold jewelry, including bracelets, and a royal sceptre. The oldest group of jewelry in the world is undoubtedly the four bracelets of the queen of King Zer or Teta (4366 B.C.), which was discovered with a portion of the mummy in a hole in a wall. This is 1500 years earlier than any other jewelry thus far identified. The bracelets show a wonderful perfection in the soldering of the gold. They also show the turning point in the development of Egyptian art; the finest bracelets are formed of alternate plaques of gold and turquoise, each surmounted with a royal hawk. The turquoise hawks are clumsy, of a more archaic form than those on the gold pieces.

An American archæologist, Theodore M. Davies, has made one of the most interesting discoveries of recent years in excavating the tomb of Thothmes IV. of the 18th dynasty. The tomb contained the chariot in which he rode at Thebes. Like other royal tombs it consisted of a gallery cut in the heart of the mountain. After sloping downward for a considerable distance it is interrupted by a deep square well; on one of the walls is a band of paintings. On the farther side of the wall the passage turns back, and finally opens into a large chamber, at the extreme end of which is a magnificent sarcophagus of granite covered with texts from «The Book of the Dead.» On either side are smaller chambers; the floor of one of them was covered with the offerings made to the dead king, consisting of mummified loins of beef, legs of mutton, and trussed ducks and geese. Clay seals with the name of the Pharaoh had been attached to the doors of the chambers, and it is stated the raised portions of the seals having been smeared with blue ink before being pressed on the clay. A great many of the objects in the tomb of Thothmes were found to be broken, and this was explained by a hieroglyphic inscription on one of the paintings which adorn the walls of the vestibule to the chamber in which the sarcophagus was found. That inscription states that the tomb was plundered by robbers, but that it had been restored as far as possible to its original condition by Hor-em-heb, the reigning Pharaoh. The floor was covered with vases, dishes, symbols of life, and other objects in blue faience. Unfortunately, nearly all of them had been wantonly broken, though in some cases the breakage had been repaired in the time of Hor-em-heb. Equally interesting is a piece of textile fabric into which hieroglyphic characters of different colors have been woven with such wonderful skill as to present the appearance of painting on linen. The chariot is one of the finest specimens of art that have come down to us from antiquity. Along with the chariot was found the leather gauntlet with which the king protected his hand and wrist when using the bow or reins.

Recent excavations at Abydos have brought to light the royal tomb of Menes, of the first dynasty, in which was found a large globular vase of green glaze, with Menes' name inlaid in purple. Thus polychrome glazing is taken back thousands of years before it was previously known to exist. There are also several pieces of delicately carved ivory of that age. One represents the figure of an aged king, which, for subtlety of character, stands in the first rank of such work, and ranks with the finest work of Greece and Italy. A camel's head modeled in pottery takes back its relation to Egypt some 4,000 years. Hitherto no trace of the camel appeared before Greek times. The ivory carving of a bear also extends the fauna of early Egypt.

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Samuel Augustus Binion,
Author of 'Ancient Egypt, or Mizraïm.'

Egyptian Bean, a name sometimes given to the bean-like fruits of the *Nelumbium speciosum*, or sacred lotus, found in China, India, Australia, but no longer on the Nile.

Egyptian Blue, a brilliant pigment consisting of the hydrated protoxide of copper mixed with a minute quantity of iron.

Egyptian Exploration Fund, a foundation for the excavation and study of Egyptology, set on foot by Amelia Blandford Edwards, the English novelist and Egyptologist. Edouard Naville, W. M. F. Petrie, and others have worked under its auspices, making important discoveries of ancient temples, writing, pottery, etc.

Egyptian Literature. The advance that has been made in recent years in the decipherment of the ancient writings of the world enables us to deal in a very matter-of-fact way with the Egyptian inscriptions. Their chief mysteries are solved, their philosophy is almost fathomed, their general nature is understood. The story they have to tell is seldom startling to the modern mind. The world was younger when they were written. The heart of man was given to devious ways then, as now and in the days of Solomon,— that we can affirm full well; but his mind was simpler; apart from knowledge of men and the conduct of affairs, the educated Egyptian had no more subtlety than a modern boy of 15, or an intelligent English rustic of a century ago.

To the Egyptologist by profession the inscriptions have a wonderful charm. The writing itself in its leading form is the most attractive that has ever been seen. Long rows of clever little pictures of things in heaven and earth compose the sentences; every sign is a plaything, every group a pretty puzzle, and at present, almost every phrase well understood brings a tiny addition to the sum of the world's knowledge. But these inscriptions, so rich in facts that concern the history of mankind and the progress of civilization, seldom possess any literary charm. If pretentious, as many of them are, they combine bald exaggeration with worn-out simile, in which ideas that may be poetical are heaped together in defiance of art. Such are the priestly laudations of the kings by whose favor the temples prospered. Take, for instance, the dating of a stela erected under Rameses II. on the route to the Nubian gold mines. It runs:—

On the fourth day of the first month of the season of winter, in the third year of the Majesty of Horus, the Strong Bull, beloved of the Goddess of Truth, lord of the vulture and of the uræus diadems, protecting Egypt and restraining the barbarians, the Golden Horus, rich in years, great in victories, King of Upper Egypt and King of Lower Egypt, *Mighty in Truth of Ra, Chosen of Ra*, the son of Ra, *Rameses Beloved of Amen*, granting life for ever and ever, beloved of Amen Ra lord of the "Throne of the Two Lands" in Apt Esut, appearing glorious on the throne of Horus among the living from day to day even as his father Ra; the good god, lord of the South Land, Him of Edfû Horus bright of plumage, the beauteous sparrow-hawk of electrum that hath protected Egypt with his wing, making a shade for men, fortress of strength and of victory; he who came forth terrible from the womb to take to himself his strength, to extend his borders, to whose body color was given of the strength of Mentu; the god Horus and the god Set. There was exultation in heaven on the day of his birth; the gods said, "We have begotten him"; the goddesses said, "He came forth from us to rule the kingdom of Ra"; Amen spake, "I am he who hath made him, whereby I have set Truth in her place; the earth is established, heaven is well pleased, the gods are satisfied by reason of him." The Strong Bull against the vile Ethiopians, which uttereth his roaring against the land of the negroes while his hoofs trample the Troglodytes, his horn thrusteth at them; his spirit is mighty in Nubia and the terror of him reacheth to the land of tne Kary; his name circulateth in all lands because of the victory which his arms have won; at his name gold cometh forth from the mountain as at the name of his father, the god Horus of the land of Baka; beloved is he in the Lands of the South even as Horus at Meama, the god of the Land of Buhen, King of Upper and Lower Egypt, *Mighty in Truth of Ra*, son of Ra, of his body, Lord of Diadems, *Rameses Beloved of Amen*, giving life for ever and ever like his father Ra, day by day. [Revised from the German translation of Professor Erman.]

As Prof. Erman has pointed out, the courtly scribe was most successful when taking his similes straight from nature, as in the following description, also of Rameses II.:—

A victorious lion putting forth its claws while roaring loudly and uttering its voice in the Valley of the Gazelles. . . . A jackal swift of foot seeking what it may find, going round the circuit of the land in one instant, . . . his mighty will seizeth on his enemies like a flame catching the ki-ki plant with the storm behind it, like the strong flame which hath tasted the fire, destroying, until everything that is in it becometh ashes; a storm howling terribly on the sea, its waves like mountains, none can enter it, every one that is in it is engulphed in Duat.

Here and there among the hieroglyphic inscriptions are found memorials of the dead, in which the praises of the deceased are neatly strung together and balanced like beads in a necklace, and passages occur of picturesque narrative worthy to rank as literature of the olden time. We may quote in this connection from the biographical epitaph of Ameny, who was governor of a province in middle Egypt for 25 years during the long reign of Usertesen I. (about 2716 B.C.). This inscription not only recounts the achievements of Ameny and the royal favor which was shown him, but also tells us in detail of the capacity, goodness, charm, discretion, and insight by which he attached to himself the love and respect of the whole court, and of the people over whom he ruled and for whose well-being he cared. Ameny says:—

I was a possessor of favor, abounding in love, a ruler who loved his city. Moreover I passed years as ruler in the Oryx nome. All the works of the house of the King came into my hand. Behold, the superintendent of the gangs of the domains of the herdsmen of the Oryx nome gave me 3,000 bulls of their draught stock. I was praised for it in the house of the King each year of stock-taking. I rendered all their works to the King's house: there were no arrears to me in any of his offices.

The entire Oryx nome served me in numerous attendances. There was not the daughter of a poor man that I wronged, nor a widow that I oppressed. There was not a farmer that I chastised, not a herdsman whom I drove away, not a foreman of five whose men I took away for the works. There was not a pauper around me, there was not a hungry man of my time. When there came years of famine, I arose and ploughed all the fields of the Oryx nome to its boundary south and north, giving life to its inhabitants, making its provisions. There was not a hungry man in it. I gave to the widow as to her that possessed a husband, and I favored not the elder above the younger in all that I gave. Thereafter great rises of the Nile took place, producing wheat and barley, and producing all things abundantly, but I did not exact the arrears of farming.

Elsewhere in his tomb there are long lists of the virtues of Amenemhat, and from these the following may be selected both on account of picturesqueness of expression and the appreciation of fine character which they display: —

Superintendent of all things which heaven gives and earth produces, overseer of horns, hoofs, feathers, and shells. . . . Master of the art of causing writing to speak. . . . Caressing of heart to all people, making to prosper the timid man, hospitable to all, escorting [travelers] up and down the river. . . . Knowing how to aid, arriving at time of need; free of planning evil, without greediness in his body, speaking words of truth. . . . Unique as a mighty hunter, the abode of the heart of the King. . . . Speaking the right when he judges between suitors, clear of speaking fraud, knowing how to proceed in the council of the elders, finding the knot in the skein. . . . Great of favors in the house of the King, contenting the heart on the day of making division, careful of his goings to his equals, gaining reverence on the day of weighing words, beloved of the officials of the palace.

The cursive forms of writing — hieratic from the earliest times, demotic in the latest — were those in which records were committed to papyrus. This material has preserved to us documents of every kind, from letters and ledgers to works of religion and philosophy. To these, again, "literature" is a term rarely to be applied; yet the tales and poetry occasionally met with on papyri are perhaps the most pleasing of all the productions of the Egyptian scribe.

It must be confessed that the knowledge of writing in Egypt led to a kind of primitive pedantry, and a taste for unnatural and to us childish formality; the free play and naïveté of the story-teller is too often choked, and the art of literary finish was little understood. Simplicity and truth to nature alone gave lasting charm, for though adornment was often attempted, their rude arts of literary embellishment were seldom otherwise than clumsily employed.

A word should be said about the strange condition in which most of the literary texts have come down to us. It is rarely that monumental inscriptions contain serious blunders of orthography; the peculiarities of late archaistic inscriptions which sometimes produce a kind of "dog Egyptian" can hardly be considered as blunders, for the scribe knew what meaning he intended to convey. But it is otherwise with copies of literary works on papyrus. Sometimes these were the productions of schoolboys copying from dictation as an exercise in the writing school, and the blank edges of these papyri are often decorated with essays at executing the more difficult signs. The master of the school would seem not to have cared what nonsense was produced by the misunderstanding of his dictation, so long as the signs were well formed. The composition of new works on the model of the old, and the accurate understanding of the ancient works, were taught in a very different school, and few indeed attained to skill in them. The boys turned out of the writing school would read and write a little; the clever ones would keep accounts, write letters, make out reports as clerks in the government service, and might ultimately acquire considerable proficiency in this kind of work. Apparently men of the official class sometimes amused themselves with puzzling over an ill written copy of some ancient tale, and with trying to copy portions of it. The work, however, was beyond them; they were attracted by it, they revered the compilations of an elder age and those which were "written by the finger of Thoth himself"; but the science of language was unborn, and there was little or no systematic instruction given in the principles of the ancient grammar and vocabulary. Those who desired to attain eminence in scholarship after they had passed through the writing school had to go to Heliopolis, Hermopolis, or wherever the principal university of the time might be, and there sit at the feet of priestly professors; who we fancy were reverenced as demigods, and who in mysterious fashion and with niggardly hand imparted scraps of knowledge to their eager pupils. Those endowed with special talents might after almost lifelong study become proficient in the ancient language. Would that we might one day discover the hoard of rolls of such a copyist and writer!

There must have been a large class of hack-copyists practised in forming characters both uncial and cursive. Sometimes their copies of religious works are models of deft writing, the embellishments of artist and colorist being added to those of the calligrapher; the magnificent rolls of the 'Book of the Dead' in the British Museum and elsewhere are the admiration of all beholders. Such manuscripts satisfy the eye, and apparently neither the multitude in Egypt nor even the priestly royal undertakers questioned their efficacy in the tomb. Yet are they very apples of Sodom to the hieroglyphic scholar, fair without but ashes within. On comparing different copies of the same text, he sees in almost every line omissions, perversions, corruptions, until he turns away baffled and disgusted. Only here and there is the text practically certain, and even then there are probably grammatical blunders in every copy. Nor is it only in the later papyri that these blunders are met with. The hieroglyphic system of writing, especially in its cursive forms, lends itself very readily to perversion by ignorant and inattentive copyists; and even monumental inscriptions, so long as they are mere copies, are usually corrupted. The most ridiculous perversions of all date from the Ramesside epoch when the dim past had lost its charm, for the glories of the 18th dynasty were still fresh, while new impulses and foreign influence had broken down adherence to tradition and isolation.

In the 8th century B.C. the new and the old were definitely parted, to the advantage of each. On the one hand the transactions of ordinary life were more easily registered in the cursive demotic script, while on the other the sacred writings were more thoroughly investigated and brought into order by the priests. Hence, in spite of absurdities that had irremediably crept in, the archaistic texts copied in the 26th dynasty are more intelligible than the same class of work in the 19th and 20th dynasties.

In reading translations from Egyptian, it must be remembered that uncertainty still remains concerning the meanings of multitudes of words and phrases. Every year witnesses a great advance in accuracy of rendering; but the translation even of an easy text still requires here and there some close and careful guesswork to supply the connecting links of passages or words that are thoroughly understood, or the resort to some conventional rendering that has become current for certain ill understood but frequently recurring phrases. The Egyptologist is now to a great extent himself aware whether the ground on which he is treading is firm or treacherous, and it seems desirable to make a rule of either giving the public only what can be warranted as sound translation, or else of warning them where accuracy is doubtful A few years ago such a course would have curtailed the area for selection to a few of the simplest stories and historical inscriptions; but now we can range over almost the whole field of Egyptian writing, and gather from any part of it warranted samples to set before the reading public. The labor, however, involved in producing satisfactory translations for publication, not mere hasty readings which may give something of the sense, is very great; and at present few texts have been well rendered.

We may now sketch briefly the history of Egyptian literature, dealing with the subject in periods:

1. *The Ancient Kingdom, About* 4400 B.C.–3000 B.C.—The earlier historic period — from the First Dynasty to the Third, about 3766 B.C. — has left no inscriptions to any extent. Some portions of the 'Book of the Dead' (q.v.) profess to date from these or earlier times, and probably much of the religious literature is of extremely ancient origin. The first book of 'Proverbs' in the Prisse Papyrus is attributed by its writer to the end of the Third Dynasty (about 3766 B.C.). From the Fourth Dynasty to the end of the Sixth (3100 B.C.) the number of the inscriptions increases; tablets set up to the kings of the Fourth Dynasty in memory of warlike raids are found in the peninsula of Sinai, and funerary inscriptions abound. The pyramids raised at the end of the Fifth and during the Sixth Dynasties are found to contain interminable religious inscriptions, forming almost complete rituals for the deceased kings. Prof. Maspero, who has published these texts, states that they "contain much verbiage, many pious platitudes, many obscure allusions to the affairs of the other world, and among all this rubbish some passages full of movement and wild energy, in which poetical inspiration and religious emotion are still discernible through the veil of mythological expressions." Of the funerary and biographical inscriptions the most remarkable is that of Una, an official of King Mer-en-ra (Sixth Dynasty).

Another, later but hardly less important, is on the façade of the tomb of Hehrhuf, at Aswan, and recounts the expeditions into Ethiopia and the southern oasis which this resourceful man carried through successfully. In Hehrhuf's later life he delighted a boy king of Egypt by bringing back for him from one of his raids a grotesque dwarf dancer of exceptional skill; the young Pharoah sent him a long letter on the subject, which was copied in full on the tomb as an addition to the other records there. It is to the Fifth Dynasty also that the second collection of 'Proverbs' in the Prisse Papyrus is dated. The Seventh and Eighth Dynasties have left us practically no records of any kind.

2. *The Middle Kingdom,* 3000–1600 B.C.— The Middle Kingdom from the Ninth to the Seventeenth Dynasty, shows a great literary development. Historical records of some length are not uncommon. The funerary inscriptions descriptive of character and achievement are often remarkable.

Many papyri of this period have survived: the Prisse Papyrus of 'Proverbs,' a papyrus discovered by Mr. Flinders Petrie with the 'Hymn to Usertesen III.,' papyri at Berlin containing a dialogue between a man and his soul, the 'Story of Sanehat,' the 'Story of the Sekhti,' and a very remarkable fragment of another story; besides the 'Westcar Papyrus of Tales' and at St. Petersburg the 'Shipwrecked Sailor.' The productions of this period were copied in later times; the royal 'Teaching of Amenemhat' and the worldly 'Teaching of Dauf' as to the desirability of a scribe's career above any other trade or profession, exist only in late copies. Portions of the 'Book of the Dead' are found inscribed on tombs and sarcophagi.

3. *The New Kingdom, etc.*— From the New Kingdom, 1600–700 B.C., we have the 'Maxims of Any,' spoken to his son Khonsu Hetep, numerous hymns to the gods, including that of King Akhenaten (Amenhotep IV.) to the disk of the sun, and hymns to Amen Ra. Inscriptions of every kind, historical, mythological, and funereal abound. The historical inscription of Piankhi is of very late date. On papyri the stories of 'The Two Brothers,' of 'The Taking of Joppa,' and of the 'Doomed Prince.'

From the Saite period (Twenty-sixth Dynasty, 160 B.C.) and later, there is little worthy of record in hieroglyphics; the inscriptions follow ancient models. In demotic we have the 'Story of Setna,' a papyrus of moralities, a chronicle somewhat falsified, a harper's song, a philosophical dialogue between a cat and a jackal, and others.

Here we might end. Greek authors in Egypt were many; some were native, some of foreign birth or extraction, but they all belong to a different world from the ancient Egyptian. With the adaptation of the Greek alphabet to the spelling of the native dialects, Egyptian came again to the front in Coptic, the language of Christian Egypt. Coptic literature, if such it may be called, was almost entirely produced in Egyptian monasteries and intended for edification. Let us hope that it served its end in its day. To us the dull, extravagant, and fantastic 'Acts of the Saints,' of which its original works chiefly consist, are tedious and ridiculous except for the linguist or the church historian. They certainly display the adjustment of the ancient Egyptian mind to new conditions of life and belief; but the introduction of Christianity forms a fitting boundary to our sketch. See EGYPT; HIEROGLYPHICS.

SAMUEL AUGUSTUS BINION,
Author of 'Ancient Egypt or Mizraim.'

Egyptian Sudan. See SUDAN.

Egyptian Vulture (*Neophron percnopterus*), a well-known bird which frequents both shores of the Mediterranean, southern India, and, during the winter, south Africa. It is the scavenger of Egyptian villages, collecting in numbers where carrion or garbage is deposited, but feeding also on frogs, lizards, and small mammals found in cultivated fields. The birds usually go in pairs, however, and addict themselves to particular localities, being only drawn together in numbers by abundance of their favorite food. The name, as also that of Pharaoh's hen, is given because of the frequent representation of this bird in Egyptian sculpture. See VULTURE.

Egyptol'ogy, the science of Egyptian antiquities. See EGYPT.

Ehninger, ān'ĭng ėr, **John Whetton,** American artist: b. New York 22 July 1827; d. Saratoga, N. Y., 22 Jan. 1889. He was graduated at Columbia College, studied two years under Couture in Paris and later at Düsseldorf, and served as staff-artist for an illustrated London journal. He was elected a National Academician in 1860. His works include landscape and figure subjects, among them being: 'Peter Stuyvesant' (1850); 'Eight illustrations of Miles Standish' (1858); 'Autumnal Landscape' (1867); 'Twilight from the Bridge of Pau, Basses-Pyrenees' (1878); 'Subject for Thanksgiving' (1879); 'Lady of the Manor' (1882); 'The Old, Old Story' (1884).

Ehrenberg, ā'rĕn-bĕrg, **Christian Gottfried,** German scientist: b. Delitzsch 19 April 1795; d. Berlin 27 June 1876. After studying theology, medicine, and natural history at Leipsic and Berlin, he joined in 1820 an expedition to Palestine, Egypt, and Abyssinia, returning to Berlin in 1825. In 1829 he accompanied Humboldt to the Ural and Altai ranges and to central Siberia. His great work on 'Infusoria' ('Die Infusionstierchen als vollkommene Organismen') appeared in 1838, and was at once recognized as the highest authority on the subject. It was followed in 1854 by his 'Microgeology.' Ehrenberg's work gave an enormous impetus to the study of microscopic organisms. He was the first to show that the phosphorescence of the sea is due to the presence of hosts of animalcules. Consult 'Life,' by Lane (1895).

Ehrle, Francis, German Catholic scholar: b. Isny, Würtemberg, 17 Oct. 1845. He was educated at the Jesuit College, Munster, Westphalia, and after several years in mission work was transferred to Rome, where he devoted himself to historical studies. His 'History of the Church and its Literature in the Middle Ages' (in German) is based on extensive researches in the archives of Germany, England, Spain, and Italy. It is on this work that his reputation largely rests; but he has further written a Latin history of the Papal library from 1200 to 1417, and (with Stevenson) a history of the Vatican. He was made prefect of the Pontificial Library, and placed in charge of the Papal exhibit at the Louisiana Purchase Exposition, Saint Louis.

Eibenstock, ī'bĕn-stŏk, Germany, town in the southeast of Saxony, near the Mulde, with important manufactures of lace. The tin mines nearby have been worked for about eight centuries. It is connected by rail with Chemnitz, about 40 miles distant. Pop. 7,500.

Eichberg, īʜ'bĕrg, **Julius,** American composer: b. Düsseldorf, 13 June 1824; d. Boston, Mass., 19 Jan. 1893. After being professor in the Conservatoire at Geneva, he removed to New York in 1857, and in 1859 went to Boston, where he was director of the orchestra at the Boston Museum for seven years. In 1867 he established the Boston Conservatory of Music, of which he was at the head till his death. Four of his operettas are well known: 'The Doctor of Alcantara'; 'The Rose of Tyrol'; 'The Two Cadis'; and 'A Night in Rome.'

Eichendorff, ī'ʜĕn-dôrf, BARON **Joseph von,** German poet: b. Castle of Lubowitz, Silesia, 10 March 1788; d. Neisse 26 Nov. 1857. He was one of the most gifted and original romantic lyrists of Germany. His principal works are: 'Presage and Presence'; 'War to the Philistines,' a dramatic story; 'The Life of a Good-for-Nothing,' idealizing vagabondage; the tragedies 'Ezzelin von Romano,' 'The Last Hero of Marienburg'; and other plays, and a number of histories of German literature, including 'The Ethical and Religious Meaning of the New Romantic Poetry in Germany' (1847); 'German Romance of the Eighteenth Century in Relation to Christianity' (1851); 'History of German Poetry' (1857).

Eichens, Friedrich Eduard, frēd'rĭʜ ed'oo-ärd ī'ʜĕnz, German engraver: b. Berlin 27 May 1804; d. 5 May 1877. He studied in Berlin, Paris, and Parma, and returning to Berlin in 1832 was made a member of the Academy. He left many works, including: 'Vision of Ezekiel' after Raphael; 'Magdalen' after Dominichino; 'Christ in the Tomb' after H. Carrache; 'Prince Radziwill on His Deathbed' after M. Hanzel; and some engravings after Kaeilback.

Eichens, Philip Herman, German lithographer and engraver: b. Berlin 13 Sept. 1812; d. 1886. He was a brother of F. E. Eichens (q.v.). He studied under Henzel at the Berlin Academy, and among his engravings are: 'La Joconde'; and 'Return of the Pirates of Meyerkeim.' He received medals for his lithographs in Paris 1842, 1859, 1861, and 1863.

Eichhoff, Friedrich Gustav, frēd'rĭʜ goos'-täf īʜ'hōf, French philologist: b. Havre 17 Aug. 1799; d. Paris 10 May 1875. In 1842 he became professor of foreign languages at Lyons and in 1851 inspector-general of the University of Paris. He wrote a 'General Indo-European Grammar' (1867); etc.

Eichhorn, Johann Gottfried, yō'hän gŏt'-frēd īʜ'hôrn, German theologian and Orientalist: b. Dörrenzimmern 16 Oct. 1752; d. Göttingen 25 June 1827. In 1775 he became professor of Oriental languages at Jena, and in 1788 at Göttingen. He edited a 'Repertory of Biblical and Oriental Literature' (1777–86); 'Universal Library of Biblical Literature' (1787–1803); and wrote 'Historico-Critical Introductions' to the Old and to the New Testament, and to the Apocryphal Books of the Old Testament; a 'Latin Commentary on the Apocalypse'; etc.

Eichrodt, Ludwig, lood'vĭg, German poet: b. Durlach, Baden, 2 Feb. 1827; d. Lahr 2 Feb. 1892. He studied at Heidelberg and Freiburg and published in 1848 in 'Fliegende Blätter' his comic songs, 'Wanderlust,' which had great popularity. Among his works are: 'Poems of All Humors' (1855); 'Life and Love' (1856); 'The Chateau of the Voges' (1858); 'Hortus Deliciarum' (1875); 'Gold' (1880).

Eichstätt, īʜ'stĕt, or **Eichstädt,** Middle Franconia, Bavaria, an old town in a deep valley of the Altmühl, 67 miles north-northwest of Munich. Its principal edifice is a fine Gothic cathedral, founded in 1259. Pop. 7,489.

Eider, a river of Prussia, in Schleswig-Holstein, which rises about 12 miles from Kiel, flows generally northwest, and after a course of 112 miles, of which 69 are navigable, empties into the North Sea at Tönning.

Eider Duck, a bird of the sub-family *Fuligulinæ,* or sea ducks, genus *Somateria,* distinguished by the peculiar form and feathering of the bill, and closely allied to the scoter ducks. The several species are confined to the northern regions. The American eider (*S. dresseri*) and the European eider (*S. mollissima*) are closely similar species which breed on solitary rocky shores and islands from Maine and the Farne Islands respectively, northward, the former species wintering as far south as the Delaware River. They are most abundant in Labrador, Newfoundland, Greenland, Iceland, and Norway, where they are stringently protected by law. Both species breed gregariously and in particular spots their nests are so abundant that a person can scarcely walk without treading on them. Their nests are usually formed of grass, dry sea-weed, etc., lined with a quantity of down which the female plucks from her own breast. In this soft bed she lays five eggs, which she covers over with a layer of down; then the natives, who watch her operations, take away both the eggs and the down, and this removal is repeated as often as she lays until the close of the season, when the last lot of eggs is allowed to hatch and the down removed from the nest only after the young have left. The drake does not, as is often stated, furnish any of the down. One female generally furnishes a few ounces of down. This down, from its superior warmth, lightness, and elasticity, is preferred by the luxurious to every other article for beds and coverlets; and, from the great demand for it, those districts in Norway, Greenland, and Iceland where these birds abound are regarded as the most valuable property and are guarded with the greatest vigilance. Proprietors endeavor to attract them by supplying artificial nests and otherwise, and when they settle in an island off shore, cattle and herdsmen are removed to allow them to breed undisturbed. The down from dead birds is little valued, having lost its elasticity.

The length of the eider duck is about 2 feet 3 inches, extent of the wings 3 feet, weight from 6 to 7 pounds; the head is large and the bill of singular structure, being 3 inches in length, forked at the base of the upper mandible in a remarkable manner, running high up on the forehead, and having the feathers on each side descending nearly to the nostrils; the whole of the bill is of a dull, yellowish horn color, somewhat dusky in the middle. The male is black beneath, head and back white, with a black crown. The female is reddish drab, spotted with black, with two white bands across the wings. Eiders associate in flocks, diving to great depths for shellfish, which constitute their principal food. They live much on the water, retiring to the shores to rest, particularly on the appearance of an approaching storm. Their flesh is eaten, but tastes strongly of fish. The eggs, however, are esteemed. These and the down are both frequently obtained at the hazard of life by people let down by ropes from craggy steeps.

Other species are the Pacific eider (*S. v-nigra,* and the remarkable king eider (*S. spectabilis*) of high Arctic regions. The now extinct Labrador duck (q.v.) is closely related.

Eidograph, ī'dō-graf, an instrument for copying designs invented by Prof. Wallace to reduce or enlarge them in any proportion, within certain limits; a form of pantograph.

Eidoscope, ī'dō-skōp, an instrument on the principle of the kaleidoscope, which produces an infinite variety of geometrical figures by the independent revolution of two perforated metallic disks. It may be employed with the magic lantern, when rapidly rotated, causing flashing rays of light, forming singular combinations to appear upon the screen. Variously colored glass disks may be used, producing striking combinations of color.

Eifel, ī'fĕl, **The,** a barren and bleak plateau of Rhenish Prussia, between the Rhine, Moselle, and Roer rivers, showing extensive traces of volcanic action. Its surface is diversified by crater-like depressions and volcanic peaks and ridges.

Eiffel, ā-fĕl or ī'fĕl, **Alexandre Gustave,** French engineer: b. Dijon 15 Dec. 1832. In 1858 he was intrusted with the construction of the large iron bridge over the Garonne at Bordeaux, and was one of the first to introduce caissons worked with compressed air. The bridge over the Douro at Oporto, the great viaduct of Garabit, in Cantal, and that over the Tardes, near Montluçon, and the gigantic locks designed and partly prepared for the Panama Canal are among later triumphs of his engineering skill; while in the huge framework erected for Bartholdi's 'Statue of Liberty' may be seen the germ of the idea which afterward assumed the form of the colossal iron structure (1887–9) on the Champs-de-Mars in Paris, with which his name is identified. See Eiffel Tower.

Eiffel Tower, The, a notable structure in Paris. The plans for the exposition of 1889 included a monstrous iron tower, to be raised on the Champs-de-Mars, 1,000 feet high. The designer, Gustave Eiffel, constructed it of iron lattice-work, with three elevators giving access to the summit. The uses of so stupendous an undertaking are many, and it became one of the chief permanent ornaments of the city. Its importance from a meteorological point of view cannot be overestimated, the tower enabling meteorologists to study the decrease of temperature at different heights, to observe the variations of winds, and to find out the quantity of rain that falls at different heights, and the density of the clouds.

Eigenmann, ī'gen-man, **Carl H.,** American zoologist: b. Flehingen, Germany, 1863. He was graduated at Indiana University in 1886 and studied at Harvard 1887–8. Between 1888 and 1892 he continued his scientific investigations in San Diego Biological Laboratory, the Woods Holl Marine Stations, and in the explorations undertaken for the British Museum in California, Oregon, Idaho, Montana, Dakota, and western Canada. He was appointed professor of zoology in Indiana University in 1891 and in 1895 founded and assumed the direction of the Biological Station of Indiana University. He has contributed more than a hundred papers to the proceedings of scientific societies and to scientific journals.

Eigg. See Egg.

Eight-hour Day. In the struggle for the shortest hours of labor compatible with the highest efficiency, begun in Great Britain early in the

19th century, the first great landmark was the Ten Hours' Bill of 1847, enforcing in all trades what had come about in many. But the golden ideal since 1824 (announced as such by Robert Owen in 1817) has been eight hours; possibly in remembrance that such was the rule in mediæval England; partly perhaps from the tempting threefold division of the day into equal parts, as in the rhyme "Eight hours for work, eight hours for play, eight hours for sleep, eight 'bob' a day." The eight-hour day was won in Australia in 1858. The movement on the Continent dates from the foundation of the "International" in 1864, and as a world-demand of the social reformers, from the Paris Trades-Union Congress of 1883. In the United States, till recently the subject was left to the States and to private contests, the government aiding by making short hours in its own works. In 1840 President Van Buren reduced the working day in the government navy yards to 10 hours. The first State 10-hour law, for textile workers only, was of 1849, in Pennsylvania. The first Massachusetts law was in 1874, and was due largely to the "Knights of St. Crispin." But the eight-hour movement had long before become general: in 1866 the demand was formulated at a general workingmen's congress at Baltimore, and at other meetings; and the National Labor Union was organized to secure an eight-hour day. A six weeks' strike in New England and New York, April-May 1866, attempted to secure it, but failed. In 1867 Connecticut and Illinois passed laws making eight hours a legal day "unless otherwise agreed." Pennsylvania followed in 1868 and New York in 1870. On 24 June 1869 the United States enacted an eight-hour day for its establishments; but the managers reduced wages correspondingly, allowing those who wished to work 10 hours at the old wages, which aroused such wrath that the President revoked the order. All these laws were rendered nugatory by the contracting-out clauses. In 1872 eight-hour leagues were formed in various places, and in Connecticut and New York a mass of strikes among the wood-working trades won this goal for a while; but the great depression from 1873 on prevented pressing such questions. Since 1880 several States have enacted the eight-hour law under the above conditions. But the first great concerted effort for eight hours was in 1886, when 200,000 workmen went on strike; it was at an eight-hour meeting in Haymarket Square, Chicago, that the anarchist bomb was thrown. A general strike was announced for this object in 1890, but was only partially successful, several hundred thousand workmen struck, and many employers yielded, but soon advanced the hours. The first really efficient national law was of 1 Aug. 1892, enforcing eight hours upon all laborers, mechanics, or contractors in the District of Columbia, under pain of fine and imprisonment. The short-hours' movement was first begun to protect women and children, the men sharing incidentally. It may be added that the practical results of the system are almost universally favorable. See Webb and Cox, 'The Eight-Hour Day' (1891); Rae, 'Eight Hours for Work' (1894).

Eight-hour Law, an act adopted in 1868 by the United States Congress, providing that in all government employment eight hours shall constitute a day's work. It originated in the agitation which had begun in England in 1833 by the proposition of eight hours as a legitimate working day. The agitation spread itself among the industrial classes throughout the civilized world, and first bore fruit in Australia in 1856, where it was adopted by several trades. The National Labor Union of the United States demanded it in 1866, and it came into effect in the government navy yards in 1869, and shortly afterward in all departments of government work. Its universal adoption, however, is still unrealized, and it is the source of persistent agitation among the labor organizations and parties throughout the United States, the British Empire, and on the continent of Europe. Consult: Rae, 'Eight Hours for Work' (1894).

Eighth Nerve. See AUDITORY NERVE.

Eikon Basilike, ī'kŏn ba-sĭl'ĭ-kē (Gr. "the royal image"), a work the full title of which is Εἰκὼν Βασιλική: 'The Portraicture of His Sacred Majestie in His Solitudes and Sufferings.' It was published 9 Feb. 1649, 10 days after the execution of Charles I., and within 12 months ran through 50 editions in various languages. It professes to be Charles' own composition in the form of a diary. It is written in an affectedly dignified strain, and contains numerous assertions of love for his misguided and ungrateful people. At the Restoration, Gauden, afterward bishop of Worcester, laid claim to the authorship, and a memorandum in the copy of the Earl of Anglesea, lord privy-seal under Charles II., affirms that claim with the authority of Charles II. and the Duke of York. Milton's answer to it, 'Eikonoklastes' (that is "image-breaker") appeared the same year by order of Parliament. Gauden professed to have begun the work in or about the year 1647, and to have submitted a MS. copy of it to the king. On the other hand, those who maintain that the work was by Charles, assert that he had written the first six of its 28 chapters before the battle of Naseby (1645). The question is one of much complexity. Historians generally, from Lingard to Green, have pronounced against Charles; while some of those who have sifted his claims are in his favor. See GAUDEN, JOHN.

Bibliography.— Almack, 'Bibliography of the King's Book' (1896); Doble, in the 'Academy' (1883); Scott (E. J. L.) Comments in Edition of the Work' (1880); Wordsworth (Christopher), 'Who Wrote Icon Basilike?' (1824–5); 'King Charles I., the Author of Icon Basilike' (1828).

Eildon (ēl'dôn) **Hills,** three peaks belonging to a single mass, south of Melrose, in Roxburghshire, Scotland. The highest attains an elevation of 1,385 feet above sea-level, and all command a splendid prospect and are rich in historic and legendary associations.

Eilenburg, ī'lĕn-boorg, Germany, town of Prussian Saxony, in the government of Merseburg, mainly situated on an island of the Mulde, 14 miles northwest of Leipsic. It has manufactures of calico, woolen cloth, and chemicals. Pop. (1900) 15,147.

Eilethy'ia (hieroglyph. *Nekheb;* city of Lucina, now called EL-KÂB), a city of ancient Egypt, situated on the right bank of the Nile, a little below Edfu. The present ruins consist of the remains of small temples dedicated by Rameses III. to Ra; a Ptolemaic temple dedicated to the eponymous goddess Lucina by Physcon or Euergetes II., with additions by Ptolemy Alexander I. and the elder Cleopatra; and an ancient temple dedicated by Amenophis III. to the local deities. The names of other monarchs are also found in the ruins; but the most interesting and important remains are the rock-tombs, some as early as the 13th dynasty, excavated in the hills. That of Aahmes, the "captain of the sailors," records his services in the wars of the early monarchs of the 18th dynasty against the Hyksos or Shepherds, and other Asiatic and Nigritic races. Another, that of Pahir, is decorated with rich and elaborate paintings, representing the pursuits of agriculture, fowling, fishing, etc. The city was an outpost against the southern tribes, and its fort, a large enclosure of crude brick, was of importance as early as the Shepherd war. The goddess Suben (Eilethyia or Lucina) was a special protectress of Upper Egypt. Consult: Brugsch, 'Reiseberichte,' and 'Egypt Under the Pharaohs'; Wilkinson, 'Ancient Egyptians'; Mariette, 'Ancient Egyptian History.'

Eimbeck, īm'bĕk, **William,** American geodesist: b. Brunswick, Germany, 29 Jan. 1841. He was for two years professor of mechanics and engineering, Washington University, and a member of the government solar eclipse expeditions to Illinois 1869 and to Italy 1870. He has been a Fellow of the American Association for the Advancement of Science since 1879, and is the inventor of the invariable reversible pendulum and the duplex base apparatus of coast and geodetic survey. His chief work has been in connection with the western divisions of the 39th parallel triangulation across the continent.

Eimeo, ī'mĕ-ō, one of the Society Islands, in the Pacific Ocean, about 20 miles west-northwest of Tahiti, the principal member of the group; area 51 square miles. It consists of deep valleys and abrupt hills — the former well cultivated, and the latter heavily timbered. Here Christianity was first introduced in Polynesia; and here the South Sea College of the London Missionary Society was established. Most of the natives are Protestants. Pop. 1,500.

Einbeck, īn'bĕk, or **Eimbeck,** Germany, town of Prussia, in the province of Hanover, on the Ilme, near its junction with the Leine, 40 miles south of Hanover. It carries on several industries, and the formerly celebrated Eimbecker bier ("bock" beer) is still made here. Einbeck was a place of importance in the 15th century. It was a member of the Smalkaldic League, and it figured prominently in the Thirty Years' and the Seven Years' wars. There are still remains of its old walls and towers. Pop. 8,436.

Einhard. See EGINHARD.

Einhorn, īn'hôrn, **David,** American rabbi: b. Dispeck, Bavaria, 10 Nov. 1809; d. New York 2 Nov. 1879. His first rabbinical position was at Hopstadten, Bavaria, and shortly afterward he became chief rabbi of the grand duchy of Mecklenburg-Schwerin. In 1851 he was called to Pesth, but his progressive tendencies aroused sharp opposition and his temple was closed by order of the government. In 1855 he was invited to become rabbi of the Har Sinai Congregation, of Baltimore, Md. His activity was now to be rapidly developed, for he issued his prayer-book, which was warmly received by many reformed Jewish congregations, and he began the publication of a scholarly monthly magazine in German, entitled 'Sinai,' in the interests of advanced reform. His vigorous onslaughts on slavery in 1861 led to his removal from Baltimore to Philadelphia, there becoming rabbi of the Kenesseth Israel Temple, and publishing his catechism. In 1866 he was elected rabbi of the Adath Teshurun Temple in New York, where he continued a zealous, impassioned and scholarly advocate of reform and the leader of the then radical school, until his retirement in July 1879.

Einsiedeln, īn'zē dĕln (place of the solitaries or hermits), a small town in Switzerland, canton of Schwyz, seat of a renowned abbey of Benedictine monks since the middle of the 9th century. It is a famous resort of pilgrims who visit the place in thousands to venerate an ancient miraculous image of the Blessed Virgin. For the accommodation of the pilgrims the little town has more than 50 inns or houses of entertainment. Those pilgrimages are made throughout the year, but the great annual pilgrimage culminates on the anniversary of the dedication of the abbey's church, 14 September. The present abbey is the successor of four previous edifices which were destroyed by fire; it was erected in the first quarter of the 18th century, and is an imposing pile, in the Italian style. The place was visited by Edward Gibbon, the historian, 1755, who writes that he was "astonished by the profane ostentation of riches in the poorest corner of Europe; amidst a savage scene of woods and mountains a palace appears to have been erected by magic, and it was erected by the potent magic of religion." The abbey which Gibbon then saw is still in existence and is annually visited by more than 150,000 pilgrims. It was plundered of its vast treasure of silver and gold and precious stones by the French (1798), but it is still very rich, especially in literary monuments, possessing a library of 40,000 volumes, 1,190 manuscripts, and more than 1,000 productions of the printing press in its early period.

Eiselen, Wilhelm Bernard, vĭl'hĕlm bĕr'-närd ī'zē lĕn, German gymnast: b. Berlin 27 Sept. 1792; d. Misdroy, 22 Aug. 1846. His early studies began in Berlin, and he was the pupil of the eminent gymnast Jahns. He soon became prominent among the young gymnasts of Berlin, and in 1819 began to teach mathematics. He opened a fencing school in 1825 in Berlin and a gymnasium in 1828, and had a vast number of pupils. The first gymnasium for young girls was instituted by him in 1832. He published many works on gymnastics and fencing.

Eisenach, ī'zĕ-näн, Germany, town in the grand duchy of Saxe-Weimar, at the northwest end of the Thuringian Forest, at the confluence of the Nesse with the Hörsel, 17 miles west of Gotha. In the market-place there is a monument to the memory of those from the neighborhood who fell in the war of 1870–1, and in the Karlsplatz stands the Luther memorial, unveiled in 1895. It contains many old buildings of historical and architectural importance. The manufactures are extensive, and comprise coloring materials, white-lead, woolens, beer, leather, pottery, tobacco, oil, machinery, etc. The town has many interesting historical associations. Luther was at school here, and Sebastian Bach, to whom there is a statue, was born here. Near it is the Wartburg, where Luther resided for a time for safety. Eisenach was formerly the capital of a principality of the same name. Pop. (1900) 31,553.

Eisenberg, ī'zĕn-bĕrg, Germany, a town in the province of Saxe-Altenburg, of great antiquity, birthplace of the philosopher Krause, whose statue is set up there. It possesses a famous castle, Christiansburg, and is the seat of many manufactures. Pop. (1895) 7,956.

Eisenerz, ī'zĕn-ertz, Austria, a mining town of Austria, in the north of Styria, 20 miles northwest of Bruck. It stands in a narrow mountain valley at the foot of the Erzberg (5,000 feet), a mountain so rich in iron ore that the miners, instead of cutting mines into it and following the metal in veins, quarry the rock from the outside. Aragonite of the purest white, and resembling coral branches in form, is found in caves in the mountain. Pop. 7,000.

Eisenmenger, ī'zĕn-mĕng-ėr, **August,** Austrian fresco painter: b. Vienna 11 Feb. 1830. He studied in the Vienna Academy, and early gained the first prize in drawing (1845). In 1863 he was appointed teacher of drawing in the Protestant Real-schule of Vienna. His first work of importance was the fresco which he executed in the hall of the Society of Musical Amateurs (*Musik Freunde*), 'Apollo with the Muses'; but he has painted many notable frescoes in other public buildings. He was appointed professor of the Vienna Academy in 1872, and at the same time opened a private school of fresco painting.

Eisleben, īs'lā-bĕn, Germany, town in Prussian Saxony, 18 miles to the west of Halle, famous as the place where Martin Luther was born and died. The royal gymnasium, originally founded by Luther, was rebuilt in 1883. The house in which Luther died has been recently restored. In 1883, on the occasion of the celebration of the 400th anniversary of Luther's birth, a statue of him was unveiled in the market-place. Copper and silver are mined in the neighborhood of Eisleben. A considerable trade in flower and vegetable seeds is carried on. Pop. (1900) 23,900.

Eisteddfod, ī-stet'h'vōd, the name of an assembly of Welsh bards for the purpose of musical and poetical contests. They were held at different places for the minstrels of their respective neighborhoods; at Caerwys, at Aberfraw in Anglesea, and at Mathravel in Powys. The judges were appointed by commissions from the native princes, and after the conquest from the English kings. The last was issued in 1568; but the ancient custom has been again revived by the Gwynnedigion and Cambrian societies, and annual meetings for the recitation of prize poems and performances on the harp are now held under the name of Eisteddfod. The Eisteddfod proper was announced a year and a day beforehand at an assembly called a gorsedd, at which prizes for the previous competition were awarded. At the present time yearly eisteddfods are held alternately in the north and south of Wales; and in some parts of the United States, especially throughout Pennsylvania, and other sections settled by the Welsh people, annual meetings take place, in every way similar to the rite in their native land. During the Columbian Exposition at Chicago probably the most notable Eisteddfod held in this country, took place there.

Ejectment and Eviction. Ejectment in law is a mixed action, as it is resorted to in order to recover the possession of land, and damages for the wrongful withholding of it, though the damages are nominal. Originally, it was a possessory action — that is, adapted to the recovery of the possession of land. It ultimately became a convenient means of testing the title by a series of fictions. The supposition was (and this was the substance of the fiction) that a lease for a certain number of years had been made to a tenant, «John Doe,» who had entered into possession, and had then been ejected by a person supposed to represent the party to be finally made defendant. This person was called «a casual ejector,» and was usually represented as «Richard Roe.» An action was then brought, substantially under the following title: «Doe, as tenant of Edwards (claiming the land), against Roe.» A written notice was thereupon sent in the name of Roe by Edwards' attorney to the opposing claimant (Jones), who is the person in possession. By this notice Jones was advised to defend the action, otherwise Roe would permit judgment to be taken against him, and the possession would be lost. Jones, on making application to be made defendant, was allowed to defend on condition that he would admit the validity of the fictitious portion of these proceedings, so that the matter was narrowed down to a trial of the merits of the case. The action was now deemed to be between Edwards and Jones, although Doe still remained plaintiff on the records of the court. It was a rule in this action that the plaintiff can only recover upon a legal title, as distinguished from a title in a court of equity. He can succeed upon the strength of his own title, and of its validity, and not upon the weakness of that of his adversary. He must also have a right of entry. Where that does not exist another form of action must be resorted to. This method of procedure was defective in one particular. Any number of successive actions of ejectment could be brought by the plaintiff, although he had been defeated. The only check upon actions of this kind was a resort to a court of equity, for an injunction to prevent harrassing litigation. In England the fictitious portion of the proceeding was abolished by the Common Law Procedure Act of 1852, and the action placed upon satisfactory grounds. In New York and some other States the same result had been accomplished as early as 1830.

Eviction.— Depriving a person of his lands or tenements. Technically, the dispossession must be by judgment of law; if otherwise it is an *ouster.* Eviction may be total or partial. Total eviction takes place when the possessor is entirely deprived of his rights in the premises. Partial eviction takes place when the possessor is deprived of only a portion of them, as if a third person comes in and ejects him from a portion of his land, or establishes a right to some easement over it, by an older title than that under which he holds. See Dispossess.

Ekaterinburg, ĕ-kä"tĕ-rĕn-boorg', or **Iekaterinburg,** Russia, town, in the government and 170 miles southeast of Perm, on the east side, and in the mining district of the Ural Mountains. It was founded in 1723 by Peter the Great. It has a mint, arsenal, custom-house, mining-school, hospital, and botanic garden. The art of cutting, polishing, and engraving gems, which are found in the neighboring mountains, is here carried to great perfection, and, together with mining and metallurgy, and a commerce in cattle and cutlery, forms the chief occupation of the inhabitants. Pop. 56,129.

El Bracito (N. M.), **Battle of** (Doniphan's name BRAZITO, Mexican TEMASCALITOS), 24 Dec. 1846, in the Mexican war. Col. Doniphan, marching from California to Chihuahua, was assailed at a bend of the Rio Grande, some 25 miles from El Paso, by a battalion of Mexicans under Antonio Ponce. The Mexicans fired at long range as they charged; the Americans waited till they came close, then broke them with a destructive volley, and a company of 20 horse scattered their cavalry, which fled to the mountains. American loss, 7 wounded; Mexican, 43 killed and 150 wounded.

El Caney, ĕl kä'nā, Cuba, town, on the main road, four miles northeast of Santiago de Cuba. During the Spanish-American war it was the scene of a battle between 525 Spaniards under Gen. Vara del Ray, and 4,400 Americans under Gen. Lawton. The Spaniards lost 320, and 100 were taken prisoners; the Americans lost 440. This battle occurred 1 July 1898. In 1901 the United States government purchased the battlefield and approaches for a public reservation. See SPANISH-AMERICAN WAR.

El Dorado. See ELDORADO.

El Dorado, Kan., city, county-seat of Butler County; on the Walnut River; the Atchison, T. & S. F., and the Missouri P. R.R.'s; about 25 miles east of Wichita. The city is situated in a rich agricultural region, and its principal trade is in dairy and farm products. There are several manufacturing plants, and a limestone quarry. Pop. (1900) 3,466.

El-Khargeh. See KHARGEH, EL.

El Obeid. See OBEID, EL.

El Paso, ĕl pä'sō, Texas, city, port of entry, and county-seat of El Paso County; on the Rio G.; the Atchison, T. & S. F.; the Texas & P.; the Rock I.; El Paso & N. E., Southern Pacific, and other railways; on the Rio Grande River in the extreme western part of the State. It is opposite Ciudad Juarez, Mexico, the north terminus of the Mexican Central Railway. El Paso is about midway between the tide water of the Atlantic (Gulf of Mexico) and Pacific Oceans, about 3,800 feet above sea level, and is central to the rich tributary regions of western Texas, New Mexico, Arizona, and the northern section of old Mexico; it is 600 miles from any railroad centre that may compete with it; and enjoys an extensive trade in grain, minerals, cattle and coal.

Manufactures, Business, etc.— El Paso's unequalled railroad facilities, the proximity in New Mexico of inexhaustible supplies of fuel coal, and the demand for supplies and machinery from the mines, ranches, and growing towns of its neighborhood make it one of the most important manufacturing cities of the southwest. Its most important industry is smelting the valuable ores of the neighboring region. The El Paso smelters have a capacity of about 40,000 tons of ore a month. The monthly payment to miners for ores brought in averages nearly $2,000,000, a large part of which finds its way into the stores and factories of the city; the monthly pay-roll of the smelters and other manufactories and the railways centering in the city is nearly $300,000; and these together give to the financial interests a stability that is little affected by conditions in other parts of the country. Many eastern manufacturers, especially of machinery, have large warehouses here. El Paso has four national banks, with resources amounting to $5,000,000 in 1904, and deposits of $2,500,000, as contrasted with $1,500,000 and $750,000 respectively in 1890.

Buildings, etc.— El Paso is pre-eminently a city of homes. The streets are lighted by gas and electricity, and a well-planned electric street-railway system places all parts of the city within easy reach of the business section. The more notable buildings are the Federal building, county court-house, city hall, post-office, and high school. The city has five public schools, two parochial (R. C.) schools, a business college, and is the seat of the St. Joseph's Academy and of the Rio Grande Congregational Training School and Theological Seminary. There are several handsome churches, and two well-equipped hospitals. El Paso is a noted health resort, having many excellent hotels, some of which are open during the entire year.

Government, etc.— The city is governed by a mayor and a city council elected for a term of two years. The Spanish explorers visited the site at an early time. The first settlement was made in 1827, and the town incorporated in 1869. The present charter dates from 1889 with revisions of 1891. El Paso has grown more rapidly than any other city in Texas or the southwest. The city has had no boom, its increase being healthy and substantial, and in accordance with the demands of commerce and the development of the natural resources of the country tributary to the city. Pop. (1880) 746; (1890) 10,338; (1900) 15,906; (1904 est.) 30,000.

JUAN S. HART,
Editor El Paso Times.

El Reno, Okla., city and county-seat of Canadian County; on the Chicago, R. I. and P., Choctaw, O. and G., and St. Louis, El Reno, and Western Railways, near the geographical centre of the State. El Reno is the centre for a rich agricultural district, and has flour mills, iron foundries, machine shops, ice manufactory, grain elevators and other industries; six public school buildings, public library, high school, churches of several denominations, and three banks with a combined capital of $275,000. It has gas and electric lighting, water works, and the most complete sewerage system in Oklahoma. It was first settled in 1890; made a borough the same year; and a city of the first class in 1892. It is governed by a mayor elected biennially and eight councilmen, four of which are elected each year. Pop. (1900) 3,383.

E. D. HUMPHREY,
El Reno Mill & Elevator Co.

Elæagnus, ĕl-ē-ag'nŭs, a genus of shrubs or small trees of the natural order *Elæagnaceæ.* The species, of which there are about 15, are natives of the northern temperate zone, and are characterized by deciduous, entire leaves covered with silvery or brownish scales, solitary or clustered apetalous axillary flowers, and one-seeded drupaceous fruits. They are valued in ornamental gardening for their foliage, usually decorative fruits and mostly fragrant flowers. The deciduous members are hardy in the north; the evergreen ones, which mostly come from Japan and China, only in the south. They are easily propagated by means of seeds, cuttings, and layers, and succeed upon almost any well-drained soil in a sunny situation. The best known species probably are: (1) *E. angustifolia*, the oleaster, or white olive, which attains a height of about 20 feet. It has been introduced from southeastern Europe or adjacent Asia, and has proved hardy in the bleak and cold prairie States. It is one of the most ornamental species. (2) *E. argentea*, the silver-berry, a native of the colder parts of Canada and the northern border of the United States. It seldom attains a height exceeding 15 feet and is perhaps the most popular native species. (3) *E. longipes*, the goumi, a species introduced from eastern Asia. It is gaining in favor. It attains a height of about six feet and, like the preceding, bears edible, slightly acid fruit of pleasant flavor. This last species became of horticultural importance during the last 25 years of the 19th century because it produces good crops of fruit in climates too rigorous for most of the other fruit-bearing shrubs and trees.

Elæis, ĕ-lē'ĭs, or **Elais,** the name given to a genus of palms, tribe *Cocoeæ*, and the spiny section of that tribe. It is diœcious or monœcious; the flowers, especially the males, in dense masses, packed very closely together; the fruit is partly three-sided, but somewhat irregular. *E. guineensis*, the maba or oil-palm of the West African coast, has heads of large fruits. The outer or fleshy part of the fruit is boiled in water, when the oil rises to the surface and may be skimmed off. In its native country it is used for butter. It constitutes one of the chief commercial products of western Africa. *E. melanococca* also furnishes oil. Both species yield by manufacture palm-wine.

Elæocarpaceæ, ĕ-lē-ō-kär-pā'ce-ē, a suborder of *Tiliaceæ*, mostly East Indian trees. The fruits of some are eaten. The deeply wrinkled seeds or stones of the fruit of *Elæocarpus ganitrus* are made into beads for necklaces and bracelets in India. They are often called olive nuts.

Elæocarpus, ĕ-lē-ō-kär'pŭs, a genus of plants of the linden family (*Tiliaceæ*), to which belongs the American basswood. The species of the genus are shrubs and trees, and are found chiefly in New Zealand, Australia, and southeastern Asia. The plants are of commercial importance wherever they grow. From the seed-stones of *E. ganitrus* the natives of Australia make necklaces. The New Zealanders find a rich black dye in *E. lunau*, and in India several species furnish one of the ingredients of curry-powder.

Elæococca, ĕ-lē-ō-kŏk'a, a genus of the spurge family (*Euphorbiaceæ*). The pressed seeds of *E. verrucosa*, a Japanese plant, furnish oil for burning, as do those of the Chinese *E. vernicia* oil for mixing with paint. Both these plants are cultivated and are now known under the common name of *Aleurites cordata*.

Elæodendron, ĕ-lē-ō-dĕn'drŏn, a genus of the staff-tree family (*Celastraceæ*). The plants of the genus are generally trees, natives of Ceylon, southern Asia, and western and southern Africa. The drupes of *E. kubu* are eaten at the Cape of Good Hope, while the bark of *E. roxburghii*, rubbed with water, is used by the Hindus as an external application to swellings of all kinds. *E. glaucum*, a native of Ceylon, is sometimes called the Ceylon tea-tree. Saffronwood is the product of *E. croceum*, and an oil in common use in Africa is made from *E. argan*.

Elagabalus, ē-la-găb'a-lŭs, or **Heliogabalus,** hē"lĭ-ō-găb'a-lŭs, Roman emperor: b. Emesa 204 A.D.; d. 222. His real name was Varius Avitus Bassianus, but having, when a mere child, been appointed high-priest of the Syro-Phœnician sun-god Elagabol, he assumed the name of that deity. Soon after the death of his cousin, Caracalla, Elagabalus was proclaimed emperor by the soldiers, in opposition to the legitimate sovereign, Macrinus. The rivals met in battle at Antioch 218 A.D., Macrinus was defeated, and Elagabalus assumed the purple. His reign of three years and nine months was infamous for the debaucheries of every kind in which he indulged. He instituted ceremonies in honor of the god Elagabol, and it is believed made human sacrifices to him. He was murdered in an insurrection of the Prætorians and was succeeded by his son, Alexander Severus.

Elaine, ĕ-lā'ĭn, or **Elain,** a name for the oily principle of fat obtained by submitting fat to the action of boiling alcohol, allowing the stearin to crystallize, and then evaporating the alcoholic solution; or by the simple process of pressing any oily or fatty substance between folds of bibulous paper, the oily matter or elaine is absorbed, while the stearin remains. The paper being then soaked in water and pressed, yields up the elaine. It possesses much the appearance and properties of vegetable oil, is liquid at the temperature of 60° F., and has an odor derived from the solid fats from which it has been extracted.

E'lam, the ancient name of a country or region in Asia, east of the Lower Tigris. The cuneiform inscriptions record that a king of Elam conquered Babylonia and Assyria about 2300 B.C. The later ancient writers call this country Susiana, the name being derived from its capital, Susa or Shushan, one of the most ancient cities of the East. It is now known as Khoozistan. Both the country itself, which seems to have been of considerable importance at an early period, and its capital, Shushan, are mentioned in the Bible.

Consult: Sayce, 'Inscriptions of Mal Amir'; Loftus, 'Travels and Researches in Chaldæa and Susiana'; Billerbach, 'Susa'; Dieulafoy, 'L'Acropole de Suse.'

Eland, ē'land, the largest antelope (*Oreas canna*) found in Africa. It is as big as a fully grown horse, weighs 1,000 pounds or more, and stands fully six feet high. The early settlers in South Africa called it "elk." The eland has a short, smooth coat of rich fawn color; strong, straight horns about 20 inches long; and a broad fringed dewlap falling about to the knees. The hide makes excellent harness leather; and the flesh is decidedly palatable. The elands move so slowly, and are such gentle creatures, as to be easily caught, and hence have been nearly exterminated in their native haunts. At present very few are found. In the equatorial region of western Africa is found the still larger species (*Oreas derbianus*).

Elanet, ĕl'a-nĕt, *Elanus*, a genus of *Falconidæ*, allied to the kites, which they resemble in many of their characters; but from which they differ in having the short tarsi half covered with feathers, and the claws, except that of the middle toe, rounded beneath. The tail is very little forked. One species (*E. melanopterus*) is common in Africa from Egypt to the Cape of Good Hope, and is found also in India. Another species is the black-shouldered hawk (*E. dispar*) of America, the northern limit of which appears to be South Carolina. Both of these feed chiefly on insects, which they catch on the wing, but they also prey on small birds and reptiles.

Elapidæ, ĕ-lăp'i-dē, or **Elapinæ**, a group of highly venomous snakes, having a short, rounded head covered with plates. They are more nearly related to the harmless colubrines than to the vipers, but have a poison apparatus of the proteroglyph type, which are smaller than in the viperine snakes, but very deadly. The group is a large one and found in most parts of the world, but is most numerous in the tropics. Nearly all the snakes of Australia are elapine, the whole race of cobras (q.v.), the coral and harlequin snakes and others. The genus Elaps is entirely American, and is represented by a single species in the United States (Florida).

Elaps, ē laps. See CORAL-SNAKE.

Elasmobranchii, ĕ-lăs-mō-brăng'kĭ-ī, a subclass of fishes, containing the sharks and rays. The skull is cartilaginous with only superficial calcifications and no true dermal bones; the gills fixed and shaped like pouches; the upper jaw is the pterygo-palatine bar, and the lower jaw Meckel's cartilage, attached to the skull by a large hyo-mandibular element; the exoskeleton consists of tooth-like granular tubercles or spines; and the trunk endoskeleton is cartilaginous. The ventral fins are far back and bear claspers in the males; the heart has but one auricle and one ventricle; and the intestine is provided with a spiral valve. The group is nearly coextensive with Cuvier's *Chondropterygia* or cartilaginous fishes and the Placoidei of Agassiz, and has received various other names such as Selachii and Plagiostomi. Cope distinguishes as orders the *Selachii*, which includes all living as well as many extinct forms; and the *Ichthyotomi*, which are exclusively carboniferous and have simple claspers and extensive cranial calcifications. See DOGFISH, RAY, SAWFISH, SHARK, SKATE, etc.

Elasmosaurians, ĕ-lăs-mō-sâ'rĭ-anz, gigantic marine fossil reptiles of the order *Sauropterygia*, found in cretacean beds. As a living animal it was contemporaneous with *Plesiosaurus*, of the same order, which abounded in the eastern hemisphere, and as a fossil has been found in Europe and New Zealand. Elasmosaurus had a lizard-like, elongated body, sometimes 45 feet long, flattened limbs which served as oars, and a long, paddle-shaped tail which assisted its motion through the water. The head was proportionately small, and with the neck performed twisting motions much like the corresponding parts of the swan. The contents discovered in the body indicate that this seasaurian lived on other rapacious fish, which it was able to seize with its crocodile-teeth. The fossil has been raised from cretaceous beds in New Jersey and in Kansas.

Elasmotherium, ĕ-lăs-mō-thē'rĭ-ŭm, an extinct rhinoceros which inhabited Siberia and Russia during the Pleistocene Epoch. It exceeded the Indian rhinoceros in size, and bore an enormous horn on the frontal bone of the skull. The teeth are very long-crowned, with the enamel ridges strongly crenulated. Some of the native Siberian legends are supposed to refer to this animal; it was a contemporary of early man in that region.

Elastic Limit. See ELASTICITY.

Elastic Tissue, fibrous tissue in most cases mixed with the fibres of areolar tissue. It occurs in the ligaments of the vertebræ, that of the jaw, etc., also in connection with arteries, veins, and lymphatics. It is used in the animal structure whenever an extensible and highly elastic material is required.

Elastic'ity, that property of bodies in virtue of which they tend to return to their original shape or bulk, after having been subjected to distortion, compression, or extension. The fundamental principles of the theory of elasticity are well understood; but in applying these principles to the precise solution of the practical

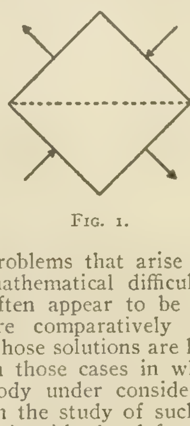

FIG. 1.

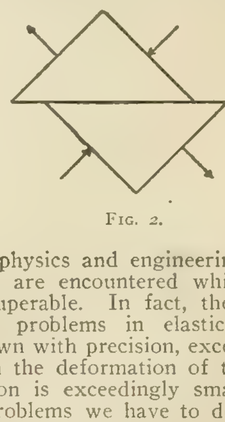

FIG. 2.

problems that arise in physics and engineering, mathematical difficulties are encountered which often appear to be insuperable. In fact, there are comparatively few problems in elasticity whose solutions are known with precision, except in those cases in which the deformation of the body under consideration is exceedingly small. In the study of such problems we have to deal (1) with the deformation that the elastic body experiences, and (2) with the forces that are associated with that deformation. In the convenient phraseology of Rankine (which has been generally adopted by later writers), the deformation itself is called a «strain,» and the internal forces that the continued existence of this strain implies are collectively known as the «stress.» Rankine's own language on this point is as follows, save for a single minor modification: «The word ‹strain› will be used to denote the change of volume and figure constituting the deviation of a definite elementary portion of a solid from that condition which it preserves when free from the action of external forces; and the word ‹stress› will be used to denote the force, or combination of forces, which this same elementary portion exerts in tending to recover its free condition, and which, for a state of equilibrium, is equal and opposite to the combination of external forces applied to it." These definitions being established, the theory of elasticity may be defined as that branch of pure mechanics which deals with the stresses and strains to which elastic bodies are subject. In an æolotropic or anisotropic body, such as a crystal belonging to the orthorhombic, monoclinic, or triclinic system (see CRYSTAL), the elastic properties are different in different directions, and it is found that the equations that are required in order completely to specify the connection between the stresses and strains that may exist in such a body involve no less than 21 constants.

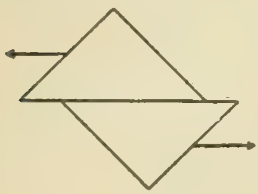

FIG. 3.

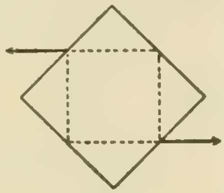

FIG. 4.

It is easy to understand that this fact implies enormous mathematical difficulties in the solution of problems relating to such bodies; and these intrinsic difficulties are still further enhanced by the fact that there is probably not one substance in nature, for which the actual numerical values of these constants are all known. (For a thorough but necessarily difficult discussion of the elastic theory of crystalline bodies, consult Rankine's 'Axes of Elasticity and Crystalline Forms,' in his 'Miscellaneous Scientific Papers.') When, on the other hand, the body has exactly the same properties in all directions (or is "isotropic"), it is found that only two constants are required; but even in this comparatively simple case the mathematical difficulties of the general theory are so great that it is usually impossible to solve problems in which the deformations to be considered are of any considerable magnitude.

In the remaining portion of this article it will be assumed that the body under consideration is strictly isotropic — that is, that it has the same

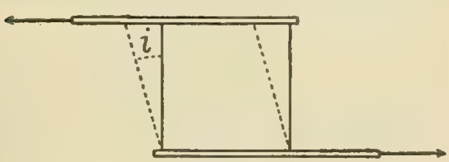

FIG. 5.

elastic properties in all directions, and in all its parts. Fortunately this restriction is not incompatible with the great majority of problems that arise in practical work. In such a body, as has been said above, there are but two independent elastic constants, which have to be determined by experiment for the particular substance under consideration. These are known, respectively, as the "bulk modulus" (or "volume modulus"), and the "modulus of simple rigidity," though numerous other names are also applied to them. If V is the original volume of an isotropic solid, and V — v is its volume when subjected to a uniform normal pressure of P pounds per square inch over its entire surface, then $\frac{v}{V}$ is called the "compression," and the "bulk modulus" of the body (which is commonly represented by the letter k) is defined as

$$k = P \div \left(\frac{v}{V}\right) = P\left(\frac{V}{v}\right)$$

The values of this modulus for some few common substances are given below.

The modulus of simple rigidity is usually defined by reference to the distortion that a small cubical portion of the unstrained solid undergoes when the distorting force is applied. Fig. 1 represents a cube of this sort, which is supposed to be so small that the force acting upon any one of its faces may be considered to be uniform over the entire face. When such a cube is in equilibrium the most general kind of stress to which it can be subjected is resolvable into stresses of two types: (1) a uniform compressive stress, acting with equal intensity on all its faces, and therefore tending merely to alter its volume without producing any distortion of form; and (2) four equal forces, acting upon four of the faces, and disposed in pairs as shown in Fig. 1, one pair being directed inward and the other pair outward. The system of forces shown in Fig. 1 tends to alter the shape of the cube by extending it in one direction, and flattening it in a direction at right angles thereto; but there is no tendency in such a system to alter the bulk of the cube, since the extension produced by one of the pairs of forces is exactly neutralized by the compression produced by the other pair. If the dotted line in Fig. 1 were a line of weakness across the cube, it is evident that the effect of the force-system in that figure would be to cause the upper part of the cube to slip, relatively to the lower part, as suggested in Fig. 2. In fact, if the forces acting upon the upper part are compounded together, and those acting upon the lower part are also compounded in the same manner, it is plain that the four forces of Fig. 1 may be considered to be equivalent to the two that are shown in Fig. 3; so that the tendency of the stress-system shown in Fig. 1 is merely to cause one part of the cube to slide, relatively to the other part, along a plane that is parallel to the direction in which the resultant forces act. A stress such as is here described is called a "shear." To estimate the resistance of a body to deformation by the action of a shearing stress, consider a small cube to be cut from the original one, as suggested by the dotted lines in Fig. 4; and for the sake of fixing the ideas, let strips be conceived to be cemented to this cube at the top and bottom, as indicated in Fig. 5, so that the equal and opposite distorting forces can be conveniently applied. Then the effect of the forces in Fig. 5 will be to distort the cube into the shape indicated by the oblique dotted lines, and the magnitude of the angle i may be taken as the measure of the rigidity of the material of which the cube is composed; this angle being smaller (for a given shearing stress), the greater the rigidity of the substance considered. Stresses such as those shown in Fig. 5 are said to be "tangential"; and the "modulus of rigidity" of a substance may be obtained experimentally by applying such a pair of tangential forces to a unit cube of the substance, and then dividing either of these equal and opposite tangential forces by the observed value of the angle i, as expressed in radians. The modulus of rigidity is commonly denoted by the letter n.

The bulk modulus and the modulus of rigidity of an isotropic substance being known, problems concerning the elastic behavior of that substance can be solved by known mathematical methods, when the strains to be considered are quite small. For these methods, advanced treatises on theoretical mechanics must be consulted. One of the best books, so far as the presentation of the general principles of the subject is concerned, is that of H. Poincaré, 'Leçons sur la théorie de l'élasticité.'

Different bodies possess different degrees of elasticity, both of bulk and of form, and the elasticity of the same body will usually vary sensibly with the temperature. A body in which a certain definite strain is always accompanied by identically the same condition of stress, at a given temperature, without regard to the variations of temperature, bulk, and form to which it may have been subjected in the intervals between successive repetitions of the experiment, is said to be "perfectly elastic." Fluids (that is, gases and liquids) possess perfect elasticity of bulk, since a given fluid always requires the application of the same pressure, in order that its bulk may be diminished by a given constant amount, at a fixed temperature. Many solids also appear to possess perfect elasticity, both of bulk and of form, so long as the strains to which they are subjected do not exceed certain limiting values. Thus when a bar of steel is extended by the application of a longitudinal tension, it will return to its original length when the tension is removed, provided the extension that was produced (when expressed as a fraction of the total length of the bar) did not exceed a certain limit. If the extension exceeded this limit, the bar will shorten upon the removal of the tensile force, but will not return precisely to its original length. The permanent elongation so produced is technically known as the "permanent set" of the material. The tensile force that will just extend a bar of unit sectional area to the point at which it first receives a permanent set, is often called, commercially, the "elastic limit" of the material; though the expression "yield point," which is less generally employed, appears to be preferable. When a tensile force is applied to such a bar as we have been considering, and in such a manner that the force, at first zero, increases gradually up to a maximum value, the bar stretches under its influence, and it is observed that for a considerable time the extension of the bar is almost precisely proportional, at any given instant, to the force that is being exerted at that instant. As the bar approaches its yield point, however, the extension is found to exceed the value that it would have if the law of proportionality held good up to the yield point. The tensile force to which a bar of unit sectional area is subjected when the departure of the extension from strict proportionality to the force is first observed is also often called the "elastic limit" of the material; though, since it does not coincide with the yield point, it is more accurately described as the "limit of proportionality." The general phenomena here discussed are observed also in connection with strains other than mere extensions. Thus when solid bodies are deformed in any way by the application of an external force, a permanent set is observed if the deforming force is large enough; and the deformation, which at the outset is proportional to the applied force, ceases to be so when that force attains to a certain limiting value. In some cases, however, fracture of the material may supervene before any permanent residual set can be actually realized, and the deformation of the material may also remain sensibly proportional to the applied force, even up to the point of fracture. The general law that the distortion of an elastic body is strictly proportional to the applied force, provided that force does not exceed a certain limit, is known as "Hooke's law," from the fact that it was first explicitly stated by Robert Hooke, for the simple case of the extension of a bar by tension (*Ut tensio sicut vis*).

When a straight bar of metal (or other solid substance) is subjected to an endwise pull, it elongates in the direction of the tension, and contracts in all directions at right angles thereto. If L is the original length of the unstrained bar, and $L + l$ is its length when subjected to the longitudinal tension P, the ratio $\frac{l}{L}$ is called the "longitudinal extension" of the bar, under the influence of the tension P. From Hooke's law it follows that the longitudinal extension, as so defined, is proportional (for small strains) to the force P, so that the quotient obtained by dividing the force P by the longitudinal extension that it produces is constant. When the sectional area of the bar is unity (or, what amounts to the same thing, when P is the tension per unit of sectional area of the bar), this constant, which has the value $\frac{PL}{l}$, and is usually denoted by the letter E, is called "Young's modulus," from the fact that its importance was first recognized by Dr. Thomas Young. Since the elastic properties of an isotropic body are determinate when the "bulk modulus," k, and "modulus of rigidity," n, are known, it follows the Young's modulus, E, is not independent of these two. In fact it can be shown that the simple relation

$$E = \frac{9nk}{3k + n}$$

must hold true among these three quantities.

It has been said above that when a bar is exposed to simple longitudinal tension its diameter diminishes simultaneously with the increase of its length. Let the absolute diminution of the diameter be divided by the diameter itself, and the absolute increase in the length be divided, similarly, by the length itself; and let these two quotients be designated, respectively, as the "lateral contraction," and the "longitudinal dilation." The ratio of the lateral contraction to the longitudinal dilation is an important physical quantity, which is called "Poisson's ratio," after the French mathematician Poisson, who studied it extensively. Mallock found it to be 0.253 for steel, 0.325 for brass, 0.348 for copper, 0.375 for lead, 0.50 for india rubber and paraffin, and zero for cork. Poisson and Navier concluded from erroneous mathematical reasoning that the ratio in question is precisely 0.250 for all isotropic bodies, and in this they were followed by Cauchy and many other distinguished authorities. It may be shown, however, that Poisson's ratio is expressible in terms of the bulk modulus and the modulus of rigidity by means of the formula

$$\text{Poisson's Ratio} = \frac{3k - 2n}{2(3k + n)}$$

This expression cannot be numerically equal to 0.250, unless the modulus of rigidity is precisely three fifths of the bulk modulus — a relation that could not be assumed to hold true generally, and which we know, from experiment, to be false for multitudes of bodies that are sensibly isotropic. The wide range of values observed by Mallock therefore corresponds, in all probability, to a similar variation in the actual value of the constant, and cannot be safely attributed to errors of experiment.

The various moduli to which reference has been made have been determined experimentally for many substances. They differ appreciably in different specimens of the same substance, being influenced both by the chemical composition and by the physical state of the specimen tested. In the following short table values are given that will apply with a fair degree of accuracy to the average specimens of steel, brass, and glass that are likely to be met with in practical problems:

Modulus	Substance		
	Steel	Brass	Glass
Young's	30,000,000	14,000,000	7,200,000
Rigidity	12,000,000	5,200,000	2,900,000
Bulk	26,000,000	14,000,000	5,800,000

In this table the unit of length is the inch, the unit of force is the attraction that the earth exerts upon one pound of matter, and stress is supposed to be expressed in pounds per square inch. The several moduli here given do not strictly satisfy the formula given above for expressing Young's modulus in terms of the bulk modulus and the modulus of rigidity; but that is because they are averages of numerous results, taken from a variety of sources, and it appears to be better to give the experimental averages just as they were obtained, rather than to manipulate them so as to bring them into precise conformity with the formula. The formula itself is sufficiently trustworthy to serve for the calculation of any one of the three moduli of a given substance, when the other two moduli of that substance are known. Consult for further numerical data Rankine, 'Useful Rules and Tables'; and Everett, 'Units and Physical Constants.' In the latter book the data are given in the C. G. S. system.

Elas'tin, an insoluble proteid substance, of which the elastic fibres of connective tissue are composed. It may be conveniently prepared from the *ligamentum nuchæ*, by boiling with ether and alcohol (to remove the fats), and afterward by prolonged boiling, successively, with water, strong acetic acid, and concentrated caustic soda, and subsequent successive treatment with weak acetic acid, water, hydrochloric acid, and water. When so prepared, elastin is not soluble (without decomposition) in any known solvent. It dissolves with decomposition in concentrated sulphuric acid, however, yielding leucin, but not tyrrsin. Elastin is digested both by pepsin and by trypsin, and it contains no sulphur. Its percentage composition, according to Muller, is: C = 55.45; H = 7.41; N = 16.19; O = 20.89.

Elate'a. See CITHÆRON.

Elater, ĕl'ā-tėr, a genus of beetles in the pentamerous sub-order, type of the family *Elateridæ*. They are familarly known as "click-beetles" or "skip-jacks," from their habit of jerking themselves with a slight noise into the air when they land or are placed on their backs. The body is arched upward and suddenly straightened with a violent muscular exertion, which lifts the animal from the ground. The legs are too short for the ordinary method of righting the body. The larvæ are only too familiar as "wireworms" (q.v.). Some tropical forms are phosphorescent. See FIREFLY.

Elateridæ, ĕl-a-tĕr'ĭ-dē, a family of *Coleoptera* (click-beetles), tribe *Pentamera*, sub-tribe *Sternoxia*. It contains the insects placed by Linnæus in his great genus *Elater*, now broken up into many genera. See CLICK-BEETLE; FIREFLY.

Elat'erin, a neutral chemical substance having the formula $C_{20}H_{28}O_5$, and obtained by alcoholic extraction of the greenish precipitate thrown down by the juice of the slightly unripe squirting cucumber, *Ecballium elaterium*. It crystallizes in hexagonal tablets which melt at 400° F., and are insoluble in water, but soluble in chloroform and in hot alcohol. Elaterin has a bitter taste, and is a powerful purgative, the dose being from the 40th to the 10th of a grain. A crimson color, changing to a scarlet, is produced when sulphuric acid is added to a solution of elaterin in carbolic acid; this reaction serving as a test for its presence.

Elat'erite, an elastic, asphalt-like mineral, known as "elastic bitumen." In color it is dark brown, with a specific gravity ranging from 0.9 to 1.2. It occurs abundantly in Derbyshire, England, and a mineral closely allied to it has been found at Woodbury, Conn.

Elaterium, ĕl-a-tē'rĭ-um, a mixture of principles formed as a precipitate, occurring spontaneously in the juice of the fruit of the wild or squirting cucumber, *Ecballium elaterium*, the active principle of which is elaterin. The squirting cucumber is a small perennial, of the cucumber family, indigenous in Persia, India and the warmer Oriental countries, and has been extensively cultivated even as far north as England. The fruit itself is 1½ to 3 inches long by 1-3 to 3-4 of an inch, oblong or oval in shape, covered with soft bristles, and yellowish green in color. It is firm externally. As the fruit ripens fermentation takes place in the interior with the formation of gas. This accumulates in sufficient quantities to exert considerable pressure, bursting the fruit at its base and squirting the seeds some distance. In this manner the fruit is distributed. Flaterium has been used for centuries as a cathartic, the phenomena of the squirting seeds having suggested its function. Elaterin itself is an neutral principle of the formula $C_{20}H_{28}O_6$. It forms in minute white prismatic crystals, without odor and with a slightly gritty and bitter taste. Elaterin is one of the most active of all the hydragogue cathartics. It operates with violence even in minute doses. It is particularly of service in conditions in which there is general dropsy and no inflammatory condition of the intestinal tract. Elaterin is given in doses of from 1-40 to 1-10 of a grain.

Elba (Lat. *Ilva;* Gr. *Æthalia*), a small island belonging to the kingdom of Italy, in the Mediterranean Sea, off the coast of Tuscany, and with several much smaller isles, lying at the mouth of the Gulf of Piombino. The island of Elba is 18 miles from east to west, with a width varying from 2½ to 12 miles in its widest part. The mountainous districts of the island yield large quantities of superior iron, marble, lodestones, and alum, besides wines and fruits. On the first abdication of Napoleon in 1814, Elba was assigned to him as a residence and empire. Here he accordingly took up his residence, in the month of May; and on 26 Feb. 1815, he secretly left the island, and, landing in France, began that brief and final career, known in history as the «Hundred Days.» Elba was a place of celebrity in the time of the Romans, and famed then, as now, for its yield of iron. Two good ports are Porto-Ferraio and Porto-Longone, both well fortified. Pop. 25,480.

Elbe, ĕl'bĕ (ancient ALBIS; Bohemian, LABE), a river of Germany, one of the largest in Europe. It rises on the southwest slopes of the Schneekoppe or Snowcap, one of the Riesengebirge, between Bohemia and Silesia. From this point it flows nearly due south into Bohemia for about 50 miles, when it turns to the west, and after about 40 miles takes a general north-northwest direction till it empties into the North Sea, intersecting Saxony, a considerable portion of Prussia, and in the latter part of its course separating Holstein on its right from Hanover on the left. The length, including windings, is upward of 780 miles. The principal affluents are on the right, the Iser, Schwarz-Elster, and Havel; on the left, the Alder, Moldau, Eger, Mulda, and Saale. In the lower part of its course the river is divided by five large and seven small islands into several arms, which unite again about five miles below Hamburg. The mean depth is 10 feet, average breadth 900 feet. It is more or less navigable for about 470 miles, but its estuary at Cuxhaven is much encumbered with sandbanks. It is well stocked with fish. On 1 July 1870, the navigation of the Elbe was declared free from Hamburg to Melnik in Bohemia. There is an important system of canal navigation in connection with the Elbe, Hamburg, for instance, being in this way connected with Berlin.

Elberfeld, ĕl'bĕr-fĕld, Germany, town in the Prussian Rhine province; 15 miles east of Düsseldorf, in the beautiful valley, and on both sides of the Wupper, enclosed by lofty hills. It has no historical or antiquarian importance. Its prosperity has been acquired mostly within the present century, and is due to the cotton manufacture, of which it is the central locality in Rhenish Prussia. In addition to the cotton manufacture, which, under a variety of forms, is the great staple of the town, linen, woolen, silk and mixed silk goods, ribbons, and velvet are extensively made, and largely exported. There are also numerous mills for spinning cotton twist, linen yarn, and worsted, and dye-works, celebrated for the richness of their colors. The environs are almost covered with bleachfields. Pop. (1900) 157,927.

Elberfeld System, a system of poor-relief which originated in the appointment of six visitors in 1800, to investigate applications for aid, in the manufacturing town of Elberfeld, Prussia. The city was subsequently divided into districts, the number of visitors was increased, and the operations developed, until by 1852 what has become known universally as the Elberfeld System was adopted. Its main features are the division of the city into 26 districts subdivided into 364 precincts, each precinct being administered by an almoner who investigates each application, in cases of emergency provides immediate assistance, and as long as aid is afforded, visits the applicant twice a month. Money relief is granted fortnightly according to a fixed schedule, any earnings in the meantime being deducted; when needed, working implements are provided. A meeting of the almoners under the presidency of an overseer takes place every fortnight to discuss cases and to vote necessary relief, a report of the meeting being laid the next day before the directors who are chosen from four councilmen and four citizens with the mayor as chairman *ex officio.* The directors superintend and advise on the whole city's work. The positions of almoners, overseers, and directors are of a purely honorary character. The advantages of the system in the improvement of the condition of the poor have been strongly apparent, the ratio of persons assisted in 1889 being 7 per 1,000 as against 17 per 1,000 in 1855. See also CHARITIES.

Elberon, N. J., sea-coast summer resort in Monmouth County, on the Pennsylvania and the Central Railroad of New Jersey. Pop. (1901) 200. Here President James A. Garfield (q.v.) was taken after he was shot by Guiteau, 6 Sept. 1881, and died here 19 Sept.

El'berton, Ga., city, county-seat of Elberton County; on the Southern and the Seaboard A. L. R.R.'s; 90 miles northeast of Atlanta. It is in a cotton-growing section and the chief industries are connected with the cultivating, shipping, and manufacturing of cotton. It contains manufactories for cottonseed-oil, cotton goods, compressing cotton, and for fertilizers for the cotton plant. The quarries nearby give employment to a number. Pop. 3,902.

Elbeuf, ĕl'bĕf, France, town, in the department of Seine-Inférieure, 11 miles south-southwest of Rouen, situated in a beautiful valley on the left bank of the Seine. It has handsome churches, public buildings, and homes. It has spinning-mills, dye-works, and all accessories for the complete production of woolen manufactures, chiefly of lighter cloths, checkered stuffs, fine colored flannel fabrics, and all kinds of fancy goods. Pop. 40,500.

El'bing, Germany, seaport town, in West Prussia, on the Elbing, near its entrance into the Frische-Haff, 32 miles east-southeast of Dantzic. It is divided into the old and new towns, the former of which was once surrounded by turreted walls and gates, but these for the most part have been removed. It has shipbuilding yards, which do a considerable trade in building and repairing vessels. Its manufactures include cloth, leather, soap, tobacco and beer.

By means of a canal it has connection with the Vistula, and the harbor was improved by the opening in 1884 of a mole 3,500 yards long. Pop. 50,121.

Elbow. See ARM.

Elbow Joint. See ARM.

Elbruz, ĕl'brooz, or **Elburz,** (1) A mountain range of Persia, running for 450 miles along the southern border of the Caspian Sea. It has a number of subordinate parallel ridges, enclosing extensive and fertile valleys; and unlike most Persian ranges, it has numerous prominent spurs, the highest peak being Mount Demavend (q.v.). (2) Elbruz is also the name of the loftiest summit of the Caucasus.

Elcano, Juan Sebastian de, hoo-än' sā-bäs-tē-än' dā āl-kä'nō, Spanish navigator: b. Guetaria, Guipuzcoa. He was captain of the Concepcion, accompanying Magellan, and was the first to circumnavigate the world, completing his journey of three years 8 Sept. 1522. He went with Garcia Jofre di Loaysa on the westward voyage to the Moluccas, and died after passing the straits of Magellan and gaining the Pacific.

Elcesaites, ĕl-sē'sa-īts, or **Elkesaites,** a sect founded in the 2nd century, during the reign of Trajan. They derived their belief from the teachings of the Book of Elkesai, supposed to have been inspired by an angel. Their system seems to have been a commingling of Oriental philosophy with Sudaism and early Christianity. Probably put into practice with the idea of satisfying the want of those persons seriously troubled by the religious chaos of the day caused by the mighty conflict of greater creeds. The followers of Elkesai or Elxai are often confounded with Ebionites (q.v.). The best account we have of the Elcesaites is given by Hippolytus in his chief work, 'Philosophumena.'

Elchingen, ĕl'hĭng-ĕn, Bavaria, village, on the Danube, nine miles northeast of Ulm, which gave the title of Duke of Elchingen to Marshal Ney, who here defeated the Austrians 14 Oct. 1805. In the neighborhood are the ruins of a Benedictine Abbey of the same name, founded in 1128. There are two villages, Ober and Unter Elchingen, the former on the same hill with the abbey, the latter to the northeast of it. The hill on which the abbey stood was occupied by Mack, who had his headquarters in Ulm; while Ney, on the right bank of the river, repaired the bridge of Elchingen, forced the passage of the river, and took Elchingen by storm.

Elder, John, English engineer: b. Glasgow 1824; d. 1869. Educated in Glasgow, he was first employed as director of the drawing office of Napier's establishment, becoming later a member of the great ship-building firm which was known after 1860 as Randolph, Elder & Company, employing more than 4,000 men. His fame rests upon his invention of the compound or combined high and low pressure engines, saving nearly 40 per cent of fuel.

Elder, Susan Blanchard, American writer: b. Fort Jessup, La., 19 April 1835. She was married to C. D. Elder of New Orleans. She began to write for the press, under the name «HERMINE,» when quite young. She has published: 'The Loss of the Papacy'; 'James the Second'; 'Savonarola.' Her contributions to Roman Catholic publications are numerous. Her dramas are written for representation in Roman Catholic colleges.

Elder, William Henry, American Roman Catholic prelate: b. Baltimore, Md., 22 March 1819; d. 31 Oct. 1904. When 12 years old he entered Mount Saint Mary's College, Maryland, and at 18 was graduated and sent to Rome, where he was ordained priest 29 March 1846. Returning to America, he accepted the professorship of theology at Mount Saint Mary's, became its president, and remained here until consecrated bishop of Natchez, 3 May 1857. On one occasion, when the Federal authorities, who had taken possession of the city, bade Bishop Elder offer certain public prayers and command his clergy to do likewise, he stoutly refused, declaring that in thus ordering him they were usurping the right of religious liberty, and rather than comply he accepted imprisonment; when the case was reported at Washington he was promptly released. In 1878 Natchez was visited by an epidemic of yellow fever and the bishop fell a victim to the plague, which carried him to the point of death. In 1880 he left Natchez to assume the duties of coadjutor to Archbishop Purcell, of Cincinnati, Ohio, who at once retired, leaving Bishop Elder to settle the perplexing difficulties that disturbed the diocese. Upon the death of Archbishop Purcell, in 1883, Bishop Elder succeeded to the archbishopric of Cincinnati. The archdiocese now (1905) has a Catholic population of about 200,000; 312 priests; 184 churches; 105 parochial schools; 4 orphanages and 7 hospitals, besides seminaries, colleges, academies, and charitable institutions.

Elder, *Sambucus*, a genus of shrubs or small trees and a few perennial herbs of the natural order *Caprifoliaceæ*. There are about 20 widely distributed species characterized by opposite, pinnate leaves, small white flowers usually in compound cymes, and black, red, white or green, juicy fruits (berries or drupes). Many of the species are used in ornamental planting, since they are readily propagated by root and stem cuttings, succeed well upon nearly all soils, are of rapid growth, graceful form, and are attractive both in flower and fruit. The best-known species in America is *S. canadensis*, the common or sweet elder, which is frequently seen in fence-rows, along roadsides, and on the margins of woods throughout southern Canada and the greater part of the United States. It attains a height of 10 feet or more, bears abundant fragrant flowers in midsummer and black berries in early autumn. These fruits are used where they can be obtained plentifully for making pies and elderberry wine. Several horticultural varieties have been introduced for their golden or variegated foliage, and one variety with large fruits was introduced in 1890. The flowers are used for making a wine, a perfume, and a «water» used in confectionery. Economically this species ranks as a minor fruit. Like some other members of its genus, it has also been used in medicine, but is rapidly giving place to other drugs. Probably *S. nigra*, the common European elder, ranks next in importance. It is much larger, often attaining a height of more than 20 feet. The yellow, hard, tough wood is readily polished and is used for making skewers, fishing-rods, needles for making fish-nets, and as a substitute for boxwood. It is also employed for the same horticultural and economic purposes as the preceding species, and has numerous fancy-leaved varieties. Other well-known species are the scarlet elder (*S. racemosa*), an Old-World species, and the red-berried elder (*S. pubens*), a native of North America, considered by some botanists to be identical. There are also several unrelated plants which are popularly known as elder, as box-elder (*Negundo aceroides*), wild elder (*Aralia hispida*), also known as bristly sarsaparilla, and marsh-elder (*Iva frutescens*).

Elders, among Calvinistic churches, a body of men elected by the communicants from among their number to aid the minister in portions of his spiritual work. With the minister, they constitute the executive of the congregation. Among the Jews the elders are the rulers or magistrates of the people. The instinct of mankind considers the old fitter than the young to rule, and at first probably every «elder» was really pretty well advanced in life; but the designation ultimately came to be used more of office than of age. «The elders of the congregation,» or simply «the elders,» are mentioned as early as Lev. iv. 15. Seventy of them were appointed as associates of Moses (Num. xi. 16). They are combined with the officers (Deut. xix. 12), with the princes (Ezra x. 8), with the priests (Lam. i. 19). In the New Testament they are described as having given currency to traditions (Matt. xv. 2), and taken a chief part in compassing the death of Jesus (Matt. xxvi. 59; xxvii. 20), etc. There were elders, also, of single towns, as of Succoth (Judges viii. 14), and of Jezreel (2 Kings x. 1).

Eldon, John Scott, Earl of, English jurist: b. Newcastle 4 June 1751; d. London 13 Jan. 1838. He was educated at Oxford; was called to the bar in 1776, and in 1782 was made king's counsel. Next year he entered Parliament, supported Pitt, and was made solicitor-general and knighted. In 1793 he became attorney-general, and in 1799 was created chief justice of the court of common pleas, and raised to the peerage and the House of Lords under the title of Baron Eldon. He became lord chancellor (1801), and retained this post under the subsequent administration of Pitt until the death of the latter in 1806. A year later, however, he resumed the chancellorship under Liverpool, and held it without break for 20 years. In 1821 he was created an earl by George IV. On the accession of the Canning ministry in 1827 he resigned the chancelorship, and never again held office. As a lawyer he was a master of English jurisprudence; as a politician he was opposed to reform. See Campbell, ‹Lives of the Lord Chancellors›; Tuiss, ‹Public and Private Life of Lord Eldon› (1844).

Eldo'ra, Iowa, city, county-seat of Hardin County, near the Iowa River, on the Iowa Central, and the Chicago, I. & D. R.R.'s; 122 miles west of Dubuque. The region is rich in deposits of clay, and brick making, the manufacture of tiles and sewer pipes are the chief industries. Pop. (1900) 2,233.

Eldorado, ĕl-dō-rä'dō (from the Spanish *El Dorado*, the Gilded Man), the region of undiscovered treasure in South America. In the article Dabaiba we have traced the famous Eldorado myth back to those stories which, at the beginning of the 16th century, were current among the Indians of Darien about «a temple lined with gold,» and have shown why the Spanish explorers failed to recognize in distant Cuzco, with its temple of the sun-god, the real basis of such accounts. The *name* Eldorado, however, with which the ever-receding or shifting territory, the subject of all those stories, has been stamped, was at first not the name of a place but of a person; and the name-giving addition to the myth is localized very precisely in the table-land of Bogotá, as follows: Lake Guatavitá (north of the present capital of Colombia; elevation above sea-level 3,199 metres) was regarded by Indian tribes dwelling in that neighborhood in the 15th century as a holy place, and pilgrims who resorted to it often cast their offerings of gold and emeralds into its waters. Whenever a new chief of Guatavitá was chosen, nobles and priests of his tribe bore him to the lake, as A. F. Bandelier has written, «upon a barrow hung with disks of gold. His naked body was annointed with resinous gums and covered all over with gold-dust.» The chief plunged into the lake; spectators made the usual offerings of gold and jewels; and, on the conclusion of this ceremony of consecration, the new ruler and his subjects went down to dance and feast in Guatavitá village. The Chibchas, (q.v.) conquered Guatavitá about the end of the 15th century, and under their general government this extraordinary local custom had been discontinued for a number of years before the first Spanish settlements were made on the Caribbean coast — there was no longer an independent Guatavitá chief to signify his acceptance of the local religious beliefs in a fashion so dramatic; but native folk-lore continued for a century, at least, to make much of this glittering symbolic figure and the sacred lake. In 1529, Dalfinger, governor of the German colony in Venezuela, set out from his little capital of Coro, and probably reached the edge of the high plain of Bogotá by way of the Magdalena River; there the resistance of the Indians obliged him to turn back. Four years later the report of the vast treasure secured by the conquerors of Peru (Atahualpa's «ransom» alone was officially valued at 3,933,000 ducats of gold and 672,670 ducats of silver) appeared to justify ventures undertaken in reliance upon the wildest Eldorado tales. It is also true that a fresh outbreak of the gold-fever affected the Spanish colonists everywhere in America, more or less, but especially those in the agricultural settlements (Compare: Dominican Republic, sub-title *History*); and that leaders of those colonies, in order to retain their men, were obliged to make fresh efforts to find treasure. In Santa Marta, an expedition was organized to ascend the Magdalena River to the highlands; at Coro, Georg von Speyer organized a campaign for the exploration of the Meta plain, far inland. The former expedition under command of Quesada in 1537 reached the old home of the gilded chief; and although Guatavitá either hid its gold or was actually poor (40 years having passed since it had ceased to be a place of pilgrimage), the treasure collected in this neighborhood, principally at the villages of Tunja and Iraca, was officially valued at 246,676 pesos in gold, or about $1,200,000, besides 1,815 emeralds. Von Speyer went astray among the tributaries of the upper Orinoco, but his lieutenant, the German, Nicolaus Federmann, leading a company from Coro, reached the Bogotá highlands in time to meet there not only Quesada but the conqueror of Ecuador, Benalcazar, who came up from the south, having also heard the story of the Gilded Man. Each of these leaders considered himself the discoverer of the country, and they proceeded together to Spain, to submit their claims to the Spanish court, leaving their forces to hold the Eldorado which had been despoiled by the Chibchas, ransacked by themselves.

We are, therefore, unable to agree with Bandelier when he says that, after this time, «Transplanted by the over-excited imagination of the white men, the vision of the *dorado* appeared, like a mirage, enticing, deceiving, and leading men to destruction on the banks of the Orinoco and the Amazon.» The Gilded Man had been located, and that part of the myth was buried. Subsequent explorations were planned to discover rich countries which were Eldorados only in the modern sense of the word; and we find that the word was used with nearly its present signification at the time when the Amazon River received its name. The legend is especially noteworthy in connection with the history of the Venezuelan settlement under the direction of the German Welsers. Having received the province from the Spanish crown practically as a mortgage security for money loaned, Welser and his associates tried to recover the advances they had made from the revenues of the district; and since the coast lands were found to be less profitable than they had expected, they engaged in one Eldorado expedition after another. Dalfinger, Federmann, and Von Speyer have been mentioned; before the utter ruin and failure of the colony at Coro, Von Hutten's expedition penetrated to Omagua, a region near the Amazon, west of Rio Negro and the Cassiquiare. The Spanish conquerors of Peru and Ecuador were led by the search for further stores of wealth to make the most important geographical discoveries east of the Andes. Gonzalo Pizarro set out from Quito to explore the forests (1539–42), hoping to find spices there, and also «wealthy regions in which the people went around adorned with gold.» His lieutenant, Francisco de Orellana, with 53 men in a bark, becoming separated from the main body of the expedition, went on down the Amazon to its mouth. The Dominican Carvajal, Orellana's chronicler, relates that women took part in the fighting against the Spaniards, and that a captive Indian spoke of a tribe of Amazons rich in gold living north of the river. (Compare Prescott's 'Conquest of Peru,' II., 164–5, note). Wandering Indians brought to Peru about the middle of the 16th century reports of countries rich in gold and silver, which lay far eastward; and the viceroy made use of the Eldorado fever thus excited to rid Peru of a large number of disorderly persons. In 1560 a company of criminals and desperados, with women, set out from Santa Cruz de Capacoba, proceeding in boats, canoes, and even upon rafts, down a tributary of the Amazon, under the leadership of Pedro de Ursua. In January, 1561, Ursua was murdered by conspirators, and eventually Aguirre, chief conspirator, transformed the remnant of the expedition into a piratical band; captured the island of Margarita, and invaded Venezuela. At least four Eldorado expeditions proceeded from the north coast toward the interior before the end of the century, in addition to that one which Sir Walter Raleigh led in 1595. Consult: Bandelier, 'The Gilded Man' (New York 1893), and Brinton, 'The Myths of the New World' (New York 1868).

MARRION WILCOX.

Eldridge, Shaler W., American abolitionist: b. West Springfield, Mass., 1817; d. Lawrence, Kan., 17 Jan. 1899. He removed to Kansas in 1855, and became proprietor of the American House in Kansas City, soon recognized as the headquarters of Freesoilers. In 1856 Eldridge opened the Free-State Hotel in Lawrence, but soon afterward a pro-slavery court issued a writ of indictment, declaring the place a nuisance, and it was destroyed by a posse led by Sheriff Jones. This occurrence caused great excitement among the Freesoil men, who commissioned Eldridge to visit Washington with a petition in their behalf, and also to sit in the convention that nominated Fremont. Later he became a member of the National Republican Committee and agent to promote immigration into Kansas. Under the last authority he led a large number of settlers to Kansas. During one of these trips, with a party of 350 men, he was taken prisoner by United States troops. Subsequently he recruited a party of Freesoilers, who retook the arms from the United States officers at Lecompton. He was instrumental in giving much aid to the Free-State cause by smuggling large amounts of ammunition and provisions into Kansas Territory. During the Civil War he served in the Union army.

Eld's Deer, a deer (*Cervus eldi*) native to the Malayan region. It is about four feet tall, lives in swampy places, and is often found in large herds. Its habits are like those of the Indian swamp-deer. The antlers are peculiar in that the brow-tine sweeps down over the forehead and that the upright part has numerous points.

Eleanor of Aquitaine, queen of France and afterward of England: b. 1122; d. Fontevrault, France, 1 April 1204. She was the eldest daughter and heiress of William IX., Duke of Guienne or Aquitaine, and was married 2 Aug. 1137, to Prince Louis, who in the same year succeeded to the throne of France as Louis VII. She was gay, frivolous, a lover of poetry and art, and could not sympathize with the ascetic spirit of her husband. She accompanied him on the second crusade to the Holy Land in 1147. At that time he complained of her preference for other men, and on their return from Asia they were divorced 18 March 1152. A short time afterward she bestowed her hand upon Henry Plantagenet, the future Henry II. of England. This alliance, which made Henry master of Eleanor's vast possessions in France, produced pernicious and protracted wars between France and England. She bore him many children, but his infidelities and neglect changed her love into hatred. She incited her sons Geoffrey and Richard to rebel against their father, was imprisoned in 1174, and remained in confinement until after Henry's death in 1189, when she was released by his successor, Richard I., who placed her at the head of the government on his departure for the Holy Land. She negotiated his marriage with the daughter of the king of Navarre, and went to Germany with his ransom from captivity. She afterward retired to the abbey of Fontevrault, and surviving Richard, lived to see him succeeded by one of her other sons, John Lackland, the signer of Magna Charta. She was a favorite personage with the troubadour poets of the day, and appears in a very different light in their works from that in which she is represented by French and Norman chroniclers.

Eleanor Crosses, memorials of Eleanor of Castile. She was the wife of Edward I. of England, and d. Lincolnshire 1290. Her body was taken to London by her sorrowing husband who subsequently erected a monument, terminating in a cross, at every spot where her funeral train had rested. These places were Lincoln, Grantham, Stamford, Geddington, Northampton, Stony Stratford, Woburn, Dunstable, St. Albans, Waltham, East Cheap, and Charing Cross, but the list varies slightly as given by different authorities. The crosses at Geddington and Waltham remain, although considerably altered by restoration in the latter case. That at Charing Cross, destroyed in 1647, was replaced in 1863 by a new one reproducing the original.

Eleatics, ē-lē-ăt'ĭks, a Greek sect, so called because founded at Elea, in Sicily, by Xenophanes of Colophon, about 538 B.C. Zeno, who flourished 464 B.C.; Empedocles, 435 B.C.; and Melissus 428 B.C., were leading philosophers of this school. That which from the commencement distinguished the Eleatic school from the Ionic was its method, which in the one case was dialectic, in the other empirical. Starting from the observation of external nature, the Ionians endeavored to discover some elementary principle, as water, air, fire, or a combination of elements, by the action of which the phenomena they observed might be accounted for. The Eleans made the abstract idea of Being or God, deduced from the contemplation of the universe as a whole, their starting-point; and their reasonings sometimes led them to deny the reality of external phenomena altogether. This was the result of the development which the principles of Xenophanes received from his followers Parmenides and Zeno, the latter of whom denied the existence of variety in any form. See IONIAN PHILOSOPHY; IONIAN SCHOOL; XENOPHANES; ZENO.

Eleazar, ĕl-ē-ā'zär (Heb. "God hath helped"), the third son of Aaron, and high priest after him (Ex. vi. 23; Num. xx. 25–28). The high priesthood continued in his family through seven generations, till the time of Eli, when we find it transferred to the line of Ithamar. In the reigns of Saul and David it was restored to the line of Eleazar, and so continued till after the captivity.

Elecampane, ĕl-e-kăm-pān' (*Inula helenium*), a plant of the sunflower family (*Compositæ*). The stem is three or four feet high, thick, pubescent, and branching above; the radical leaves are often two feet or more in length; the flowers are large and yellow. The plant is a native of Europe and Asia, naturalized in the United States. It grows abundantly along roads and in waste places. The root is perennial, and has a bitter aromatic taste. Elecampane is cultivated occasionally as an ornamental plant, and the flowers are sometimes used to adulterate arnica. The root was formerly much employed in medicine, but has fallen into disuse. It contains a number of active principles, the most important being a volatile oil, inulin, which is a form of starch, and a camphor, helenin. By reason of the camphor and the oil the action of the drug is somewhat stimulant and stomachic. Elecampane was once very much used in the treatment of bronchitis and amenorrhœa. As a hot infusion it subserves practically the same purpose as camomile tea, being a good diaphoretic.

Election, a word used in astrology in the plural form, and meaning certain opportunities of times, elected (or chosen) by astrological observations, as most fit for a particular business or enterprise.

In theology, the word (singular) is applied to the act of God in selecting some persons from the race of man to be regenerated by his spirit, to be justified, to be sanctified, and to receive other spiritual gifts in this world, with eternal life in the next. The Calvinistic doctrine makes this election take place by God's mere good pleasure, without any foreseen merit in the individuals chosen. The Arminian one considers that God chooses those who he foresees will accept the offer of the Gospel and act as true Christians till death. The third chapter of the Westminster Confession, entitled "Of God's Eternal Decree," uses more decided language. The strongest adherents of this view are in the Presbyterian churches, though there is a tendency to soften the harsher features of the system. Many Baptists hold the same doctrine, as do the Calvinistic Methodists.

Elections. In early colonial days, local officials in New England were chosen in town meeting, much as they are to-day. Nearly all those of the southern colonies were appointed. In New Amsterdam (now New York), the right to elect its own magistrates was long refused by Director Stuyvesant. "If," he said, "the nomination and election of magistrates were to be left to the populace who were the most interested, then each would vote for some one of his own stamp, the thief for a thief, the rogue, the tippler, the smuggler, for a brother in iniquity, that he might enjoy greater latitude in his vices and frauds."

The illicit use of money in elections began almost at the beginning of political history in America. Rhode Island, for instance, found it necessary to pass a general act against bribery and corruption in 1737, and 10 years later replaced it with one even more stringent. Judging by its provisions the evil must have been alarmingly prevalent in that colony. To this day Rhode Island is the New England State where most complaint is made of the same evil. The other New England colonies found no such laws necessary, but all the rest had them save New York and Maryland. In England the purchase of votes was for centuries as natural a thing as the sale of boroughs, and no serious attempt to prevent it was made till 1854, when the Corrupt Practices Prevention Act defined bribery, forbade certain petty expenditures, and required the making public of election expenses of a certain character by proper returns. This and further legislation did not remedy the evil materially, and in 1883 a much more drastic measure was adopted, which has been the model for legislation elsewhere. The novel and essential idea in it was the naming of an election agent by each candidate, and the holding of him responsible for publicity as to expenditure. Such American States as have copied this device, have rendered it futile by failing to copy the further proviso found in England, definitely limiting expenditure, with the penalty of invalidation of election in the case of any proved excess. An English candidate standing for a borough of 2,000 electors may not disburse, either by himself or through his agent, a sum exceeding £600; for every additional thousand electors, an extra £30 is permitted. In the counties, where the area is wider and the inevitable expense larger, £650 is the limit for a register of 2,000 electors, with an increase of £60 for every additional thousand. Contrast this with the situation in American congressional districts, where expenditures of from $10,000 to $100,000 by candidates are far from unknown. It is estimated that the total party expenditure in the last national campaign was well over $5,000,000, to which figure it had grown from $100,000 spent to elect Lincoln in 1864. Add to this the money used for the thousands of candidacies for minor places, and it is clear that the total is so enormous as to make adoption of the complete English reform almost inevitable in the near future, for though a great part of the outgo is for what are conventionally considered legitimate purposes, the mere fact of its size and growth is enough to compel legal limitation if America is not to become a plutocracy. At present a lukewarm public opinion attaches little disgrace to electoral corruption, and easily condones the offense of the public official who indirectly recoups his election expenses out of the public treasury. Therefore, almost in vain do halfway reformers pile penal statute upon penal statute. The Massachusetts law has 56 sections of election penalties, and it is typical. Three years after the passage of the New York Reform-ballot Law in 1890, investigation by a public-spirited committee of 50, together with the finding of more than 60 indictments by the grand jury, demonstrated that false registration, false voting, and bribery were as easily and safely practised as they ever were, and that perjury had enormously increased, owing to the number of safeguards which must be sworn away by the fraudulent voter and the collusive inspector. But deplorable as are all these facts, it is on the other hand true that the great majority of the members of our various legislative bodies, as well as our elected officials, are honestly elected. The diminution of corrupt practices is one of the benefits expected from the use of voting machines. (See BALLOT.) False counting of ballots has been an easy and common way to vitiate election results. In many a city ward the election officials return any majority the boss desires. Though the evil has been lessened in some of the States by strict laws, under the strictest of them it is still possible for knavish counters to nullify ballots by adding marks, and the lawmaker cannot keep pace with the shrewdness of the trickster. Furthermore, it is believed that the errors of machinery are likely to be in the aggregate far less damaging than those made under the present system by the voters themselves. In a contested election case in New York the court estimated that an average of five ballots had been rejected as defective in each election district in the preceding election. In 1895, in the city of New York, out of a total in round numbers of 300,000 votes cast, 9,283 were defective, and 20,400 were blank. Of the 412,319 men who voted in the Massachusetts State election of 1902, 13,630 failed to have a vote for governor recorded, some, no doubt, with intention, but many through carelessness.

Another potent source of election evil is found in faulty methods of identifying the voter. The fraud that results takes the form of "impersonation" (voting on another man's name), or "repeating" (voting more than once). To lessen the likelihood of these crimes, some States require every voter to establish anew each year his right to vote; others allow a name once on the lists to stay there till death or removal causes it to be dropped. With our dread of red tape and formalities, we hesitate to adopt the ultimate remedy, that to be found in France, where every man, as he steps up to the ballot-box, must produce his "electoral card," on which are inscribed his full name, profession, and residence. This card is issued by the mayor of the town where the voter lives, after the latter has established his identity and majority by the production of a properly attested "act of birth." Each electoral card is numbered, and when it is presented at the polls, the judge of elections takes it, and calls off the number and name, while two other judges, with the official poll list before them, repeat aloud the number and name and check off on the register. Then, and not till then, the first judge accepts the ballot from the voter and drops it into the box; and before handing back the card, he tears off a corner of it, which renders it useless for further voting that day. These bits of card are strung on a wire and are counted, at the close of the polls, to see if they tally with the number of ballots in the box. See BALLOTS.

Under prevailing methods the views of large numbers of voters are not represented by men of their choosing. Minority parties get a voice in legislative assemblies only by the haphazard preponderance of their members in a few localities. In every voting district that group of electors which is in the minority has no direct representation, and sometimes for a generation its members will go to the polls in vain. Though Norway, in its constitution of 1814, appears to have been the first country to make an attempt to change this, the subject did not attract general attention till toward the middle of the century. In 1844 Thomas Gilpin published in Philadelphia a pamphlet that led a long train of literature, and in 1857 appeared the first of several books by Thomas Hare, in whose idea of "personal representation" J. S. Mill thought he discovered "the greatest improvement of which the system of representative government is capable." Since then many plans to accomplish the same end have been suggested. All presuppose that more than one place is to be filled at a time, as a board of aldermen to be elected on a general list, or several representatives from one district. The simplest plan is the single-vote system, where each elector has but one vote and the candidates getting the largest number of votes are declared elected. It has been used in Philadelphia by the Republican party in the election of ward executive committees, and by the Democratic party in choosing inspectors of election. It is the method justified by the theory that no voter is entitled to be represented in any representative body by more than a single representative, and would seem admirably adapted to the conduct of the internal affairs of parties. On the other hand, where the supremacy of party views is the issue, it is manifestly objectionable, as without an impracticable degree of party machinery and discipline, the majority party, if it has nominated as many candidates as there are places to be filled, many so scatter its votes that less than half of them will be elected, and in any event cannot allot its votes so as to make sure of a result proportionate to its preponderance. Systems based on the "limited vote" theory meet this objection to some extent. Under them each voter may vote only for some fixed number of candidates less than the number to be elected. In operation this secures representation to the minority party second in rank, but with no relation to its numerical importance, and smaller minority parties get no representation at all. A modification of the idea was embodied in a law passed by the Massachusetts legislature in 1903, providing that each political party shall nominate 8 candidates for the board of aldermen in Boston; as 13 are to be chosen, this is expected to secure that not more than 8 shall be of any one party. With the next group of systems, those known as "cumulative," arithmetical complications grow. The first practical test of the idea came in 1870, when it was adopted as the method of electing English school boards, and in the same year it was put into the Constitution of Illinois by the proviso that "each voter may cast as many votes for one candidate as there are representatives to be elected, or may distribute the same or equal parts thereof among the candidates as he shall see fit." To each legislative district were allotted three members, so that a voter could cast his three votes for one, a vote and a half for each of two, or one vote for each of three. A mass of testimony on the practical working of the system, collected by M. N. Forney in 1893, indicated that on the whole the people of the State deemed it decidedly advantageous, yet far from perfect. Unquestionably it secures its object, the representation of minorities; in 1892 there was not an Illinois district in which any one party elected all three representatives. The chief objection comes from the chance and temptation for members of the majority to "plump," that is, cast all three votes for one man: sometimes this permits the minority to elect two men, when the bulk of the majority vote is concentrated on one popular candidate; therefore it invites to contests between party colleagues instead of political antagonists, breeds jealousies, and disrupts organizations. These evils have been more conspicuous in the choice of English school boards, for the more men to be elected, the greater the dangers from "plumping." The wasteful accumulation of votes for the more popular candidates or those of the more powerful factions, has permitted small factions to secure the election of members when not really entitled thereto by their numbers, and thus have let in weak or mischievous men. To guard against this by the *proportional* representation of minorities, systems of three varieties have been devised. The first, known as the "free list" plan, provides that the lists of candidates shall be made up by the parties before the election, and that the seats to be filled shall be divided between the parties in the proportion of the total votes cast by each, the higher men on each list to be declared elected to the number their party proportion warrants. This system has been in use in some of the Swiss cantons, and Belgium enacted it into law in 1899. Its weakness is that it makes election wholly a party matter, practically preventing independent candidacies. A "freer list" plan advocated by William H. Gove of Salem, Mass., provides that the lists shall be made up by the candidates, rather than by the parties. In advance of the election the candidates are to designate who shall get the benefit of any ineffective votes cast for them. When the votes are counted, the first step is to divide the total number of ballots by that of the places to be filled; the quotient determines the number of votes a candidate must get in order to be elected,— his "quota." Votes cast for any one man beyond his "quota" are ineffective, and are ignored, so far as he is concerned, but are to help some other candidate, and the same is true of votes for candidates receiving so small a number that they must fail of election. The "freest list" system, the Hare plan, has the list of preferences made up by neither the party nor the candidate, but by the voter, who designates on his ballot the order of his choice. In the counting, as soon as it appears that a first-choice candidate needs no more votes, the second-choice candidate moves up into his place, getting credited with the ballots until he in turn has reached his quota, and so on. Though advocated by very many able men, from Mill on, the quota plans have as a rule failed to pass beyond the first critical point, legislative comprehension. Like all other plans for minority representation, too, they run counter to the belief, ingrained in Anglo-Saxon communities especially, that only the majority has a right to share in the work of representative government. Furthermore, the English and American adhesion to the two-party idea renders it probable that minority representation will make the more headway among the continental nations, accustomed as they are to government by groups. In America its most promising opportunity is in the choice of local legislative bodies where partisanship on national lines may sometimes disappear.

There is no legal, philological, or popular agreement as to the use of the word "majority" in matters of election. In computation it may mean the amount by which the greater number exceeds the less, if but two numbers are compared; or the amount by which the greatest number exceeds the total of the lesser numbers; or the amount by which the greatest number exceeds the next to the greatest. For the last case we customarily use the word "plurality," but in England the normal designation is "majority," and candidates have been elected with regard only thereto from time immemorial. The weight of American usage restricts "majority" to excess of the greatest number of votes over the total of the rest, and we say that for a majority a total of one more than half is necessary. This practice dates from colonial times. In Massachusetts, New York, New Jersey, South Carolina, and Georgia, a majority seems to have been required; in other colonies as a rule a simple plurality sufficed. New York put the plurality rule into her Constitution of 1777, and most of the other States followed her example, but the belief in the virtues of an absolute majority lingered in the New England States till the middle of the following century.

Propositions to go back to the absolute majority plan are now very rarely heard, and in the matter of popular elections the subject still has importance only because the Constitution of the United States requires an absolute majority of electoral votes for the choice of President. In conventions the majority rule yet prevails, occasionally entailing hundreds of ballots, and in the Democratic national conventions a two thirds vote is required to nominate. In primaries and caucuses the plurality plan prevails by almost invariable custom, voters everywhere being unwilling to give the time required for repeated ballots. The courts have had various occasions to consider whether a majority of the votes cast at an election on any question means the majority of those who voted on that question. In 95 U. S. 369 the court held (Miller and Bradley, JJ., dissenting) that "all qualified voters who absent themselves from an election duly called are presumed to assent to the expressed will of the majority of those voting, unless the law providing for the election otherwise declares." But in 69 Ind. 505, where an amendment to the Constitution received less than a majority of all the votes at the election, but a majority of those cast for or against the adoption of the amendment, it was held (two judges dissenting) that the amendment had been neither ratified nor rejected. The celebrated action of Speaker Reed in counting for purposes of a quorum those present and not voting, is of course in line with the theory that a majority of those voting should prevail, and it is significant that his decision, much criticised at the time, has now been accepted by almost everybody as good parliamentary law.

The absence of voters from the polls is a recognized evil, for which the remedy commonly proposed is compulsory voting, secured by imposing penalties for failure to vote. Neither evil nor remedy is novel. In 1636 the general court of the Plymouth Colony provided that "for default in case of appearance at the election without due excuse, each delinquent to be amerced 3*s.* ster." The custom continued certainly beyond 1671, for in the revision of the laws then published, the fine was put at 10 shillings. Other colonies had like laws, Virginia maintaining hers throughout her history. Her first law on the subject made the fine 100 pounds of tobacco, and in 1662 this was increased to 200 pounds. Some of the New England towns fined freemen who came late to the town meeting. None of the States have revived the colonial idea, of a money fine, probably because the evil is diminishing, rather than increasing. It is of comparatively small moment now in our presidential elections, where five sixths of the voters take part, and the absence of a large share of the remaining sixth can be accounted for by sickness, age, accident, inclement weather, and other reasonable excuses, but it is still of unfortunate importance in State and municipal elections, though even there diminishing. In Belgium, Switzerland, and some other European countries, punishments are inflicted on non-voters. In Belgium, for the first offense the culprit is at once cited to appear before a justice, who reprimands or fines him; the second offense is more severely punished, and the name of the refractory citizen is published by the magistrate and posted on the gates of the town hall. The man who, without excuse, has abstained from voting 4 times in 10 years is considered unworthy of citizenship; his name is stricken from the poll lists, and for 10 subsequent years he is debarred from holding any public office. Illinois has an ingenious penalty, putting on the jury lists the names of persons who fail to vote. It might be expected that this would benefit the suffrage more than the jury system. One of the proposed forms of punishment is that the voter who once omits to vote shall not be allowed to vote thereafter until he shall have purged himself by paying a fine, but this would be no hardship to most of the apathetic citizens.

Besides the specific remedies in process of application or proposed for the cure of the evils our methods of election have developed, there are general reforms of many kinds with this as their purpose in whole or in part. One of them is the movement for lessening election evil by lessening elections, which has prevailed in nearly all the States to the extent at least of substituting biennial for annual elections. Another seeks improvement by having State and municipal elections on different days, and New York has gone so far as to put them in different years. Another, applicable only to municipal elections, looks to the abolition of national party lines in local affairs. Still another finds promise in the reduction of the number of elective offices. (As to the methods of nominating candidates, see CAUCUS; and for further information upon this subject, see BALLOT; POLITICS; etc.)

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Elective Affinity, a term formerly used in chemistry, in connection with the supposed fact that when a given chemical substance is mixed with two or more others with which it is capable of combining, it will exhibit a preferential affinity for one of them, and combine with that to the exclusion of the others. This view of chemical action is now known to be incorrect. See EQUILIBRIUM, CHEMICAL.

Elective Courses and Elective Studies, as applied to colleges and universities in particular, and to all schools in general, may be defined broadly as that system of education which permits the student or learner to choose his own subjects of study during the time of attendance at school. The matter of allowing more latitude of choice to the individual pupil has attracted much attention in recent years, with the result that many radical changes have been made in the courses of study in some of the colleges and universities in the United States. Formerly Harvard, Yale, and other American schools required that students should pursue certain studies in order to obtain the degree of bachelor of arts; and such restriction eventually led to the exclusion of all studies that did not contribute to the obtaining of the desired degree. Gradually the secondary schools adopted compulsory courses of study preparatory for colleges, and crowded out many of the studies that might fit the student for business life without going the college road. The special commercial, scientific, and art school came into existence to meet the wants and needs of a large number of students. Many of the leading schools of the United States have in recent years modified their courses of study, and to-day allow a choice of subjects. The new colleges, Leland Stanford, Jr., Chicago, Cornell, and others, have allowed from the first more freedom in the selection of subjects than was formerly permitted by the other schools. The «optional» or the «elective» system is not new; it was in existence in many of the leading schools in Mediæval Ages and even earlier, and success and failure have attended the system according to the methods used in its enforcement. The strongest and best work in any school has been done where the needs of the individual have been taken into consideration. Where able instructors, those who understood human nature and its needs, have guided the immature student, or to use the modern term, where there were wise «advisers,» the system was a success. The importance of the adviser is shown in the marvelous results accomplished by the independent schools which came into existence in the United States, especially in the West, about the middle of the 19th century. Thousands attended those schools, and with good results, because wisely directed and guided by capable, conscientious advisers. The pupil when left to his own discretion may choose studies «along the lines of least resistance,» or «soft» courses, and may not select the studies necessary for the foundation of any system of education. Students of the maturity of mind required for entrance to Johns Hopkins or similar institutions cannot be compared with the younger pupils who constitute the freshman classes of the majority of our colleges. In order to ascertain what colleges and universities sanction elective courses it is necessary to obtain the latest changes direct from the college authorities. Consult: Burns, 'Elective System of Studies in Colleges' ('Catholic World,' Vol. LXXI., 366); Eliot, 'Educational Reform' (1898); Hanus, 'Problem of Electives' ('Popular Science Monthly,' Vol. LVIII., 58); Phillips, 'Electives in American Education' ('Pedagogical Seminary,' Vol. VIII., 206); Shaler, Thurber, and others, 'Elective Studies in Secondary Schools' ('Educational Review,' Vol. XV., 417); Thurber, 'Some Problems of the Elective System' ('School Review,' Vol. IX., 79).

Electoral College. See ELECTORS.

Electoral Commission, 1877. The electoral vote in the presidential election of 1876 showed 184 undisputed votes for Tilden; 163 for Hayes; four States with 23 votes — South Carolina, 7; Florida, 4; Louisiana, 8; Oregon, 3 — sent in conflicting returns. If the Republicans won all the contests, Hayes was elected by one vote. Of these States, the first three returned popular majorities for Tilden electors; but the «carpet-bag» governments in each had constituted «returning boards,» whose function was to throw out enough Democratic votes, on the ground of intimidation of negro voters, to leave a Republican majority. Neither the reality of the intimidation, nor the arbitrariness of the assumption that but for it the negroes would all have voted and all voted Republican, is now disputed by either party. Oregon chose Hayes electors; but as the returning boards would give the Republicans the other three States, and therewith the election if upheld, the Democrats ousted a Hayes elector on a technicality and replaced him by a Tilden one, as a basis of compromise or a menace. Obviously, the Republicans could not compromise anything and win; and as they held the administration and the army, they could defy threats. The Senate was Republican, the House Democratic; there was therefore a deadlock on the admission of returns, as the 22nd Joint Rule, throwing out disputed States, had been repealed by the Senate 20 January for this very emergency. Finally, as an alternative to a most dangerous anarchy, both sides agreed on a joint commission to pass on all the contests; the Democrats being confident that it could establish no guiding principle whatever, of going behind the returns or not, accepting or rejecting State certificates as conclusive, which would not give them at least one of the disputed States. They underestimated the intellectual resources of their opponents. The Act creating the commission was approved 29 Jan. 1877; its decisions could only be reversed be concurrent action of both Houses. The body was to be composed of five members of each House and five associate justices of the Supreme Court; the latter as indicated were two Republicans and two Democrats, and were to select a fifth. The Senate appointed three Republicans, — G. F. Edmunds of Vermont, O. P. Morton of Indiana, and F. T. Frelinghuysen of New Jersey; and two Democrats,— T. F. Bayard of Delaware, and A. G. Thurman of Ohio, the latter taken sick and replaced by Francis Kernan of New York. The House appointed three Democrats,— H. B. Payne of Ohio, Eppa Hunton of Virginia, and J. G. Abbott of Massachusetts; and two Republicans,— J. A. Garfield of Ohio, and G. F. Hoar of Massachusetts. Obviously, therefore, the odd justice would have the deciding voice. The Republican judges were William Strong and Samuel F. Miller; the Democratic, Nathan Clifford and Stephen J. Field; they chose Joseph P. Bradley as the fifth. The counsel were — Democratic, Charles O'Connor of New York, Jeremiah S. Black of Pennsylvania, Lyman Trumbull of Illinois, R. T. Merrick of the District of Columbia, Ashbel Green of New Jersey, Matthew H. Carpenter of Wisconsin, George Hoadley of Ohio, W. C. Whitney of New York; Republican, W. M. Evarts and E. W. Stoughton of New York, Stanley Matthews and Samuel Shellabarger of Ohio. Other lawyers appeared on special points. The States were taken up in alphabetical order,— Florida, Louisiana, Oregon, South Carolina,— and the vote upon each was eight to seven for the Republicans, on every contested point, Mr. Justice Bradley sustaining all the contentions of that side. The broad decision was, that Congress cannot, as it had done repeatedly before, go behind the returns and take evidence as to the manner in which State majorities for electors have been obtained. On other points the decisions varied with the cases. In particular, the Democrats contended that the question as to the eligibility of an elector who is also a government official — a combination forbidden by the Constitution — was decided in two different ways within two days, on the Florida and Louisiana cases, in both to the profit of the Republicans; and Judge Bradley published a defense of his action. The court adjourned *sine die* on 2 March. The peaceful acceptance of the decision was much helped by the Democratic speaker, Randall of Pennsylvania, who firmly checked all Democratic attempts to "filibuster."

Electoral Reform. See ELECTIONS.

Electoral Votes, the votes cast by the presidential electors or electoral college for President and Vice-President. Prior to 1804 each elector voted for two candidates for President. The one who received the largest number of votes was declared President; and the one receiving the second largest vote, was elected Vice-President. The votes for the first President were: George Washington 69; John Adams (Mass.) 34, John Jay (N. Y.) 9, R. H. Harrison (Md.) 6, Jno. Rutledge (S. C.) 6, John Hancock (Mass.) 4, Geo. Clinton (N. Y.) 3, and scattering 7. In 1900 the electoral votes cast by the electoral college were as follows: For President, William McKinley, 292; William J. Bryan, 155; for Vice-President, Theodore Roosevelt, 292; Adlai E. Stevenson, 155. See ELECTORS; ELECTORAL COMMISSION.

Electors, German Imperial (Ger. Kurfürst), certain princes of the old German empire who had the right of electing the emperors. The number of the electors was early fixed at seven, including the archbishops of Mainz, Cologne and Trèves, the king of Bohemia, the count palatine of the Rhine, the duke of Saxony, and the margrave of Brandenburg. Later, electorates were given to Bavaria and to Hanover; in 1802 the Bavarian electorship had expired, the archbishops of Cologne and Trèves were excluded, and the number of electors was increased to 10 by conferring the rank on the rulers of Baden, Würtemberg, Hesse-Cassel, and Salzburg. In 1806 the emperor gave up the imperial title, and the electors gradually adopted other titles.

Electors, United States Presidential (as a body, termed the Electoral College, a term informally used since about 1821, probably suggested by the college of cardinals; "college of electors" appears in the Act of 1845), the intermediate body for whom, and not directly for President and Vice-President, votes are cast every four years. When constituted, they were meant to be a council of the ablest men in the country, exercising an independent choice of the chief executive. The theory has never been fact for a moment, and since the third election not even a pretense; the institution is retained for very different reasons, and perhaps stronger ones. As a fact, the electors are only registers of the already pronounced party choice in candidates, and accept the officer under a solemn tacit pledge to act only as such. They are State bodies, and their integrity as such is scrupulously guarded. They consist of as many members as the State's representation in both Houses of Congress; therefore a State cannot have less than three, and New York has 39. Their method of appointment is left absolutely to the State legislatures. Till about 1820-4 they were appointed direct by the legislature in most States; in 1824 popular election had superseded it in all but six, and by 1828 in all but one,— South Carolina, which retained it till 1868. The district system, which divides the State's electoral vote, has sometimes been tried as a party compromise; but at present all parties prefer the system of having all the electors on a general ticket. The State appoints the place of their meeting; Congress has fixed the time,— the second Monday in January,— to prevent a failure of any meeting through the refusal of a minority house of a legislature to join with the majority house in setting a date. The State, by act of 3 Feb. 1887, is made absolute judge of all disputes over appointment or returns; its certificate is decisive between two sets of returns, and Congress can only intervene if the State itself is unable to decide. But what is the State? This was precisely one of the questions before the Electoral Commission (q.v.), and even the new act would seem to leave room for party decision as there; and no Electoral Commission would ever be possible again. In case of vacancy in the electoral body, by death, resignation, refusal to serve, or any other cause, the State may pass laws to fill it; if it has no such law, that vote is lost, as happened in Nevada in 1864.

At their meeting, no organization is required; but it is customary to organize and elect a chairman. They then cast separate ballots (which remain the property of the State) for a President and Vice-President. In the first three elections, each simply voted (as required by the Constitution) for two persons, one a resident of a different State, without designating the office; the one with the highest vote became President, the next highest Vice-President. Obviously, as soon as parties gained firm organization, mere party loyalty would invariably produce a tie; and in 1800 Jefferson and Burr were so tied (see JEFFERSON-BURR IMBROGLIO), the resulting scandal and danger leading to the Twelfth Amendment, which obliges them to designate the office voted for. After voting, they make three lists of the persons, offices, and number of votes, and the names of the State electors certified by the "executive authority" of the State; seal them, and certify each; transmit two to the President of the Senate, one by messenger and one by mail, and deposit the third with the federal judge of the district. They have then no further functions.

On the second Wednesday in February, in the Representatives Hall and in presence of both Houses of Congress assembled, the president of the Senate opens and counts the State returns, and announces the result. In case of a tie the House decides by a majority of States, each having one vote; on a tie for Vice-President, the Senate decides in the same way. If no one candidate has a majority, the Houses decide in the same manner, choosing from the three highest candidates on the list. Thus, in 1824 John Quincy Adams was elected President by the House; in 1837 Richard M. Johnson was elected Vice-President by the Senate. But suppose the third and fourth are ties. This quite probable contingency has not been provided for, and may cause trouble. There was formerly a custom, when a State sent in conflicting electoral returns, of announcing the final result "in the alternative"— so many votes with, so many without, the disputed returns; but the Act of 1887 ends this, and it was always unworkable where the disputed votes were vital to the election. By the 22nd Joint Rule of Congress up to 1876, in case of dispute the returns from that State were thrown out, but in anticipation of the struggle over the returning boards, the Republican Senate on 20 Jan. 1876 repealed the rule.

The electoral system, despite its utter theoretic absurdity and undemocratic character, is never seriously menaced, because of its great practical utility in settling the presidential question at once on the counting of State votes. With direct popular vote, where parties are closely balanced, the result could not be known perhaps for months, and then might depend on a few thousand votes in a half-lawless district; fraud and violence would have infinite possibilities, and we should be on the verge of civil war every few years. The danger of the district system, often proposed, is the certainty of the districts being gerrymandered.

Elec'tra, in Greek legend, the name of several personages. (1) One of the Oceanides, wife of Atlas, and mother of Dardanus by Zeus. (2) A daughter of Atlas and Pleione, who became one of the Pleiades. (3) A daughter of Agamemnon, king of Argos, who incited her brother Orestes to avenge their father's death by killing their mother, Clytemnestra. Orestes gave her in marriage to his friend, Pylades, and she became the mother of Strophius and Medon. She is the subject of a number of dramas, both ancient and modern.

Electrical Alarm, or **Thermostat,** an instrument arranged to give an alarm or announcement when the temperature in its vicinity reaches a pre-determined degree. (See ELECTRIC SIGNALING. *Automatic Fire Alarm Signals.*) Thermostats are also employed to automatically maintain a given temperature by opening and closing drafts, through the medium of electro-magnetically operated devices. Thermostats are operated on open or closed circuits, as desired. There are electro-pneumatic and mercurial thermostats which operate by expansion of a gas or mercury, respectively.

Electrical Diapason, a tuning fork the vibration of which is maintained by means of electro-magnetism virtually on the principle of the electric door-bell (see ELECTRIC SIGNALING). This instrument, provided with a resonator, was employed by Helmholtz in his notable experiments on the composition of sounds.

Electrical Endosmosis. See ENDOSMOSIS.

Electrical Engineering. Electrical engineering is probably the youngest of all the professions, for it has hardly been recognized as a regular profession for more than 15 years past. As a result, the men who have reached prominence in it to-day have attained their positions from widely different courses of preliminary training; many of them are men who started life in other lines of work and afterward turned to electrical pursuits on account of the sudden growth and importance of the business. In consequence of this, all methods of preliminary education are represented and their relative values can be estimated. The argument runs largely between two classes of men, — one represented by the so-called "practical man" and the other by the theoretical electrician; the graduate of the machine shop and the graduate of the university. Both of these types have attained success, but the correct answer to the argument will probably be found in a proper combination of the two types. In the past some of the most successful electrical engineers have belonged distinctly to the class of practical men with little theoretical training, but the conditions have changed. In the early days of the profession, there was little theory or predetermination of results and work was carried on largely by guesswork or by cut and dried approximations. At the present time, however, such a state of development has been reached that exactness of result is essential to success and work based upon exact theory becomes imperative. In a stationary condition of an art a man with practical experience only may become very familiar with all the existing types of apparatus and, knowing their various applications, may qualify, to an extent, as an engineer. But the extraordinarily rapid growth of the electrical arts places electrical engineering apart from all the other engineering branches, for new discoveries and theories make radical changes from year to year in the construction and operation of electrical machinery. The engineer whose education is based only upon practical experience cannot keep up with the progress and change resulting from it, and falls behind; whereas, the man with knowledge of the theory, and a mind trained by the theoretical studies and scientific reasoning, easily grasps the theory of the change and readjusts his mind to the new without difficulty or delay. Many instances can be cited of men who have been prominent as electrical engineers, who have been dropped out of place in the course of the rapid progress which has been made, on account of a lack of theoretical foundation in their knowledge. Those who have retained their positions throughout the growth of the art have done so by persistent study along theoretical lines.

In its present state electrical engineering is the most scientific of all engineering professions. A man must be to a great extent a physicist, a chemist, and a mathematician, as well as be familiar with machinery and its design, in order to be a worker in the broadest field. Many of the problems connected with other branches of engineering can be solved by common sense and by one's sense of proportion as guided by experience and by the eye. But most of the problems in electricity are invisible, so to speak, and can be understood only through their expression in the form of symbols. Probably no one will dispute to-day that the preliminary education of an electrical engineer demands a special training in those theoretical branches, mathematics, physics, chemistry, and mechanics, sufficient to train his mind into accurate methods of thought and reasoning and to supply him with the actual technical information which he will need in the practice of his profession. But theory alone is not all. The human mind is such that it works with difficulty in pure theory without a series of mental pictures to fix and co-ordinate the ideas, and the study of theory is likely to make little lasting impression unless the physical meaning of the theory is brought out by constant association with actual apparatus which demonstrates the application of the physical law. The best course of training for an electrical engineer would seem to be a broad course of education in general subjects at the preparatory school before entering college, with practical work, if possible, along lines of simple mechanics, such as carpentry, in order to train the mind into a sense of proportion and the relations of parts, which is the basis of all engineering. Next, a college course with general subjects the first year, and afterward, for the remaining years of the course, those general and theoretical subjects which have a direct bearing upon the practice of the electrical profession, such as mathematics, mechanics, physics, chemistry, theoretical electricity, and magnetism and thermodynamics. This should be supplemented by actual daily practical work with machinery operating by the principles covered by the theory studied and demonstrating all the phenomena incident to the theory. After graduation an apprentice course should be pursued in some large electrical manufacturing establishment where the commercial relations of the knowledge acquired in college can be clearly set forth. Large machines can be operated which are not available at a college and experience in the installation of large plants can be obtained, and experience gained in the designing departments where all kinds of commercial apparatus are laid out.

After a few years of this training specialization may begin along the lines selected for the life work but preferably not before. A man makes a mistake to consider himself a qualified electrical engineer after he has been graduated from college, for he is not one. His mind has been trained into a condition where he can readily absorb the principles of the electrical profession, but that is all, and the subsequent apprentice training is as important as the college course, in order to acquire the broad viewpoint from which to make the correct start in the direction in which a man is best fitted. It perhaps means a smaller income the year after graduation from college, but it means much more at the end of five years. But theory and practice are not the only elements necessary for the successful engineer. There are many qualities required in common with other professions; executive ability, business knowledge, presence of mind and ability to handle men, nerve and resourcefulness in handling machinery in times of emergency, are all necessary to the successful engineer. These elements cannot be acquired in the study of theory and practice alone, and many men who have stood high in their college courses have failed afterward in the practice of their profession because of a lack of these qualities. The study of chemistry becomes more and more important as the profession advances, for the branch of electro-chemistry is rapidly developing and is likely to become one of the largest fields in the application of electrical science. And almost above all comes a training in the English language. No man who cannot express himself clearly and concisely in writing or in conversation can hope to attain a prominent position in his profession. The education of an electrical engineer, however, must never be considered as completed. The art advances so rapidly that constant study is necessary, even to keep up with the progress of the times. But an electrical engineer should be willing to do more than this. He should study to keep ahead of progress and do his share toward the instruction of others.

H. W. Buck,
Electrical Engineer.

Electrical Manufacturing Industry. The place that electricity as a manufacturing industry and as a factor of public service occupies in American social economy is well illustrated by the fact that during 1905 the expenditure of the people of this country for electrical apparatus and for electric light, traction, telegraphy, telephony, etc., reached the sum of $1,000,000,000, while the total capitalization of investment in these fields amounted to well over $5,000,000,000 up to the end of the same year. Large and exaggerated as such figures may seem to persons who have not studied the subject, they are based closely on the latest statistics compiled by the U. S. census office from the direct returns of the corporations concerned, as required by act of Congress; and if they err at all it is in many instances on the side of understatement. This class of data was first collected in 1900 for electrical manufacturing, the writer being the special agent entrusted with the task. It was shown then that 580 establishments with over 45,000 employees of all kinds were producing apparatus worth, all told, $91,348,889; while the product of 132 other concerns, of an electrical but subsidiary nature, brought the total up to $104,738,719. The same investigation revealed the fact that from 1880, when crude attempts to formulate such data were made, there had been a steady average gain each year of 20 per cent, although this might vary as to any individual branch of the industry. The same work is being done by the census office in 1906,

PRODUCTION OF AMERICAN ELECTRICAL APPARATUS.

	1904.	1905
Dynamos	$18,500,000	$22,200,000
Transformers	5,000,000	6,000,000
Switchboards for lighting and power	3,000,000	3,750,000
Motors for all purposes, including traction	35,000,000	42,000,000
Storage batteries	5,000,000	7,000,000
Primary batteries	1,250,000	1,750,000
Carbons	2,250,000	2,750,000
Arc lamps	2,500,000	3,000,000
Incandescent lamps	6,000,000	6,500,000
Lighting fixtures	3,750,000	4,500,000
Telephonic apparatus	30,000,000	37,500,000
Telegraphic apparatus	2,500,000	3,000,000
Insulated wires and cables, submarine cables	35,000,000	40,000,000
Conduits, interior and underground	2,000,000	2,500,000
Rheostats, heating and cooking apparatus	3,000,000	3,500,000
Annunciators	250,000	300,000
Electric clocks	150,000	150,000
Lightning arresters, fuses, etc.	1,000,000	1,500,000
Measuring instruments	3,350,000	4,000,000
Telepherage, etc	250,000	500,000
Miscellaneous apparatus	19,750,000	25,000,000
Grand Total	$175,500,000	$217,400,000

but meantime the accompanying table is presented as a probable approximation to the facts on a basis of increase varying from over 20 per cent downward.

The four classes of apparatus first named represent an output of nearly $74,000,000; yet two of the largest producers of this machinery show an output in 1905 of over $80,000,000, chiefly made up of these items; and there were some ten other large producers. In like manner the output of telephonic apparatus seems unduly heavy, but the annual report of one leading company devoted to this class of goods showed a total in 1905 of over $46,000,000; so that if only two-thirds were taken as telephonic product, the estimate above would leave only $7,500,000 to be accounted for by a score of other large manufacturers in this field, whose product in some instances runs into millions of dollars. An important factor entering into these calculations is, of course, the cost of raw material, especially copper; and a rise in price of that metal from around 14 cents to about 20 makes a perceptible difference; but it does not affect the validity of the impressive total shown. The preliminary figures of the U. S. census office for 1904 report a total of $157,000,000, but this does not include any of the manufacturing done for themselves by the street railway companies, local lighting compaines, and large industrial concerns.

The other great domain of electrical "manufacturing" is the generation of current for various functions, employing at the centre of supply or at the innumerable points of distribution, the apparatus enumerated above. Here the evidence is close at hand, haying also been compiled by the census office, with the writer as special agent, and coming down to the end of 1902. These four great fields of consumption will be referred to in more detail later, but the subjoined table will show here the approximate amounts paid by the public for current and service:

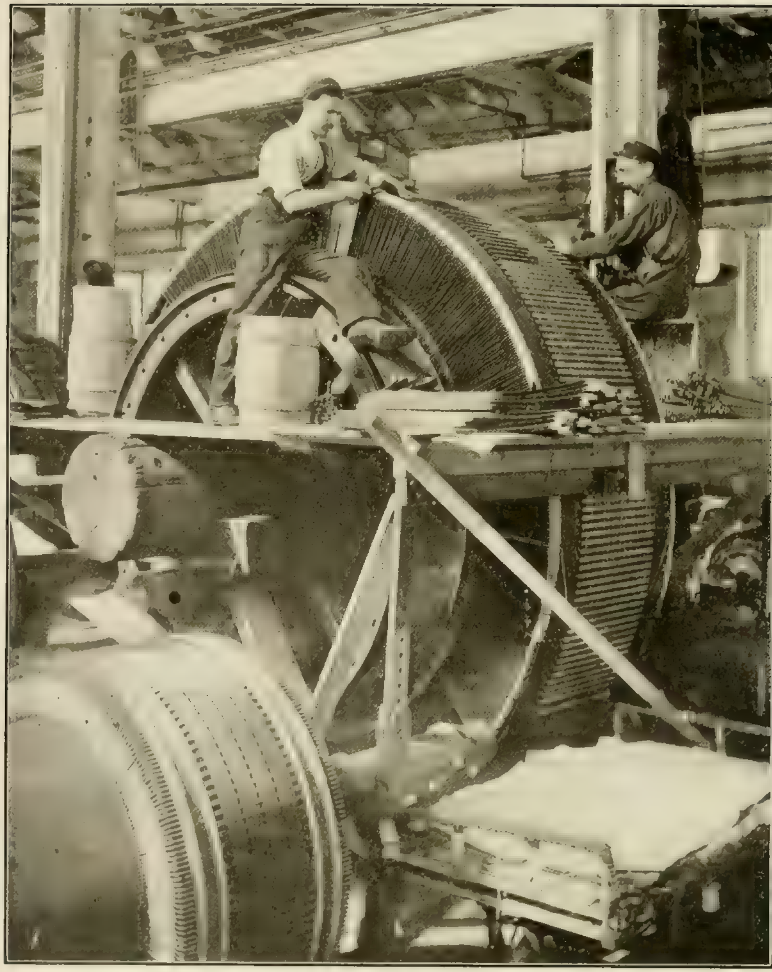
XPENDITURE FOR PUBLIC ELECTRIC SERVICE.

	1904	1905
Telegraph and Submarine Cable	$ 40,000,000	$ 45,000,000
Telephone	110,000,000	140,000,000
Electric Light	120,000,000	135,000,000
Street and other Railways	290,000,000	325,000,000
Isolated Light or Power Plant Supply	60,000,000	75,000,000
	$620,000,000	$720,000,000

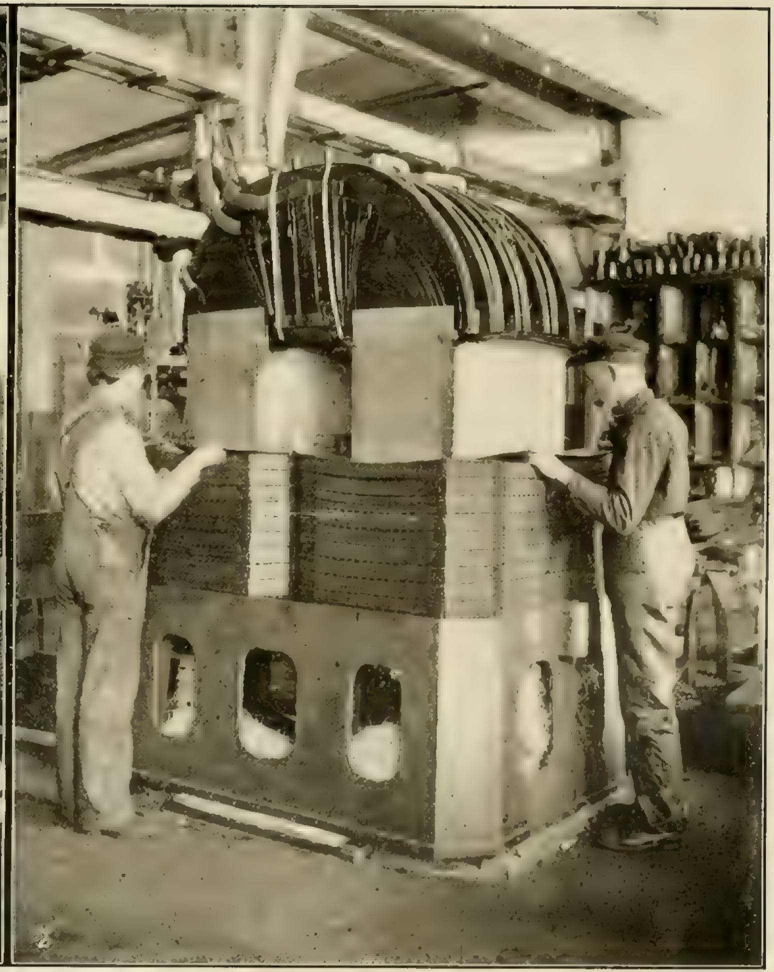
It is proper to include isolated plant supply, as that field consumes a very large part of the apparatus, and a great many of the installations are larger than the central stations in fair-sized cities. The above table, however, as will be seen, does not include any allowance for the vast production in electro-metallurgy, although thousands of tons of aluminum, for example, are produced by electricity every year. Nor do the figures include electro-therapy, municipal fire alarms, police signal systems, train telegraphs, signal corps work, etc. It will thus be seen from the data submitted, and to be corroborated further, that the electrical bill of the American public has now attained the billion-dollar mark. In that statement lies a new and significant measure of the civilization developed on this continent, and of its character. A careful study of comparative statistics would go to prove that in no other country in the world does electrical consumption attain even $5 per capita — or less than half as much as here.

Back of 1850 there was no electrical manufacturing in the United States worthy the name, except in telegraphy, still in a rudimentary stage. The date of 1860 may be associated with the real beginnings of submarine cable work, although it is only of late that American cables have been made for and laid in deep sea water; 1870 may well stand for the stock ticker, burglar alarm and that group of minor but important signalling systems; around 1880 came the double terrific outburst of energy in the exploitation of the telephone and of the electric light; in 1890 began the tremendous commercial development of the trolley and the electric railway; the year 1900 associates itself closely with power transmission and electro-metallurgy; since when every year has witnessed the practical crystallization of some new art — the application of the Roentgen ray; the employment of radium; the widespread introduction of wireless telegraphy, the development of telepherage; the multiplication of electric automobiles; the rapid invasion of every new factory by the electric motor drive.

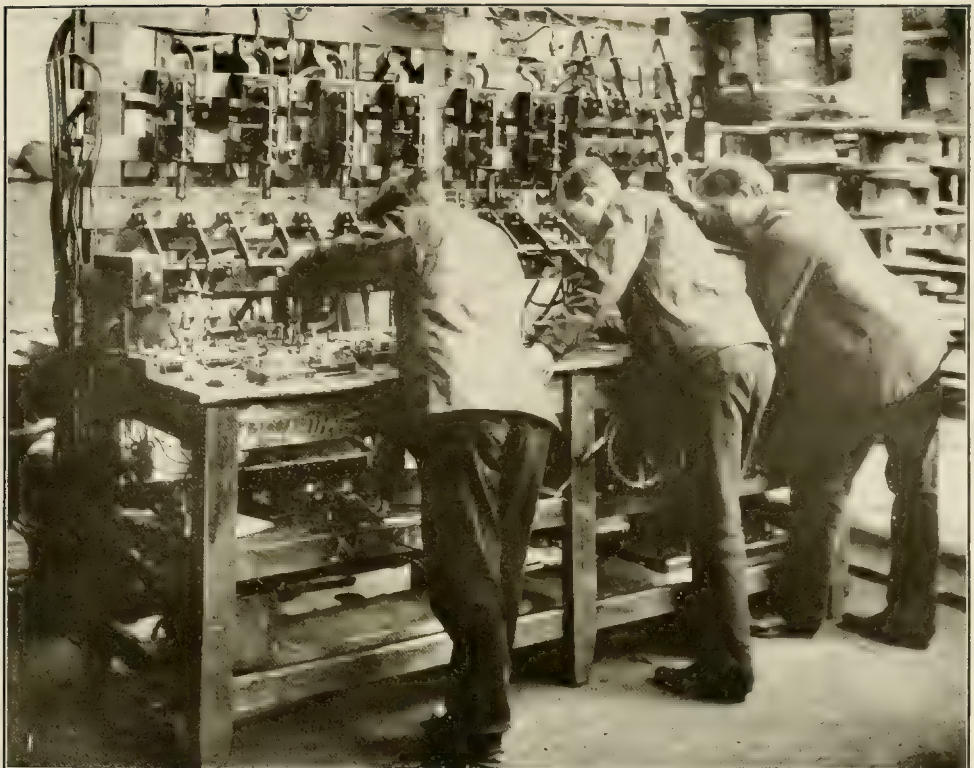
The amount of capital invested in electrical manufacturing in 1900 was $83,130,943. It had certainly doubled by the close of 1905, for in addition to the legitimate necessities for new capital the period was one of stock inflation, by combinations and otherwise, and electricity did not escape the craze. The industry thus represented is widely scattered over about a score of States, but has a relatively few centres, notably Pittsburgh, Chicago, Schenectady, Cleveland, Lynn, Fort Wayne, Newark, N. J., New York City, Pittsfield, Ampere, N. J., Cincinnati, Milwaukee, Harrison, N. J., Boston, Saint Louis. As will be noted, the industry has not gone beyond the great continental rivers, and has its centre of gravity in Ohio; but there has been some electrical manufacturing of the Pacific Coast, notably for its own service by a great shipbuilding corporation. The reasons that determine the location of the factories at the points named have often been arbitrary, nearness to skilled mechanical labor being one strong attraction; another being the nearness of the inventive genius or the controlling capital applied to the particular art. Such would be the explanation of the large production of electric lamps in Cleveland, Harrison and Saint Louis; the reputation of the measuring instruments from Lynn, Pittsfield and Newark. The raw materials of electricity — copper, iron, steel, glass, lumber, rubber, are universally available, so that there is no specific compulsion to be near a given source of supply; although cheap power is undoubtedly the cause of the concentration at Niagara of industries that employ some twenty different processes of electric reduction, extraction, refinement, etc. In some instances the determination has been due to causes not on the surface at all, as, for example, in the massing of "independent" telephone production around Chicago, for which the only

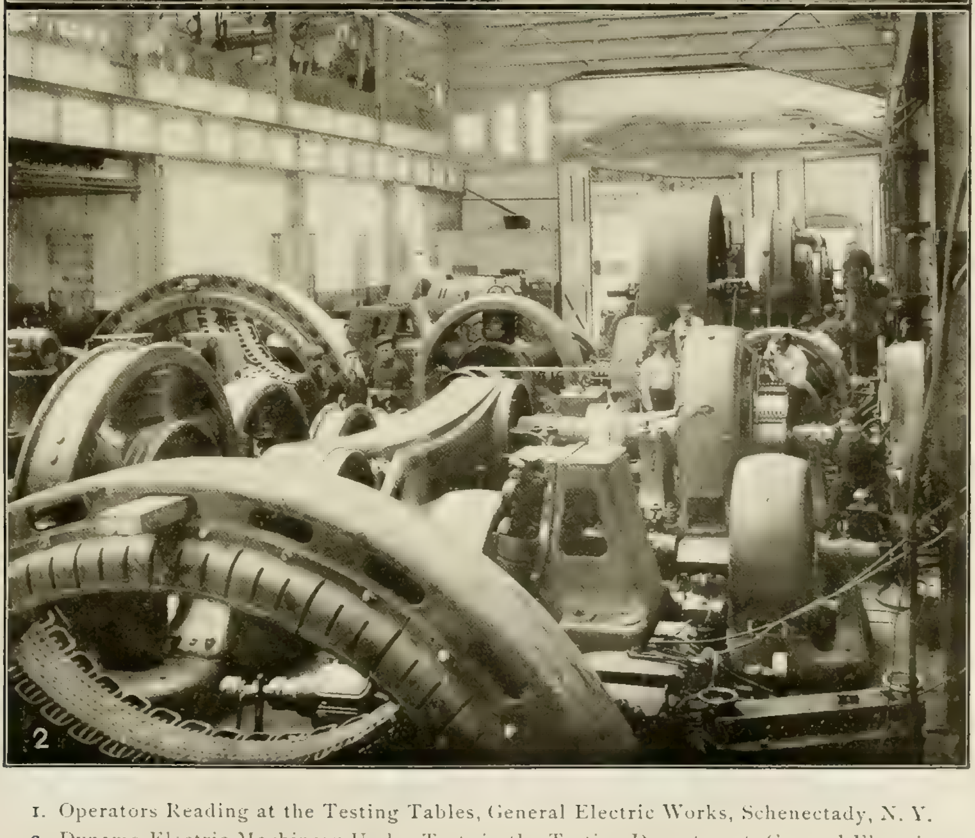


1. Winding the Armature of a Large Direct Current Generator, General Electric Works, Schenectady, N. Y.



2. Building Up a 1100 K.W. Transformer, Westinghouse Works, Pittsburgh, Pa.





1. Operators Reading at the Testing Tables, General Electric Works, Schenectady, N. Y.

2. Dynamo Electric Machinery Under Test, in the Testing Department, General Electric Works, Schenectady, N. Y.

apparent explanation is the fact that the opposition to the Bell system has been most vigorous in the West. Hence, while there are many valid economic arguments in concentrated manufacture, electricity appears to remain free from any marked tendency in that direction. Yet there is a striking capacity of production massed at some points. Thus the Westinghouse Electric & Manufacturing Company reporting in 1904 on its Pittsburgh factory gave the floor space at over 2,000,000 square feet and the employees as 9,000; while the General Electric Company in the same year for its Schenectady works reported 2,519,000 feet of floor space and 10,000 employees. Both concerns have, however, large factories at other widely separated points.

The nature of electrical manufacturing is indicated by the large proportion of skilled mechanics employed in it, and the fewness of the women and children. The factory wage-earners in 1900 numbered 40,890. Of these, 37,298 were men, of 16 years and upward; 6,975 were women; the children under 16 were 679. In the larger pieces of apparatus, such as dynamos and motors, machine tools and automatic mechanisms do a great deal of the work; but in the production of such appliances as incandescent lamps and telephones the assemblage of a number of minute parts gives opportunity for the healthy employment of the cheaper labor of women and children. In this respect, however, the steady tendency is toward automatic machinery, not requiring less human effort in the long run, but increasing and rendering less costly the output. The incandescent lamp is a conspicuous example of this. The exhaustion of the air from the lamps by mercury pumps in 1881 required from four to six hours. This was reduced to half an hour in 1895. A better result is secured to-day by simple piston pump and chemical exhaust, in one minute. The glass working operations have all been changed from hand-and-mouth labor by glass blowers of special skill, to machine work done by unskilled labor; so that the labor cost of the glass item is barely 10 per cent of what it was in 1882. In the best known of the early lamps split bamboo was used for the filament, each piece requiring eight separate hand operations. Squirted cellulose is now used. In one large factory where this employs 83 operators, the retention of the obsolete bamboo methods would have necessitated the employment of over 2,150 women. Moreover the lamp of 25 years ago had 30 times as much platinum in it as now, and platinum outranks gold for expensiveness. Nor is this all. Early lamps consumed about 100 watts for 16 candle-power. To-day the standard carbon filament lamp takes only 50 watts for the same candles, and the newer metal filament lamps like the tantalum show less than two watts per candle. The estimated useful life of the good modern 16 candle-power carbon filament lamp is 10,000 hours, or about as many times that of the lamp of 1880 as there are years between that date and 1905. As to price, the facts quoted above as to lessened cost of production explain why a lamp originally selling for one dollar can now be had for 15 cents, or even less.

Other changes in electrical manufacturing down to the present time may be briefly noted. Telegraphic apparatus has not undergone much remodelling, except in the way of refinement, and the key remains supreme over all "machine" or automatic devices; although duplex and quadruplex circuits carry a very large proportion of the business. In telephony the changes have been chiefly in suppressing the magneto call bell at the subscriber's station; the concentration of all the energizing current at the "common battery" or "central energy" exchange, where the storage battery has also become the main source of supply; and the abolition of the numbered drop on the switchboard in favor of small incandescent lamps whose flashes notify the operator as to what is to be done in connecting and disconnecting subscribers. More latterly the new switchboards have been manufactured with adjuncts in the shape of numbering devices to register the calls of each subscriber who is on the "measured rate" basis of charge. Some of the newer automatic boards on exchanges dispense entirely with the "hello girl" at central. In electric lighting the changes in the incandescent lamp have been referred to. The production of the old open arc lamps with which all the work was done in the first twenty years has been reduced to a minimum, and the manufacture of enclosed arcs has grown up, these lamps consuming carbon slowly and thus requiring attendance, say once a week or fortnight instead of once a day. More recently, however, "flaming arcs" of far higher brilliancy have been introduced by some manufacturers and in time are likely to change the conditions again. But both the electric arc and incandescent illuminants have been challenged or supplemented by newer candidates for favor, as in the large vacuum tubes with luminous mercury vapor or other gas, and in the "Nernst" lamps with semi-incandescent members known as "glowers." There is no question that these last comers have helped electricity in its long continued struggle with gas, now so cheapened and improved; and in general it is felt that the art of making and using electric lamps is on the eve of a new departure.

In the manufacture of dynamo electric machinery notable changes have been made and are, of course, in process. The first machines of the "magneto" type now slumber in museums; the early dynamos of the self-excited, small direct-current type are rapidly following them. The commercial electric lighting art employing electricity in bulk started in this country on the direct-current basis with small low voltage dynamos for incandescent lighting, and with small high voltage dynamos for arc lighting. A change was early made to single phase alternating current dynamos, enabling both kinds of light to be served through transformers, from one machine, and also embracing a larger territory for supply of current. The next change, in order to include motor service, was to polyphase dynamo generators, and these of the three-phase type are distinctly in the lead, with the significant result that they have been the means of giving a much improved position to all apparatus and systems of localized direct current consumption. Without exception every large American city has its electric current supply on this basis — three-phase generation of current and transmission to substation at high voltage; with reduction to low voltage direct current for reservoir storage batteries or for immediate supply to lamps, motors, heaters, etc. There is, however, a very large quantity manufactured of the various classes of alternating current motors — single-phase, two-phase, three-phase, induction, etc., chiefly employed in connection with long distance transmission and mining projects. The direct current motor is manufactured in enormous numbers, and in sizes from the fan type up to those of hundreds of horse-power for work in the cities and for a great many mills, factories and other industrial establishments where electricity has virtually become the recognized leading motive power.

One notable change in dynamo manufacture has been due to the perfection of the steam turbine. Originally dynamos were small and all belt-driven by shaft and countershafting from the engine or the waterwheel, and such practice still prevails, although direct-connected types have long been prevalent and are now found everywhere,— in which the armature or the rotating field is attached directly to the prime mover. Now, however, the turbo-generator is rapidly being introduced in which engine and dynamo are virtually one integral unit of mechanism: and as the rotary steam turbine is naturally of high speed and demands little space, a number of notable economies over reciprocating methods appear to have been gained or to be on their way. These turbo-generators are built either horizontal or vertical, and in some instances the turbo-generator at low pressure has actually been operated with success on the exhaust from the reciprocating engines previously installed. The turbo-generators manufactured for electrical plants now equal in individual capacity the largest direct-connected units hitherto dominant, viz., 10,000 or 11,000 horse-power.

For electric railway work, the whole apparatus until a recent date has been of the direct current type, but alternating current single-phase apparatus is now being manufactured in large quantities and has been successfully introduced on trolley systems, while it has also been adopted for such large steam systems as that of the New York, New Haven & Hartford Railroad. On the great majority of American street railways the overhead trolley and direct current motor remain in supremacy, although the current is furnished and rectified from alternating sources, as in electric lighting. In the large cities, the under-running trolley gliding against contact rails in a shallow conduit is in vogue. There are several elevated roads employing contact shoes picking up current from third rails, and the same method prevails in all the new or projected subways, such as that of the Interborough Company in New York City. Latterly the great electrical manufacturing companies have been called upon to produce huge electric locomotives for the steam systems undergoing conversion. A notable instance of this class of work is the order given by the New York Central & Hudson River Railroad for 30 direct current electric locomotives for the terminal service in New York, each weighing 85 tons, with four 550 horse-power gearless motors, and hauling heavy trains at a speed of 75 miles per hour, a requirement exceeded in the tests. Other classes of electric locomotives are in demand, however, notably for mining, and of this kind one company alone has built 650 for use in all parts of the world. The activity in the demand for electric railway apparatus may be formed from the announcement of one company that its sales of such machinery reached $2,000,000 in January 1906.

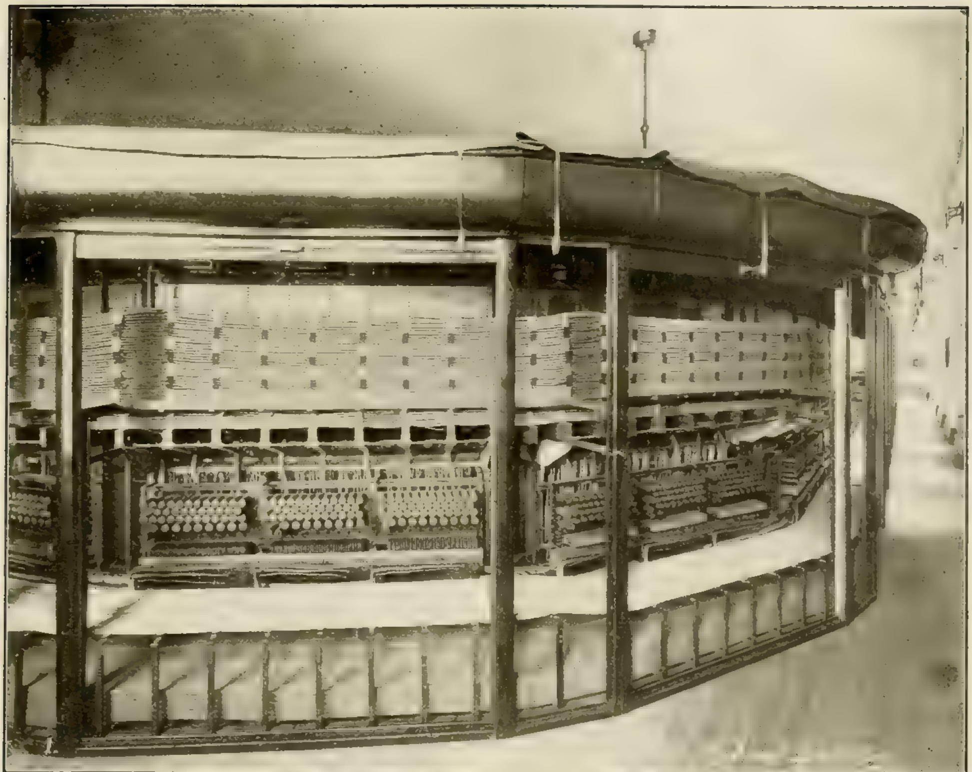
The statistics of the electric lighting industry last available are those of 1902, for central stations, and are given in the subjoined table:

CENTRAL LIGHTING STATIONS, 1902.

	Private stations.	Municipal stations
Number of stations	2,805	815
Cost of construction and equipment	$482,719,879	$22,020,47[illegible]
Gross income	$78,735,500	[1]$6,965,105
Income from sale of current	$77,349,749	[1]$6,836,856
Income from all other sources	$1,385,751	$128,249
Total expenses	$62,835,388	$5,245,987
Salaried officials and clerks:		
Number	6,046	950
Salaries	$5,206,199	$457,381
Wage-earners:		
Average number	20,863	2,467
Wages	$13,560,771	$1,422,341
Power plant equipment: [2]		
Steam engines—		
Number	4,870	1,060
Horsepower	1,232,923	147,018
Water wheels—		
Number	1,398	82
Horsepower	427,254	11,218
Generating plant equipment:		
Dynamos—		
Direct current, constant voltage—		
Number	3,405	418
Horsepower	418,913	23,533
Direct current, constant amperage—		
Number	2,957	582
Horsepower	157,768	37,763
Alternating and polyphase current—		
Number	4,300	822
Horsepower	896,315	90,688
Output of stations in kilowatt hours, total for year	2,311,146,676	195,904,439
Total number of arc lamps	334,903	50,79[illegible]
Total number of incandescent lamps	16,616,593	1,577,451

[1] Includes estimated income from public lighting.
[2] In addition there were gas engines and auxiliary steam engines with a capacity of 26,635 horsepower.

Since that year there has been an average increase annually estimated at not less than 15 per cent, although in some instances it has run much higher and in some much lower. The gross income is believed, as noted above, to have grown by the end of 1905 to $135,000,000. A marked tendency of the present century has been the grouping together of local properties for the manufacture of current, so that, as in New York, Boston and Chicago, the whole service is unified under one private management. In similar manner whole sections of a State have come to enjoy service that, while under one control, has numerous generating and distributing points. Thus the whole of northern New Jersey is furnished electric light, heat and power by the Public Service Corporation, which also administers the trolley system in the same region. Another kindred process has been that of grouping together in one ownership scattered central stations, so that a single company or engineering firm will direct the management of a score of such properties. The general result



1. Rear View of Large Telephone Switchboard, Showing Subscribers' Sections, with Multiple Cables, Trunk Cables, Answering Jack Cables, and Cord Circuit Cables.

2. Switchboard Wiring Department, Western Electric Co. Factory — Forming Keyboard

of this, on the whole, has been good, in various economies and in a higher grade of skill applied to the work. Capital for improvements has been more readily obtainable, and the securities of the industry have been brought into the investment market, for public patronage, many of the stocks selling at high quotations on the exchanges and the bonds being at a premium.

The same statement applies to the electric railway industry, the figures for which, of 1902, the latest census returns available, show that there were in existence 817 operating street and electric railway companies and 170 companies leased to and operated by other companies, making a total of 987 companies. These companies owned or controlled 22,676.99 miles of single track. The par value of the capital stock and funded debt outstanding amounted to $2,308,282,099. The average net capital liabilities per mile of single track owned for the companies reporting both factors were $96,287. The total income and expenses of the operating companies amounted to $250,504,627 and $219,907,650, respectively. The companies gave employment on the average during the year to 133,641 wage-earners, and paid $80,770,449 in wages. There were 7,128 salaried officials and clerks employed, to whom $7,439,716 was paid in salaries. The roads carried 5,871,957,830 passengers of all kinds. Unfortunately a number of the street-railway companies in existence at the census of 1890 failed to make reports to the census office, and, therefore, a comparison of the statistics of the two censuses must be, to that extent, defective, exaggerating somewhat the growth which actually took place. From the items as reported it appears that the single-track mileage increased from 8,123.02 miles in 1890 to 22,576.99 miles in 1902, or 177.9 per cent, and the number of fare passengers carried from 2,023,010 to 4,809,554,438, or 137.7 per cent. Electric railway statistics down to the end of 1904, the latest available, give the following figures: Miles of lines, 29,548; capital stock, $1,761,572,000; funded debt, $1,455,520,000; total capital liability, $3,217,092,000; liability per mile of line, $106,000.

Notable developments of recent years have included the electrical annexation of all the elevated railways, the creation of subways for passenger traffic, and the rapid building up of interurban systems, which connect hundreds of towns and cities, and by their flexibility of service, speed and cheapness of construction, operation and fare, compete on winning terms with the steam railroads. In fact, several of the larger trunk lines, like the New York Central and Pennsylvania, have acquired such networks to turn them into feeders and to regulate their competition. Another striking development has been that of handling freight, so that whole rural regions now depend on the trolley for supplies and for the swift removal of their crops of fruit and vegetables.

A development of electrical manufacture that is larger than supposed but by no means yet what has been anticipated of it, is automobiles (q.v.). Some years ago preparations were made for a very general introduction of these machines, but the depreciation of tires, batteries and motors under the taxing conditions of rough city streets was too heavy to be borne except where good rates of hire and fare could be secured. Nevertheless a great many hundreds of such automobiles are in use and the number is growing daily. One manufacturing concern that devotes its energies to electric trucks, drays, delivery wagons, etc., has built over 800 for different industries in the last five years. The New York Edison Company has a large garage of its own and some 50 electric runabouts, trucks, etc., for the service of its own system. The electric cab service in New York maintains in constant employment 500 broughams, coupés, hacks and hansoms, which in winter can only be secured by an order well in advance of the hour.

A branch of electrical manufacturing of recent development, though old in antecedents, is that of telepherage, in which the traveling motor going to and fro incessantly picks up its current from the overhead bare wire, cable or rail on which it moves, and also carries its burden of freight aerially in the same manner. The ground is thus relieved of tracks, the floor of a factory is no longer blocked by moving cars or hand carts, and the motor with automatic attachments can run freely to and fro over long stretches of line. It is now proposed to build such systems for the rural service of

COMPARATIVE SUMMARY — TELEPHONE AND TELEGRAPH SYSTEMS, INCLUDING SUBMARINE CABLE SYSTEMS.

	Telephone systems	Telegraph systems
Number of systems	4,151	25
Miles of wire	4,850,486	[1] 1,318,350
Salaried officials, clerks, etc.:		
Number	14,124	829
Salaries	$9,885,886	$1,162,632
Wage-earners:		
Average number	64,628	26,798
Wages	$26,369,735	$13,877,041
Capital stock and bonds outstanding, par value	$348,031,058	$162,946,525
Common stock	$269,180,076	$115,853,525
Preferred stock	$4,869,621	$1,200,000
Bonds	$73,981,361	$45,893,000
Total revenue	$86,825,536	$40,930,038
Operating expenses and fixed charges, except interest on bonds	$61,652,823	$28,998,884
Interest on bonds	$3,511,948	$1,949,150
Dividends paid	$14,982,719	$6,256,693
Net surplus	$6,678,046	$3,725,311
Total assets	$452,172,546	$195,503,775
Construction and equipment (including telephones)	$366,561,694	$156,911,448
Real estate	$22,716,538	$4,768,131
Stocks and bonds of other companies	$9,938,342	$25,939,944
Machinery, tools, and supplies	$9,689,691	$945,795
Bills and accounts receivable	$30,629,677	$3,084,739
Cash and deposits	$12,291,840	$3,287,384
Sundries	$344,764	$566,334
Total liabilities	$452,172,546	$195,503,775
Capital stock	$274,049,697	$117,053,525
Bonds	$73,981,361	$45,893,000
Cash investment, unincorporated companies	$6,161,299	$7,310
Bills and accounts payable	$44,302,999	$6,244,585
Dividends unpaid	$188,067	$366,666
Reserves	$31,029,628	$7,859,648
Sundries	$1,124,265	....
Surplus	$21,335,230	$18,979,041

[1] Includes miles of wire operated by Western Union Telegraph Company outside of the United States, but does not include 16,677 nautical miles of cable operated by submarine cable systems.

mails, etc., and as feeders to trolley lines and steam railroads. The amount of work in this field of manufacturing in 1905 is estimated at $500,000, and the tonnage handled was heavy to a remarkable degree, the telphers in some instances reaching a capacity of several horse-power.

ELECTRIC FIRE ALARM SYSTEMS REPORTING DIFFERENT VARIETIES OF CONSTRUCTION AND EQUIPMENT, GROUPED ACCORDING TO POPULATION OF CITIES.

Character of Construction and Equipment	Number of Systems, by Population Groups				
	100 000 and over.	50,000 and under 100,000.	25,000 and under 50,000.	10,000 and under 25,000.	Under 10,000.
Overhead construction:					
Pole line—					
Owned exclusively	4	4	3	21	82
Leased exclusively	18	23	50	157	261
Owned and leased	13	10	23	43	50
Overhead construction exclusively	5	24	63	202	387
Underground construction:					
Conduit—					
Owned exclusively	6	5	2	4	2
Leased exclusively	14	8	11	15	5
Owned and leased	9	....	....	....	....
Both overhead and underground construction	31	13	13	19	7
Boxes or signaling stations:					
Signaling boxes exclusively	36	37	70	220	383
Annunciating boxes exclusively	....	....	....	1	8
Both signaling and annunciating boxes	....	....	....	....	1
Special telephones	24	9	18	27	26
Central office equipment:					
Manual transmitters exclusively	16	1	5	13	8
Automatic transmitters exclusively	8	28	56	87	35
Both manual and automatic transmitters	12	8	9	11	3
Receiving registers, all kinds	29	20	32	53	48
Receiving circuits	35	37	72	124	54
Transmitting circuits	35	32	56	93	39
Both receiving and transmitting circuits	35	32	56	93	39
Telegraph switchboards exclusively	4	13	28	70	31
Telephone switchboards exclusively	11	3	2	4	1
Both telegraph and telephone switchboards	18	6	4	1	1
Single circuits exclusively	....	....	4	97	341
Central station power equipment:					
Engines	1	1	....	1	2
Dynamos	1	1	1	3	8
Motor generators and dynamotors	8	2	3	5	6
Engines, dynamos, motor generators, and dynamotors	1	....	....	....	....
Dynamos, motor generators, and dynamotors	1	....	1	1	4
Battery cells—					
Primary	19	18	34	140	311
Storage	29	29	48	88	76
Both primary and storage	13	10	7	9	5

The U. S. census statistics for the year 1902, for telegraphy and telephony, are combined in the foregoing table, which permits an idea to be obtained of the relative importance of the two arts, and shows how rapidly telephony has gained upon its older rival.

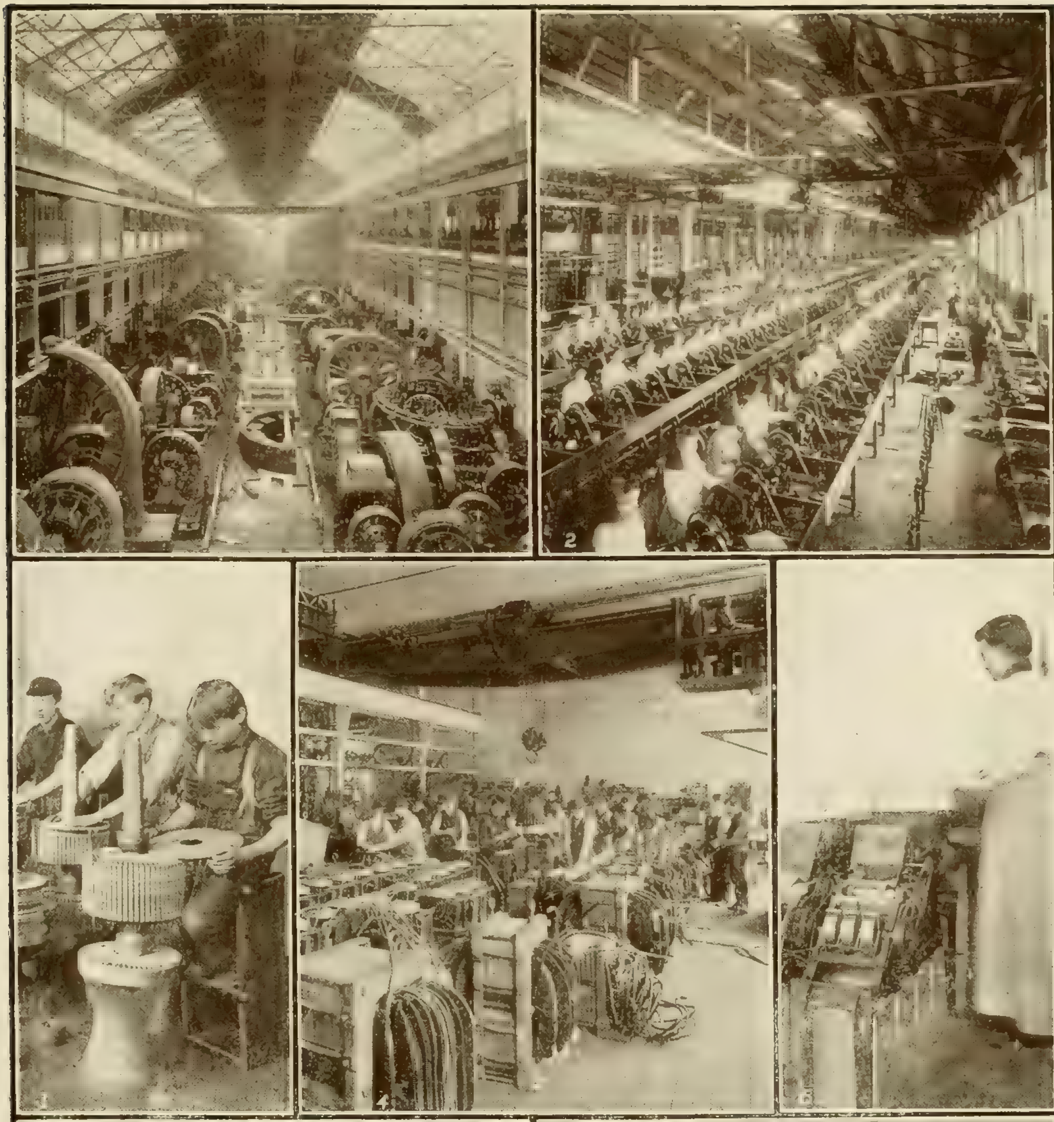
The telegraph figures, however, do not embrace any of the extensive work done by the steam railroads, largely for train dispatching. Nor do they include fire alarm telegraphs or police patrol systems. Both these latter systems are extensive, as will be understood from the accompanying tables.

The following table gives similar totals and analyses for the municipal police patrol systems of the country:

ELECTRIC POLICE PATROL SYSTEMS REPORTING DIFFERENT VARIETIES OF CONSTRUCTION AND EQUIPMENT, GROUPED ACCORDING TO POPULATION OF CITIES.

Character of Construction and Equipment	Number of Systems, by Population Groups				
	100,000 and over.	50,000 and under 100,000.	25,000 and under 50,000	10,000 and under 25,000.	Under 10,000.
Overhead construction:					
Pole line—					
Owned exclusively	4	2	4	3	1
Leased exclusively	20	19	30	26	10
Owned and leased	10	9	5	4	1
Overhead construction exclusively	6	19	29	25	12
Underground construction:					
Conduit—					
Owned exclusively	5	5	1	2	....
Leased exclusively	14	6	9	6	....
Owned and leased	9	....	....	....	....
Both overhead and underground construction	28	11	10	8	....
Boxes or signaling stations:					
Signaling boxes exclusively	28	28	34	24	11
Telephone boxes exclusively	4	2	4	8	1
Both signaling and telephone boxes	1	....	1	1	....
Special telephones	22	11	16	5	2
Central office equipment:					
Manual transmitters exclusively	9	6	12	8	1
Automatic transmitters exclusively	1	3	6	2	1
Both manual and automatic transmitters	4	4	3	....	1
Receiving registers, all kinds	30	26	34	19	6
Receiving circuits	32	27	34	21	6
Transmitting circuits	28	25	33	21	5
Both receiving and transmitting circuits	28	25	33	21	5
Telegraph switchboards exclusively	3	9	6	4	2
Telephone switchboards exclusively	17	9	18	11	1
Both telegraph and telephone switchboards	9	3	2	....	....
Single circuits exclusively	3	3	5	11	6
Central station power equipment:					
Motor generators and dynamotors	7	1	2	1	....
Battery cells—					
Primary	22	19	20	24	9
Storage	18	20	23	11	2
Both primary and storage	6	9	5	3	1

Reference has already been made incidentally to the branches of electro-chemical and electro-metallurgical manufacturing. Few persons realize how enormous these have become. The production of aluminum by electricity in the United States in 1903 reached a total of 7,500,000 pounds. For 1902, Prof. Munroe, the well-known expert, stated that by means of electricity sodium and other metals (not including aluminum), caustic soda, bleaching agents and powders, bromine and potassium bromide, potassium chlorate, litharge, graphite, calcium carbide, carborundum, carbon disulphide, and phosphorus



[1] Heavy Construction Work in the Erecting Shops. [2] A Section of the Winding Department where Small Coils are Made. [3] Assembling Armature Cores. [4] Mounting Large Transformers. [5] Mica-Splitting Machine. [6] 650 Horse Power Gas Engine Generating-Set in the Power Station. [7] Connecting Street Railway Armatures.

INTERIOR VIEWS IN THE WORKS OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

were produced to a value of $2,045,535. Practically all the copper, except «Lake,» produced in America to-day is treated electrolytically. The latest accurate figures available show that 275,000 metric tons of American copper were produced in 1900, and that in 1899 no fewer than 198,000 tons were due to electrolytic treatment, which since then has become universal in use.

Of late years there has been a rapid growth in the foreign demand for electrical manufactures of American make, while the importations have assumed relatively insignificant proportions. During 1905, the export of the smaller electrical apparatus, as distinguished from dynamo-electric machinery, but including telegraph and telephone instruments, reached a total of $5,648,435. The exports of electric machinery during the same year amounted to $7,409,242, so that the total was not less than $13,057,677. This, compared with a total of $11,039,758 in 1904, is a gain in one year of $2,017,919, or nearly 20 per cent. This healthy condition of the foreign demand is the more remarkable when it is noted that a number of leading American electrical manufacturers have deliberately limited their own business of this character by establishing large factories abroad, or by making arrangements with foreign manufacturers by sale of patents, etc. Thus there are huge factories due to American initiative or capital and skill producing what is virtually American electrical machinery and apparatus at Rugby and Manchester, England, Antwerp, Belgium, Havre, France, Paris and Berlin, as well as many shops where such goods are turned out under contract or working arrangement of some kind.

THOMAS COMMERFORD MARTIN,
Editor of the 'Electrical World.'

Electrical Measuring Instruments. The four electrical quantities which are being constantly measured in electric circuits are ohms, amperes, volts and watts. The usual method of measuring ohms, that is, the electrical resistance of a circuit, is to use a Wheatstone Bridge, which is described elsewhere. The electrical resistance of a circuit may also be measured by what is called «fall of potential method,» which consists in sending a measured current through the circuit and measuring the difference of potential between the terminals of the circuit, as illustrated in Fig. 1. When the current is measured in amperes and the difference of potential is measured in volts, the resistance is obtained by taking the ratio of the volts to the amperes. The instruments used in this measurement are amperemeters and voltmeters, which are described below.

In measuring amperes, advantage may be taken of three different physical effects of the electric current: (1) The electrochemical effect, (2) the magnetic effect, and (3) the heating effect. Instruments which are used for measuring currents by taking advantage of the first of these phenomena are called *voltameters.* When an electric current is passed through a dilute solution of sulphuric acid and water, the water is electrolyzed and the component gases, oxygen and hydrogen, are given off respectively at the two metallic terminals by means of which the current enters and leaves the water. These two terminals may be placed in the two limbs of a vertical U tube, such as the arrangement illustrated in Fig. 2, where A and B are the two ends of the U tube and EE are the two metallic electrodes. The arrow shows the direction of the flow of the electric current from the battery. A riser C is provided to maintain the supply of acidulated water as the gasses collect in the upper limbs of the tube.

A water voltameter such as is here illustrated, has not been found convenient or satisfactory for measuring currents, and voltameters in which the electrolytes are the solutions of salts of metals are preferred for actual measurements. Copper plates in a solution of copper sulphate may be used, and silver terminals in a solution of nitrate of silver are often used. On account of the expense of the silver consumed and the care required in using a silver voltameter, it is not satisfactory for measuring currents exceeding one ampere. For larger currents the copper voltameter is preferably used.

Voltameters are used in practice only for the purpose of calibrating galvanometers, or for similar purposes, as they are not sufficiently convenient for general use. The liquid must be kept quite pure and of proper density, con-

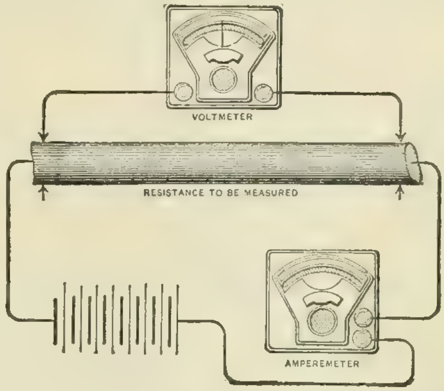


FIG. 1.—Arrangements for measuring resistance by "fall of potential."

veniences must be available for cleaning, drying, and accurately weighing the cathodes, and in order that a satisfactory measurement of the current may be made, the period during which it flows through a voltameter must be considerable. But the silver voltameter has been proved to be so satisfactory for use as a standard that the practical unit of current is now defined as the current which flowing for one second through a suitable voltameter will deposit .001118 grams of silver on the cathode.

Most of our common instruments for measuring currents depend upon the magnetic effect of the current for their indications, and each is really a modified galvanometer provided with a pointer to indicate the deflections of the needle or movable coil. Such instruments arranged for convenient, everyday measurements of electric currents are generally called *amperemeters* or *ammeters,* and they are made in numerous forms, some of them intended to be mounted upon switchboards in dynamo rooms, and others made up in more or less portable form so that they may be carried around to be used at any convenient place. The switchboard instruments, namely, those intended to be mounted on switchboards, are used in large numbers in electric lighting plants or works, where they may be seen mounted upon marble or slate boards along with switches for controlling the current. They are here used to show the dynamo attendants how much current is being generated by the plant at any moment and what proportion is furnished by each dynamo.

The portable form of these instruments is the form ordinarily used in laboratories for experimental work.

According to the mechanical details entering into their construction, electromagnetic

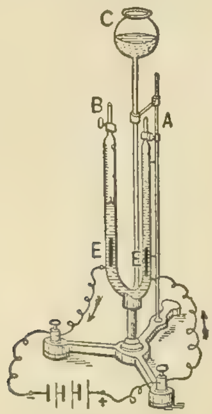


FIG. 2.—Water Voltameter.

amperemeters may be roughly divided into three classes: (1) Those having soft iron parts which are moved by the magnetic attraction set up by the current in the coils of the instrument; (2) those having permanently magnetized parts which are acted upon by the magnetic force set up by a current in the coils of the instrument, either the coil or the magnet moving under the influence of the magnetic force; (3) those having no iron in their construction, but having two coils, one of which is moved by magnetic force exerted between them when a current flows in both.

The moving parts of these instruments are usually mounted on pivots which are carefully wrought to reduce the friction to a small value, and the instruments may be considered equivalent to galvanometers arranged with the moving parts mounted on pivots, instead of being mounted upon a delicate suspension, and each provided with a pointer arranged to play over a scale graduated to read in amperes.

If the magnetic force caused by the current in the coils of an amperemeter had nothing except the friction to overcome, every current would pull the pointer entirely across the scale. As the instrument should be constructed so that the movement of the pointer is proportional to the current in the windings, a proper force must be arranged to hold the pointer back, and this may be done by properly counter-weighting the parts or using a suitable spring to oppose the magnetic force set up by the current.

Instruments of the first class may be cheaply constructed, and formerly were commonly made by dynamo builders for use in electric light plants, but it is difficult to make them extremely accurate because the coercive force of the iron prevents it from responding equally to equal magnetic changes. For this reason instruments of the first class cannot as a rule, be used where great accuracy is essential, but only where an accuracy within from 2 per cent. to 5 per cent. is sufficient, as for instance in the ordinary switchboard instruments of electric plants. For measurements that require great accuracy, instruments belonging to the second or third class must be used, and these can be made so that their readings do not vary more than one-half of one per cent. from true values when the instruments are used with proper care.

The best form of such instruments consists of a modified D'Arsonval galvanometer with a movable coil mounted upon pivots and arranged with a pointer to play over a scale, which was first successfully produced by Dr. Edward Weston. The Weston amperemeters and voltmeters made of this construction may be properly said to have revolutionized the everyday measurements of amperes and volts.

Fig. 3 shows a plan of a Weston amperemeter. A A represent the binding posts of the amperemeter through which the current may be led to and from the instrument. W W are wires within the instrument, and E consists of a series of conducting shunts between the conductors W W. The movable coil C is connected by the wires W W with the binding posts, and a fixed proportion of the current flows through this movable coil which bears a ratio to the total current depending upon the electrical resistance of the shunt E and of the movable coil. The movable coil is mounted on pivots within the magnetic field of the permanent magnet M, and any motion which is

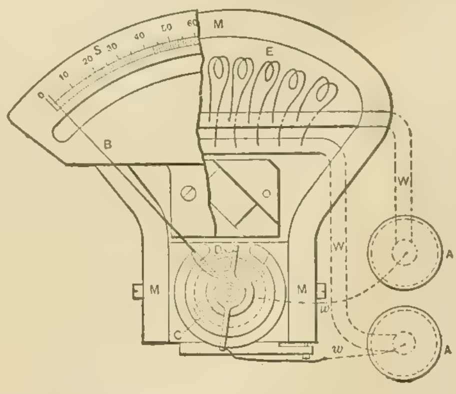
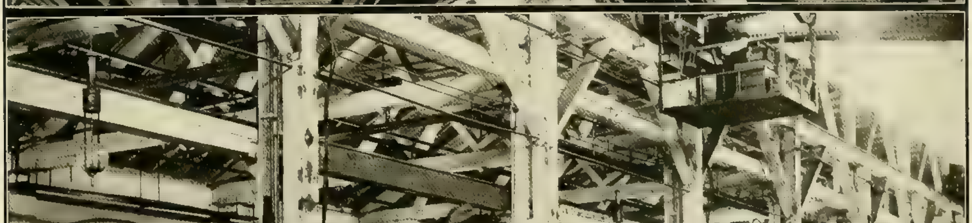


FIG. 3.—Plan of the Weston Amperemeter.

caused by the magnetic effect of a current flowing through the coil is opposed by the spiral spring D. The spring and the pole pieces of the magnet M are carefully designed so that the movement of the coil shall be directly proportional to the current flowing through the coil, and the deflection is indicated on the scale S by the pointer B that is attached to the coil.

Fig. 4 shows a sectional end view of the working parts of a Weston instrument. A stationary soft iron cylinder is mounted within



1. Winding Armatures in the Westinghouse Works, Pittsburgh, Pa.
2. A Portion of the Armature Winding Department, General Electric Works, Schenectady, N. Y.

the movable coil C for the purpose of improving the magnetic circuit of the magnet, and the conductors of the movable coil move between it and the pole pieces of the magnet.

Weston or similar instruments are used a great deal where accurate portable current measuring instruments are required, and instruments following this type are now manufactured in large numbers in this and foreign countries.

Magnetic instruments belonging to the third class are frequently called *electrodynamometers* because their indications are caused by the magnetic effect of the current in the fixed coils acting on the current in the movable coils.

Fig. 5 shows an early form of electrodynamometer which is arranged for use as an amperemeter. This is often called the Siemens Electrodynamometer. The coil marked F in this instrument is fastened to the frame of the instrument, and the coil marked M, which stands at right angles to the first, is suspended by a heavy silk fibre or a wire so that it is free to rotate. The ends of the conductor composing the movable coil dip into little cups C C containing mercury, and these are connected with a circuit arranged so that a current can enter and leave the movable coil. The spring G is attached at one end to the movable coil,

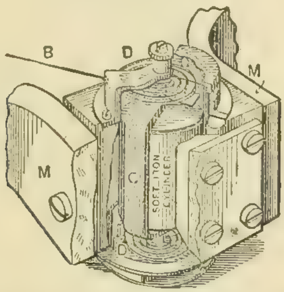


FIG. 4.—Sectional end-view of mechanism of Weston Direct Current Amperemeters and Voltmeters.

and at the other end it is connected to a thumbscrew T called a torsion head, by means of which this spring may be twisted. When a current flows in the coils, the magnetic force tends to turn the movable coil so as to place it parallel with the fixed coil. This force is balanced by twisting the spring by means of the thumbscrew. The amount of twist is shown by the pointer B, and it is proportional to the force exerted by the coils on each other, which in turn is proportional to the square of the current flowing in the circuit. The pointer S indicates when the movable coil is at its zero position.

Very accurate and permanent standard instruments have been designed for measuring currents by this direct magnetic action, but they have not been made sufficiently portable to bring them into much use. The most important of these are the current balances of Lord Kelvin, one of which is illustrated in Fig. 6. The fixed and movable coils in these Kelvin balances are parallel to each other and horizontal. The force with which the coils tend to move toward each other when a current flows in them is directly balanced and weighed by means of a slider moving on a scale beam. In order to avoid any disturbing effect from the earth's magnetism, coils are placed at both ends of the balance arm.

Instruments utilizing the heating effect of the current are usually called «hot-wire» instruments. If the heated wire is carefully enclosed so that its temperature is not affected by air currents, it will rise a definite number of degrees in temperature for each current that is passed through it, and the rise of tem-

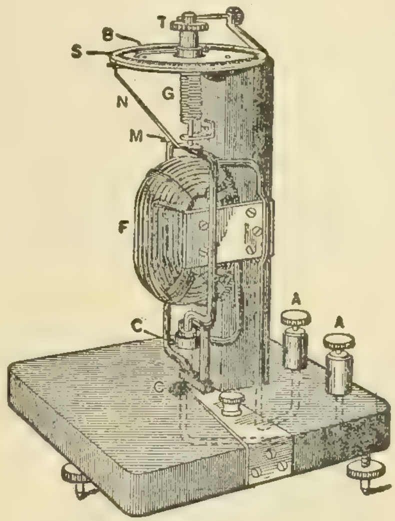


FIG. 5.—Siemers Electrodynamometer.

perature is proportional to the square of the current. This heating of the wire is indicated by its expansion in length; and the wire, if properly selected and protected, will take up a corresponding length with each current which may flow through it, so that measuring its length is equivalent to measuring the square of the current. A simple model of an amperemeter depending upon this action is illustrated in Fig. 7. The long, thin wire is clasped at one end in a stationary binding post, and the

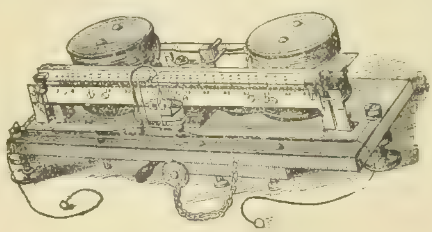


FIG. 6.—Kelvin Balance.

other end is wrapped around and fastened to a small wheel of metal. This wheel is supported on steel pivots, one of which is connected to another binding post. The wire is kept under a constant strain by means of a spring which is fastened to the periphery of the wheel. When the wire is heated and thereby lengthened, the wheel is turned by the contraction of the spring, and a pointer which moves over a graduated scale indicates the amount of expansion of the wire. When the wire is again cool and contracts, the wheel is pulled back into its old position by the shortening of the wire.

Instruments for measuring electrical pressures, in volts, may be made of the same forms as the amperemeters utilizing the magnetic effects and the heating effects of electric currents. Instruments intended to measure electrical pressures are ordinarily called *voltmeters,* and when they are constructed to utilize the aforenamed effects of the electric current are really amperemeters wound with coils of high resistance so that very little current will be wasted in the process of making the measurements of the electrical pressure or voltage. Such an instrument really measures the very small current that is caused to flow through the resistance of its winding by the voltage or electrical pressure to be measured. The resistance of the instrument is of constant value, and the voltage is therefore directly proportional to the flow of current through the instrument. It is consequently possible to graduate the scale so that the position of the pointer indicates volts.

Many instruments, amperemeters and voltmeters, have scales that are uniformly graduated, and the readings can only be converted into amperes or volts by consulting a calibration curve or a table giving the values corresponding to different readings. Other instruments are constructed so that the readings may be multiplied by a fixed constant, which has been experimentally determined, for the purpose of converting them into amperes or volts. But in the most used instruments, the scales are so divided and marked that the divisions read directly in amperes and volts. These instruments are generally called «direct reading» instruments.

Fig. 7.—Simple Illustrative Model of Hot-wire Amperemeter.

Currents which rapidly alternate in direction cannot be measured by magnetic instruments like the Weston instruments having permanent magnets; but they can be measured by instruments having soft iron parts which are moved by the magnetic attraction set up by the current in the coils of the instrument, or by instruments of the electrodynamometer class. In the first class of instruments, the soft iron core is always attracted by the coil in which the current flows, without regard to the direction of the current, and the attraction in an electrodynamometer is also independent of the direction of the current because the current reverses at the same time in both coils. Any iron cores which are used in instruments designed to measure these alternating currents, must be built up from thin strips or fine iron wires so that parasitic eddy currents shall not be set up in them by the reversals of the magnetism. The working parts of an instrument which operates by the attraction of the coil D upon a thin iron strip C, are illustrated in Fig. 8, the exterior of the case having been removed so that the working parts shall be exposed.

The heating effect of currents is also independent of the direction of the current flow, so that hot wire instruments may be used for measuring alternating currents and voltages. Hot wire instruments are free from influences due to external magnetic effects; they may be used on either direct or alternating current circuits and when used on the latter they are independent of frequency or wave form; and for these reasons they have a considerable vogue for alternating current measurements. On the other hand, the scale divisions are not uniform because the heating effect and hence the elongations of the wire are proportional to the square of the current flowing through it, and there are some other serious inconveniences attaching to this construction.

When very large currents are to be measured, it is often inconvenient and expensive to build an amperemeter with conductors large enough to carry the entire current. In these instances an amperemeter of small capacity

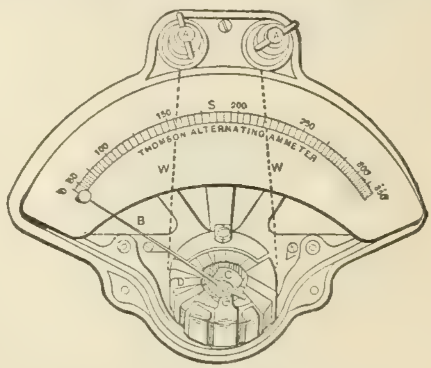


Fig. 8.—Thomson Alternating Current Amperemeter or Voltmeter, in which magnetic effect of coil acts on bit of soft iron.

may be shunted by a German silver wire or rod, and the shunted instrument may then be calibrated and used to measure the large current. This arrangement has become quite universal in the large electric light works where very great currents are to be measured, and it is not uncommon in ordinary portable instruments. Indeed, nearly all Weston amperemeters, such as illustrated in Fig. 3, consist of a milli-amperemeter arranged with a proper shunt E inside the case.

An entirely distinct method of measuring electric pressures is by means of electrometers, and when these are converted into portable form for everyday use they are called electrostatic voltmeters. They are particularly useful for measuring alternating voltages. Instruments with magnetic coils are not very satisfactory for measuring alternating voltages because their indications are likely to be effected by the frequency of the alternations of the current.

The electric power which is used in any part of a continuous current circuit may be determined by measuring by means of an amperemeter the current flowing through the circuit and measuring by means of a voltmeter the pressure or voltage at the terminals of the circuit. The product of the number of amperes by the number of volts gives the power in watts. Instruments are made which themselves perform this double measurement and multiplication so their indications are directly proportional to power, and these instruments are called *wattmeters*. The simplest form is an electrodynamometer in which one coil is wound with many turns of fine wire exactly as though it were to be used as a voltmeter coil, and the other coil is wound with a few turns of coarse wire as though it were to be used in an amperemeter.

The action of such a wattmeter is best explained by an illustration. Suppose it is desired to measure the power used by an electric motor,—the fine wire coil of the wattmeter is connected across the terminals of the motor, and the coarse wire coil of the wattmeter is connected in series with the motor. The magnetic effect of the fine wire coil is then proportional to the voltage at the motor terminals, and the magnetic effect of the coarse wire coil is proportional to the current flowing through the motor. The force exerted to move the movable coil is proportional to the product of the two magnetic effects, consequently, this force is proportional to the watts. The arrangement is diagrammatically illustrated in Fig. 9, where W is the wattmeter, V V′ are

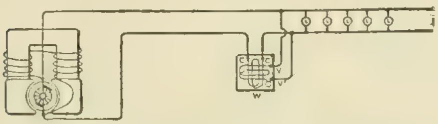


Fig. 9.—Illustration of the manner in which the coils of a Wattmeter are connected with the main circuit.

the terminals of the fine wire coil, and C C′ are the terminals of the coarse wire coil. This figure is intended to show a dynamo furnishing current to a set of incandescent lamps L L L L L, and the wattmeter is introduced in circuit for the purpose of measuring the power delivered to the lamps.

The instrument just described is called an indicating wattmeter, but it is often desirable to make a registry of the continuous consumption of power by a customer during a given period, such as a month, and such an instrument is illustrated in Fig. 10, which is called the Thomson recording wattmeter. This is built like a little electric motor without any iron in its working parts. It is arranged with its revolving part or armature A to be connected to the circuit like the fine wire coils of a wattmeter, and its field magnetizing windings W W to be connected in circuit like the coarse wire coils of a wattmeter. The magnetic pull which tends to make the armature rotate is proportional to the product of the two magnetizing effects, so that the rotative effect, or torque, is proportional to the watts in the circuit. If the speed of such an armature is made proportional to the magnetic pull, it is easily seen that every revolution of the armature means a certain number of watts used for a fixed length of time. Such instruments usually have attached to the spindle of the armature a set of dials D like those of a gas meter, which record the revolutions and are so marked that the consumption of electric energy may be recorded in what are known as «watt hours.» The record of these instruments is really an adding together of the total watt hours of the electric circuit for a period, and the instruments are therefore preferably spoken of as «integrating wattmeters.»

If no external retarding force were applied to the armature of such an instrument, it would tend to run at an excessive speed for any current flowing through the apparatus, and, to make the instrument give an accurate record of power, a retarding force which is proportional to the speed of the armature must be applied to the spindle. This is admirably arranged in the Thomson recording wattmeter by placing at the bottom of the spindle S a flat disk of copper C, on either side of which are placed the poles of permanent magnets M. The rotation of the disk between the magnet poles generates electric currents in it which are attracted by the magnets and retard the motion of the disk.

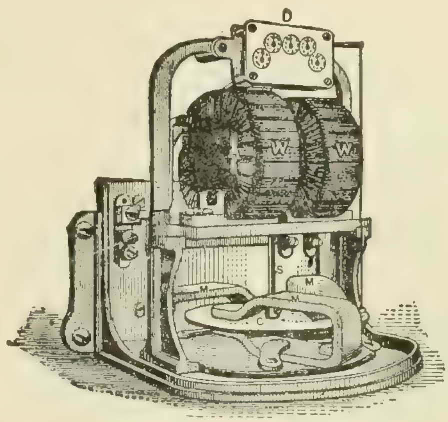


Fig. 10.—Thomson Integrating Wattmeter.

When the power in alternating current circuits is to be measured, it is necessary to make the self-induction of the fine wire coil of the wattmeter practically negligible in comparison with the resistance of the coil, to prevent the readings of the instrument being affected by the frequency of the alternations of the current, and this is brought about by introducing a coil of high resistance and of practically no self-induction in series with the fine wire moving coil of the instrument.

The number of alternations made in each minute by the alternating currents that are ordinarily used in practice is so great that the movable coil of an electrodynamometer acts exactly as though it were pulled around by a continuous force proportional to the average of the variable force which results from the magnetic action of the alternating current. This is true whether the instrument is arranged to be used as an alternating-current amperemeter, in which instance the two coils are placed in series with each other and both are of low resistance; or the instrument is arranged to be used as a voltmeter, in which instance the two coils are connected in series with each other but both are of relatively high resistance and their resistance is re-enforced by that of a supplementary non-inductive coil of high resistance; or the instrument is arranged for use as a wattmeter, in which instance one of the coils is of low resistance and is a current coil to be connected in series with the main circuit, while the other coil is a fine wire coil of high resistance re-enforced by a supplementary non-inductive resistance coil, and is a pressure coil to be connected across the terminals of the circuit.

Bibliography.—For further information in regard to electrical measuring instruments consult: D. C. and J. P. Jackson, 'Elementary Book on Electricity and Magnetism:' Swenson and Frankenfield, 'The Testing of Electromagnetic Machinery and Other Apparatus;' Gerhardi, 'Electricity Meters: Their Construction and Management;' Gerard, 'Electrical Measurements' (translated from the French), and other treatises.

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Electrical Meter. See ELECTRICAL MEASURING INSTRUMENTS.

Electrical Mortar, a small mortar in which is placed a discharge to take place between two bodies of contrary electricities. The discharge is so instant as to expel a light ball placed in the mouth of the mortar.

Electrical Motor, a machine for the conversion of electrical energy which has been supplied from an external source into mechanical energy. See ELECTRIC MOTOR; DYNAMO-ELECTRIC MACHINE; ELECTRIC MACHINE; ELECTRICAL TERMS; ELECTRIC ALTERNATING CURRENT MACHINERY; ETC.

Electrical Power. See DYNAMO; POWER; TRANSMISSION OF POWER, LONG DISTANCE; ELECTRIC TRANSMISSION OF ENERGY, LONG DISTANCE; POWER HOUSES; ELECTRIC ALTERNATING CURRENT MACHINERY; ELECTRIC DIRECT CURRENT; ELECTRIC FURNACES; ELECTRIC LOCOMOTIVES; ELECTRIC BATTERY; ELECTRIC STORAGE BATTERY; ELECTRICITY; ETC.

Electrical Railways. See TRACTION, ELECTRIC; STREET RAILWAY CONSTRUCTION; RAILWAY (ELECTRIC) ECONOMICS.

Electrical Terms. The development of electrical industries and applications during the last 20 years has been so rapid and considerable as to constitute one of the salient characteristics of this era. Prior to that time a knowledge of electrical phenomena, terms, and phrases was limited to a few philosophically minded persons. During that time, however, this knowledge has spread not only to a large professional and artisan class enlisting to-day more than half a million persons in the United States alone; but has also extended in a considerable measure to the public at large. We can hardly read through the news of a day in the columns of a newspaper without encountering electro-technical words or phrases. The telegraph delivers its messages at every door. The telephone whispers into thousands of households in every large city. The electric light shares with the primeval flame the brightening of the evening fireside. These things speak in a language of their own and force their own terms upon our speech. The following is a list of about 100 of the electrical terms in very general use:

AIR-BLAST TRANSFORMER.—A transformer which is cooled, when operating, by a blast of air delivered through its framework.

ALTERNATING CURRENT.—A current which periodically alternates, or reverses in direction.—A to-and-fro electric current; in contradistinction to a direct current. See ELECTRIC ALTERNATING CURRENT MACHINERY.

AMMETER.—An abbreviation of ampere-meter. An instrument which measures in amperes the electric current flowing through it.

AMPERE, INTERNATIONAL.—A unit of electric flow or current, theoretically derived, by electromagnetic principles, from the centimeter-gramme-second system of units. Practically defined as the current which will deposit 1.118 milligrammes of silver per second in a standard type of electrodepositing bath.

ANODE.—The electrode from which a current enters an electrolyte, or conductor. A positive electrode.

ARC LAMP.—An electric lamp consisting essentially of a column of intensely heated vapor maintained between two closely opposed, or slightly separated, conducting pencils which are usually of carbon. Much used for the illumination of streets, factories, and grounds. See ELECTRIC LIGHTING.

ARMATURE.—In an electromagnet, the movable element of iron or steel which is attracted to, or released from, the poles. In a dynamo, the element which is connected with the line, and which is subject to rapid cyclical changes in magnetic flux during operation.

ASYNCHRONOUS MOTOR.—An alternating-current motor in which the rotation is not synchronous with the rotating element of the generator supplying the driving current. See ELECTRIC ALTERNATING CURRENT MACHINERY.

BRANCH-FUSE.—A fuse inserted in a branch wire or circuit.

BRUSHES OF A DYNAMO-ELECTRIC MACHINE.—The conductors which convey current from one element to another, when there is relative motion between them. Usually, stationary conductors resting upon a rotating commutator and carrying current either to or from the same. See DYNAMO-ELECTRIC MACHINERY.

BUS-BARS.—An abbreviation of "Omnibus-bars." The main conductors in a central station, to which generators or feed-wires may be connected.

CANOPY.—In electric wiring of buildings, a metallic plate or disc attached to a wall or ceiling at an outlet to conceal the hole made where the wires protrude.

CATHODE.—The electrode by which a current leaves an electrolyte or conductor. A negative electrode.

CEILING-ROSETTE.—An insulating block fastened to a ceiling, in which electric supply wires terminate, and from which a pendant flexible cord, or other pair of conductors, descends to a lamp or fixture. Usually circular in form and fairly ornate in appearance.

CIRCUIT-BREAKER, ELECTRIC.—(1) A device for opening and restoring a circuit, either by hand at will or automatically, in the case of an overload. (2) A switch that automatically opens at overload, usually by electromagnetic mechanism.

COHERER.—In wireless telegraphy, a receiving device consisting of an imperfect contact, the resistance of which is broken down on the passage of an electric wave, thereby enabling an electromagnetic mechanism to respond.

COMMUTATOR.—A device for commuting or changing the direction or path of a current. In a dynamo, the element which enables the alternating currents generated within the armature to be delivered as a unidirectional current to the external circuit.

COMPOUND MOTOR OR GENERATOR.—A motor or generator having both a shunt winding and a series winding on its field magnets.

CONTINUOUS CURRENT.—A current uniform both in strength and in direction. A steady direct current.

CONTROLLER.—A device for controlling an electric machine or circuit. A controlling switch.

CONVERTER OR ROTARY CONVERTER.—A machine which operates by means of a rotating commutator to convert alternating currents into direct currents for distribution.

CURRENT, ELECTRIC.—A flow or passage of electricity along an electric circuit, usually measured in amperes.

CUT-OUT, ELECTRIC.—(1) A device for automatically interrupting an electric circuit in which an excessive current flows, by the melting of a fuse-wire or strip carrying the current and heated thereby. (2) A device for supporting or holding an electric fuse.

DIELECTRIC.—An insulating material capable of being subjected to electric stress.

DIRECT CURRENT.—A current which, however greatly it may vary in strength, always flows in one and the same direction. A unidirectional current. See ELECTRIC DIRECT CURRENT.

DUPLEX TELEGRAPHY.— The method of sending messages in both directions simultaneously over one and the same telegraph wire. See TELEGRAPHY.

EFFICIENCY OF A DYNAMO, MACHINE, APPARATUS, OR TRANSLATING DEVICE.— The ratio of the power given out to the power taken in, usually measured in per cent. The ratio of output to input. A measure of the effectiveness of transformation or utilization of power by a device. Example, a motor which delivered 9 horsepower, mechanically, while receiving 10 horsepower, electrically, would have an efficiency of 90 per cent.

ELECTRODE.— The conducting terminal by which electricity finds either ingress to, or egress from, an electrolyte, a conducting mass or a dielectric. Commonly, a metal plate immersed in an electrolytic solution.

ELECTROLYSIS.— The chemical change accompanying the flow of electricity through electrolytes, to which class nearly all conducting liquids belong. See ELECTROLYSIS.

ELECTROMAGNET.—A magnet excited by an electric current and whose magnetism mainly disappears on the cessation of the exciting current.

ELECTROMOTIVE FORCE (abbreviated E.M.F.)— The force in an electric circuit which produces therein, or tends to produce, an electric discharge or current. Electric pressure. Voltage. Usually measured in volts.

ENCLOSED ARC LAMP.—An arc lamp enclosed almost air-tight within a narrow glass globe, from which the oxygen in the contained air soon becomes consumed during operation, thus leaving the carbons burning in inert gas and greatly prolonging the duration of their serviceable life.

FEEDER.— In an electric distributing system, a supply conductor carrying current from a power-house to main conductors, and not itself connected to motors, lamps, or translating devices.

FIXTURE, ELECTRIC-LIGHT.— Originally, an electric lamp-holder fixed to a wall or ceiling. Now, any electric lamp-holder whether fixed or semi-portable.

FREQUENCY OF AN ALTERNATING CURRENT.— The number of complete cycles, or to-and-fro motions, effected by the current in one second of time. The periodicity.

GALVANOMETER.—An instrument for measuring the strength of an electric current. Usually a sensitive instrument which measures the strength of a very feeble current, as distinguished from an ammeter.

GALVANOSCOPE.—An instrument for detecting the passage of an electric current.

GENERATOR, ELECTRIC.—A machine which is capable of generating an electric current. Usually a dynamo-electric generator or dynamo.

GROUND.—(1) The mass of the earth, considered as an electric conductor. (2) A return circuit provided through the ground. (3) A fault or leak of electricity to ground through a defect in the insulation of a conductor.

HIGH-POTENTIAL SYSTEM.— In electric distribution, a system of conductors, generators, and translating devices in which the pressure or voltages is relatively high. Specifically, an electric distributing system, which, according to fire insurance rules, has within it a pressure of over 550 volts and less than 3,500 volts.

INCANDESCENT LAMP.—An electric lamp consisting essentially of a glowing filamentary conductor maintained at an incandescent temperature by a traversing electric current.

INDUCTION MOTOR.—An asynchronous alternating-current motor in which the currents flowing in the winding of the secondary member are induced electromagnetically by the currents flowing in the primary member. See DYNAMO-ELECTRIC MACHINERY; ELECTRIC ALTERNATING CURRENT MACHINERY.

INSULATION, ELECTRIC.— The property of nonconduction. Particularly the property possessed by a conductor when it is kept out of contact with, or out of likelihood of discharge to, the ground or neighboring conductors.

INTERIOR CONDUIT.—A tube or raceway placed in the interior walls, floors, or ceilings of a building, to guide, hold, and protect the wires or conductors supplying the building.

JOULE, INTERNATIONAL.—A unit of work theoretically derived from the centimeter-gramme-second system of units and equal to 10,000,000 ergs. Approximately equal to 0.74 foot-pound.

KILOWATT-HOUR.—A unit of work generally used in the sale of electric energy. One thousand watt-hours, 3,600,000 joules; approximately 2,700,000 foot-pounds or 1,200 long-foot-tons, or 1.34 horse-power hours. The work done by one ampere under a pressure of 1,000 volts in one hour.

LIGHTNING ARRESTER.—A device connected to an electric circuit or system for the purpose of protecting the system from damage by atmospheric electricity. Commonly a device connected to an aerial line either on a pole or near the point of entrance to a station, and offering a separate conducting path to ground along which lightning discharges may be deflected. See DYNAMO-ELECTRIC MACHINERY.

LOAD.— The output of, or demand upon a machine, usually measured either in terms of current delivered or of power delivered. A load may be light, heavy, normal, full, half, excessive, etc., according to the output of the machine at the time considered.

LOW-POTENTIAL SYSTEM.— In electric distribution, a system of conductors, generators, and translating devices in which the pressure or voltage is relatively low. Specifically, an electric distributing system, which according to fire insurance rules, has within it a pressure less than 550 volts and more than 10 volts.

MAGNETIC FIELD.—Any region in space permeated by magnetism. A magnetised space. Commonly a magnetised air-space.

MAGNETIC FLUX.— The magnetism or magnetic influence which permeates a magnetic field. This influence possesses at any point both intensity and direction. By reference to these properties the magnetic lines of influence may be conceived of as stream lines or lines of magnetic flow or flux, and may be expressed in terms of a unit named the *Maxwell*.

MAINS.— In an electric distributing system, the street-supply conductors, to which the house-service wires are connected. The main conductors intended for connecting to lamps, motors, or devices at any point along their route. In house-wiring, the principal supply wires, as distinguished from submains, taps, or branches.

MEGOHM.—A million ohms; derived from "Ohm" and the prefix "mega" signifying by convention one million, and literally, in ancient or modern Greek, "great."

MICROPHONE.—An apparatus capable of having its resistance affected by very feeble sounds and, therefore, of enabling such sounds to be heard with the aid of a telephone in the circuit. In telephony, the carbon transmitter connected with the diaphragm against which the speaker's voice is directed.

MORSE CODE.— The code of dots and dashes forming the alphabet of the Morse system. See TELEGRAPHY.

MORSE SYSTEM OF TELEGRAPHY.— The system of telegraphy originally devised by Samuel Morse, in which an electromagnet placed in the telegraph line circuit responds to impulses of the sender's key, and actuates an armature in such a manner as to give either audible or legible signals to the receiving operator. See TELEGRAPHY.

MOTOR, ELECTRIC.—A machine for transforming electric power into utilisable mechanical power. Motors almost invariably operate on electromagnetic principles. See DYNAMO-ELECTRIC MACHINERY; ELECTRIC ALTERNATING CURRENT MACHINERY.

MOTOR-STARTER.—An automatically operating device for starting a motor from rest with a proper rate of acceleration by the simple act of closing a switch.

MULTIPOLAR DYNAMO.—A dynamo having more than one pair of magnetic poles in its field frame.

OHM, INTERNATIONAL.—A unit of electric resistance, theoretically derived, by electromagnetic principles, from the centimeter-gramme-second system of units. Practically defined as the resistance offered by a uniform column of pure mercury 106.3 centimeters long and weighing 14.4521 grammes, at the temperature of melting ice.

OIL-COOLED TRANSFORMER.—A transformer which is cooled, when operating, by a flow of oil through its framework.

OSCILLATING CURRENT.—A dwindling alternating current or discharge.

OVERLOAD.—An excessive load or duty imposed upon a machine or device. An abnormal or an extra load.

PHASE.— The fractional development of an alternating electric wave with reference to a cylic condition such as the zero point in the positive direction. Usually measured in degrees of 360 to the complete cycle.

POLYPHASE SYSTEM.—An alternating-current distributing system employing a plurality of alternating currents definitely differing in phase. See ELECTRIC ALTERNATING CURRENT MACHINERY.

POWER-FACTOR.—The ratio of the actual power, in watts, absorbed by a circuit or conductor carrying an alternating current, to the apparent power consumed in volt amperes.

PRIMARY VOLTAIC CELL.—A voltaic cell which derives its energy from its chemical constituents and which consumes or converts those constituents irreversibly during action; as distinguished from a secondary cell which, after discharging, may be recharged by the action of an electrical charging current.

QUADRUPLEX TELEGRAPHY.— The method of sending four messages simultaneously over one and the same telegraph wire, two in one direction and two in the opposite direction. See TELEGRAPHY.

RAIL-BONDS.— The conducting straps or bridges applied between contiguous ends of rails in an electric railway in order to improve their electric conducting power.

RELAY.—An apparatus, usually electromagnetic, which controls and operates a local circuit by opening or closing the same. In telegraphy, a sensitive electromagnet inserted in the telegraph line which, by the movement of its armature, operates a sounder, or other translating device, in a local circuit, with a vigor that the line current could not directly exert. See DYNAMO ELECTRIC MACHINERY.

RESISTANCE, ELECTRIC.— The property of conducting substances by virtue of which they obstruct or oppose the passage of an electric current. Usually measured in ohms. The opposite or inverse of conductance.

RHEOSTAT.—An adjustable electric resistance.

ROTER.— The rotating element of a machine as distinguished from the stationary element.

SERIES MOTOR OR GENERATOR.—A motor or generator whose field-magnet winding is connected in series with, or in succession to, its armature.

SERIES-PARALLEL CONTROLLER.—A device on the platform of an electric street car, operated by a handle, by the aid of which the motorman can with his left hand connect the motors under the car either in series or in parallel, so as to vary the speed of the car.

SHADE.—In electric incandescent lighting, the ornamental bell or cover, usually of glass, secured over a lamp in order to scatter or reflect the light and produce either a better distribution of light or a more pleasing effect upon the eye of the observer.

SHUNT.—An electrical by-pass. A conductor which is applied to the terminals of an apparatus or branch in order to divert a part of the current from that branch.

SHUNT MOTOR OR GENERATOR.—A motor or generator whose field-magnet winding is connected in shunt to, or in parallel with, its armature.

SHORT-CIRCUIT.—A cross between active electric conductors whereby an excessively strong current is produced. Usually a metallic bridging between two or more supply wires, whereby a violent overload of current results, capable, in extreme cases, of producing violent arcing, burning, or disruptive local effects.

SINGLEPHASE SYSTEM.—An alternating-current distributing system employing a single alternating current supplied by the generator, as distinguished from a polyphase system.

SOCKET OF INCANDESCENT LAMP.— The holder into which an incandescent lamp screws or attaches and which contains the ends of electric supply wires, for supplying current to the lamp.

STATOR.— The stationary element of a machine as distinguished from the rotating element.

STORAGE BATTERY.—A grouping of secondary or storage cells. See ELECTRIC STORAGE BATTERY.

STORAGE CELL.—A voltaic cell which receives its electrochemical energy from the electrolytic action of a charging current. A voltaic cell which is alternately charged and discharged.

SUB-STATION.— In an electrical distributing system, a local or auxiliary power-house for facilitating the operation or control of the system. A station which is subsidiary to a principle station or power-house.

SWITCH, ELECTRIC.—Any device for opening, closing, or modifying an electric circuit. Usually a hand-operated device for opening and closing a circuit.

SWITCHBOARD.—An assemblage of switches, controlling or indicating devices mounted upon a frame for the purpose of convenient control or inspection of an electric path, circuit, or system of circuits. Originally, a board with switches mounted on it; now typically, a metal frame holding vertical slabs of slate or marble, with switches, controlling handles, and indicating or recording instruments mounted thereon, in an electric central station or distributing centre. In telephony, a frame holding the switches and other devices by which connections are made between subscribers.

SYNCHRONOUS MOTOR.—An alternating-current motor in which the rotation occurs in synchronism with the rotating element of the generator supplying the driving current. See ELECTRO ALTERNATING CURRENT MACHINERY.

THIRD RAIL.— In an electric railway system, a supply conductor running parallel to the track and consisting of a steel rail electrically continuous and supported on insulators, for carrying current to the car-motors. See THIRD-RAIL SYSTEM.

THREE-PHASE SYSTEM.—An alternating-current system employing three alternating currents, of equal strength, differing in phase by 120°, or one-third of a cycle.

THREE-WIRE SYSTEM.— In electric distribution, the system which provides three main conductors, the middle one of which is neutral, or midway in potential between the other two.

TORQUE.— The twisting effort, rotating effort, or mechanical couple exerted by a motor at a shaft. Often measured in pounds' weight at one foot radius.

TRANSFORMER.—A device for changing the pressure or current of electric energy supply. Usually, a stationary electromagnetic device consisting of a laminated iron core and two insulated windings, a primary and a secondary. The device transfers electric power of alternating currents from the primary to the secondary circuit, and changes the voltage in the ratio of the number of turns in the two windings.

TRANSFORMER, STEP-DOWN.—A transformer which locally lowers the electric pressure; i. e., which has a lesser number of turns in the secondary than in the primary winding and thereby produces a lower voltage in the secondary circuit than in the primary.

TRANSFORMER, STEP-UP.—A transformer which locally raises the electric pressure; i. e., which has a greater number of turns in the secondary than in the primary winding and thereby produces a higher voltage in the secondary circuit than in the primary.

TRANSLATING DEVICE.—Any device actuated electrically which receives electrical energy and translates it into energy of some other type, such as mechanical energy.

TROLLEY-WHEEL.— The metallic wheel which is carried at the upper end of a street-car trolley pole, and which is pressed upward against the trolley wire, in order to maintain running contact therewith.

TURBO-ALTERNATOR.—A machine consisting of an alternating-current generator mounted upon the shaft of a steam turbine.

TWO-PHASE SYSTEM.—An alternating-current system employing two alternating currents, of equal strength, differing in phase by a quarter cycle, or such that one current has maximum strength when the other is passing through zero.

TWO-WIRE SYSTEM.— In electric distribution, the system which provides two main conductors, between which lamps, motors, or translating devices are connected in parallel.

VAPOR-LAMP.—An electric lamp consisting of a glass tube or chamber usually containing mercury and mercury vapor, exhausted of air, and kept illumined by the passage of an electric current through the vapor admitted by electrodes sealed into the walls.

VOLT, INTERNATIONAL.—A unit of electric pressure or current-driving electric force, theoretically derived, by electromagnetic principles, from the centimeter-gramme-second system of units. Practically, the international volt is a certain fraction of the electromotive force of a standard type of voltaic cell at a standard temperature.

VOLTMETER.—An electrical measuring instrument for determining the value of the electromotive force connected to its terminals. A voltage measurer.

WATT.—A unit of power, activity, or rate of working, equal to 1/746th of a horse-power, or to 44.4 foot-pounds per minute. The power expended by a current of one ampere under a pressure of one volt. The power expended by an E.M.F. of one volt through a resistance of one ohm. The power expended by one ampere through a resistance of one ohm. Theoretically derived from the centimeter-gramme-second electromagnetic system of units.

WATT-HOUR.—A unit of work, much used in electrical measurements, equal to the work done in one hour at an activity of one watt; approximately 2,700 foot-pounds; exactly 3,600 joules. The work done by one ampere under one volt pressure, in an hour.

WATTMETER.—An instrument connected to an electric circuit and measuring the power delivered to the circuit in watts. Also the abbreviated and somewhat misleading name sometimes given to a watt-hour-meter, an instrument placed in an electric consumption circuit to register on a dial the total amount of electric energy which has passed through the meter and on which a charge may be rendered to the consumer.

WHEATSTONE BRIDGE.—An instrument devised by Sir Charles Wheatstone for measuring electric resistance, by effecting a balance between the resistance to be measured and an adjustable known resistance. The balance employs a bridge, or bridging conductor, usually containing a galvanoscope.

WIRELESS TELEGRAPHY.— Generally, any method of signalling which does not employ wires. Specifically, the method of signalling which employs invisible electromagnetic waves radiated from a sending station and detected at the receiving station. See TELEGRAPHY, WIRELESS.

For definitions of mechanical terms see the articles in this encyclopedia on MECHANICAL TERMS; BOILER TERMS; FOUNDRY AND FORGE SHOP TERMS; ENGINE, ENGINEERING AND STRUCTURAL TERMS; TOOLS; VALVE AND VALVE TERMS; WORKSHOP TERMS; AND LOCOMOTIVE, DESIGN AND CONSTRUCTION OF THE MODERN.

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Electric Alternating Current Machinery. A loop of wire revolving in a magnetic field is the simplest form of an alternating current generator. The direction of induced electromotive force in the two halves of the loop, which cut the magnetic flux in opposite directions, is such that the combined electromotive force at the terminals is double that of either revolving conductor alone. This induced electromotive force is proportional to the rate of cutting the magnetic lines, and therefore to the sine of the angle by which the plane of the coil differs from the plane midway between the poles and normal to the magnetic flux. At its zero position, or when the planes coincide, the coil is cutting no lines of force and we have $\sin a = 0$. The electromotive force, however, grows as we depart from this zero position, assuming uniform speed, until, when 90° is reached the rate of cutting of the lines becomes a maximum, $\sin 90° = 1$. Passing on, the electromotive force dies away until 180° is reached, when the value again is zero. From this to 270° we have an increasing electromotive force, but of opposite polarity and at the end of the revolution, or 360°, again reach zero. Thus we have in one revolution in a two-pole field, two waves of pressure of the same form but of opposite sign. The one is called the positive wave and the other the negative. One such revolution, or one positive wave and one negative wave, constitute what is called a cycle, or period, which in technical literature is designated by the symbol ∿ = one sine wave. The great majority of systems have a frequency between 60 ∿ and 25 ∿. Both of these frequencies are standard practice in this country, and the values between are chosen for special cases. Owing to the high frequency of commercial systems, alternators are built with more than one pair of poles, in order to keep the revolving speed within reasonable limits.

Average and Effective Values.— If we plot the values of the instantaneous pressures as ordinates, with time as abscissa we have a correct representation of the generation of alternating currents, and the shape of the wave. When the total number of lines cut per revolution by a coil revolving at constant speed remains the same, the average induced electromotive force remains constant, regardless of the distribution of the magnetic flux. The effective value, however, the value read by the meter and the value which corresponds in its heating effect to the direct current value, is not independent of this distribution.

The Place of Alternating Current Systems.— The direct current for the railway at 550 volts, and for the lighting and power systems of the densely populated centres of our large cities in the Edison three-wire system 110 to 220 volts, seems to have become standard practice. Nevertheless the low radius of distribution without excessive cost of copper, even in the 550 volt railway system with a grounded return, makes necessary a great multiplicity of moderate sized or small plants, operating at low efficiency. It is here that the alternating current comes to the front. While commutators (q.v.) can be built for collecting direct current at 1,000 volts, alternators (q.v.) can be built for 12,000 volts and step-up transformers (q.v.) of high economy are quite possible at 75,000 to 100,000 volts. Remembering that the copper cost is inversely as the square of the voltage, the great possibilities of the alternating current system are at once seen.

Energy from Waterfalls.— Electrical energy from waterfalls that a few years ago were, at most, points of scenic interest, is now supplied to more than 50 cities in North America. The line from the 15,000 H. P. plant at Colgate, California, to San Francisco, by way of Mission San José, where it is supplied with additional power, has a length of 232 miles, and is the longest transmission of electrical energy in the world. The line between the 13,300 H. P. plant at Electra and San Francisco is 154 miles. In the east, the line between Shawinigan Falls and Montreal covers a distance of 85 miles. The great 200,000 H. P. plant at Niagara regularly supplies Buffalo with 16,000 H. P. of energy for railway, power, and lighting.

The Alternator.— Small alternators and those of moderate potential usually collect their current from insulated rings mounted on the shaft and connected to the ends of the armature winding. Through brushes, the current is taken to the external circuit. In some machines a rectifier is added for supplying sufficient unidimensional current to produce the necessary additional field to overcome the drop due to increase of load. All commercial alternators are supplied with an exciter, or direct current dynamo, whose function is to supply current to the field windings. The field spools are usually connected in series. The amount of current thus necessary, on a full non-inductive load varies from 1½ to 3 per cent. of the total output of the alternator. Owing to the difficulty of collecting large currents by means of brushes and of preserving good insulation between the rings and shaft, the revolving field type of machine is now used in almost all large installations, the field current from the exciter being supplied through cast-iron rings mounted on the shaft, or in the case of the inductor type, consisting of an annular ring surrounding the inductor or revolving element, which consists of laminated iron poles suitably spaced and keyed to the shaft. The windings being stationary, there are no moving connections, either for the field current or the main current of the machine. In either type the alternating current is taken from the terminals of the windings, usually at the bottom of the frame.

Polyphase Machines.— If two armatures, of the same number of turns each, be connected to the shaft at 90° from each other, and revolved in a bi-polar field, and each terminal be joined to a collector ring, we have two separate electromotive forces differing in phase by 90° or a two-phase machine. With 120° phase difference and three sets of armatures we have a three-phase winding. By properly interconnecting the three circuits, we may use but three wires for transmission, or four, in accordance with the system used. The construction of multiphase machines is similar to that of the single-phase type, excepting that in the former we have as many armatures, series connected, as there are phases.

In the two-phase three-wire system, the wire from the common junctions of the phases carries 1.414 times the current of the outer wires. The electromotive force between the outer wires is also $\sqrt{2}$ E, when E is the electromotive force per phase, or between either outer wire and the common return. When this system is used it is important that the load be carefully balanced on the phases and that the power factor be kept as high as possible in order to keep the voltage on the phases nearly alike at the receiving end. Single phase motors or lamps may be connected to either or both phases, but it is very important that no load be connected between the outer wires, as the effect is to badly unbalance the voltages on the different phases.

In the three-phase star connected system the line voltage is $\sqrt{3} = 1.732$ times the voltage on the coils of the machine, or the machine voltage, which is the pressure between any one of the three line connections and the common neutral. The line current in this system is the current that flows through any one of the machine windings. In the delta connection, the line voltage is the same as the voltage across any phase of the machine, while the line current, being the resultant of two currents, is $\sqrt{3} = 1.732$ times the current flowing through any phase of the machine.

Energy Polyphase.— In a two-phase circuit, whether three or four wire, the energy flowing is the sum of the products of each phase current by the phase pressure. Two wattmeters are used. In the three-phase system when E = volts between lines; I = amperes on lines; W = total watts output of machine,— then, whether the connection be star or delta, the total output is $\frac{3E \times I}{\sqrt{3}} = 1.732$ EI, always supposing the system be balanced. Thus the output of the machine is not changed by changing the connections from star to delta. In the balanced three-phase system, one wattmeter will register the total output if its constant be multiplied by 1.732. Two wattmeters are usually employed.

Regulation of Alternators.— The regulation of modern alternators varies from 5 to 6 per cent, which means that in case the full, non-inductive load of an alternator be taken off, the speed and excitation being kept constant, the terminal pressure will rise by an amount corresponding to from 5 per cent to 6 per cent of its full load voltage. Close regulation means a much better voltage-regulation on the system and stronger synchronizing power. A certain amount of armature reaction is necessary to avoid large cross currents on changing the field of one or more machines operating in parallel, in the attempt to preserve the same terminal voltage. The efficiency of large alternators is about 96 per cent to 97 per cent.

Frequency.— In regard to the frequency best adapted to transmission work, or to local distribution, various factors enter into the problem. At 60∿ both arc and incandescent lamps can be operated satisfactorily. The transformers are smaller and cheaper than at 25∿ and motors are very satisfactory both as to low first cost, range of speed, and good starting torque (q.v.). Frequencies over 60∿ have been abandoned. The line drop, due to reaction increases with the frequency, a change of frequency from 25∿ to 125∿ would, on the same line, more than double the line drop. While as a rule 60∿ apparatus is cheaper than that for 25∿ yet the increase in polar speed often becomes difficult without increasing the number of poles to an undesirable extent, which, in 60∿ apparatus, may be sufficient to make the parallel operation of low speed direct-connected alternators quite difficult.

Self-induction.— When a current is introduced into a circuit a magnetic field is produced, surrounding the conductor, the rise of which causes a counter electromotive force. This electromotive force is called the electromotive force of self-induction. The effect of self-induction upon electric currents is directly comparable to the effect of inertia on a material body. It is that quality that tends to hinder the introduction, variation, or extinction of the current in a circuit. As this effect is greatest at times of most rapid change of magnetism set up by the current, in alternating current circuits, it becomes a maximum when the inducing current is passing through zero, and therefore, the counter electromotive force of self-induction lags 90° behind the current in the circuit. It also follows the sine curve provided the current flowing is sinusoidal.

In a circuit containing several impedances in series, the joint impedance is not the sum of the individual impedances, but is obtained by taking the square root of the total added reactances squared plus the total added resistances, squared, or Impedance =

$$\sqrt{(R_1 + R_2 + R_3)^2 + (2\pi fl_1 + 2\pi fl_2 + 2\pi fl_3)^2}$$

The joint impedance of several impedances in parallel is found as follows. Construct a parallelogram from the reciprocals of two of the impedances, each expressed in its proper phase relation. The direction of the diagonal will give the phase of the resultant impedance, and its reciprocal amount will give the reciprocal of its length. For more than two, the method of the polygon of forces is applied.

The effect of self-induction varies with the frequency of the current supplied, and as the square of the number of turns in a circuit. The self-induction in the armature of an alternator has two effects. The first is to produce a lagging current and thus lower the terminal voltage, and the second is a demagnetizing effect. The current is thrown into such a phase that it produces lines of force directly opposed to the field and thus lowers the voltage by reducing the total flux. The effect of armature reaction depends upon whether the current is leading or lagging in phase. A lagging current lowers the voltage of an alternator and a leading current raises it.

Capacity.— All insulated conductors have the quality of being able to hold stored on their surface, a certain quantity of static electricity, and are thus condensers. The charging and discharging of an alternating current circuit causes the current to flow from the generator into the line and then back into the generator again, with the frequency of the alternator, in order to keep up the static potential on the line. As this charging current is greatest when the rate of change of electromotive force is greatest, a sinusoidal wave of capacity electromotive force with 90° difference in phase from the machine electromotive force is produced. This leads the active electromotive force by 90° and is thus 180° or opposite to the electromotive force of self-induction. If we have a circuit in which the electromotive force of self-induction is just equal to the capacity electromotive force, and these two parts of the circuit are in series, the effect of both is neutralized and we have, as in direct currents, $W = E \times C$.

The Transformer.— The one piece of apparatus that, more than all else has made possible the electrical transmissions of energy to long distances, is the transformer. This is the apparatus that receives in one set of coils the dangerous potential of the line and transforms it into whatever potential is desired for lights or motors, which are supplied from an entirely separate winding. The transformer consists of a magnetic circuit of laminated iron or mild steel interlinked with two electric circuits, one, the primary, receiving electrical energy and the other, the secondary, delivering it to the consumer. The effect of the iron is to make as many as possible of the lines of force set up by the primary current cut the secondary winding and there set up an electromotive force of the same frequency, but different voltage.

Not only does the transformer make possible the transformation of voltages, but it also permits of changing from one system to another. Thus a single-phase primary may supply a three-wire Edison system, of course, with alternating current. A two-phase system can be changed to a three-phase or *vice versa;* a four-wire two-phase may make a three-wire two-phase, and many other useful combinations be effected. The Scott connection for changing two-phase to three-phase, or the opposite, uses but two transformers. One has a ratio of, say, 10 to 1, with a tap at the middle of its secondary coil. The other must then have a ratio of 10 to .867 = 10 to $\frac{\sqrt{3}}{2}$. One terminal of the secondary of this transformer is connected to the middle of the other secondary, and the remaining free ends of both secondaries form the three terminals of a three-phase circuit. The value $\frac{\sqrt{3}}{2}$ is the altitude of an equilateral triangle of which the base is unity, and thus we may consider the current to be taken from the corners of an equilateral triangle, which represent, in phase and potential difference, a true three-phase system. The current in the transformer of secondary, .867 being the resultant of the other two phases, is greater than under normal two-phase conditions; and, therefore, the windings must have about 15 per cent more copper. If two similar transformers are used the secondary of each has taps giving 50 per cent and 86.7 per cent of full voltage. In many large installations, notably at Niagara Falls, we find two-phase generators feeding three-phase lines through Scott connected step-up transformers. In small systems standard transformers may be used having ratios of 10 to 1 and 9 to 1 respectively, and the results will be quite satisfactory.

The Induction Motor.— Acting upon the well-known fact that a copper disk could be made to revolve by rotating a horseshoe magnet so that the lines of force cut the disk, Ferraris, Tesla, Dobrowolsky, and others have developed the present type of induction motor. The credit for the first commercial application of the rotating field caused by currents of displaced phase probably belongs to Tesla. At the present day the value of these discoveries in the transmission and distribution of power can hardly be estimated. The induction motor is somewhat similar to the direct-current shunt motor. Both motors have field and armature windings. In both cases, also, the field is connected directly across the mains. In the shunt motor the armature current is supplied through brushes and a commutator to the windings, while in the induction motor the armature current is an indirect current, the field acting as the primary of a transformer of which the armature is the secondary. In both motors the efficiency is inversely proportional to the armature resistance, as is also the speed regulation of the motors. The less the armature resistance the higher the efficiency and the closer the regulation of speed between no load and full load. In practice, either element may be the one to revolve. The rotation is produced by the reaction of the armature, or indirect current, on the revolving magnetic field, which results in dragging the moving element around in order to keep up with the field flux, as it passes around the face of the primary windings. This field, being the resultant of two or more alternating fields of different phases, rotates with the polar frequency of supplied voltage. The secondary winding is made up of copper bars set in slots in a laminated iron core and running across the armature parallel with the axis of rotation. This separating of the old copper disk into narrow bars constrains the current to flow into the best direction for producing torque and avoids the waste of the unconstrained Foucault currents in the Arago disk, and thus makes the motor much more efficient. Sometimes the secondary windings are joined to heavy short circuiting rings, at both ends resulting in the squirrel-cage type of motor; and in other cases the secondary windings are taken out through collector rings, if the secondary be the rotating element, and starting resistances are inserted in series to lessen the reaction due to excessive starting current and thus improve the starting torque. When up to speed these resistances are cut out and the terminals short circuited as in the squirrel-cage type.

The Asynchronous Generator.— If the motor be driven by power from an outside source up to true synchronism, no current will flow in the secondary, and the primary current or field current will be wholly made up of the wattless exciting current, just as in a transformer at no load. The slip, or amount by which the motor speed at full load differs from synchronous speed may be as little as 2 to 2½ per cent of the speed of synchronism in large motors, and in small motors may be 5 per cent or more. If the motor above mentioned be forced above synchronism the motor becomes a generator, provided the connection to the mains is left closed, and when a negative slip of the same amount as full load slip as a motor is reached, the generator will be giving out its full output at the same frequency as the exciting circuit. The possibilities of this system are interesting.

The Synchronous Motor.— The synchronous motor is merely an alternating current generator of special design. Both motors and alternators have a direct current field and an alternating current armature. The operation of a synchronous motor, when once brought up to speed and thrown into circuit is the same as that of an alternator in parallel with one or more alternators. When the back pressure of the motor is equal and directly opposed to that of the line no current can flow. The friction, however, causes the revolving element to lag slightly behind the line pressure, and a current is driven through the motor by the generator. This current increases directly with the lag behind the central-phase position caused by increased load. A good synchronous motor, while always revolving at the same polar speed as the alternator supplying the line current will carry a load of five or six times full load before it breaks out of step, and becomes practically a short circuit on the system. The current which passes through such a motor on short circuit, while held down by the inductance of the windings, is yet sufficient to rapidly damage the insulation if not cut off. The great advantage of the synchronous over the induction type of motor is that the power factor can be raised or lowered at will. By raising the field strength of a synchronous motor the current taken by the motor may be made leading and hence help keep up the line voltage on a heavy inductive load. This is of the greatest importance in practice. It is good practice to set the field strength for a good power factor at full load. At light loads the motor is assisting the generator to maintain the required pressure. Another advantage of the synchronous motor is that it can easily be built for very high voltage, especially the revolving field type,— a 12,000 volt motor is not at all unusual practice. Thus the use of transformers may be dispensed with.

The Rotary Converter.— The rotary converter is a specially designed direct-current generator provided, at proper points in the winding with taps to collector rings, from which, if the machine is run as a motor from the direct current side, an alternating current may be taken. Usually the alternating current is taken from the secondaries of suitable transformers and supplied to the rings, driving the rotary as a synchronous motor, the direct current being taken from the brushes on the commutator. As the reaction of the incoming alternating current about balances that caused by the outgoing direct current, the armature reaction of such a machine is very small and the brushes can be always kept in one fixed position. If the taps from the armature are taken off at points differing 180° from each other, electrically, we have a single-phase rotary. If connections are made 90° apart we have a two-phase rotary, using four collector rings. Taking 120° around the armature for our taps we have a three-phase rotary, using three collector rings. By adding to the number of taps and therefore to the number of rings we may have a six-phase rotary. The output of a rotary is greater than its output as a direct current generator, chiefly, on account of the absence of armature reaction and because at certain positions the current flows straight from collector ring to commutator and thus avoids the loss due to heating. The rotary converter, with its step-down transformer, is the most efficient means we now have of transforming the high tension polyphase currents of our large central stations to direct current for the Edison system, and for railway purposes. This piece of apparatus is wound either shunt or compound, in accordance with the use for which it is intended. As in the case of the synchronous motor, the rotary is a valuable help to the central station by running at a very high power factor. By over-exciting the fields the current taken by the rotary becomes leading and helps to hold up the voltage of the central station in case of a heavy load of induction motors by means of the armature reaction of the generators. Owing to very high commutator speeds at the higher frequencies, rotaries are not much used on frequencies above 60 ∿ At this frequency they operate satisfactorily. At lower frequencies, however, rotaries are at their best, and will stand enormous overloads, sudden changes in load and other disturbances with perfect satisfaction. The voltage of the direct current end of a rotary is that of the peak of the sine wave of the alternating pressure, and thus a voltmeter across the collector rings would read $\frac{E}{\sqrt{2}}$ where E is the direct current electromotive force in single and two-phase rotaries. In the three-phase system the ratio between the alternating current pressure and the direct current at the commutator brushes is $\frac{\sqrt{3}}{2\sqrt{2}} = .613$. Thus in the Edison system operating at 250 volts we should have to transform down to $250 \times .613 = 153$ volts at the secondary of the transformers. While rotaries can be started up without field, from the alternating current side, it is not good practice, excepting in certain special cases. Generally they are started up exactly like a shunt motor, synchronized and then thrown upon the alternating current line. When a rotary is started up from the alternating current side, on closing the field switch it is impossible to tell what the polarity will be. Rotaries operate in parallel with perfect satisfaction, as a rule, on both the alternating current and the direct current sides. The storage battery is always used in a large rotary installation to insure against any possible contingencies. On compound rotaries the equalizer must be used, just as in the case of direct-current compound generators. See DYNAMO ELECTRIC MACHINERY.

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Station Superintendent Phila. Elect. Co.

Electric Annealing, a process of annealing by the heat generated by the passage of an electric current through the body to be annealed, or in which heat generated by an electric current is used in place of ordinary heat. The heat developed in a conductor by an electric current is equal to the product of the square of the current by the resistance of the conductor $= C^2R$. An interesting experiment showing the fusing power of the electric current is made in the following manner: Provide a glass or porcelain vessel containing a mixture of sulphuric acid and water. Introduce a lead plate electrode suitably connected with the positive pole of a continuous current generator. Connect by a flexible wire the negative pole to a stout pair of metal pliers. When, by means of the pliers, a metal rod is immersed in the acid solution the liquid is seen to boil near the plate, which is brought to a dazzling whiteness in a few moments, and presently begins to melt. The heating is so quickly produced that the liquid or the body of the rod has not time to become hot. In a short time a temperature of 7,000° F. may be developed, and with a very strong current a temperature of 14,000° F. has been produced.

Electric Annunciator, a form of annunciator used in private houses, offices, and hotels. They are used to call messengers, to announce an alarm, and to indicate the source of the alarm in connection with electric burglar-alarm apparatus, and for numerous other purposes. In some forms of annunciator the source of the call is indicated by the movement of a needle on the face of the case opposite a given number; in others a shutter drops, disclosing the number or name of the room or office. See ELECTRIC SIGNALING.

Electric Arc, a brilliant luminous arc produced when an electric current is passed between two pointed carbon rods placed a short distance apart. The rods are first put in contact so as to allow the current to start. On their being separated slightly the arc is formed, and once formed it serves as a conductor whereby the flow of current is maintained. The temperature of the electric arc is the highest which has been obtained by artificial means. See ELECTRIC LIGHTING.

Electric Aura, a current or breeze of electrified air employed as a mild stimulant in electrifying delicate parts, as the eye.

Electric Automatic Fire-alarm. See ELECTRIC SIGNALING.

Electric Balance, an instrument for measuring the attractive or repulsive forces of electrified bodies. A form of electrometer, consisting of a graduated arc supported by a projecting plate of brass which is attached to the perpendicular column. A wheel, the axis of which is supported on anti-friction rollers, and is concentric with that of the graduated arc, carries an index. Over this wheel, in a groove on its circumference, passes a line, to one end of which is attached a light ball of gilt wood, and to the other a float, which consists of a glass tube about one fifth of an inch in diameter, terminating in a small bulb, so weighted that the index may point to the centre of the graduated arc. The difference between the weights of the float when in and out of water is known, and the diameter of the wheel carrying the index is such that a certain amount of rise or fall of the float causes the index to move over a certain number of graduations on the arc. See ELECTROMETER.

Electric Bath, in electro-plating, the solution used for depositing metal as contained in a vat or tank. In electro-therapeutics, a bath with suitable arrangements, electrodes, and connections, for treating patients with electricity. See ELECTROPLATING.

Electric Batteries. *Caustic Alkali or Copper Oxide Cells.*—In the gravity or Calland primary cells a liquid depolarizer is used to prevent polarization of the cell. In the caustic alkali cell a solid depolarizer is employed — oxide of copper. The term polarization is used to define the action which takes place in a voltaic cell due to the liberation of hydrogen. The difference of electric potential between some of the metals and between some of the metals and gases is very slight. Between zinc and hydrogen it is almost equal. Hence, when the metal zinc is employed with copper or carbon in a primary cell without a depolarizing agent, the hydrogen forming on the surface of the negative plate opposes an electro-motive force practically equal to that of the zinc. Consequently no current will flow after a few minutes in such a cell. It is the function of a depolarizer to unite with and neutralize the hydrogen.

The elements of the caustic alkali cell are zinc and oxide of copper in a solution of caustic potash or caustic soda. In this cell the zinc is dissolved virtually as it is in sulphuric acid solutions. When the circuit of the cell is closed an electro-motive force is established and the water of the solution is decomposed, the oxygen going to the zinc plate, with which it unites, forming oxide of zinc; the hydrogen goes to the negative plate, where it unites with oxygen of the oxide of copper, forming water and setting free metallic copper. In this way the free hydrogen which would "polarize" the cell is neutralized.

This type of cell was introduced in 1881 by Lalande and Chaperon, France. Their cell consisted of a glass jar, in the bottom of which the oxide of copper was contained in an iron cup; the zinc plate was supported in the solution of caustic potash by a wire, from the cover of the jar. To prevent the carbonic acid gas of the air from combining with the caustic potash, the solution was covered with a layer of petroleum oil. This cell has undergone many modifications at the hands of Edison, Gordon, and others.

Edison Primary Battery.—This is an oxide of copper battery. The elements employed in it are zinc and black oxide of copper. The solution is a high grade caustic soda, in the proportion of 25 parts of caustic soda to 100 parts of water. The initial electro-motive force of these cells is .98 volt; on closed circuit, .7 volt. Their internal resistance varies with the size of the plates, from .09 ohm to .02 ohm. The current output in the first case is 37.5 amperes; in the second case, 33.35 amperes. The oxide of copper cell has the advantage that its internal resistance falls with use, inasmuch as the continued reduction of metallic oxide from the oxide of copper increases the conductivity of the plate; in practice, however, a film of metallic is deposited in advance on the copper oxide plate to insure a low electro-motive force at the start.

The containing vessel of the Edison cell is a porcelain jar having a porcelain cover, through which the connecting wires or rods of the plates enter the cell. The copper oxide plate is obtained by roasting copper turnings, which are then ground to a fine powder and mixed with 5 to 10 per cent of magnesium chloride. The oxide is then molded into plates, which are held in a frame in the cell, as at cc, Fig. 1. zz are

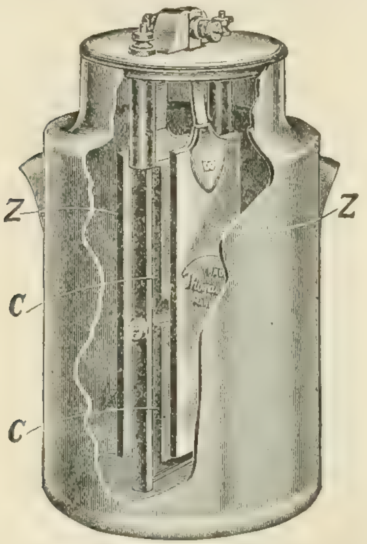


Fig. 1.—Edison Oxide of Copper Battery.

the zinc plates, one on each side of the copper oxide plates. The size of this cell is 7½ by 15 inches. It is designed for cautery and dental motor work. Its internal resistance is .02 ohm; its capacity is 600 ampere hours.

Other batteries of the oxide of copper type made in this country are the Gordon and the Challenge batteries. These various cells differ mainly as to details of construction and in the quality of materials used, upon which much of the success of this cell depends. Pure zinc, well amalgamated with mercury, is found to be essential, also an oil that will not saponify. If oil were not used, the solution would "creep" up the zincs, when the caustic soda would combine with the carbonic acid gas of the air, forming carbonate of acid, which would quickly reduce the zinc above the solution to the consistency of paste. Care must be taken in the handling of the solution, as it is injurious to the skin and to clothes. Batteries of the oxide of copper type are extensively employed in connection with spark coils for gas-engine work, and for numerous other purposes requiring continuous current, as these are eminently closed circuit batteries. They can also be used as open circuit batteries.

Edison Storage Battery.—As intimated in the article on Electric Storage Batteries (q.v.), this battery uses an alkali hydroxid (caustic potash solution) as the electrolyte. The positive active material (negative pole) is iron oxide; the negative active material (positive pole) is nickel oxide. The active materials consist of specially prepared oxides of iron and nickel in form of a powder. The iron oxide is enclosed in a nickel-

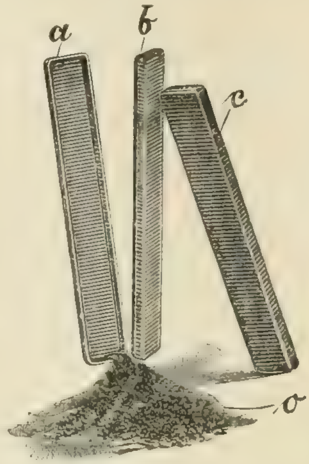


Fig. 2.—Edison Storage Battery.

coated steel, finely perforated pocket, or long, thin box, each pocket being made in two sections, *a b;* one section closing on the other, *c,* Fig. 2; *o* is the loose active material. These pockets are then placed in a nickel-plated steel grid. The nickel oxide is placed in similar pockets which are placed in a grid identical with that of the iron oxide pockets. A grid with and without the pockets is shown at the right

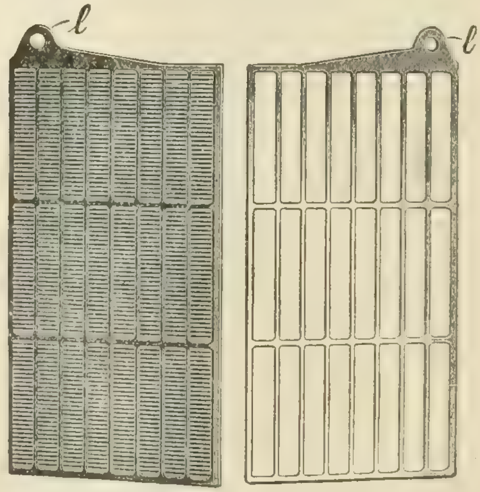


Fig. 3.—Edison Storage Battery.

and left of Fig. 3, respectively. The pockets and grid are then subjected to a pressure of about 100 tons in a hydraulic press, which virtually welds the sections of pocket together, and fastens them tightly in the grid. There is no perceptible difference in the outward appearance of the iron and nickel oxide plates thus formed.

One type of this cell, Fig. 4, consists of 28 plates, that is, 14 iron plates and 14 nickel plates.

The 14 iron plates are strung on a metal rod *I* by means of the circular hole in their lugs, *l*, *l* (Fig. 3). The 14 nickel plates are similarly strung on a rod N, each plate being separated by a washer *w*. The plates are then arranged in such a way that an iron and nickel plate alter-

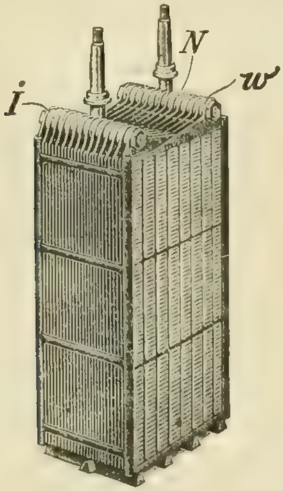


Fig. 4.—Edison Storage Battery.

nate as outlined in the figure, the respective plates being insulated from one another by hard rubber rods. The plates thus assembled are then placed in a nickel-plated steel vessel through the cover of which the projections from the rods

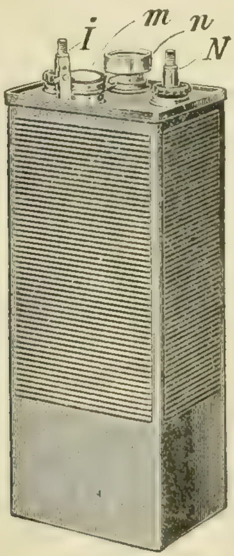


Fig. 5.—Edison Storage Battery.

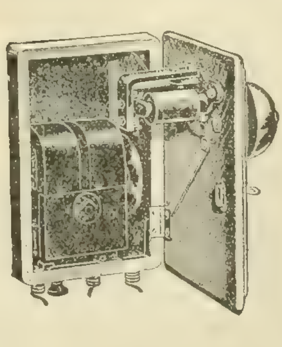
N I pass (Fig. 5), and by which projections the different cells are coupled together by suitable connecting pieces.

The electrolyte of this cell is a 20 per cent solution of potash. Unlike the sulphuric acid solution of the lead storage battery, the alkaline solution of the Edison battery does not undergo change during the process of charging or discharging the cell, but appears to act merely as a carrier of oxygen from the iron oxide plate to the nickel oxide plate during charge, and from the nickel oxide plate to the iron during discharge. In charging, however, a small amount of the water is decomposed. The operation of the cell during charging, briefly stated, is as follows: The iron oxide is reduced to spongy metallic iron, its oxygen being carried against the force of chemical affinity to the nickel oxide plate which is converted into superoxide of nickel, NiO_2. During discharge the oxygen returns to the iron and the superoxidized nickel becomes nickel oxide; the energy that had been stored in the iron during charge now being converted into electrical energy in the circuit. In other words, "the cell is an oxygen lift. Charging pulls the oxygen away from the iron and delivers it temporarily to the nickel. The condition is then stable, until the circuit of the cell is completed. Discharge then allows the oxygen to fall back from the nickel to the iron with the natural affinity of iron and oxygen." (Kennelly.)

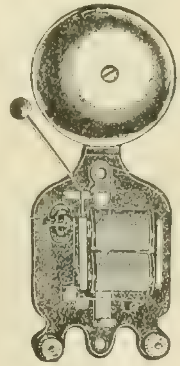
The maximum electro-motive force of this cell is 1.5 volts. Its average electro-motive force is 1.2 volts. A 28-plate cell has an internal remittance of .0013 ohm. Its output at 60 amperes is 210 watt-hours. The weight of this cell is 18 pounds. The only attention that the cell requires is to see that distilled water is added as required; to facilitate which a mounting *m* is provided on the cover through which by means of a "filler" the necessary water is added. Another mounting *n* on the cover, termed a separator, holds a wire gauge which separates any portion of the caustic soda that might be carried up with spray, and the gases liberated from the water in charging.

An advantage of this battery is that it is not injured by overcharging, by heavy discharges, by complete discharge, by standing charged, partly discharged or completely discharged. See BATTERY. WILLIAM MAVER, Jr.

Electric Bell. (1) Magnetic or dynamic: Two electro-magnets, parallel and in series, having at their extremity a vibrating armature in close proximity pivoted between them; fixed to this armature is a clapper vibrating between two gongs. The current passes through the fields, magnetizing the cores, and in generating an alternating current vibrates the armature and rings the bell. (2) Battery-bell: A single coil or bob-



Magneto-Bell.
Door open.



Electric Door Bell.

bin of wire, wound around an iron core; a vibratory armature, pivoted at one **end**, and passing at a right angle by the core of the bobbin; at the other end of the armature is a clapper, a gong situated close to the clapper.

Two bobbins are used in the electric door-bell shown in the illustration. The armature carries a contact point, the operation of which is fully described in the article on ELECTRIC SIGNALING (q.v.). The magneto bell is largely used in telephony.

Electric Blue-print Making, a modern process of wholesale photographic printing by the aid of machinery, the electric light, and the blue-print (q.v.). One of the best machines is continuous in its operation, and is fed by the operator with great lengths of tracings and blue paper in much the same manner as the washerwoman feeds the wet clothes into a wringing machine. The large wooden drum, around which the tracings and printing paper pass, is moved either by a connection with the shafting or by an electric motor mounted on the apparatus, the speed of the drum being regulated by a device shown on the top of the machine. A traveling apron of transparent material takes the place of the glass in the printing frame of the ordinary type, and as it is under tension at all times, it insures an even and close contact at all points. This apron is wound on a small drum at the top and after passing along the large drum where the contact and exposure take place, it is wound up on the drum below; after the printing operation has been completed it is rewound by hand back on the upper drum. In the rear of the machine are three arc lamps with reflectors, which concentrate the light on the tracings which, with the exposed prints, drop out into the box in front. The blue paper may be kept in a roll ready for use on the upper front part of the machine, or may be fed in small sheets with the tracings where the work being done is of ordinary size.

The machines are made in two widths, 30 and 42 inches; the apron supplied with them is 70 feet long, and prints of this size can be made as readily as smaller ones where it is desired. The ability to make prints of this size greatly enlarges the sphere of usefulness of the blue-print.

Electric Burglar-alarm. See ELECTRIC SIGNALING.

Electric Call-box System. See ELECTRIC SIGNALING.

Electric Candle, a modification of the arc form of electric light, in which the carbon pencils are parallel and separated by a layer of plaster of Paris. Invented in 1877 by Jablochkoff, a Russian engineer. This invention is noteworthy as having revived an interest in electric illumination. See ELECTRIC LIGHTING.

Electric Condenser: LEYDEN JAR. When an insulated conductor is charged with electricity by friction, a battery, or other source of electromotive force, it will excite or "induce" in any neighboring conductor a charge of electricity. If the electricity in the first body be "positive," that induced in the neighboring body will be "negative." Thus, in Fig. 1, in which A and B are metal plates separated by air, glass, mica or other insulating material, if A be charged by the positive pole of battery *b* it will induce a charge of negative electricity on the plate B. Such an arrangement of plates is termed an electric "condenser," and in various forms it is one of the most useful instruments employed in multiplex, printing, automatic, wireless and other systems of telegraphy. It is also indispensable in telephony and has found a field in electric light and power circuits. The electricity held or "bound" in the plates is termed static electricity. The quantity of electricity or "charge" accumulated at the plates is equal to the product of the electromotive force of the charging source by the "capacity" of the condenser; that is, virtually its electricity holding ability. In fact, however, what the condenser holds is electrical energy, which, when discharged, is given up as work, equal to, $\text{Work} = \frac{K \times E^2}{2.712}$ foot pounds where K is the capacity in farads, and E is the charging electromotive force in volts. It can be shown that the charge of a condenser rests on opposite sides of the di-electric, and that in charging the condenser as much electricity leaves plate B as enters plate A. The capacity of a condenser varies with the distance between its opposite plates, being greater the nearer they are together, and increases with the surface of the plates. The capacity also varies with the insulating material or dielectric used to separate or insulate the plates. The property of dielectrics to which this so-called inductive effect is due is termed specific inductive capacity. The property which this inductive capacity seemingly imparts to conductors is termed electro-static capacity, or "capacity." The inductive capacity of air is taken as the standard. Air being unity, the specific inductive capacity of paraffin is about 2; vulcanized India-rubber, 2.94; gutta-percha, 4.5; mica, 5; flint glass, 6.5 to 10. The Leyden jar is a well known type of condenser. The most common form of condenser is generally constructed of many sheets of tin foil, separated by a thin sheet of insulating material, such as paraffin paper, mica or glass; the alternate sheets of tinfoil are connected together

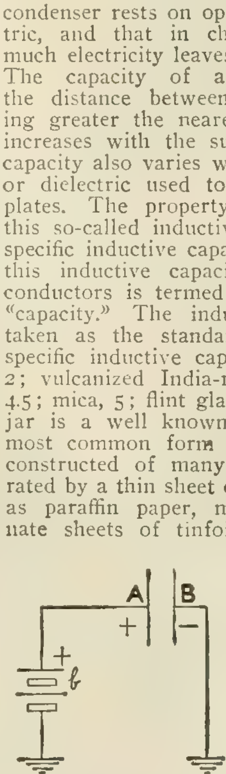


FIG. 1.

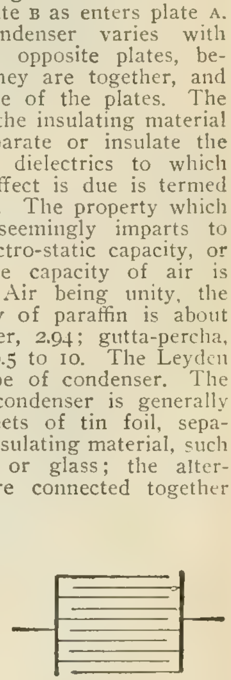


FIG. 2.

metallically at separate ends as indicated in Fig. 2. All conductors, like telegraph, telephone, electric light and power wires, possess electrostatic capacity. In the case of overhead conductors the wire is one plate, the air is the dielectric and the earth is the other plate of the condenser. In cables the wire is one plate, the insulating material is the dielectric and the armor or earth the other plate. The capacity of overhead conductors is very much less than that of underground or submarine conductors, due to the closer proximity of the latter to the earth and also to the greater specific inductive capacity of its dielectric.

Electric Direct Current, as distinguished from the alternating current, is so-called because of the fact that it travels in one direction along a conductor. If this conductor joins the terminals of a source of energy, as a dynamo, (q.v.), the current is said to flow from the positive pole of the machine along the conductor to the negative pole.

Probably the first man to detect current electricity was Galvani about the year 1786. To Volta (q.v.), however, is certainly due the credit of first developing a practical electrochemical cell. In the year 1800 Volta exhibited a cell known as the "Voltaic Pile," consisting of a series of disks, copper and zinc, alternately separated from each other by a cloth saturated with brine; on joining wires to the end disks, quite a perceptible shock may be felt by touching with the tongue or moistened finger, the two terminals simultaneously. This simple cell was the starting point of all the electro-chemical batteries of the present day. With the discovery of Volta of the laws of difference of potential between different metals when placed in contact or joined by a fluid electrolyte, began the development of very many varieties of cells, all on the same principle; yet even now, the two metals he chose, zinc and copper, constitute the elements of the Daniell cell very frequently used for telegraphic purposes. The changes which would readily suggest themselves in Volta's first cell would be, increasing the amount of corroding liquid and placing the elements, zinc and copper, in a vessel which would properly contain the fluid.

The theory as given by Gore of the electrochemical cell is as follows:

"The essential cause is the stored-up and ceaseless molecular energy of the corroded metal and of the corroding element of liquid with which it unites, while contact is only a static condition; and chemical action is the process or mode by which the molecular motion of these substances is more or less transformed into heat and current."

The electromotive-force of chemical generators is small, rarely exceeding two volts per cell. This necessitated a large number of cells connected in series; that is, the positive terminal of one connected with the negative terminal of the adjoining cell, the electro-motive force thus produced being the product of the electromotive-force of one cell by the number of cells. By connecting the two positive and the two negative terminals of two rows of cells, an increased quantity of current can be obtained at the potential of one row. The first method is called joining battery cells for intensity and the second for quantity. It is known that the energy generated in a chemical cell is produced by the consumption of zinc. The cost of this energy must necessarily be high, as both zinc and the chemicals are expensive, so that the use of current electricity was quite limited until the introduction of the dynamo electric machine, which might be called the mechanical method of transforming energy from some source, such as a steam-engine, into current electricity, as contrasted with the chemical method.

In the year 1831 Faraday discovered and announced the principle of electro-magnetic induction. This opened up the field of what might be called the commercial generation of current electricity. The principle discovered by Faraday, which forms the basis of all dynamo electric machines, is that if a wire is moved in a magnetic field, so as to cut the lines of force, a current will be generated in the wire, and it is upon this principle that all dynamo electric machines depend for their action. The converse of this law he also announced, namely, that when an electric current is applied to the dynamo by some external source such as the battery or another dynamo, the machine will furnish mechanical power. Hence a dynamo electric machine may be considered either as a generator or as a motor.

All dynamos consist of two essential parts, one, the field magnet, which is usually stationary, and the other, the armature on which the copper conductors are mounted and which revolves on a shaft between the poles of the field magnet. This armature is so arranged as to cut the lines of force flowing between the magnetic poles. The lines of force are imaginary lines flowing from the north pole to the south pole of any magnet. They can easily be traced by placing a piece of paper above the magnet and sprinkling on this paper iron filings. If the paper be covered with mucilage the filings will maintain a permanent position so that they may be studied at the leisure of the student.

The field magnets may be made of steel, magnetized, or preferably they may be electro-magnets made of soft iron over which a coil of wire is wound carrying a current of electricity which induces magnetic lines in the iron. It is to be noted that if the ends of the magnet (q.v.) are bent in the form of a horseshoe, the lines will be intensified by the reduction of the air space between the poles, and as the amount of current induced in the wire depends on the number of lines of force cut, the greater the strength of the field magnets, the greater will be the current induced.

Considering first the ideal simple dynamo: This would consist of a single loop mounted on centres rotating between the poles of a magnet, each end of the loop being connected to a collector which in direct current machines is called a commutator, and is mounted on the shaft outside of the poles, and insulated therefrom. If the loop is placed in a vertical position and moved through 180°, each side will pass through the whole number of lines of force flowing between the poles which will induce a current in one direction in the loop. If the rotation is maintained in the same direction during the next 180° it will cut the lines of force in the opposite direction, that is, the lines of force will be passing through the loop in the opposite direction to that in the first case. This will induce a current which will be in the opposite direction from the current induced through the first half of the revolution; so that the current will be pulsating, first in one direction and then in the other during each revolution. If the collector or commutator be cut into two halves parallel with the shaft and the ends of the loop be connected one to each half and if a pair of brushes be supplied to collect the current, one above and one below the commutator; when the loop is vertical, the brushes will be changing contact from one end of the loop to the other and as no current is then being generated, the change is made without sparking and current flowing in the same direction continuously can be obtained from the brush terminals. During the moment of changing from the one contact to the other, the circuit is momentarily opened or interrupted. This would cause sparking at the brush or collector, were it not that the brushes are placed at a point at which the current is practically zero. This is found in practice to be slightly in advance of the theoretical neutral point on account of lines of force being dragged in the direction of rotation by the conductors.

To advance from the ideal simple dynamo: — the next step is to reduce the air gap between the poles of the field magnet and concentrate the lines of force in the effective space. This is accomplished by placing an iron core on the armature which in the first place reduces the magnetic resistance of the air gap and thus increases the number of lines of force through the armature conductors, and also serves as a support for them. Other machines were built with shuttle wound armatures, the armature consisting of an iron shuttle cut out with grooves longitudinally to take the conductors. These were usually wound with a number of turns of copper wire, the ends being brought out to a two-part collector or commutator. (See ELECTRIC ALTERNATING CURRENT.) The next step was to add to the number of coils on the armature so that during each portion of a revolution, some part of the armature conductors would be doing maximum work. Should an additional coil be added to the ideal generator, at right angles to the first coil, the capacity of the machine will be doubled. This complicates, to some extent, the collector rings and may necessitate the opening of the circuit when current is flowing so as to cause sparking and burning of the brush. A machine built on these lines would, therefore, be better adapted for generating small currents as the sparking at the brushes would be otherwise very destructive to the commutator. Machines of this type are known as open coil.

The next important step was made by Gramme and Pacinotti, which was to close the coils with themselves so as to form a continuous circuit in the armature and connect from each coil at its junction with the next one to the collector sections, the number of sections being the same as the number of coils. In the four-coil armature, the current generated can either pass to the collecting brush directly or when it moves out of position so that the contact is broken and made with the next section, the current can flow through the armature coils to the same brush if necessary, and when that coil passes from one polar position to another and is giving current of opposite polarity this current can flow directly to the other brush, and so continuous current is generated. There is also no point at which the circuit is open. There may be a slight sparking as the section moves from the brushes, but violent sparking is reduced as there is always another path for the current to flow to either brush.

The drum armature is distinct from the ring armature in that the wires are wound on the outside of the core and do not pass through it. This type is frequently called the «Siemens'» armature on account of the number of successful machines built by Siemens. Of the whole number of lines of force passing between the poles and through the core, there are very few lines passing in the inside, they being diverted by an iron core so that they pass through the wires on the outside of the core; the conductors inside of the core are thus of little use, their only function being to complete the circuit and carry current between the successive turns on the outside of the core; so that by winding the wires on the outside surface only, the amount of idle wire is reduced, the only material that is not active being the cross-connecting pieces at the ends.

The Gramme ring was used very largely on early machines for the reason that it afforded means for easier mechanical construction, and machines of this type were generally successful, on account of their simplicity. Pacinotti designed a core having teeth similar to a gear wheel. In this way the air gap between the armature and pole pieces could be reduced somewhat, resulting in an increased number of lines of force. It also afforded an additional support to the coils and added to the mechanical strength of the machine.

To be considered next are the field magnets: There are a number of constructions which may be employed. (1) The so-called permanent steel magnet which consists of a bar or bars of steel bent to the shape desired, tempered and magnetized. The method of magnetizing these magnets consisted of placing them in contact with other magnets or with an electro-magnet. The present method would be to insert the steel bar into a helix carrying a heavy current and in a short time the bar would be magnetized. The dynamos built with permanent steel magnets of this type are what is known as magneto dynamos. The chief objection to this form of magnets is that a steel magnet cannot be made as powerful as an iron magnet which is energized or as it is commonly called, excited from a source of electricity. In the first generators permanent magnets were used, but a great step in advance in dynamo design was to arrange the magnet poles so as to be self-excited. A portion of the current generated in the armature is sent around the coils wound around the cores of these field magnets so as to excite them. At first, however, magnets were substituted consisting of soft iron upon which was wound a coil of copper wire, the current for energizing these pole pieces being first supplied from a small magneto generator or a voltaic battery. Sometimes the machine will not generate on starting up sufficient current to excite the magnets and it is necessary to excite them from some external source so as to give the initial strength to the magnets and allow them to build up from the current generated in the armature. It is usually found that there is sufficient residual magnetism left in the iron of the field magnets, after the machine has once been in operation, to start the current in the machine and properly build up the fields.

In regard to field windings, two distinct types are used: (1) the series winding, in which all the current generated in the armature passes around the field poles and thence out to the line or circuit; and (2) the shunt winding in which a portion only of the current is used in the field, the connection being made across the main terminals of the generator. In the first case the wire on the field windings is necessarily large so as to carry all the current for which the machine is designed and in the second case it is a small wire of many turns, the product of amperes and turns being about the same in either case. In another design, both a shunt and a series winding of a few turns is employed, constituting a compound winding.

It will be seen that in the first case, that of the series winding, the field strength will depend upon the resistance of the total circuit including the resistance of the armature, the field winding, and the external circuit. In a machine of this type the voltage or pressure generated will vary in proportion to the demands. This is the standard winding for the series arc machines used for city lighting such as the Brush and Wood types. In the case of the shunt-wound machine the current flowing in the field coil depends upon the pressure between the generator terminals, so that with an increased out-put and consequent loss in the armature the voltage will fall off slightly, thus reducing the field strength. This necessitates some means of varying the field current so as to maintain a uniform pressure at the generator terminals. This is usually accomplished by means of an external resistance in the field circuit composed of German silver or iron wire which can be varied by means of a switch-head so arranged as to cut out certain portion of this resistance step-by-step and so increase the current through the fields, thus preserving a uniform voltage.

In a combination of series and shunt windings commonly called the compound type, as the output of the generator is increased, there is a greater flow of current through the series windings and consequent increase of magnetic strength of fields so that it is possible to compensate for the loss due to the resistance of the armature windings and maintain a uniform pressure at the generator terminals. The output of the dynamo depends upon the strength of the field magnets, the magnetic permeability of the material and the rate at which the lines of force are cut by the armature conductors so that the higher the speed, the greater the output of the dynamo. In the early machines very high speeds were common, armatures of small diameters being employed. These were objectionable for mechanical reasons so that the design was changed in order to increase the number of pole pieces. Instead of the field being composed of two poles, it was arranged so that a greater number of poles could be used, this type of machine being known as the multipolar dynamo. As each conductor would pass between a number of poles during each revolution the speed could be proportionally reduced.

The dynamo, as previously stated, is a machine for converting energy in the form of mechanical power into electrical power, or vice versa, so that a motor is a machine for converting energy in the form of electricity into mechanical power. The early types of motors were based on the principle that a magnet would attract the opposite pole of another magnet, and if one set of magnets is arranged on a wheel, and the other stationary, the movable magnet will be drawn around. To make this effective it will be necessary to interrupt the forces at what might be called the dead centres so that the wheel would have continuous motion. This is accomplished by either introducing a screen, or, more satisfactorily, by the use of electro-magnets with a movable contact so that the magnets are energized intermittently, allowing the wheel to revolve in accordance with impulses received from the magnetic poles.

When we consider the dynamo as a motor the current supplied to the terminals will take two paths, one through the armature and the other through the field coils. The field current energizes the pole pieces, and the current traveling in the armature is similar to another magnet inasmuch as a coil carrying the current will be attracted or repulsed by a magnet according to the directions of the current through the coil, so that the wire will be forced around by attraction and repulsion. By considering the effect of the commutator the motion is seen to be continuous. When the armature starts to revolve the conditions then existing will be similar to the armature in action as a dynamo resulting in an electro-motive force being generated in the armature wires, which will be in the opposite direction to the incoming current. This is what is called the counter electro-motive force of the motor, and will tend to reduce the amount of current which will flow through the armature conductors. It is, therefore, evident that when a motor is started there will be a rush of current through the armatures, as the resistance is very small, and as there is no counter electro-motive force while the machine is not in motion to check the flow. For this reason, in the direct current motor it is necessary to introduce an external resistance into the armature circuit to hold back the current which would flow, until the machine reaches full speed. The resistance is then gradually reduced until full speed is obtained. The effect of this counter electro-motive force when the resistance is cut out entirely is to materially assist the self-regulating qualities of the machine. Any load applied to the motor would tend to slightly reduce the speed, which effect, by also reducing the counter electro-motive force and allowing more current to flow through the armature, tends to keep the speed from falling much below normal in the shunt motor. Motors can be built either with a plain shunt field winding or with a series and shunt winding, depending on their requirements. The direction of rotation depends on the direction of the current through the armature. To reverse the rotation, therefore, it is only necessary to reverse the current in the armature, leaving field connections as they are. If the current is changed in both field and armature, the result would naturally be that the machine will continue to revolve in the same direction as before.

To reduce the speed of the direct current motor it is only necessary to add resistance to the armature circuit so as to limit the current flowing therein, and by so doing almost any desired speed may be obtained, from 1 per cent up to full rate of speed. There are a number of other methods by which variable speeds can be obtained, one of them being by varying the field strength. Any motor, however, operating at a lower field or armature current than normal conditions would require is naturally operating at reduced power. On account of the valuable features in relation to speed control, the reversibility, and the automatic speed control inherent in shunt machine, together with a large torque of the series machine, the direct current motor fulfils more nearly than any other the practical requirements in machine-shops, textile mills, and general manufacturing establishments.

For electric railway work, in which the direct current is employed (see TRACTION, ELECTRIC), the compound wound generator and series motor is the usual standard practice. Often this type of generator is over-compounded so as to more than overcome the drop through the armature resistance and allow higher voltage at full load than at no load, so as to overcome, in a way, the drop of potential on the feeders and preserve the uniform voltage over the system. In lighting and power work the shunt and compound dynamos are both used. (See ELECTRIC LIGHTING.) And in the business centres of our large cities where the direct current is generally used, the rotary converter fed from a high tension alternating central station is very often employed, together with storage battery. One of the chief reasons why the direct current is used so generally in preference to the alternating, outside of the fact that more satisfactory motor may be obtained therefrom, is the total absence of all inductive effects so troublesome in large secondary alternating systems, where the pressures are low and the currents very large. A much more uniform pressure can be kept on the supply mains of a direct current system than an alternating one, especially if many large motors are connected, and this fact, together with the use of the storage battery, which can only be used on direct current systems (for other information on storage batteries see article on STORAGE BATTERIES), enables the large lighting companies to use a very efficient type of incandescent lamp, which, being generally freely renewed by the company, by its longer life aids materially in keeping up the value of the business.

The shunt and series motor each has its own field of usefulness. When a very powerful starting torque and rapid acceleration are necessary the series motor is used, as in the case of street railway, electric locomotives, electric cranes; and on steamships where the direct current alone is used, as on the Kentucky and Kearsarge, of the United States navy, not only is electricity used for lighting, but also for operating ammunition hoists, hoisting anchors, operating boat cranes, and even the steering gear of the ship itself.

In machine-shops and manufacturing establishments where a more or less constant speed may be required, and in elevator work, the compound and the shunt motor are commonly employed. The shunt motor is very well adapted for operating at any speed desired, and for machine tools it is at present without a peer for an efficient and easily regulated source of power. Unlike the series motor, where the speed varies with the load, the shunt motor is practically a constant speed machine. When thrown on the lines it rapidly comes up to normal speed, and then from no load to full load will not greatly deviate therefrom unless purposely thrown to a slower point of the controller. As a series motor would run away if left in a circuit with a load suddenly removed, the shunt motor, or sometimes the compound, which is used in order to preserve an absolutely uniform speed from no load to full load, and is necessary in a few places where absolutely constant speed is required, is the standard motor for driving textile machinery in large mills, factories, and other establishments.

Direct current is more suitable for general requirements than alternating current. It is essential to use direct current to charge storage batteries. Storage batteries fulfil an important function in direct current distributing systems, as by this means a reservoir is established which is useful in taking care of sudden demands caused by the consumer, or it may take the place of defective generators or apparatus.

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Electric Discharge, the escape of electricity, whether slowly and silently, or more quickly and violently, from any receptacle or generator.

Electric Door-bells. See ELECTRIC SIGNALING.

Electric Drill, a drill for metals or rock worked by an electromagnetic motor. For metals a rotary motion, for rocks a reciprocating or percussory action, is imparted.

Electric Eel (*Electrophorus electricus*), a great eel inhabiting the marshy waters of the llanos in South America. It belongs to the family *Gymnotidæ* and order *Plectospondyli* (qq.v.), and with a few allied species is distinguished from all other eels by the partial coalescence and modification of the anterior vertebræ. It is remarkable chiefly for the great size of its electric organs, which consist of two pairs of longitudinal bodies between the skin and the muscles of the caudal region, divided into about 240 cells and supplied by more than 200 nerves. The eel can discharge sufficient electricity to kill an animal of considerable size, and is said to possess power, when in full vigor, to knock down a man and benumb the limb affected, in the most painful manner, for several hours after communicating the shock. By frequent use of this faculty it becomes impaired, and a considerable interval of rest is required to recruit its electrical properties. According to Humboldt the natives of South America make use of horses in taking the electric eel. The animals are driven in a body into a stream or pond where the fishes abound, and the latter, having exhausted their stores of electricity by repeated attacks upon them, are then easily taken. The horses are sometimes so severely stunned by the shocks that they fall and are drowned. Specimens of the *Electrophorus electricus* are reported to attain the length of 6 or 7 feet, but ordinarily they are about 3½ or 4 feet long. The flesh is eatable and is said to resemble that of the common eel in appearance and flavor. See ELECTRIC FISHES.

Electric Egg, an ellipsoidal glass vessel, with metallic caps at each end, which may be filled with a feeble violet light by means of an electric machine acting on it after a vacuum has been made inside the glass.

Electric Elevators. See ELEVATORS.

Electric Escapement, a device actuated by electric impulse which intermittingly arrests the motion of the scape-wheel and restrains the train to a pulsative motion — acting, in fact, in the place of a pendulum.

Electric Field, any space wherein electric force exists. See ELECTRICITY.

Electric Fire-alarm. See ELECTRIC SIGNALING.

Electric Fishes, several quite unrelated fishes which possess the extraordinary property of communicating an electric shock to animals with which they come in contact. The organs which are the source of this power have been much studied by both anatomists and physiologists. They are in all cases — with the possible exception of *Malapterurus* — formed by the modification of muscular tissue, and consist of a mass of numerous closely packed prisms, each divided into a series of compartments filled with a gelatinous substance. One surface of the fibrous disks thus formed receives a rich nerve supply and is electrically negative, the opposite surface being positive. The entire organ may therefore be likened to a group of voltaic piles. Among the *Elasmobranchii* (q.v.), many of the skates possess rudimentary electric organs, which reach a high degree of development in the torpedo (*Torpedo*, q.v.) and an allied genus (*Hypnos*). In these two genera the organs occupy a large area on each side of the head and the prisms are arranged vertically and are supplied by large nerves, four pairs of which arise from a special electrical lobe of the hinder part of the brain, while a fifth is a branch of the trigeminal. In the electrical catfish (*Malapterusus electricus*) of the Nile, and some allied species, the entire body is enveloped by an electric layer beneath the skin and the muscles. In the electric eel (q.v.) and all other electrical fishes the organ is placed by the side of the tail and the prisms are disposed longitudinally. Not alone in structure but in the phenomena of rest and activity these organs bear a striking resemblance to muscles, which also normally exhibit weak electrical currents.

Electric Fluid Theory. To explain electrical phenomena this theory was propounded in 1759 by Du Fay and Symmer. The "theory of electric fluids," as it is called, is as follows: That every body contains an indefinite quantity of an imponderable subtle fluid, that this fluid is composed of two fluids which are self-repulsive but mutually attractive. When a body is in its natural state, the two fluids are in combination, and neutralize each other. The act of electrification consists in the forcible separation of the two fluids, whereby one is diffused over the body rubbed and the other over the rubber, one kind of electricity never appearing without an equal quantity of the other. This theory, however, must be regarded as a mere provisional conception, and not a proved scientific truth. See ELECTRICITY.

Electric Furnaces. Electric furnaces are devices for localizing the heat of an electric circuit and utilizing it. In the usual technical use of the term it signifies a device or receptacle in which a comparatively high temperature is developed for the purpose of effecting a chemical reaction or producing a change of state in the substance to be treated, such, for instance, as the reduction of an ore, the formation or disruption of a compound, or the fusion or volatilization of a metal or compound. Electric furnaces comprise means for developing the necessary heat at the point or points desired, and for subjecting the material to be treated, technically known as the "charge," to the influence of this heat. The several types or classes of electric furnace will be briefly described according to the principles employed. The heat development in any given portion of a circuit is proportionate to the resistance offered to the passage of the current; hence those portions of the circuit external to the furnace proper are always composed of metals which conduct the current well, and generally of copper or aluminum, whereas the resistance of those portions of the circuit in which the heat is to be localized is relatively high. These latter portions of the circuit may consist of gases, in which case an arc is formed and the localization of the heat is extreme; of substances of high melting and boiling points, in a state of fusion, when an electrolytic effect, to be hereinafter more fully referred to, usually supervenes; or of solids, such as platinum and other difficultly fusible metals, carbon, graphite and carbonaceous mixtures, or such bodies as the oxides of the alkaline earths which become conductive when heated. These three classes of furnace, wherein the heat is localized in a gas, a liquid, and a solid, respectively, may be conveniently designated by the terms arc furnace, electrolytic furnace, and incandescent furnace, although as will appear it is not always easy to apply one or another of these names to the actual constructions. Although electrically developed heat is relatively costly, the fact that it can be locally applied, within the interior of the charge if so desired, is an important advantage, and the utilization of the heat is often so complete that its use represents a real economy. The heat lost is that which is carried from the furnace by the escaping products of the reaction, and that which is conveyed by radiation, convection, or conduction, from the walls, the electrodes, and other exposed portions of the structure. Inasmuch as the exposed surfaces of a furnace are roughly proportionate to the square of its dimensions, whereas its capacity varies as the cube, it is evident that other things equal, the larger the furnace the less will be the percentage of total heat which is lost and the greater will be the efficiency. This indicates the employment of large units. It is always possible to reduce the expenditure of electrical energy by making use of heat otherwise generated, such heat being employed for raising the temperature of the charge previous to its introduction into the electrically heated zone, or for heating the exposed surfaces of the furnace structure in order to check radiation therefrom. Furnaces in which chemical reactions are conducted, as, for instance, those in which calcium carbide is produced, often yield gaseous products which are not only themselves very highly heated, but are capable, by combustion, of further heat development. It has frequently been proposed to utilize this heat by conducting such gases through or around the incoming charge or by burning them in flues surrounding the furnace, but the greater complexity of the structure and the difficulty of purifying the large volume of dust-laden gas constitute practical difficulties of a serious nature.

The Arc Furnace.—When an electric arc is formed in air between carbon terminals there is observed to be a definite limit to the length of arc which can be maintained with a given current strength; furthermore this limit which at first increases almost in proportion to the current strength, increases very slowly as the current density reaches higher values. The maximum length of the arc is therefore limited. The temperature of the carbon terminals may attain 3,500° C., at about which point, under atmospheric pressures, carbon volatilizes. The temperature of the incandescent gases of the arc is perhaps a thousand degrees higher. It follows that the arc furnace, in its simplest form, is adapted particularly for subjecting small charges to extremely high temperatures, and its value for experimental work is apparent. For use upon a commercial scale it is generally necessary to so distribute the heat from the arc that a comparatively large body of the charge may be acted upon in a given time. This result may be accomplished by establishing a plurality of arcs in adjacent portions of the charge, by exposing the charge to the heat radiated from one or several arcs not in contact with it, by causing the arc to move relatively to the charge, or by moving the charge through or past the arc. The temperature of that portion of a charge which is in immediate contact with an arc may be practically that of the arc itself and is uncontrolled; the operations for which this method of procedure is suitable and economical are relatively few. The high temperatures which the electric furnace is capable of producing have opened a new field to chemistry, but in order to insure the formation, in theoretical quantity and in a state of purity, of many compounds, a careful regulation of the temperature is essential; for the highest attainable temperatures are capable not only of giving rise to new combinations but also of breaking them down, resolving them into simpler bodies or even into their elements. A single instance of the importance of heat regulation may be offered: If a mixture of sand and coke be cautiously heated in an electric resistance furnace a partial reduction of the sand occurs, and a product containing silicon, oxygen and carbon and known as «siloxicon» is formed; at a somewhat higher temperature the reduction is complete and there results an amorphous body having the essential composition of carbid of silicon and technically called «white stuff»; at somewhat higher temperature ranges this amorphous body passes into the crystalline carbid of silicon «carborundum,» a compound approximating in hardness the diamond itself; and at still higher temperatures, approximating those of the arc, this carborundum is broken down, its silicon escapes as a vapor, and its carbon remains in the form of graphite. The effect of high temperatures upon reactions is two-fold: in the first place the velocity of the reaction is increased, so that chemical changes which at lower temperatures occur slowly or not at all take place rapidly or even with explosive violence; in the second place new conditions of equilibrium are established, and the chemical elements, entering into that combination which, under the circumstances, is the most stable, sometimes give rise to compounds not before known. To produce a given result, however, it is usually necessary to work within definite temperature limits, and since the heat of the arc cannot well be controlled, it is necessary to govern the temperature of the charge by limiting the duration of its exposure to this heat. As above pointed out, this may be accomplished by moving the arc through or near the charge or by moving the charge through or past the arc, the duration of contact being so adjusted to the quantity of charge and to its specific heat as to bring it to the desired temperature. As a rule, however, the arc as a source of heat is both wasteful and inefficient.

The Electrolytic Furnace.—When a direct current of sufficient volume is caused to pass through a molten salt not only will the salt be maintained in fusion by the heat developed by its own resistance, but it will be «electrolyzed,» that is to say, it will be decomposed in such manner that one of its component parts, which may be a metal, will tend to accumulate at one electrode, while another component, which was before in combination with the metal, will appear at the other electrode. That electrode at which the current is assumed to enter the molten bath, and at which the negative or non-metallic portion of the compound appears, is called the «anode,» while the other electrode, which receives the positive or metallic element and at which the current is considered to leave the bath, is designated the «cathode.» Thus if common salt, sodium chlorid, be fused and traversed by a direct current, the negative element chlorin will appear at the anode and the metal sodium at the cathode. If the substance of either electrode be such that the element liberated in contact with it can combine with or dissolve in it, the corresponding compound or solution will be formed: If, for instance, the fused sodium chlorid be electrolyzed with an anode of carbon and a cathode of molten lead, chlorin will be evolved at the anode and escape from the bath, while sodium, dissolving in the lead, will yield an alloy from which the metal sodium, or its hydroxid caustic soda, may be obtained. In electrolytic furnaces also it is essential to carefully regulate the temperature, not only because an unnecessarily high temperature means a waste of energy, but because of losses arising through volatilization of the bath and the recombination of the separated products of the electrolysis. So important is this last factor that in certain cases, as, for instance, in the separation of metallic sodium from molten caustic soda, it is absolutely essential to the success of the process that the temperature be maintained within limits of a few degrees only.

The Incandescent Furnace.—This term is commonly applied to those furnaces wherein the heat is developed by the passage of the current through a body which initially at least is solid. Such body may comprise a rod or core of carbon or carbonaceous mixture; a granular bed or core consisting of fragments of coke, retort carbon or graphite; the charge itself, often admixed with a quantity of carbon sufficient for its reduction; the furnace product when this is conductive and possesses a volatilizing point sufficiently high to permit the necessary temperature to be attained; or a pyroelectrolyte, that is to say, an oxid or mixture of oxids which is normally non-conductive or substantially so, but which while remaining unfused becomes capable at temperatures considerably above the normal of carrying the current. Each of these resistance materials possesses its advantages for particular lines of work, but all have in common the advantage of permitting accurate and ready adjustment of the temperature by varying the amount of current passing. These incandescent furnaces have, therefore, the widest applicability, and in case the resistance material used is carbon the maximum temperature attainable is probably not inferior to that of the terminals of the electric arc. The above defined types are not always sharply distinct, but under certain conditions the operation proceeds under two or perhaps all three of the methods. Thus if the resistance consists of fragments of carbon, the current may traverse the interspaces in the form of minute arcs; and if this fragmentary carbon be commingled with a suitable ore or compound there may be present also an electrolytic effect; the primary fusion of an electrolyte is often accomplished by means of a resistance rod connecting the electrodes, or this fusion may be accomplished by the arc. Furthermore a given furnace structure is often capable of either mode of operation according to the character of the charge and the adjustment of the electrodes with reference thereto. The most important as well as the most characteristic applications of the electric furnace have relation to certain elements and compounds which cannot be produced directly, if at all, by other means. See ELECTRO-CHEMISTRY; ELECTRO-CHEMICAL INDUSTRIES.

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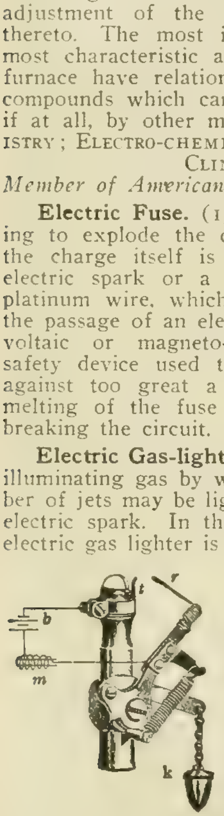
Electric Fuse. (1) A device used in blasting to explode the charge. The fulminate or the charge itself is lighted by means of an electric spark or a resistance section of fine platinum wire, which is heated to redness by the passage of an electric current induced by a voltaic or magneto-electric battery. (2) A safety device used to protect electric circuits against too great a volume of current. The melting of the fuse will stop the current by breaking the circuit.

Electric Gas-lighting, a method of igniting illuminating gas by which one or a large number of jets may be lighted simultaneously by an electric spark. In the figure a simple form of electric gas lighter is shown. A metal tongue *t*, insulated from the burner, is supported near the tip as indicated. A metal rod carried on suitable levers brushes across the tongue *t* when the knob *k* is pulled down, thereby closing and opening, as it does so, an electric circuit which includes the rod *r*, tongue *t*, battery *b*, of two or three dry cells, and a spark coil *m*, consisting of a bundle of iron wires surrounded by a coil of copper wire. At the re-opening of the circuit a spark occurs at tongue *t* igniting the gas. For lighting the gas jets in large halls an electric circuit is carried from one jet to the next and two terminals of the circuit are upheld over the gas tip. The spark jumps across from one terminal to the other when the spark coil or static machine is operated, thereby igniting all the jets in the circuit. In this arrangement the terminals of the circuit are arranged in multiple.



Electric Generation. See GENERATION.

Electric Generator. See DYNAMO; ELECTRIC MACHINE.

Electric Induction. See ELECTRICITY; INDUCTION

Electric Lighting. In 1800 Sir Humphry Davy discovered that if two pieces of carbon are joined by a conductor to a source of electric current, and such pieces momentarily touched together, so that the circuit is complete, and a flow of current established; upon their separation for a short distance, a flame is emitted, and, if the current be sufficiently powerful, this flame will continue, the carbon points will become intensely hot and emit a brilliant light. In separating the carbon points, the extra potential induced by the self-induction of the circuit is sufficient to leap the small air gap and thereby vaporizes a small quantity of carbon. Carbon vapor being a conductor, allows the current to flow across the gap. The vapor is of high resistance; therefore the vapor is heated to a high temperature. In 1809, Davy exhibited his arc light before the Royal Institute of London, his carbon points being charcoal from the willow, and his source of current a voltaic pile.

In the phenomena of the direct current between carbons, the current is presumed to flow from the positive to the negative, tearing away the particles of carbon from the positive, and depositing upon the negative electrode. The positive electrode thus becomes hollowed out, and some of the particles becoming deposited upon the negative electrode, it assumes a pointed form. The temperature of this flame of vaporized carbon is very high. In it the most infusible substances, as flint, platinum, and the diamond, melt. The carbon points emit the larger portion of the light, and the positive point more than the negative. The resistance of the arc may vary from 1 to 100 ohms. It requires a current strength of 3 to 10 amperes, and a minimum electromotive-force of 40 to 50 volts to maintain a satisfactory lighting arc.

Davy used wood charcoal for his electrodes, and while they were of excellent quality, on account of their softness would last only a short time. As the arc would burn away, it was necessary to continually adjust them, or the arc would go out. Therefore it was found necessary to have carbons of sufficient density to last a reasonable time; and purity so that the light may be steady. Also to have a mechanism to automatically feed the carbons, and keep them a constant distance apart, as well as automatically bring them together in order to start the arc. Refined petroleum coke, ordinary gas coke, or lamp black is now taken for the base material, thoroughly ground and mixed into a stiff paste, dried and carbonized out of contact with the air. A very hard and uniform carbon is thus obtained, in any desired size, the usual length being 12 or 14 inches, and diameter $\frac{7}{16}$, $\frac{1}{2}$, or $\frac{5}{8}$ inch. Broadly, the lamps may be divided into two classes: series and multiple. Each system into two sub-divisions: the open and the enclosed.

The electric energy lost from the point of generation to the lamp may be expressed, $W = C^2R$: where W is energy in watts, dissipated as heat in conductors, C is current in amperes, and R is resistance of circuit in ohms.

Therefore, from the equation it is noted, the loss is in proportion to the square of the current, R remaining constant. Therefore, in distributing electric energy to a number of arc lamps, it is more economical to keep the current constant, and have the lamps joined in series.

Two types of lamps were evolved to meet these conditions, as well as a generator to keep the current at a constant quantity, (1) the differential lamp; (2) the shunt lamp. In the differential lamp, the current must remain at a constant point. The main current is carried to a pair of lifting magnets, over which, but wound in opposition thereto, is a coil of high resistance, the terminals of which are cut around the arc itself, and called the shunt magnet. When current is thrown into the lamps, the main current pulls the carbons apart until sufficient potential is obtained at the arc to force current through the shunt magnet, which neutralizes the main magnet, thereby securing a balance, and maintaining the potential at the arc constant. In the shunt type lamp, the shunt magnet circuit is so arranged as to trip the clutch holding the carbon rod, thereby allowing the carbons to come together, should the potential around the arc exceed the predetermined amount. This lamp will burn upon any current strength, providing it is enough to operate the main magnet.

The conditions common to both types of series lamps are: (1) As the carbons burn away, they must be fed down gradually and not allow the potential around the arc to exceed a certain amount; usually 51 to 53 volts. (2) Should the carbon rod stick, or anything happen to disarrange the lamp, there will be a protective device or devices usually called cut outs, so the lamp will not be burned up, or the circuit opened.

Since the advent of arc lighting, there have been many forms of lamps evolved, using carbons in all forms. But at the present day all have come to practically the same style and form of lamp, with few modifications.

Multiple Arc Lamps.— Arc lamps may be arranged for multiple burning at 110 or 220 volts: As most cities are provided with low tension, constant potential mains, it is convenient to be able to place arc lamps upon the same system as incandescent and the motors. This style of lamp requires a large amount of copper for a given distribution for the reason given in former formula. The lamp itself is most uneconomical, as the voltage at the arc must be cut down to 50, which is absorbed in a steadying resistance at the top of the lamp. The open type of lamp for multiple burning is almost obsolete.

The Enclosed Arc.—The open arc is now being largely superseded by what is called the enclosed arc. It was discovered that if the arc be surrounded by a small air-tight globe, it greatly modified the character of the light, and the carbon would last much longer. The small globe prevents the air from having access to the carbon, thus preventing its oxidation. When the lamp is started, it soon exhausts the oxygen contained in the globe, and if the globe is tight, the carbons will last from 80 to 175 hours. This type of lamp is now used almost exclusively for multiple burning both for alternating and direct current. The voltage at the arc is from 75 to 80 volts, and requires from 3½ to 6 amperes. Upon a constant potential circuit, it is necessary to absorb the difference between 80 and 110 volts with a resistance at the top of the lamp. With the alternating current lamp this reduction is obtained much more economically by means of a reactance which absorbs the excess potential. The enclosed arc is meeting with considerable success also, on constant current circuits. They usually are operated at five amperes. The great advantage obtained is the small cost of carbons and attention. The light is considered superior to the open arc.

The Incandescent.— The great objection attending the use of the arc system of lighting was that the light was too intense for most purposes required inside. It could not be readily subdivided. From the earliest days of electric lighting, various inventors endeavored to subdivide the light. The idea of using continuous conductors, instead of the discontinuous as in arc lighting, was tried in almost every conceivable form. These conductors were to be heated to a white heat and rendered incandescent by the passage through them of an electric current. The great difficulty arose from the fact that to give useful results, the working temperature of the material was so near its melting point, that any slight increase in the current would destroy the conductor. In 1878 a great improvement was effected in the platinum incandescent lamp, which was obtained in a condition to safely withstand a much greater current strength. The platinum filament was placed in a vacuum, and slowly heated therein. The occluded gases were slowly liberated, and it was discovered that if a high vacuum were maintained and the wire raised to a point just below its melting point, the point of fusion was raised, and the physical character of the metal was considerably changed. This lamp, however, was never a commercial success.

Various inventors experimented with the platinum lamp, enclosed in a vacuum, but the great improvement was made by the substitution of carbon filaments for platinum. This was done by an American, J. W. Starr, who employed plates inside a glass vessel containing a Torricellian vacuum. Many patents were taken out in all countries for lamps of various types, but none were commercially successful; many, perhaps, for the want of a cheap method of generating the electrical energy, as well as the fault of the lamp itself.

The advent of the first successful incandescent lamp dates from about 1879, when Edison gave us the carbon incandescent lamp, and from that time the growth of the incandescent electric lighting industry has been extremely rapid.

Every incandescent lamp consists of a carbon filament attached to two platinum wires; a glass bulb in which a vacuum is formed, and finally a threaded base attached to the bulb, and designed to hold the lamp in its socket.

The following is in a general way the method by which the lamps are made. The bulbs are blown at the glass factory whence the manufacturers obtain them directly. The first manipulation consists of preparing them for the filament. The nature of the filament varies with different systems. There are three kinds employed. Some (Swan) employ cotton thread; others gelatine or vitrified cellulose (Khotinski Lave-Fox); and others use vegetable fibres (Edison-Siemens). Finally, some employ a natural fibre submitted to a chemical process (Langhans Cruto Seel). Form is given to the filament according to its nature, either by means of a die, or between cylinders, or by cutting it out while in a plastic mass. The fibre thus obtained is transformed into compact carbon by prolonged baking at a high temperature in a crucible or by heating with the electric current itself. To give the filament homogeneity, and the desired resistance, a layer of carbon should be deposited on its surface; this deposit is effected in many ways, which are peculiar to each manufacturer. A very simple method consists in immersing the filament in petroleum, and raising it to a red heat in that liquid. The filament being cut to the desired length, Edison clamps the carbon with platinum wires, and covers the points of attachment with a layer of electrolytic copper; Lave, Fox, and Swan deposit a greater quantity of carbon there, while other manufacturers employ a special cement. Soldering to the carbon tends just now to become more and more the practice. The filaments may be fixed in the bulb in two ways; either the two wires are fused into a piece of glass called the budge, which is next fused into the neck of the bulb; or else the wires are fixed separately on the edges of a glass socket, which is then fused into the bulb. A small tube is also fused to the top of the bulb in order to provide for the production of a vacuum. The exhaustion of the lamps takes place by means of mercury pumps. The vacuum obtained, the lamp is tested. Then the luminous intensity, and the resistance when cold, are measured. The dimensions of the filaments vary with the luminous intensity of the lamp; they should be proportionately greater as the normal intensity of the lamp is higher. These dimensions depend also upon the specific resistance of the carbonized substance. As to the form of the section of the filament, the circular one is preferable because it presents the minimum resistance for a given surface. In Edison lamps the filaments have a section 0.3 MM by 0.1 MM, and a length when straightened out of 125 MM for 16-candle-power lamps, and 110 MM for those of 10-candle power (Paliz).

The reason for withdrawing the air from the bulb is that if the filament were heated in the air, the oxygen of the air would combine with the carbon causing combustion and consequent destruction. Even enclosed as it is in a vacuum the filament is slowly destroyed by the intense heat at which it is operated. Aside from the advantage named is the fact that there is no heat conducting medium between the filament and the globe, practically all the heat that is emitted being that which radiates from the filament (a small amount is lost by conduction through the leading-in wires). If there were any gas or vapor within the bulb it would conduct additional heat to the glass walls, and also dissipate heat by convection, so that with a given current in a given filament, the temperature of the filament would be reduced, and, therefore, less light would be obtained. The destruction of the filament referred to is not due to combustion because as just explained there is no oxygen left in the bulb. There is a disintegration of the filament by some process that has never been positively identified, or explained, the results being, that impalpable particles of carbon are deposited on the inside surface of the bulb, causing a gradual darkening of the glass, that is readily discernible.

The leading-in wires are made of platinum because that metal has the same coefficient of expansion by heat as that of glass. Were the coefficient different, they would, when heated, expand unequally, and crack and spoil the vacuum. Carbon is an exception to the general rule, that almost all conductors increase in resistance when the temperature is raised. Its resistance decreases rapidly with an increase in temperature up to the red point. Thereafter, up to the white, the resistance decreases more slowly. The ordinary filament, when at its working point, has about one half the resistance as when cold. The standard filament gives out a mean illumination of 16-candle power at right angles with the axis of the lamp from base to top.

The power required for the usual 16-candle power standard lamp varies from 50 to 64 watts, depending upon the temperature at which the filament is operated. The higher the temperature of the filament, the higher the efficiency in watts per candle power, and also the shorter will be the life. The life of the filament in this way limits the efficiency of the lamp. The candle power of the incandescent lamp may be greatly increased by simply increasing its filament temperature by the simple expedient of increasing the current, but thereby its life is shortened. The increase in candle power is not directly in proportion to the increase in current but in a considerably higher ratio.

The following table shows roughly the relation between voltage, watts, and candle power for 16-candle-power filaments requiring normally 3.1 and 3.5 watts per candle respectively, and to be worked at 100 volts.

Column A is for 3.1 watts and B for 3½ watts.

Effect of insufficient and excessive voltages upon the candle-power wattage and life of an incandescent lamp filament.

Volts at terminals	Candle power	Watts		Per cent of normal life	
		A	B	A	B
96	12.6	45.5	51.7	220	247
97	13.4	46.5	52.7	179	195
98	14.2	47.5	53.8	146	153
99	15.1	48.5	54.9	121	126
100	16.	49.6	56.	100	100
101	16.95	50.7	57.2	82	84
102	17.9	51.7	58.4	68	70
103	18.9	52.7	59.5	56	58
104	19.85	53.6	60.5	45	47
105	20.8	54.5	61.4	37	39

The foregoing table shows the importance of maintaining the potential on the terminals of an incandescent lamp at the normal working point. Any slight excess materially shortens its life. As previously stated, the resistance of an incandescent lamp filament is much lower when hot than cold, approximately in the ratio of two to one. That is, the resistance is twice as high cold as when hot when at normal burning temperature. The illumination is rated in candle power, and power consumed in watts per candle measured when the lamp is giving its rated candle power, but this condition is not obtained with any incandescent lamp through a large portion of its active life. When a new lamp is placed in circuit, it will usually give the full candle power or a trifle more at the start, and the candle power will rise to a value from 5 per cent to 11 per cent higher than the rating. It soon, however, begins to fall off with a constant diminution up to the breaking point.

The rise and fall of candle power are due to changes in the structure of the filament. The resistance at first decreases allowing more current to flow, and consequently higher temperature and more light. This is indicated by the rise of the curve from 16.2 C. P. to 17.3 C. P. during the first 50 hours. Then the diminution of resistance ceases, and is followed by the gradual wasting away of the filament, which causes a gradual increase in resistance, by reducing its cross section. The current thus gradually falling off, taken together with the decreased surface of the filament, and the deposit of carbon upon the globe, causes the fall in candle power indicated. The decrease in candle power is not directly proportional to the decrease in current, thus the energy per candle power increases rapidly after the first few hundred hours.

In addition to the arc and incandescent, we now have also the Nernst lamp, which is of late coming into prominence as a lighting agent, and which has many valuable qualities. The Nernst lamp is the invention of Prof. Walther Nernst of Göttingen University, a leading authority in the chemical world. Prof. Nernst was making experiments as to the principles underlying the efficiency of the Welsbach gas mantle. The exact elements and their proportions of the Welsbach mantle have been more or less of a secret, but it is well known that certain metallic oxides, such as thorium, yttrium, cerium, zyrconium, glucinum, erbium, have entered into their manufacture; probably the first three mentioned being the chief ingredients. These very refractory materials are of a yellowish, or a whitish color. They are non-volatile save at exceptionally high temperatures. Prof. Nernst in his early experiments took certain of these substances, such as magnesia oxide mixed with porcelain, which is a high class insulator when cold, but, he found, were electrolytes when hot. These are called conductors of the second class, or such chemical substances as are decomposed upon the passage of a direct current.

In order to adapt the principle to commercial lamps, there are many problems to be solved. The Nernst Lamp Company of Pittsburg, Pa., hold the American patents, and have developed a very successful lamp. The lamp consists of units of one or more glowers, each rated at about 50-candle power, and used upon 110 to 220 volt alternating current. The lamp consists of: (1) the glower; (2) the steadying resistance; (3) the heater. The resistance of the glower decreases rapidly when heated, and upon a constant potential circuit would immediately burn up were it not for a resistance of iron wire whose resistance increases with the temperature, and which is adjusted to balance the decrease in resistance of the glower. The glower when cold is a non-conductor, and, therefore, must be heated by some source before it will conduct the current and maintain itself at the conducting temperature. The Nernst Lamp Company have arranged for this by surrounding or placing in close proximity to the glower a device called a heater, which consists of a coil of platinum wire so arranged that the current is first switched in to this wire, which in turn heats up the glower to the conducting point, and then the heater is automatically switched out.

On account of the very high temperature of the Nernst lamp glower the efficiency is very high. The light is very pleasing; in color it stands midway between the yellow and red rays of the incandescent carbon lamp, and the violet and blue of the arc lamp. It is, however, so dazzling white it is usually placed in ground glass globes.

The electric arc and incandescent lamps are the most efficient practical transformers of the energy of fuel and falling water to light which we have.

The following table gives the mechanical equivalent of the most common lights:

Candles	86	watts	per	candle.
Oil lamp	57	"	"	"
Petroleum lamp	48.8	"	"	"
Bats wing gas burner	93.2	"	"	"
Argand	68.8	"	"	"
Siemens intensive burner 230 candle power	45.6	"	"	"
Incandescent lamp 16 C. P.	3.5	"	"	"
Arc lamp	.8	"	"	"

The eye is affected by ether waves between .810 microns and .360 microns; 1 micron equals .001 millimetre. All vibrations of a wave-length above or below the points named do not affect the eye as light, and are, therefore, useless and represent so much wasted energy.

The quantity, therefore, of energy radiated from a source of light is composed of two parts: (1) the energy affecting the eye, or vibrations between the limits of .360 microns and .760 microns; (2) the vibrations above and below .360 Y and .760 Y and the total energy expended is $Z = X + Y$. Where X is energy producing visible rays, Y is energy producing invisible rays and Z is total energy expended.

The ratio $\frac{X}{Z}$ of the energy of the luminous radiators to that of the totality is called the optical efficiency of the source. There are two methods used in ascertaining this efficiency: First, passing the rays emitted by the source successively through a layer of bisulphide of carbon, which allows all rays to pass, and through an equal layer of alum solution, which allows only luminous rays to pass. The intensity of the radiators is measured by a thermo-electric pile. The second method, which is of great exactness, can be only employed for incandescent lamps. The lamp is placed in a calorimeter with the blackened copper sides filled with water. The whole of the heat radiated is absorbed by the water and metallic sides of the calorimeter. The elevation of temperature of the water is then measured in unit of time. The calorimeter is then replaced by one of thin glass, which in this case absorbs the obscure rays alone. It is said by this method an exactness of .3 per cent is easily obtained (Paliz).

The following table shows the results obtained by various authorities upon the optical efficiency of various sources of light:

Designation of light source	Per cent Optical Efficiency	Authority
Hydrogen flame	3.00	Tyndall
Oil lamp	3.00	"
Ordinary gas burner	4.00	"
Swan Lamp 16 C.P. run at 2.6 C.P.	2.3	Blattner
" " " " 9.2 "	2.8	"
" " " " 13.2 "	3.6	"
" " " " 20.6 "	5.2	"
Edison " " " 4 "	3.6	"
" " " " 8.3 "	4.5	"
" " " " 17 "	6.2	"
" " " " 28.6 "	8.5	"

Designation of light source	Per cent Optical Efficiency	Authority
Bernstein 32 C. P. run at 15 C. P.	4.2	Blattner
" " " " 30 "	6.5	"
" " " " 50 "	7.3	"
" " " " 90 "	9.9	"
Arc Lamp inclination 0°	8.4	Nankano
" " " 10°	12.4	"
" " " 20°	17.4	"
" " " 30°	18	"
" " " 40°	18.2	"
" " " 50°	19.8	"
" " " 60°	5.5	"
" " Spherical Efficiency	16.6	Nichols
Magnesium Lamp	15.	"
Geissler Tube	32.7	

Mechanical Equivalent of Light.

1 — candle power — { .2713 watt.
(Stillman { 12 foot lbs. per minute.
{ 720 foot lbs. per hour.

The low value of the common radiants is due to the fact that they are based upon the incandescence of carbon. We have made immense strides in the cheap production of electricity, but the advance in the transformation of the electric energy to light has not been so rapid. From the transformation of the energy of the coal to light through the medium of the furnace, steam boiler, and engine to electricity and to light, the greatest loss occurs in the last transformation, as the following example will show:

The ordinary steam boiler and furnace, when intelligently operated absorbs from 70 to 80 per cent of the heat energy of the coal, and in a modern triple expansion condensing engine will give or transform 15 per cent of the energy in the steam to mechanical, and in ordinary good practice will run from 2 to 3 pounds of coal per horsepower hour. The electrical generator will transform 92 to 93 per cent of the mechanical to electrical energy, and this will be delivered to consumers at 95 per cent, or a loss of 5 per cent.

We, therefore, will have delivered to the consumer approximately 10 per cent of the theoretical energy of the coal. If the conversion to light is through the medium of the incandescent lamp, we will throw away 95 per cent of this energy, and secure as light only $\frac{9.5}{100}$ or practically 1 per cent of the energy of the coal. Such are the extravagant methods of the 20th century in spite of our boasted progress.

ELECTRIC LIGHTING COMMERCIALLY.

A perfect light should possess the following qualities:

Purity.—It should not consume or pollute the air.

Brightness.—It should be soft and brilliant.

Cleanliness.—It should be harmless to furniture, books, pictures and decorations.

Coolness.—As it is light, and not heat, that is required, the less heat given off the nearer the light will approach perfection.

Convenience and Reliability.—It must be readily available whenever required, and self-lighting.

Easy Distribution.—It should be available wherever and in whatever quantity desired.

Safety.—It should be free from all risk of fire.

How far do the present illuminants, namely, gas, oil, and candles, comply with the foregoing conditions?

The following table shows the oxygen consumed, carbonic acid produced and air vitiated by the combustion of certain bodies producing the light of 12 standard candles each burning 120 grains per hour.

Light Producing Material Equal to 12 Standard Candles	Cubic Feet Oxygen Consumed	Cubic Feet Air Consumed	Cubic Feet Carbon Acid Produced	Cubic Feet Air Vitiated	Heat, lbs. of Water Raised 10° F.
Cannel Gas....	3.30	16.50	2.01	217.50	195.
Common Gas...	5.45	17.25	3.21	348.25	278.6
Sperm Oil.....	4.75	23.75	3.33	356.75	233.5
Benzole	4.46	22.30	3.54	376.30	232.6
Paraffin	6.81	34.05	4.50	484.05	361.9
Sperm Candles.	7.57	37.85	5.77	614.85	351.7
Wax	8.41	42.05	5.90	632.25	383.3
Tallow	12.	60.	8.73	933.	505.4
Electric	*None*	*None*	*None*	*None*	*13.8*

LIGHTING BY GAS.

In the production of light by illuminating gas, oxygen is consumed and carbonic acid gas is formed, a 12-candle-power gas burner consuming 5½ cubic feet of oxygen and forming 350 cubic feet of carbonic acid gas per hour. The heat produced by one ordinary gas jet in an hour increases the temperature of 280 pounds of water by 10° F. Gas also gives off a considerable amount of soot, as may be observed by holding a saucer over the flame. This illuminant has the disadvantage that it usually requires a match or taper to light it, but a pilot flame or an electric lighting device (q.v.) overcomes this defect. The light from the ordinary gas jet is not unpleasant, but its illuminating qualities are rather poor. The introduction of the Welsbach burner of recent years has, however, greatly improved the quality of gas as an illuminant, and has enabled gas to compete fairly successfully with electric lighting where otherwise its use would have been discontinued. Oil lamps and candles, although still largely used in many countries, can scarcely be compared with either electric light or gas as illuminants.

In the incandescent light is to be found almost a perfect light. Since it gives off no waste products of any kind, it has no deleterious effects upon the atmosphere of the rooms or buildings in which it may be utilized. Its light is white, soft, and brilliant, yet not dazzling. The lamp itself is also rather ornamental than otherwise, and it lends itself readily to external ornamentation without danger of fire, since of course it gives off no flame. Nevertheless, by way of caution it may be noted that, comparatively insignificant as is the heat which the incandescent lamp emanates through the glass bulb, it cannot be allowed to rest for an undue time in touching proximity to inflammable materials, since experiments have shown that when such a lamp is encased in two thicknesses of muslin for about six minutes, and fresh air is admitted to the interior, the muslin has burst into flame. Again, an article of celluloid pressed against the lamp for three minutes has ignited; and a newspaper, under similar conditions, ignited in three quarters of an hour.

For an equal candle-power, however, the heat given off by the incandescent light is only one twentieth that given off by gas, and about one fortieth that given off by tallow candles.

In the matter of convenience the incandescent lamp is practically superior to any lamp at all approaching it in illuminating qualities. The lamps can be placed in any position, pointing upward, downward, or horizontally. It requires neither match nor taper to light it. By its means a room can be lighted by the turn of a switch before entering and left in darkness on leaving it. The incandescent lamp is of course unaffected by drafts and if required will burn under water. For use in mines where explosive gases are to be feared this lamp is the only one that can be used with practically absolute safety.

WALTER H. JOHNSON,
President Electric Light Company, Philadelphia.

Electric Locomotives. The New York, New Haven & Hartford Railroad Company are now preparing for the electrical operation of the main line between New York city and Stamford, Conn., a distance of 33 miles. Between Woodlawn and Stamford the road is equipped with the Westinghouse single-phase, alternating current system, the trains being operated by electric locomotives which take alternating current from the overhead trolley line. The power equipment includes three Westinghouse-Parsons horizontal steam turbines driving 25 cycle, alternating current generators of the revolving field type, which have a rated continuous capacity of 3,750 kw. each, when running single phase, and 5,500 kw. when supplying a three-phase service. The generator armatures are designed for both single-phase and three-phase connection. They are wound for 11,000 volts, and are connected direct to the trolley system. No transforming stations or reducing transformers along the line are required, but the entire system is operated from a single central station without the interposition of substations or auxiliary apparatus of any kind between the switchboard and the cars. This desirable simplicity is made possible by the alternating-current system and the high trolley e.m.f. which is employed.

The New York Central & Hudson River Railroad Company has electrically equipped its New York terminal for a distance of 34 miles on the main line from Grand Central Station to Croton, and for 24 miles on the Hamilton Division as far as White Plains. All trains within this zone are hauled by electric locomotives of special construction, built by the General Electric Company and the American Locomotive Company. These locomotives are capable of regularly making the trip from the Grand Central Station to Croton, a distance of 34 miles, with a total weight of 435 tons, in 44 minutes without a stop. The heaviest of these trains weigh 875 tons and is drawn by two of these locomotives. Maximum speeds of from 60 to 65 miles per hour are attained. The designers have secured in these machines the best mechanical features of the high-speed steam locomotive combined with the enormous power and simplicity in control made possible by the use of the electric drive. The locomotive has four driving axles, on each side of which is mounted the armature of a gearless electric motor having a normal rating of 550 h.p. The total rated capacity of the locomotive is 2,200 h.p., although for short periods a considerably greater power may be developed, making it more powerful than the largest steam locomotive in existence The dimensions of the locomotive and other data regarding it are as follows:

Number of driving wheels	8
Number of truck wheels	4
Weight	95 tons
Weight on drivers	68 "
Wheel base, driving	13′
" " total	27′
Maximum tractive power (draw-bar pull)	34,000 lbs.
Tractive power per ton engine weight	330 "
Wheels, driving	44″
" engine truck	36″
Length over buffer platforms	37′
Extreme width	10′
Height to top of cab	14′ 4″
Diameter of driving axles	8.5″
Maximum power	3,000 h.p.
Speed, with 500 ton train	60 m.p.h.
Voltage	600
Normal full-load current	3,050 amperes
Maximum full-load current	4,300 amperes
Number of motors	4
Rating of each motor	550 h.p.

The motors mark a noteworthy departure from ordinary motor construction. The armatures are built directly upon the axles. The locomotive thus secures the advantage of direct application of power to the driving axles and avoids the losses of power in gear and pinion which are encountered in ordinary railway motors. There are only two pole pieces, which are practically part of the truck frame and have flat vertical faces. There is no necessity, therefore, of preserving a rigid alignment between armature and field, and the armature can have a large free vertical movement without danger of striking the pole pieces. The maximum weight of the motor, consisting of its field and frame, is carried with the truck frame upon the journal box springs outside of the driving wheels.

This construction, besides being strong and simple in design, greatly facilitates repairs and renewals, as an armature with its wheels and axle may be removed by lowering the complete element without disturbing the fields or any other part of the locomotive and a new element inserted in its place. All parts are also especially accessible for inspection and cleaning.

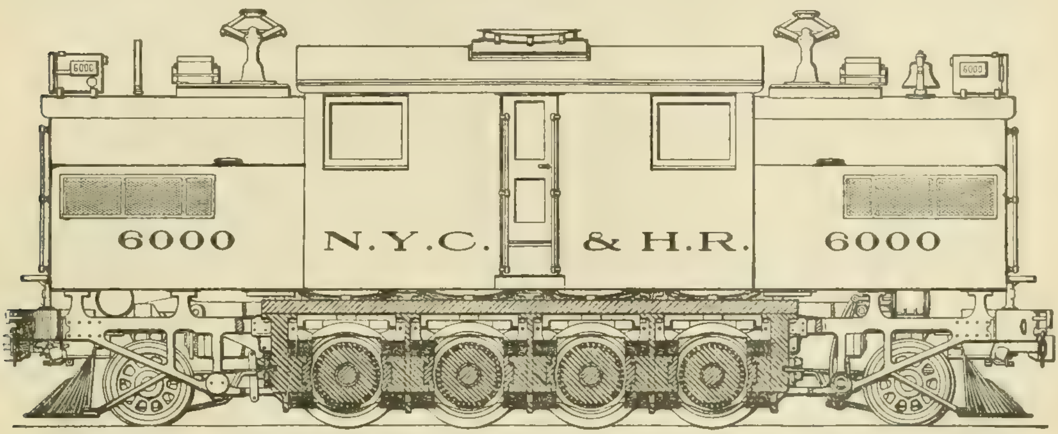
The dead weight on each driving axle is practically the same as on an ordinary steam locomotive, and is about 10 per cent. less than that on the heaviest types, while in addition, there is no unbalanced weight to produce vibration with attendant injuries to track and roadbed construction. The actual reduction in the expense of maintaining the rails and roadbed due to the absence of pounding and rolling will have an important bearing on the up-keep of the permanent way.

A longitudinal section of the locomotive frame is shown in the drawing. The main frame is of cast steel, and forms not only the mechanical frame of the locomotive, but also part of the magnetic circuit of the motors. The magnetic fields are arranged in tandem, the end pole pieces being cast as part of the end frames and the double pole pieces between the armatures being carried by heavy steel transoms bolted to the side frame and forming part of the magnetic circuit as well as cross-braces for the track. The field coils are wound upon metal spools which are bolted upon the pole pieces. Proper distribution and division of the weight of the locomotive among the axles is accomplished by suspending the main frame and superstructure from a system of half-elliptic springs and equalized levers of forged steel, the whole being so arranged as to cross-equalize the load and to furnish three points of support.

The method of control is the Sprague-General Electric multiple unit system. In this system the engineer handles a small controller, which operates the control circuit. The current in this control circuit operates in turn the main contractors, admitting current to the power circuit. The master controller is located in the motorman's cab, while the contractors are located in the spaces at the forward and rear ends of the locomotive. By use of this system two or more locomotives can be operated from the leading cab as a single unit. The motive power may, therefore, be easily adapted to the weight of the train. A single locomotive will be able to operate heavier trains with a single engine crew operating both locomotives simultaneously.

The control system permits three running connections; namely, four motors in series, two groups of two in series parallel, all four motors in parallel. The motor-reverser, contractors, rheostats, and other controlling appliances are all of the multiple unit type. The master controller, however, is fitted with a special operating lever about 4 inches long and capable of being moved through an angle of about 75 degrees. A current-limiting device is provided in the master controller and consists of a friction clutch operated by an electric magnet which is energized by the current passing through one of the motors, the arrangement being such that when the current exceeds a predetermined amount the cylinder cannot be rotated further until the current has fallen sufficiently to allow the relay to drop. As long as the current does not exceed the desired limit the automatic feature is not in operation.

The superstructure consists of a central cab for the operator, containing master controllers, engineer's valves for air brake, and switches and valves required for operating sanding, whistling, and bell-ringing devices. This apparatus is furnished in duplicate, one set on each side of the cab, and is arranged so as to be easily manipulated from the operator's seat, while at the same time a practically unobstructed view to front and rear may be obtained from the windows. The air gauge, meters, etc., are located so as to be easily read by the driver. There is a central corridor extending through the cab so as to permit access from the locomotive to the cars behind, and the contractors, rheostats, and reversers are arranged along the sides of the corridors in boxes of sheet steel which are sheathed on the inside with fireproof insulating material. In the operator's cab there is placed a motor-driven air compressor having a capacity of 75 cu. ft. of free air per minute. The compressor is controlled by a governor which automatically cuts the motors in and out of circuit when the air pressure falls below 125 lbs. or exceeds 135 lbs.



Longitudinal Section of Locomotive.

Current is collected from the third rail by multiple-contact spring-actuated third-rail shoes, the supports of which are carried on channel irons attached to the journal box. There are four of these shoes on each side of the locomotive. In the yards at the terminal the large number of switches and crossings necessitates an overhead construction in places, and additional contacts are, therefore, mounted on the top of the locomotive for collecting current when the locomotive is passing over these points. This device may be raised and lowered by air pressure controlled from the engineer's cab. A magnetic ribbon fuse is placed in circuit with each shoe and overhead contact device so as to secure protection in case of accidental short circuit.

The danger from fire and explosion is always present in the operation of a steam locomotive carrying fire under a forced draft, and a boiler charged with high-pressure steam. All such dangers are eliminated from the electric locomotive. The substitution of a simple rotating member in the electric locomotive for the cranks, side rods, pistons, and other parts connected with reciprocating motion in the steam locomotive diminishes the possibility of accident. The lack of vibration and the omission of boiler, firebox, high-pressure piping, valves, and reciprocating parts reduces to a minimum the wear and liability of breakdown.

The electric locomotive is easily controlled and operated, the crew is always free to watch the track and signals, and the locomotive itself is always ready for immediate service at any hour of the day. The crew of a steam locomotive, on the other hand, devotes a large part of its time during actual operation to attendance on fires, shoveling coal, and watching steam and water gauges, while a considerable portion of each day is wasted in getting up steam and waiting on side tracks or at coal chutes for taking on coal and water and cleaning fires. The resulting economies of time and labor tend materially to increase the daily mileage capacity of the electric locomotive and decrease its operating expense.

In the absence of noise and smoke the electric locomotive has an advantage that has long been recognized. This feature alone has caused its adoption in certain cases, such as switching around buildings, in city streets, or in tunnels. The New York Central and the Baltimore & Ohio installations are prominent examples in which this feature would have forced the adoption of the electric locomotive, even if no consideration of economy 'ad been present.

The electric locomotive is lighter for the same draw-bar pull, due to the fact that every wheel is usually a driver. The average steam locomotive carries only 40 to 60 per cent. of its weight on the drivers, so that for the same draw-bar pull the weight of the electric locomotive is about 50 per cent. of that of the steam locomotive. The cranks and side rods of a steam locomotive are balanced with counterbalancing weights on the drivers. If this balance is not carefully adjusted the resultant pounding on the track is destructive to rails and track alignment. As compared with this the decrease of maintenance of way chargeable to an electric locomotive of about half the weight of its steam competitor (with drivers which are naturally in balance) and exerting a uniform and steady torque, may be a very considerable item.

The great difference in the maintenance account of electric and steam locomotives is not generally appreciated. A steam locomotive seldom makes a run of more than 150 miles without going into the roundhouse, where it is subjected to a thorough examination by skilled mechanics. About once every year it is sent to the repair shop for a general overhauling and there tubes, crown sheets, guides, and other wearing parts are replaced. It is generally estimated that the average annual outlay for steam locomotive maintenance amounts to 5½ to 6½ cents per locomotive per mile run, or an average of $1,800 to $2,200 per annum per locomotive. An electric car making a daily mileage of 200 to 300 miles requires no attention except inspection of the car journals, and with this fact in mind it is easy to understand why the maintenance expense of electric locomotives is extremely low.

The steam locomotive is limited in power to the possible dimensions of its boiler and firebox and these in turn are limited by space between the driving wheels and permissible height of the centre of gravity above the rail head. The electric locomotive can be built to have far greater power than the steam locomotive without exceeding these limits and at the same time is able to use the power it exerts to better advantage, due to the uniform torque on its drivers, and the perfect control of its speed.

Trains of weights exceeding the normal can be handled only by double heading. With steam operation this requires two independent locomotives operated by separate crews. With electric operation the two locomotives are coupled together and operated as a single unit with but one engine crew. A good example of this is seen in the 160-ton Baltimore & Ohio locomotive. This locomotive is made of two similar units. Each unit may be used separately for light trains, while the two may be coupled together, making a single locomotive of twice the weight for heavier trains.

Excessively cold or windy weather hinders the operation of steam locomotives. In zero weather the radiation of heat from engine boilers reduces their steaming capacity so that heavy passenger trains can be operated only by double-heading, and even then are very often badly off schedule. No such radiation can occur with electric locomotives. The conductivity of feeders and wiring is so much improved at low temperatures that the efficiency of an electric system is noticeably higher in coldest weather.

One of the most important factors in increasing the economy of electric installations and the possibility of the substitution of electrical for steam operation of railways lies in the method of power generation. In this respect the recent development of the steam turbine has played an important part. The principal advantages of steam turbines for generating electricity are: Small floor space per kw. capacity, reducing to a minimum the cost of real estate and buildings; uniform angular velocity, thus facilitating the synchronizing and paralleling of alternators; simplicity in operation and low expense for attendance; entire freedom from vibration, and approximate noiselessness; small oil consumption; high steam economy at all loads; high steam economy with rapidly fluctuating loads; steam economy is not appreciably impaired by wear or lack of adjustment in long service; adapted to high steam pressure and high superheat without practical difficulty and with consequent improvement in economy; condensed water is kept entirely free from oil and can be returned to the boilers; ability to use steam from any stage of the turbine for heating without the troubles that such use on a large scale brings with compound reciprocating engines.

In the development of electric traction apparatus the knowledge to be gained from experiments under practical operating conditions is of special value. When a new railway motor control system or other part of railway equipment is designed it should be thoroughly tested and perfected before put into practical use. These tests should include operating tests on electric locomotives, heat runs on railway motors, tests of brakes, controllers and control systems, and of train resistance and wind effect. Interesting tests recently made to determine the relative merits of steam locomotives and electric motors for heavy traction work show that the electric motor can accelerate a given train more quickly than a steam locomotive with the same weight on drivers.

The General Electric compensated motor recently developed neutralizes or compensates for the armature reaction. With this motor it is possible to operate either on alternating or direct current, and the type of equipment which has been developed is capable of operating on 5,000 volts alternating current or 600 volts direct current. Thus, it is entirely practicable to operate suburban sections of a given line by a high-tension alternating current system, and, with the same cars and equipment, to run on the 600-volt direct current in towns. See the articles on the LOCOMOTIVE; also TRACTION, ELECTRIC; RAILWAY ROLLING STOCK.

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Electric Log, an electric circuit through the log-line to the detent of an escapement in the register-log, so that by touching a key on deck a circuit may be completed, an armature attracted, and thus the starting and stopping of the mechanical register in the log be exactly timed.

Electric Loom, electricity used as the motive power for a loom. In 1852, an electric loom was exhibited by Bonelli at Turin. The invention was at that time in a crude state, but has since been much improved. The object is to dispense with the perforated cards required in the Jacquard apparatus. See LOOM.

Electric Machine, or **Dynamo Static Machine** (now extensively employed in therapeutics), for exciting electricity by friction or by static electric induction, as distinguished from dynamo electric machines in which electricity is excited by cutting magnetic lines of force. The excitation of electricity by friction was observed by the ancients, and the origin of the term electricity is derived from the Greek word electrum, signifying amber, in which the attracting power of electricity after friction was first noticed. See ELECTRICITY, FRICTIONAL.

It was subsequently found that a glass rod or a rod of sealing wax also possessed this electrical property when rubbed. Later on, other methods of exciting static electricity, such as by the electrophorus, were discovered. Such methods were, however, slow and laborious and better devices were sought for, resulting in the development of two general types of dynamo static machines, namely, frictional machines and induction machines, the first representing the rubbed glass rod or wax type; the second, the electrophorus type. These machines provided means whereby the rubbing and the induction might be performed continuously and mechanically.

Frictional Electric Machine.— The first continuous frictional machine, due to Nairne, consisted of a glass bottle, or hollow cylinder, mounted on a horizontal axis, well insulated, and turned by a winch or handle on suitable supports. See Fig. 1. On one side of the cylinder and pressing firmly against it, is placed the "rubber," a cushion of leather, C, stuffed with horse-hair, and sometimes faced with silk. From the upper edge of the cushion a silk flap, S, passes over the cylinder, reaching half way round. A brass cylinder, or a wooden cylinder plated with metal, P, termed the prime conductor, supported by a glass or ebonite rod, R, is

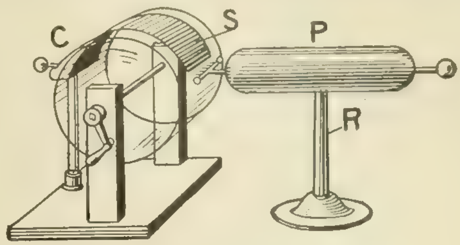

FIG. 1.—Cylinder Frictional Machine.

placed as shown. A metallic comb is attached to the left end of the prime conductor, as indicated in figure.

Before the machine is set in operation an amalgam of zinc and tin or other suitable metals, is sprinkled or pasted on the surface of the rubber. When the cylinder is turned electric sparks are seen and heard to play on the cylinder from the edge of the flap, negative electricity being accumulated on the amalgam surface and positive electricity on the surface of the cylinder, due to the friction between the glass and the amalgam coated surface of the rubber. As the cylinder is a non-conductor of electricity this positive charge is held on its surface until the cylinder in revolving brings it beneath the comb, where it acts inductively on the prime conductor, P, attracting negative electricity to its near end and repelling positive electricity to its far end; the negative electricity escaping across the points of the comb as an electrical breeze, or brush discharge, uniting with and neutralizing the positive electricity on the glass cylinder opposite the comb, which portion of the cylinder is then ready to take a positive charge as before when it again reaches the rubber. When the prime conductor by these successive charges of positive electricity has attained a high potential, sparks several inches in length will jump from its far end to the hand or any other ground connection. To obtain a continuous supply of electricity from the prime conductor, P, it is necessary to connect the rubber C to the ground, which is usually done by allowing a metal chain attached to a steel plate on the back of the cushion to lie on the floor or table; this permitting the negative electricity excited in the rubber to escape to earth. In this way also a negative stream of electricity may be drawn from the machine. The use of the amalgam on the rubber has the effect of largely increasing the conductivity of the cushion, and it also provides a substance between which and glass the surface friction for the exciting of static electricity is greater than that between leather and glass.

The quality of the glass used in electrical machines is important, that containing most silica, such as the material from which ordinary pale green bottles are made being most suitable for this purpose.

Plate Electric Machine.—This is another form of the frictional machine. The principle of its operation is the same as that of the cylinder machine just described. It consists of a circular plate of glass, or ebonite, E, Fig. 2, in place of the cylinder. Two sets of rubbers, S S, are placed on opposite sides of the plate, and as the plate is rotated positive electricity is developed on the glass, which is collected by the prime conductor P virtually as in the case of the cylinder machine.

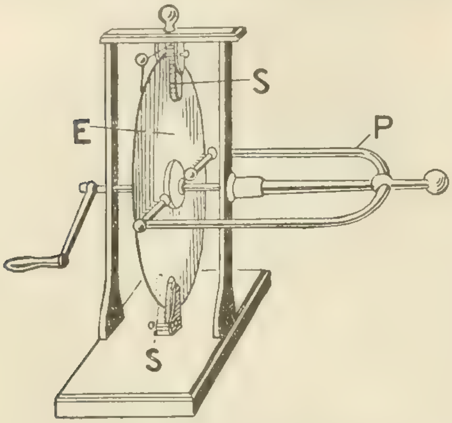

Fig. 2.—Plate Frictional Machine.

Static Electric Induction Machine.— These machines depend for their action upon static induction as exemplified in the case for example of the electrophorus which may be briefly described here.

Electrophorus.—A simple electrophorus consists of a cake of resin or vulcanite 12 or 15 inches in diameter and one inch thick, resting on a tin or iron plate. A disc of metal, termed the cover or carrier, somewhat smaller than the cake of resin, is provided with an insulating handle. When the cake is rubbed with dry flannel it becomes negatively electrified. If now the cover be placed on the cake, its positive electricity is attracted to the side of the cover next the cake. Now let the cover be touched by the finger and its negative electricity will escape to earth. If now the cover be lifted from the cake it will contain free positive electricity which may be used for charging a condenser or Leyden jar. The cover may again be placed on the cake and the foregoing process may be repeated a number of times before the charge in the resin will be entirely exhausted. The cake when electrified, with the disc in its place, and undisturbed, will retain its charge for weeks.

A number of induction machines based on the foregoing principle have been devised, among the best known being the Holtz and the Wimshurst, which are sometimes termed continuous electrophori.

Holtz's Electric Induction Machine.— This consists of two glass plates or discs about two feet in diameter, placed side by side and separated by a very small air space. One plate is fixed; the other is rotated, the fixed plate being slightly larger. The moving plate is mounted on a well-insulated axle. On diametrically opposite points of the fixed plate there are two sector-shaped holes or windows. On the back of the fixed plate, at the windows, are glued paper inductors or armatures, blunt tongues from which are caused to pass through the windows until they nearly touch the moving plate, which must be rotated in the direction opposite to that in which the tongues point. Opposite the inductors there are placed metal combs attached to brass rods or electrodes, which carry brass balls that at their terminals are movable to and from one another. In starting the machine the two balls are brought together and a negative charge from a rubbed ebonite rod is given to one of the inductors; then when the plate is rotated and the balls are separated, sparks jump across the space. The action of the machine is very complicated and need not be gone into here further than to say that in effect it is virtually similar to that of the electrophorus, the initial charge imparted to the armature inducing opposite electricity in the rotating disc, which in turn delivers a charge to the metal comb, which charge by successive charges as the disc rotates is augmented until it attains a potential of 50,000 volts and more. These discs are rotated at a speed varying from 120 to 450 revolutions per minute. See ELECTRO-THERAPEUTICS.

Wimshurst's Influence Machine.— This machine, due to Mr. James Wimshurst, is one of the most efficient and reliable of the induction electric machines. It consists of two glass discs, which in practice have varied in size from 14½ inches to 7 feet in diameter. These discs suitably mounted on insulated axles are placed side by side and both are rotated, but in opposite directions. On the outer surface of each disc thin metal strips, or sectors, M, are glued, as indicated in Fig. 3. Two adjustable metal

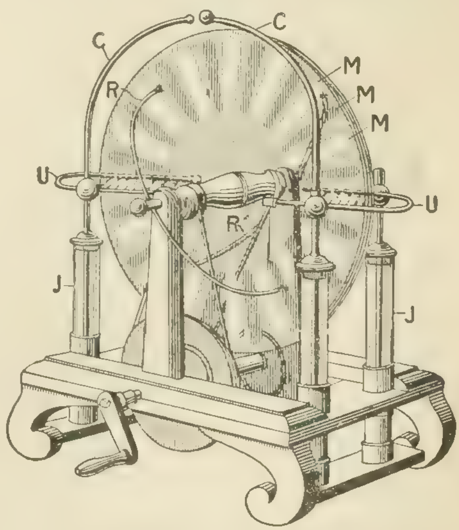

Fig. 3.—Wimshurst Electric Machine.

"neutralizing" rods R R, terminating in small brushes that glide over the metal strips, are supported as shown, at oblique angles to one another; one opposite each disc. *U*-shaped collectors, U U, carrying metal combs, diametrically opposite to one another, are metallically connected to the electrodes or prime conductors, C C. These collectors are supported on metal rods that rest in what are practically Leyden jars or condensers, J J. The best position of the brushes on rods, R R, relative to one another and to the combs is, like the brushes of dynamo electric machines, found by actual test to be virtually as shown in the figure. In practice the prime conductors are usually arranged as indicated in Figs. 4, 5.

The object in employing condensers, J J, is to add capacity to the prime conductors, thereby increasing the amount of electricity that can be accumulated, and hence increasing the energy of the discharge, and this use of condensers is common to all static electric machines. The action of this machine in operation is also complicated. The Wimshurst machine is self-exciting, that is, it starts without any externally applied electric charge, as is requisite with the Holtz machine. It has been thought that the initial charge is due to the friction of the air in the space between the two oppositely revolving plates, this space not exceeding one eighth of an inch. Apparently the metal sectors are the equivalent of the inductors in the Holtz machine; the neutralizing rods serving to allow the repelled electricity in one sector to escape to a diametrically opposite sector on the same plate, where it in turn acts inductively on the opposite sector on the opposite plate, the free electricity when it reaches the collectors being carried off as a discharge by the prime conductors. Frequently a small Wimshurst machine is used to excite a larger Holtz machine.

All static electric machines, owing to the high potentials which they develop, require extra precautions as regards insulation, even the damp atmosphere of a room preventing their successful operation. Some other insulating materials, such as ebonite and gutta-percha, are less hygroscopic than glass, but these materials are not so durable as glass; hence the latter is given the preference for the plates of these machines. But to add to their insulating qualities they are always covered with a shellac varnish, and are enclosed in a glass chamber or box from which moisture is extracted by sulphuric acid or other desiccators, contained in suitable vessels within the chamber. These machines are now usually operated by electric motors. Although the electromotive force developed by these machines is very high, the current, owing to the high resistance of the machines, is comparatively low. Thus tests have shown the output of a Holtz machine to be, with a six-inch spark, 71,000 volts and .00048 ampere, equal to 34 watts, and with a spark of 18 inches, 180,000 volts and .0002 ampere, equal to 36 watts (Sheldon). The efficiency of the machine is, in the first instance, 27 per cent, and in the second 19.5 per cent. The current is approximately directly proportional to the rotation of the plates. The Holtz machine and others of its type are continuous current machines, and at a given speed their current output and electromotive force are constant. By efficiency is meant the energy given out by the machine as compared with that expended in driving it. The efficiency of a dynamo electric machine is often over 90 per cent. The electric power expended in driving these machines, under test, was, in the first case, 126 watts, and in the second case, 180 watts. Later tests by Sheldon on other static machines show an efficiency of 40 to 46 per cent, with an output of 10 to 12 watts.

To increase the volume of current from static electric machines, the number of plates is increased. Hence machines of the Holtz and other more or less similar types are constructed with from say 6 revolving and 6 stationary plates to 16 revolving and 16 stationary plates, or more as may be desired. In many cases the stationary plates are square or oblong sheets of glass. For therapeutic purposes, machines giving at least a 12-inch spark are considered advisable. Plates made of micanite have been tried for static machines, but with some doubt as to their durability. See ELECTRO-THERAPEUTICS.

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Electric-magnetic Machine. There have been constructed a number of machines for the development of electricity by magnetism. These are termed "magneto-electric machines," and are largely used by the medical profession. See ELECTRO-THERAPEUTICS.

Electric Microphone. The principle of this instrument was discovered by Professor David E. Hughes, an American resident in London, who announced the discovery in a paper delivered before the Royal Society, London, in 1878. The microphone, as the name implies, largely amplifies sounds. It consists of a vertical carbon pencil pivoted loosely at both ends in solid carbon receptacles which are fastened to a thin sounding board, which board is suitably upheld by one edge on a solid block or base. When the carbon pencil is made part of an electric circuit in which are also a small battery and a telephone receiver, sounds are many times amplified; even a small cotton ball dropped on the block is heard in the telephone like a bullet falling on the floor. A number of theories have been advanced to explain the action of the microphone; one, adopted by the courts in this country in a case in which the validity of the Berliner telephone transmitter was an issue, being that the action is due to the remarkable effect of sonorous vibrations in varying the electrical resistance at a loose contact between solid electrodes. The most common form of carbon telephone transmitters in use to-day are varieties of the microphone. It may be added that Prof. Hughes gave this instrument to the world gratis. The principle of the microphone has also been utilized in a stethoscope.

Electric Motor, a machine by which electrical energy supplied from an external source is converted into mechanical energy. See DYNAMO; ELECTRIC MACHINE. Also ELECTRIC ALTERNATING CURRENT MACHINERY.

Electric Navigation. Vessels of small draft are now propelled by electricity. The power drives a motor, which actuates a screw propeller. The current is generally supplied by a storage battery. From their noiselessness electric boats are peculiarly available for nocturnal torpedo operations, and the universal equipment of modern warships with electric lighting and power plants makes their use possible at all points. This type is often termed an electric launch, and most or all electric boats fall under this category.

Electric Pendulum, a form of electroscope consisting of a pith ball suspended by a non-conducting thread.

Electric Phonograph. See PHONOGRAPH

Electric Police Signals. See ELECTRIC SIGNALING.

Electric Power. See DYNAMO; POWER.

Electric Railroad. See TRACTION, ELECTRICAL.

Electric Railroad Block Signals. See ELECTRIC SIGNALING; RAILWAY BLOCK SIGNALS.

Electric Repulsion, the mutual tendency of similarly electrified bodies, or similar electric charges, to repel one another.

Electrics and Non-electrics. The chief work of the earliest experimenters in electricity was to divide bodies into electrics, which they could excite by friction, like amber; and non-electrics, such as the metals, which they could not so excite. These names were given to the two classes by Gilbert of Colchester (1600). But Du Fay (1733–45) showed that electrics are identical with non-conductors, and non-electrics with conductors; and that the reason why non-electrics did not exhibit excitement by friction was that the electricity was conducted away from them as fast as it was produced. The distinction was thus broken down.

Electric Signaling. While it is true in a broad sense that any method of communicating intelligence to a distance is embraced in the term telegraphy, in the present instance the term electric signaling will be employed to cover the signaling systems and methods described in this article. This term is perhaps the more appropriate inasmuch as certain of the systems to be outlined in reality partake more of the nature of mere signals than of a means of transmitting intelligence as that term is generally understood. Almost without exception electro-magnetism is employed in the operation of electric signals. See ELECTRO-MAGNETISM.

The Electric Door Bell.— This is perhaps the best known and one of the simplest methods of electric signaling. In its operation it employs a primary battery, a push button at the door, a vibrating bell within the house, and a wire connecting the push button and the bell. The bell and its armature, the connecting wire, the push button and the battery comprise the electric circuit. The push button is merely a key consisting of two strips of metal which when pressed together allows the current to flow. The electric bell consists of a coil of wire wound around a soft iron core. Its armature carries at its free end a small hammer which, when the armature is attracted, strikes against a small gong, ringing it. The vibration of the hammer is brought about by a very simple device. Normally the armature rests against a contact point which is a part of the circuit; the armature itself also being a part of the circuit. The circuit is normally open at the push button. When this button is pressed the circuit is closed and the armature of the bell is forthwith attracted, its hammer striking the gong at that instant. In the act of moving forward, however, the armature leaves the contact point against which it had been resting, with the result that the circuit is opened at that point. This has the effect of permitting the iron of the bell to lose its magnetism, whereupon the armature falls upon its contact point, again closing the circuit with the result that the armature is again attracted, which action is continuously repeated so long as the push button is pressed in. A small spiral or tension spring suffices to keep the push button normally open. See ELECTRIC BELL.

Annunciator Signals.— The "annunciator" or call-bell systems so generally used in hotels and offices utilize the principle of the door bell. Annunciator systems in fact might be termed multiple electric door-bell systems. Usually a wire runs from each room to a central point or office where the annunciator is placed. This annunciator contains within its case a small electro-magnet for each room. One battery is caused to supply the current for all the circuits by simply connecting the wire from each room to the terminals of the battery. In a similar way one bell at the annunciator is caused to respond to all the calls that come. The armature of each electro-magnet within the case carries a small shutter, on which is placed the number or letter of the room with which it is connected. This shutter is held out of sight by means of a small catch hook attached to the armature of the magnet until the push-button in a given room is pressed, whereupon the armature is attracted, releasing the shutter, which instantly drops, showing the number. At the same time the annunciator bell rings, directing the attention of the clerk to the call. In other forms of annunciators the falling of the armature is caused to deflect a small arrow on the face of the case, beneath where is marked the number, name or letter of the room. There may be almost any number of rooms from 1 up to 100 or more connected with one annunciator. In practice one wire is usually run from the battery and annunciator to each room. This is called the "common return" wire. A separate wire, as stated, in addition is run from each room from the common return wire through the push button to the electro-magnet in the annunciator, thereby supplying a separate circuit for each room.

Burglar Alarm Signals.—For simple domestic purposes the arrangement employed for burglar alarm signals is also closely akin to the systems just described, the main difference being that the finger push-button is displaced by a circuit closing contact in the frame of a window or the jamb of a door. To bring about the result desired the circuit closer is placed on the frame of the window in such a way that the movable portion of the circuit closer projects beyond the surface of the window frame. The contacts of the circuit closer are held apart normally by a simple spring. In order that when the window is closed this projection may not be depressed, a piece is cut out off the window sash at a point directly opposite the projecting circuit closer. In an analogous manner the circuit closer is attached to a door jamb. The wires leading to the circuit closer are concealed behind the woodwork. When a window is raised or a door is opened by an intruder the contact points of the circuit closer are brought together, whereupon the annunciator bell is rung, giving the alarm, and at the same time the room where the door or window has been opened is indicated by the dropping of the corresponding shutter in the annunciator. The annunciator is located in any desired part of the house, usually in a bedroom. The method described is termed an open circuit method. In such systems what is known as open circuit batteries, such as the ordinary dry batteries, or the wet Leclanché batteries may be used. In some cases, to guard against a momentary opening of a door or window, such as would only occasion a short ring of the alarm bell, not sufficient perhaps to arouse a sleeper, an auxiliary arrangement is provided at the annunciator consisting of a drop arranged to close the bell circuit continuously until the drop is re-set. A small switch is provided near the annunciator by means of which the alarm circuit may be opened during the day-time so that needless alarm may not be given by the ordinary opening of windows. Other switches are also used for the purpose of testing the various circuits to see that they are in proper working condition. See Electric Annunciator.

Central Office Burglar Alarm System.—This system, as the name implies, relates to one in which the ringing of an electro-magnetic alarm in a central office will announce the presence of intruders in the building or buildings in which the protecting apparatus is installed. The central office may be any convenient distance from the protected buildings. These systems are frequently termed electric protective systems. The plan usually adopted is to run a net-work of wires through partitions, across floors, skylights, etc. These wires are part of a circuit extending to the central office, and the said wires are so connected with the circuit that any interference with them, after they have been "set," will cut out a high resistance, consisting of a coil of wire, suitably placed in the circuit of the protected building. The cutting out or short-circuiting of this resistance will so increase the strength of the current in the circuit as to operate a "double-balanced" instrument in the central office. If on the other hand the resistance is not "cut out," but instead the wires of the circuit be cut or broken, by accident or design on the part of intruders, the consequent absence of current, or even a slight decrease of current, will likewise cause an alarm in the central station. The double-balanced instrument at the central office is usually a relay, the armature of which carries a needle that normally stands at a zero point, from which point it may be deflected in either direction. An increase of current on the circuit deflects it in one direction — a decrease of current allows a spring or weight to deflect it in the other direction. In either case the alarm is given when the needle moves and an attendant is despatched to the premises from which the alarm has emanated. Each relay is of course suitably numbered or otherwise designated in the central office so that the building with which it is connected is known.

Telegraph Message Service or Emergency Signals.—This service relates to the supplying or calling of messengers, policemen, firemen, etc., at the call of or by a "subscriber," in whose house or office a "call box" has been placed. This call box is electrically connected by means of a wire with a central office at which the messengers are located, and from which office communication with police and fire headquarters can quickly be made. Each call box is numbered and is supplied with what are termed "make and break" attachments which are set in operation by the turning of a crank on the cover of the box. These attachments, when thus operated, transmit automatically to the central office the number of the box, which at once indicates to that office the location of the signaling box. The construction and operation of the call box are as follows: A crank is mounted rigidly with a recoil spring on a shaft. On this shaft is also mounted, but loosely, a cog-wheel. A "break-wheel," having a number of slots in its periphery, is geared with the cog-wheel in such a manner that it receives a tendency to turn in a given direction, but it is normally prevented from turning by the engagement of a pin on its side with a curved cam which is attached to a prolongation of the crank arm. When, however, the crank lever is turned to, say the right, preparatory to sending in a call, the cam is automatically moved out of the path of the said pin and the break-wheel is then free to move. By a suitable pawl and ratchet, the cog-wheel is prevented from moving when the crank is turned to the right. The effect of turning the crank is to wind the recoil spring. When the crank is let go the spring unwinds and turns with it the break-wheel which completes a revolution; at the end of which it is again held by the pin as before. The break-wheel is made part of the circuit leading from the box to the central office. A flat metal spring which is also part of the said circuit rests on the periphery of the break-wheel in such a manner that when the wheel is making its revolution the spring falls into the slots on the said periphery and opens the circuit as many times as there are slots provided. If, for instance, the number of a given box is 24, there will be cut on the periphery two slots in close succession, then an interval of unbroken metal surface followed by four slots in succession. The circuit in such a case, as the wheel rotates, will be opened twice in succession, closed for an interval, and then opened four times in succession, with the result that a bell at the central office will give out, first two strokes, and then four strokes, on its gong. A large number of such boxes can be placed on one circuit without causing confusion. The call box just described suffices to send in a swift call for a messenger. When it is desired to make it possible to call a policeman, doctor or fireman by the same type of box, it is provided with a "stop" that projects through the cover in such a way that the crank cannot be moved beyond a certain point. The ordinary position of the "stop" would be at the messenger call, in which case the number of the box only would be sent in when the crank is turned. If, however, a doctor should be desired, the stop is moved to a point marked "doctor," on the cover of the box and in turning the crank it is moved up to that point. This farther movement of the crank has the effect of bringing into operation one or more additional slots on the periphery of the break-wheel in consequence of which the box number is preceded by one or more single strokes on the bell, which indicate to the central office attendant that a doctor, fireman or policeman, as the case may be, is desired.

Fire Alarm Telegraph Signals.— The importance of electricity as a time saver in announcing the existence of a fire can scarcely be overestimated. A special feature of the electric fire-alarm system is that it not only gives the alarm, but also indicates to the firemen the location of the fire, or within a very short distance thereof. It may be noted that a simple fire alarm system is in many respects similar to the systems just described, in that it consists of a central office or station in which alarm apparatus and battery are located, and of signal boxes in the street and elsewhere by which to transmit alarms to the central office. A wire connects the central station with the various signal boxes in the streets and fire-engine stations. In each signal box is placed a break-wheel, practically similar to that used in the call-boxes of the district messenger or emergency service; the main difference being that owing to the more exposed position of the fire alarm boxes, and their greater relative importance, more substantial boxes are employed. In general these signal boxes are supplied with an inner and outer door to protect the apparatus from the elements. The signal boxes are provided with a crank or a hook which on being operated causes an alarm to be sent to the central station giving the number of the box from which the call has emanated. The signal box is also provided with a small electric gong, which rings each time the circuit is opened. This intimates to the one sending in the alarm that the alarm is being properly transmitted. It also serves the purpose of intimating to any one who might open an adjacent box to send in an alarm therefrom, that the alarm is already being sent, thus preventing interference. At the central station and the various fire stations a gong is struck a number of times corresponding with the number of the box from which the alarm emanates. In the same circuit also an ink-recording register in the central office marks on a paper strip the number of the signaling box, thus giving a permanent record of such alarm. Inasmuch as it is not good practice to put more than 25 or 30 signal boxes on one circuit, but yet is very important that all the fire stations in a given district should receive the alarm, a repeating device is utilized at the central station which receives the alarm from any one of the circuits and thereupon repeats it automatically or manually to all the other circuits.

Automatic Fire Alarm Signals.— In many of the large cities of the United States an auxiliary to the regular fire alarm system, consisting of some form of thermostat included in a circuit in the building to be protected, is employed. This system again is somewhat analogous to the messenger telegraph system described, the chief difference being that in the one case the signal box is manually operated, while in the other case an increase of temperature, due to fire, by affecting the thermostat causes the alarm to be transmitted. Thermostats are of different types. One type consists of a crescent-shaped spring, made up of two strips of metal, steel and copper, one over the other. One end of the spring or strips is fastened to a support, the other end is adjacent to a contact point of an electric circuit. As the metals named do not expand equally under increased temperature the spring as a whole bends when the temperature increases, and the movable end makes connection with the contact, thereby closing the alarm circuit with the result desired. Other types of thermostats are made of easily fusible alloys. Still another form of thermostat consists of a drum-shaped box, holding substances which have a high expansion under increased temperature. The expansion causes the ends of the box to bulge, thereby closing an alarm circuit.

Police Electric Signals.— These may be considered as more or less amplified fire alarm systems, consisting as they do of signal boxes placed on poles and in booths along the routes of the policemen; from which boxes signals of all kinds may be transmitted to and from police headquarters. The signal boxes are connected by a suitable wire with headquarters; and each box has a break wheel, carrying the number of the box. A telephone outfit is also placed in the box by means of which the policemen may converse with the main station. In fact the telephone is used nearly exclusively, the policeman as he arrives at a signal box sending in a signal which intimates to the attendant at headquarters the number of the box at which he has arrived in the course of his beat, whereupon the attendant communicates with the policeman and takes his number, thus getting a record of his whereabouts. If the officer desires to send in a special signal of any kind, as for an ambulance or wagon, or for assistance, he can do so by a special arrangement within the box. In some cities certain citizens are supplied with keys of the signal boxes. Such citizens are authorized to send in signals for police assistance in cases of emergency, and thus the police force is practically augmented by a volunteer service.

Railway Electric Block Signals.— A block system in brief consists of a means of showing manually or automatically certain signals which indicate to the engineer of a train that a certain portion or section of the track before him is "clear" or occupied. The road is divided into sections or blocks which are of various lengths depending in a great measure on the topography of the route, and the amount of traffic. The length of a block varies from 600 feet to several miles. The signals employed in a "block" are either "safety," "caution," or "danger," represented by a white light or sign, a green light or sign, and a red light or sign, respectively. The sign usually consists of the well-known semaphore arm. In automatic electric systems the circuits and apparatus are generally so arranged that the entrance of a train to a "block" sets the danger signal and that signal is displayed until the train passes out of that block into the next, when the danger signal is lowered and the caution signal is shown. When the train passes into a second block ahead the caution signal is lowered and safety is shown. The part assigned to electricity in the operation of these signals consists generally of actuating electro-magnets which are placed in circuits capable of being opened, closed or short-circuited by the signal or car wheels of a train, which electro-magnets are caused directly or indirectly to operate the various signals. In what is known as the Union Switch and Signal Block system, the semaphores are operated against gravity or a counterpoise by compressed air. This air is compressed by a compressor and is conveyed along the track in an iron pipe. A cylinder and piston are suitably arranged on each semaphore pole, the piston being attached to the semaphore arm in such a way that it may operate the arm as the piston rises and falls. The compressed air is let into the cylinder by valves under control of electro-magnets, which in turn are controlled by the track circuits, the latter, as stated, being controlled by the car wheels of a train. The compressed air effects the downward movement of the semaphores against the weight of a counterpoise. At this time the signal is at safety. If therefore the air supply fails or the electric apparatus or valves in any way become inoperative, the counterpoise brings the semaphore to the danger position. Another electric block system, known as the Hall Railway Signal System, uses a disk enclosed in a drum-shaped box on the top of a pole. This disk is operated by an electromagnet, the latter being attracted by an electric current which is under control of the engine, the latter operating, as it passes, a heavy circuit closer by the side of the track. There is one of these circuit closers at the beginning and end of a block. The engine thus sets the signal to danger as it comes into a block and sets it at clear as it leaves the block. In the more recent installations of electric block systems the semaphores are operated by electric motors contained in the base of the semaphore pole. These motors do away with the need of compressed air. A device named the Miller Cab signal is different from the foregoing systems. It consists of suitable apparatus and battery for operating certain electric lights in the engine cab. Normally a white light is burning, but when there is another train on the block in which the train enters, the circuits are so operated that the white light is cut out of the circuit and a red light is lit up in its place. This of course notifies the engineer of the near proximity of another train. See RAILWAY SIGNALS.

For a more detailed and illustrated account of the foregoing systems, the reader may be referred to the author's 'American Telegraphy and Encyclopædia of the Telegraph.'

WILLIAM MAVER, JR.,
Author of 'American Telegraphy.'

Electric Smelting. See METALLURGY.

Electric Storage Battery, The. The principle of the electric storage battery was known as far back as 1801, for in that year Gautherot discovered the secondary current obtained from a cell which consisted of two silver or platinum electrodes immersed in a common salt solution. He first charged the cell by passing a current through it ; then breaking the charging current, he connected the two plates to the terminals of a galvanometer and obtained a momentary deflection, indicating a flow of current in the reverse direction to the original charging current. This, then, may be said to have been the discovery of the principle of the storage battery, but it was nothing more, since 41 years elapsed before anything noteworthy, more, was done toward its development. In 1842, however, Sir William Grove constructed his famous gas battery, which was a long step ahead in the direction of a commercial accumulator. Grove's battery consisted of a pair of platinum strips immersed in dilute sulphuric acid, each strip surrounded on the top and sides by a closed glass tube which collected the gas developed in charge, and kept each gas in contact both with its respective electrode, and with some of the adjoining acid surface. If this apparatus, after having current passed through it for some time, be connected to a galvanometer, it will yield a small current in the reverse direction for a considerable time, or until the oxygen and hydrogen developed by the charge have gradually become absorbed by the platinum and have recombined to form water. It will be seen that this cell was a very great advance over the experiment of Gautherot, but yet it was absolutely without practical value as a storage battery, and a great deal of thought and labor expended since Grove's time have failed to further develop it.

It remained for one Gaston Planté, a Frenchman, in 1860, to make the one more important step which immediately demonstrated the wonderful possibilities of the storage battery, and which set other inventors to work all over the world. His experiment consisted in making a cell which had lead strips instead of platinum, immersed in dilute sulphuric acid, as was used by Gautherot; this cell being charged by a current would yield a very considerable reverse or «secondary» current. Planté's important discovery, however, was that each time such a cell was charged and discharged the amount of the secondary current, or the «capacity,» of the cell increased ; and further experiments showed that by not merely discharging the cell but by charging it up in the reverse direction each time, the capacity was brought up even more rapidly. Planté was thus enabled to make secondary cells having enough capacity to give them great commercial importance, and since the changes and improvements which have been introduced since his time are all directly along the same lines and all involve the same fundamental principles, it is eminently fitting and proper that to Planté has been attributed the honor of inventing the storage battery. Examining his results carefully, Planté found that the lead plate which was connected to the carbon or negative pole of the primary battery, became coated with a film of dark brown peroxide of lead, and the lead plate connected to the zinc terminal of his primary cell was coated with spongy metallic lead. Each time the current in the secondary cell was reversed a little more of the solid metallic lead of the plate became peroxidized, and the gradual accumulation of this film of «active material» on both plates, caused the increase in capacity. Planté arranged a large series of cells through which he continually passed a current, first in one direction, then in the other, the duration of the charges gradually increasing, and by this treatment, in course of time, his plates accumulated a considerable thickness of active porous lead and lead peroxide upon their respective surfaces, and after one or two months of the treatment (which he called formation) were ready to be used. It will readily be seen that this forming process for converting the solid lead into active material was very troublesome and expensive, and it was in overcoming this difficulty that the next great step ahead was taken. While Planté's batteries might have been of great commercial value, the very limited use of electricity at that time necessarily curtailed its usefulness very much, and it was not until the development of the dynamo that the real need for a storage battery was felt. It was in response to this need that Camille A. Faure, in 1881, patented a method for making storage batteries, by which the long forming process of Planté was entirely obviated. Instead of chemically attacking the surface of the metallic lead plate, Faure covered the surface with lead oxide in the first instance. A single charge then was sufficient to convert this into lead peroxide upon the one plate and metallic lead upon the other. This invention, which is virtually the last great stride toward the perfection of the storage battery, is commonly credited to Faure, but incorrectly so, since Charles F. Brush, in America, working independently of Faure, arrived at the same principle at almost the same time, so that in this country priority was given to him, and it is Brush's patent which has ever since controlled the so-called "pasted" plate throughout the United States. All battery plates made to this day are either after the Planté type, where part of the metallic lead plate is chemically acted upon to produce the active material, or else after the Faure-Brush, or pasted type, where the active material, usually in the form of an oxide of lead, forms an integral part of the original plate. It must not be understood from this that no improvements have been made in recent years, but rather that each improvement taken singly has been of relatively small importance, and that the vast number of these, and the constant perfection of detail, have collectively made an immense difference to its practical performance.

a few years' experience it was found that neither of these two expedients was sufficient for practical purposes, and many inventors set to work to construct grids which would effectively retain the active material, and particularly the lead peroxide upon the positive plates. The number of different forms of grid thus brought out almost surpasses belief, and a few only of the most important are here illustrated (Figs. 1 to 9).

These examples, selected from among the types of pasted plates which have been most successful, show the general tendency toward that construction of grid which will have the best grip upon the active material and which will make it as difficult as possible for the latter either to lose electrical contact with the grid or to fall to the bottom of the cell. In some cases, as the Tudor plates illustrated, the grids after being cast have been passed through rolls which turn over a part of each fin so as to give it a grip on the material; in other cases the grids

Fig. 1.— Faure.

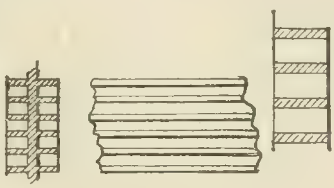


Fig. 2.— Brush.

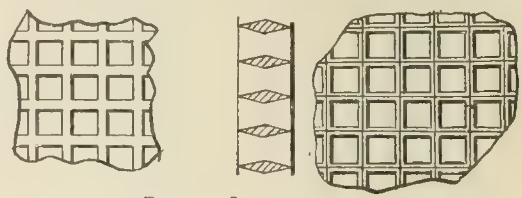


Fig. 3.— Swan.

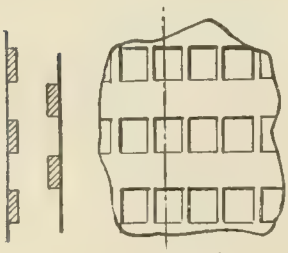


Fig. 4.— Bradbury & Stone.

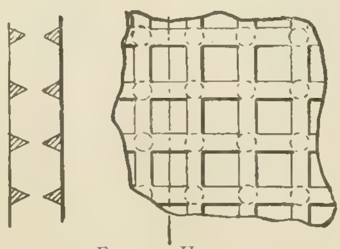


Fig. 5.— Hagen.

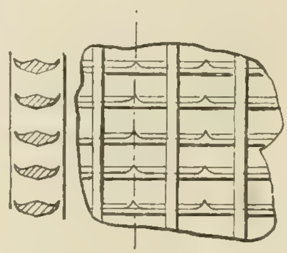


Fig. 6.— Tudor.

Figs. 1 to 12 are types of grid for pasted plates. Shaded portions represent lead, unshaded portions active material.

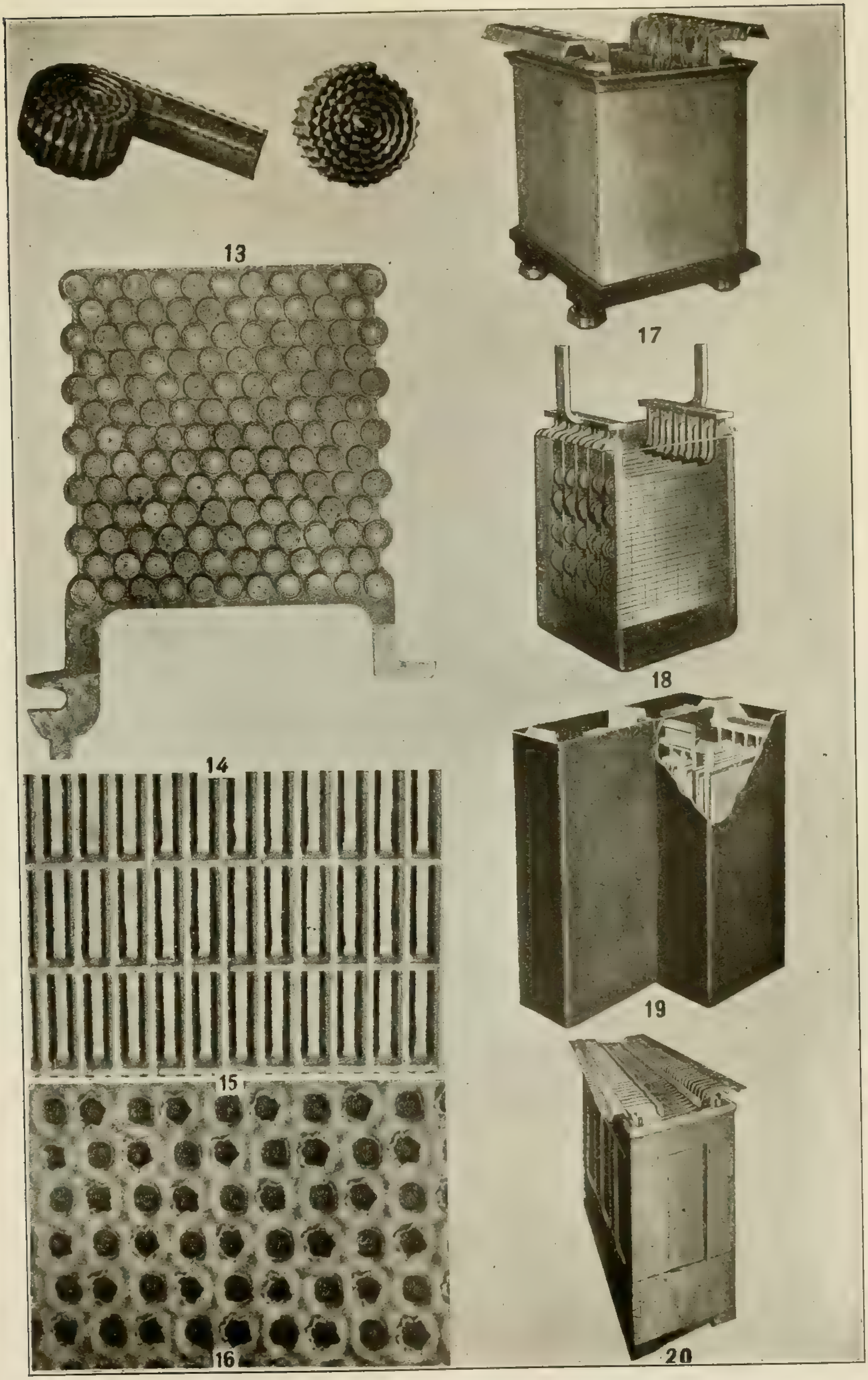
Some of these refinements of design and detail are as follows :

Faure's original plates consisted of plain sheets of lead, sometimes roughened on the surface, upon which was spread or pasted the lead oxide intended to become active material. It was soon found, however, that in practice this arrangement was entirely inadequate, since the lead peroxide on the positive plate quickly lost its hold upon the supporting sheet and fell away from it.

In order to meet this difficulty, Swan, in England, and Brush, in America, at about the same time, devised a variety of grid plates, whose object was to provide means of locking the material fast. These grids were either like a flat plate with a number of deep grooves extending into its surface (Fig. 2), or else like a flat plate having a number of holes entirely through it (Fig. 3) ; the lead oxide intended to become active material being worked into the openings in either case and there held by the large surface of contact with the grid. But with

have been cast with holes bigger in the middle section than at either surface ; and in still others, notably the chloride plate, the active material made into small blocks has been placed in the mold and the lead grid cast around it. Finally in the latest type of pasted plate two grids, each having a perforated sheet of lead cast on one side are riveted together with the sheet of lead on the outside, thus forming a number of completely enclosed pockets which hold the active material (Fig. 9).

Quite soon after the storage battery came into extensive use it began to be found that in spite of all possible precautions in the design of the grids, the peroxide of lead on the positive plates would always become soft on the surface and would gradually wash away, leaving the empty grid with little or no capacity. This inherent defect of the pasted positive led manufacturers to seek a remedy in the older or Planté type for their positives, and in this they were so successful that except for small batteries for automobiles and some few other cases



For explanation of figures, see article.

where lightness is a great factor, the Planté type of positive is now always used. Its advantages consist in the facts that, (1) the peroxide being a very thin layer and very close grained, and also being protected from the wash of the electrolyte by reason of its location in the grooves or interstices of the plate, is not readily

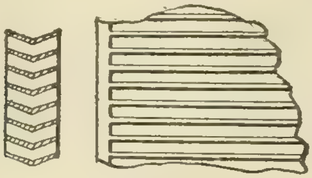


FIG. 7.— Winkler.

washed away as is the material of a pasted plate; and (2) that as the peroxide becomes very gradually disintegrated through use its place is continually filled by the fresh peroxide slowly "formed" by the working of the cell upon the surface of the main grid. The pure Planté plate made by casting a grid with very fine channels extending from one side to the other (Fig. 10), is the standard on the continent of

rugations being put on by a pair of toothed rolls.

The Planté plates consisting entirely of soft lead, are made by several different processes; by sawing the slots on both sides; by working into the surface a number of steel disks which cut into and squeeze out the metal between them, but do not remove any; by working over the surface with a sharp tool which takes a series of cuts, each time turning up a shaving at right angles to the surface but not detaching it; by rolling the lead between suitable corrugated rolls; and lastly by casting. The casting process is by far the best of all these, since it is the only one by which the plate can be made with stiffening ribs around the edges or wherever else desired. The product of all these processes is a flat plate from one quarter to a half inch in thickness, composed of a number of thin leaves lying in planes at right angles to the plane of the plate and spaced between 15 and 35 per inch, exposing to the acid a surface from five to ten times that of a plain plate of the same outside dimensions.

As the positive plates made after Planté's method came into increasing demand, manufacturers found that the process of forma-

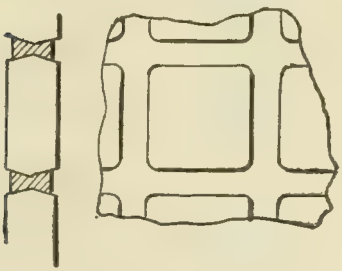


FIG. 8.— Chloride.

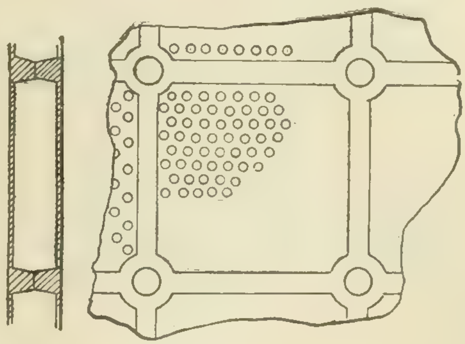


FIG. 9.— Box.

Europe, it having but the one fault, liability to become bent or "buckled" with use, to the extreme detriment of the battery.

In America, however, the type known as the "Manchester" positive has been the most successful. This plate with its prototypes is here illustrated (Figs. 11 to 14), and its distinctive feature is the combination of a stiff alloy grid with pure lead spirals or buttons, which furnish the active material. Since the peroxide of lead is "formed" by an electro-chemical process from the pure lead buttons, this plate is distinctly of the Planté type, but having the great advantage that it is very stiff and practically free from buckling, and its consequent evils, which are so common with the soft lead type. The grid for the Manchester plate is a casting of lead-antimony alloy, having a number of holes three quarters of an inch in diameter, placed as close together as possible and extending all the way through. Into each hole is forced a "button" of pure lead which offers a large surface to the acid; each lead button is made by coiling up a piece of transversely corrugated lead strip or ribbon, made by forcing solid lead under pressure through a suitable slot or die; the cor-

tion was exceedingly slow and expensive and hence they set to work to try to cheapen it. To this end they subjected the plates to be formed to the action of some chemical which would easily attack the surface and leave there a porous layer of a lead salt which could readily be "formed" into peroxide by the oxidizing agency of an electric current. Swan thus exposed his plates to the action of acetic and carbonic acid fumes, and thus covered his surfaces with white lead, while Dujardin dipped his plates into nitric acid and thus formed a layer of lead nitrate; the plates covered with a layer by either of these processes were set up in dilute sulphuric acid and there subjected to the action of a current which converted the porous layer into peroxide. It was soon discovered after this, that these two operations could be carried out together, and that it was thus possible, by adding a suitable amount of nitric acid to the sulphuric acid electrolyte, to form lead nitrate on the surface of the plate and simultaneously by the passage of a continuous current to oxidize the nitrate to lead peroxide. It is now known that the addition of almost any solvent of lead to a sulphuric acid electrolyte will very greatly facilitate the forming of plates therein, so that the process which took Planté several months is now done in as many days, nitric acid being the solvent most commonly used.

It has been stated above that the Faure, or pasted type of positive plate, is now used only for automobile work, where lightness is a primary factor, and as illustration of a plate of this kind, the so-called "exide" may be cited (Fig. 15). The grid, as will be seen, consists of a number of small lead alloy bars running parallel, and placed at the two surfaces of the plate in such manner that a bar on one side comes opposite to a blank space on the other. The active material inside the bars is held in so tightly that it can work out only as it disintegrates into very fine particles, as is normally incident to its use ; and moreover, the wash of the electrolyte in the cell is much lessened by the lead bars on the surface of the plate.

The life of any plate of this kind is not so long as that of the Planté plate, but its capacity for the same weight is considerably higher, so that for the class of work mentioned it fills a very important place.

In the early days of storage batteries both Planté and Faure used positive and negative plates of identical construction, and any form of positive described above may be used as a negative ; but the conditions under which the two plates operate are so different that it is now almost universal to use a special design for each. The main difference is that the metallic sponge lead constituting the negative active

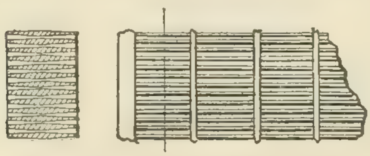


Fig. 10.— Tudor Positive.

material is quite a tenacious substance compared to lead peroxide, and consequently it does not yield to the wash of the electrolyte, and only in cases of the most flagrant abuse does it ever become softened so as to drop off from the grid. Under these circumstances, many of the grids (Figs. 1 to 9) which are quite inadequate to retain the lead peroxide of a positive plate are quite capable of making good negatives, and are in fact so used. The two forms of exide grid (Figs. 15 and 16) are among the best for small light batteries, while the box grid (Fig. 9) is the most largely used for central station work. This plate is made in two halves riveted together and completely surrounding the active material, the acid having access by means of a large number of small holes through the sheet which covers the sides. Under ordinary circumstances it is impossible for the sponge lead to work out of these perforations, so that the life of this type is much greater than that of any other heretofore developed.

Both Planté and Faure in their earlier experiments assembled their batteries by rolling up together in the form of a wide spiral the two sheets of lead which were to serve as positive and negative plates. The two sheets were insulated by means of pieces of felt rolled between them, and the whole group was immersed in the sulphuric acid electrolyte contained in a suitable glass vessel. But this form of cell was soon found very difficult to operate, since the felt gave no security against the plates becoming short-circuited, and it was frequently necessary to remove the whole element from the jar, unroll it, and substitute fresh felt, a matter of great inconvenience. To obviate this defect it has ever since been the practice to use plain flat plates anywhere between one eighth and one half inch in thickness, which either hang from the top or rest on the bottom of the jar, with a small space — one eighth to a half inch — between their adjacent surfaces. The plates are maintained in their proper position by the "separators"; either a pair of glass tubes or hard-rubber strips between each pair of plates, or else a thin sheet of insulating material such as perforated hard rubber. Formerly the glass tubes were most frequently used in large cells, and the perforated rubber sheets in small ones, but a recent development is the use of thin wooden diaphragms between the plates, which possess the great advantage that the particles of lead peroxide which are always present in the electrolyte, can never deposit between the plates

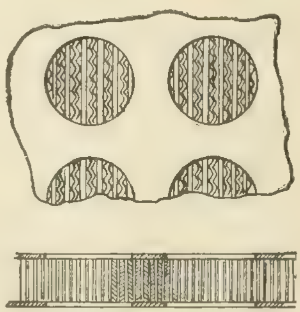


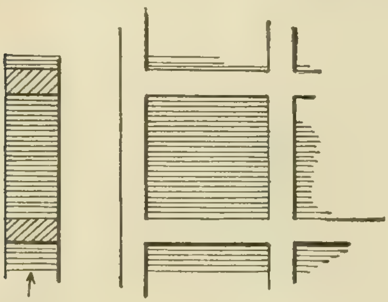
Fig. 11.— De Kabath.

so as to bridge across and short-circuit them, as often happens with the older types.

The alternate plates in a cell are electrically connected together, the two sets thus resulting constituting the two poles, and considerable care is necessary in order that all the connections may be permanent ; the only satisfactory way is to use lead throughout, and to melt or "burn" together the joints with an oxyhydrogen flame. There is then nothing that the acid can corrode and no cracks into which it can work its way so as to spoil a contact. The vessels used for retaining the electrolyte are principally of four kinds, according to the use they are to be put to; hard rubber jars for vehicle and other portable batteries ; glass jars for small stationary plants; hard sheet-lead tanks, or lead-lined wooden boxes for medium and large station plants. The plates in the rubber jars rest upon ribs at the bottom ; those in glass rest upon the edges of the jars; while in the large alloy and lead-lined tanks they rest or hang by suitable hooks or "lugs" upon glass plates which fit into the end of the cell and stand upon the bottom. (See Figs. 17, 18, 19 and 20.)

Thus far the theoretical side of the storage battery has not been considered, it will therefore be briefly discussed here.

As has been already mentioned, when a battery is fully charged the active material on the positive plates consists of lead peroxide PbO_2, while that on the negative is porous metallic lead. Knowing that a current passing through weak sulphuric acid liberates oxygen at the pole where it enters the liquid and hydrogen where it leaves, the early investigators supposed that on discharge the oxygen generated at the negative by the discharging current combined with the metallic lead there to produce lead monoxide, while the hydrogen generated at the positive combined with the lead peroxide to form monoxide and water. On charging the cell the reverse process was supposed to occur ; namely,



Alternate Lead and Asbestos Ribbons.

FIG. 12.— C. Smith.

the lead monoxide on the positive plate became converted by the oxygen there liberated into peroxide, while that at the negative was reduced by the hydrogen liberated to the state of metallic lead.

But later investigators, notably Gladstone and Tribe, noticed that the density of the sulphuric acid electrolyte always changed when a cell was either charged or discharged, rising on the former and dropping in the latter case. The amount of this change in density which they noticed was much greater than could be accounted for by the old theory, and hence they were led to examine into the chemical composition of the active material at various stages of charge and discharge. Doing this they found that both plates on discharge instead of being converted into lead monoxide were changed to lead sulphate, and hence the drop in density of the acid. Putting these reactions into the form of a chemical equation, we have:

Charged Cell.

PbO_2, XH_2SO_4, yH_2O, Pb, equals

Discharged Cell.

$PbSO_4$, $(X-2)H_2SO_4$, $(Y+2)H_2O$, $PbSO_4$.

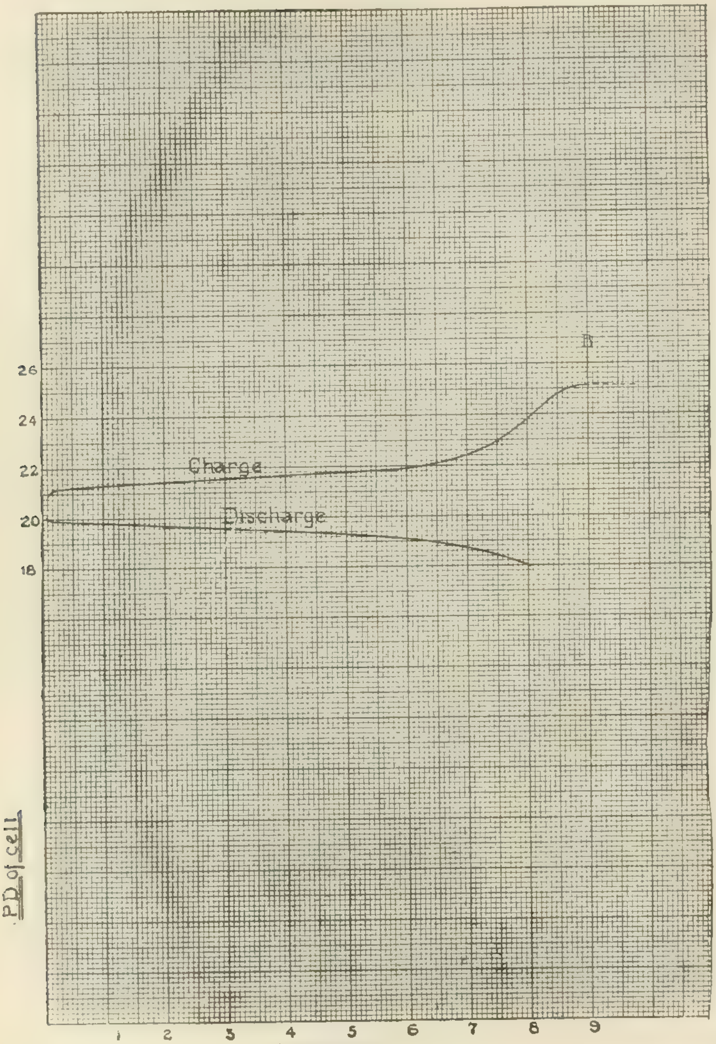
That this reaction represents approximately the changes taking place in the storage cell is now generally acknowledged, but one thing which the equation does not account for is the fact that it is never possible to obtain anything like the full theoretical capacity from a cell. That is, experience has shown that after one half — at the utmost — of the active material has been turned to sulphate, the e.m.f. of the cell has dropped to zero and we can get no further current from it. The exact reason for this is not easy to give with certainty, but it is generally supposed that as lead sulphate is a very poor conductor it is necessary that a considerable amount of lead peroxide and metallic lead respectively be left in the two plates in order that the active material as a whole shall be a conductor.

If the thermo-chemical equivalents of the above equation be considered it is found that a thermal change of 85,700 to 87,700 heat units is involved ; and the temperature coefficient of a storage cell is .022 per cent per degree Fahrenheit. The well known equation of Helmholtz,

$$E = \frac{U}{230/3} + T\frac{de}{dt}$$

(where E is the voltage of the cell, U the heat energy of the chemical reactions involved, T the absolute temperature, and $\frac{de}{dt}$ the temperature coefficient), gives from these values 1.96–2.01 volt as the e.m.f. of a storage cell at 63° Fahrenheit ; while the observed e.m.f. is 1.99-2.01, an agreement which greatly strengthens the theory. Applying to storage batteries the osmotic theory of Nernst, the German investigators Liebenow and Dolezalek conclude that the energy of the discharge is derived from the tendency of the ions of lead peroxide and of metallic lead to go into solution, and surprising as it seems at first sight this view appears to be gaining ground. At various times a great deal of most interesting work has been done upon the theory of storage batteries, yet it must be admitted that the theoretical development is far behind the practical up to the present time, and it is safe to say that, as in the case of most useful inventions, if the pioneers in the art had waited for a full theoretical knowledge the invention would never have been made.

Properties.—The fundamental property of a storage cell is its capability of storing energy, as the name implies. As has been pointed out, the source of the current of the battery is chiefly chemical energy. On the discharge of the cell this is converted directly into electrical energy, whereas on the charge the original chemical constituents are reproduced, with a consequent absorption of energy. The useful energy given out by the cell during discharge is of course never quite equal to that put in during the charge ; both the quantity of electricity and its P.D. (that is, the difference of potential between the terminals of the cell) being smaller than in the former case. When a cell is discharging at constant current, its P.D. continually falls off until it reaches zero, the drop being very much more rapid as the end approaches. These phenomena are very much more easily understood by reference to the accompanying illustration (Fig. 21), in which the abscissæ represent time in hours and the ordinates show the P.D. between the terminals. The cell has not been completely discharged until the P.D. reaches zero, but since the latter end of the discharge would be of very little value, and beside this it is found very injurious to the cell to completely exhaust it, the usual practice is to stop the discharge when the voltage reaches some definite value, usually 1.8 for the normal rate, 1.7 for the hour rate, and the "capacity" is the number of ampere hours given out to this point. Similarly, when a cell is charged with constant current the P.D. gradually rises as illustrated in the upper curve (Fig. 21), but here it will be noticed that there is quite a definite point when the charge is completed, namely when the P.D. reaches a maximum value, as at the point



marked "B"; this point "B" shows that the plates have absorbed as much oxygen and hydrogen as they can hold, and if the cell be examined at this time these gases are found to be liberated in large quantities, causing a boiling or "gassing" that is very characteristic of the charged cell.

The capacity of the cell, that is the number of ampere hours it can give out on discharge is generally the measure of its useful size, and is the chief property by which it is bought and sold. A consideration of some of the most important points bearing on capacity is therefore of the highest importance. Firstly, the capacity of an individual cell is by no means constant, as might at first thought be assumed. The capacity at any given rate of discharge varies directly as the temperature, and at constant temperature inversely with the rate of discharge. Within the ordinary range of working temperatures the capacity varies very nearly 1 per cent for every two degrees above or below 70° Fahrenheit.

Inasmuch as the energy of the cell is derived from the chemical substances which compose it, it would seem that the energy obtainable at a given temperature would be quite independent of the rate of discharge; such, however, is not the case, for when a high discharge rate is used the active material at the surface of the plate becomes quickly sulphated and forms a partial shield which prevents the acid from acting upon the material throughout the mass of the plate. On this account all types of lead storage battery give considerably less capacity at high rates of discharge than at low, but the amount of variation depends largely upon the construction of the cell.

Secondly, from the chemical equation of the discharge of the battery it follows that the amount of sulphuric acid available puts a limitation upon the capacity of the plates, and hence if the amount of acid in the cell be very small, so that at even high rates it is all used up, the capacity can be no higher at a low rate. This condition is never fully realized in practice, but in small cells for automobile use, where everything is cut down to the lowest weight, the amount of acid is very small and the capacity consequently varies but little with rate. In the case of a cell with a large excess of acid the capacity varies nearly inversely as the square root of the rate of discharge, whereas in the case of automobile batteries it is much more nearly constant, being sometimes as low as the fifth root of the current ; both these rules holding only within the ordinary range of currents. The variation of capacity with the rate is also somewhat dependent upon the type of plate used, since with very thin or very porous plates the acid is able to attack all parts of the active material more readily than with a thick or very compact one; but the effect of different kinds of plates upon this phenomenon is not so marked as might be expected.

In stating the capacity of a battery it is thus necessary to specify the rate at which it is to discharge, and the rate ordinarily assumed is that which a battery of stationary type can maintain for eight hours ; or for three or four hours if of the vehicle type.

In the lightest types of vehicle batteries it is found possible to obtain about 15 ampere hours per pound of active material, or 26 per cent of the theoretical capacity, but when the lead grids, acid, jar, connecting straps, and other accessories are included beside the active material, it is found that practically the best attainable for commercial conditions is five to six ampere hours per pound total weight of cell ; while in the large station types about one third this figure is attained.

A few words with particular regard to the electrolyte may be in place here. The two main functions of the electrolyte are first as a conductor of the current from one plate to the other, and secondly to furnish sulphuric acid, which shall enter into combination with the active material of the two plates on discharge. So far as the first function is concerned it would be preferable to use sulphuric acid solution of about 1.25 specific gravity, since that density gives the greatest conductivity. So far as regards the second function, the greater the density of the acid the better, since this would mean that a smaller total weight of electrolyte would furnish the necessary amount of acid for the discharge of the plates. But, unfortunately, there is a third consideration which must be given due weight, and that is the physical effect of the acid upon the plates. It is found that as acid above 1.2 specific gravity is used it begins to have an injurious effect upon the plates, whereas if under 1.15 it fails to carry out properly the second function, and in consequence the full capacity of the plates is not available. For ordinary usage, therefore, the electrolyte is used which shall be about 1.2 specific gravity in the charged condition of the cell, and in such amount that on discharge of the cell it will drop to about 1.15. In the automobile cells, however, it is usual to use acid that is somewhat heavier than this — as high as 1,250° to 1,300° — in order that a smaller amount of it may suffice to furnish the necessary lead sulphate on discharge ; the slightly less endurance of the plates being more than made up for the smaller total weight of the cell.

The mean P.D. of a battery on discharge may be taken at 1.9 volts, so that the maximum energy capacity is — for the vehicle type — about 10 to 12 watt hours per pound ; or, in other words, if all the energy of the cell could be expended in lifting the latter it would raise it 26,600 to 31,900 feet high. The magnitude of this figure is perhaps better realized by noting that it is about 100 times as great as the amount of energy which can be stored in a pound of elastic rubber, and 1,700 times as great as the amount that can be stored in a pound of steel wire having an elastic limit of 60,000 pounds per square inch.

The next important property of a battery is commonly its efficiency, and this is one the determination of which requires considerable care. Two curves of charge and discharge (Fig. 21) are sufficient to give the efficiency, but a chance for error lies in the fact that it is difficult to tell whether both of these curves will represent the performance of the battery for a continued period. It is found always necessary to charge for a greater number of ampere hours than are taken out on discharge, and the only way to tell how much this "overcharge" must be is to run a battery continuously for some time and carefully measure each charge and discharge. By carrying this out it is found that from 5 to 10 per cent more must be put in, in order to keep the battery in a properly charged condition, than is taken out. Furthermore, as these same curves illustrate, the mean voltage on charge is considerably higher than on discharge, and here is another source of loss. Taking the battery working at its eight hour or normal rate, the mean charge voltage will approximate 2.21, the mean discharge 1.91 ; summarizing, then, the voltage efficiency is 86½ per cent, the ampere hour efficiency is 92½ per cent, and the watt hour efficiency 80 per cent.

This last figure, the energy efficiency, is that which may be commonly obtained from a battery continually worked to its full normal rate capacity. A battery on the other hand, performing "regulating" work, that is, the steadying of a load which is subject to very large fluctuations of short duration, is called upon to alternately discharge and charge at rates as high as four to eight times the normal, lasting, however, for fractions of a minute only. Working at this service it is usual to give an overcharge once in several days, or once a week, and in the interval the battery is working at an ampere hour efficiency of almost unity, since the plates, being always only partly charged can always take up all of the charging current without the development of any gas. The periodic overcharge reduces the mean efficiency somewhat, so that 94 to 96 per cent is usually obtained in this kind of service. The voltage efficiency in this case is not materially different from that already considered, for while on the one hand the loss due to internal resistance is higher, on the other hand the successive cycles of charge and discharge follow each other so closely that the P.D. has not time to reach its ultimate value before the current is reversed and another value sought. The mean voltage which a battery maintains under these conditions, commonly called its "floating point," lies between 2.05 and 2.1 per cell ; and the shorter the intervals of charge and discharge and the lower the current the less is the departure from this mean value, while long intervals and higher currents cause the voltage to fall more on discharge and rise more on charge. With intervals such as commonly occur of from a quarter of a minute to a minute duration, and with current rates of four times the normal, the variation may be taken as 5 to 8 per cent on both sides of the floating point, and the watt hour (or energy) efficiency will then approximate 90 per cent.

To summarize the whole question, the efficiency of a storage battery in practical operation is usually between 75 and 90 per cent, the former figure applying where current rates are high and the battery plates large, and where full capacity is used, the latter where, though the current may be high, the duration of each discharge is very brief ; and the efficiency attainable in any given case is also somewhat dependent upon the temperature, type, and general condition of the battery.

The resistance is frequently an important consideration in the operation of a large battery plant, and it is the remarkably low value of this quantity which makes it possible to draw from a storage cell a very much heavier current than from a primary cell of similar dimensions. Depending upon the size and type of plates, the separation, and the condition of a cell as to whether charged or discharged, the resistance varies between .03 and .08 ohms, divided by the normal or eight hour rate of the battery in amperes, the lower value holding nearly constant throughout most of the discharge followed by a rapid rise near the end. The resistance here referred to may be called the virtual resistance, being obtained from two readings of the cell voltage, first with current flowing and second on open circuit, and the difference between these two readings, termed the «drop,» divided by the current, gives the virtual resistance. This virtual resistance is composed of two main factors, the resistance proper of the electrolyte, the plates, connections, etc., and a certain polarization resistance at the surface of the plates, and the accurate measurement of each of these factors separately is a matter of so much difficulty that it is seldom attempted.

Storage Batteries Other Than Lead.—Thus far there has been considered but one genus of storage battery ; namely, that using lead or lead compounds as the active material, and dilute sulphuric acid as the electrolyte. To the present time no storage cell using other constituents than these has come into any extensive use, but there are three other classes which deserve to be noticed. The first class, the zinc-lead cell, may be regarded as a cross between the ordinary primary cell and the lead storage cell, since in the matter of a negative it follows the former class, and in the matter of a positive the latter, while the electrolyte is sulphuric acid, used sometimes with the primary, always with the lead storage battery. Upon discharge the zinc constituting the negative is dissolved to form zinc sulphate, while the lead peroxide on the positive is reduced and converted into sulphate. Since it is always troublesome to continually dissolve and re-deposit the material of a plate without destroying its original shape, a plan frequently adopted in this class of battery is to deposit the zinc upon a thin pool of mercury in the bottom of the jar, which keeps it always fully amalgamated and tends to prevent its dissolving by local action. This expedient, however, necessitates an awkward construction of cell, with very high resistance, and it is found in practice to have a very low efficiency beside, though it has the advantage of giving a very high P.D. of between 2 and 2.25 volts. This class of cell is applicable only where low currents are used and where weight is not a great factor.

The second class of storage battery, other than lead, is known as the copper-zinc, and its chief distinction from those heretofore considered is the use of an aqueous solution of caustic potash as electrolyte. The negative, as in the last class, consists of metallic zinc which dissolves on discharge, but the positive is composed of cuprous oxide, which on discharge simply becomes reduced to the metallic state. This class possesses the disadvantage of the first class, that it is very troublesome to dissolve and re-deposit the zinc continually without its becoming very lumpy and uneven, and moreover the cupric oxide which may be formed on overcharge is slightly soluble and may thus cause a great deal of trouble. A further drawback incident to this class is its exceedingly low P.D. of only .8 volt.

The third class holds much the same relation to the copper-zinc as the lead cell holds to the lead-zinc, for it uses caustic potash solution as electrolyte, but replaces the soluble zinc negative by a grid pasted with an insoluble metallic sponge. Upon discharge, the metallic sponge becomes oxidized, while the metallic oxide on the positive becomes reduced, and on charge the original condition is reproduced. A great many experiments have been made, notably by Edison in this country and Jungner in Sweden, to determine the best active materials to use in this class of battery, but so far apparently without any very definite result. For the negative, iron and cadmium have been somewhat successful, while for the positive, nickel, cobalt, copper and silver have been recommended. The chemical reactions taking place in a cell of this class are approximately represented as follows:

Charged Cell.		Discharged Cell.
$Fe\ KOH\ H_2O\ Ni_2O_3$	=	$FeO\ KOH\ H_2O\ Ni_2O_2$

It will be noticed that this reaction is very simple and direct as compared with the reactions of any of the other classes of storage batteries, since the electrolyte maintains its composition unchanged and acts simply as a means of transporting oxygen from one plate to the other. The energy of the discharge is derived solely from the greater affinity of iron than nickel for oxygen, and consequently this class is often called the «oxygen lift» battery. The advantages claimed for this class of battery are greater capacity per unit weight, and longer life, against which must be counted the low P.D. of only 1 to 1.25 volts; and up to the present time the claims have not been commercially demonstrated, so the ultimate success of the class yet remains to be determined.

The lead storage cell on the other hand, in spite of some inherent faults, possesses such well established valuable qualities that it is constantly proving itself a commercial necessity, and is now recognized both in this country and in Europe as a standard piece of electrical equipment, in just the same light as are boilers, engines, and dynamos. See BATTERY; DYNAMO; ELECTRIC BATTERIES. HERBERT LLOYD, F.C.S.,
President of the Electric Storage Battery Co.

Electric Storm. See ELECTRICITY, ATMOSPHERIC; LIGHTNING.

Electric Stress, the force that causes the deformation of the surface of a substance within an electric field.

Electric Sunstroke, an effect similar to sunstroke, sometimes experienced by persons exposed for a long time to intense electric light.

Electric Telegraph. See TELEGRAPH.

Electric Telegraph Cable. See CABLE; TELEGRAPH.

Electric Telephone. See TELEPHONE.

Electric Tension. See BATTERY; ELECTRICITY; ELECTRO-MOTIVE FORCE.

Electric Torpedo, a torpedo operated by electricity. There are various kinds of electric torpedoes. The Sims-Edison torpedo is driven by an electric motor, and its motions are controlled from the shore by electricity. The torpedo proper is carried some distance below the surface of the water by a vessel immediately above it, from which it is suspended by two rigid bars. In the torpedo is a cable reel on which the conducting cable is disposed. An electric motor and controlling gear are also contained within the torpedo. In its front the explosive is placed. It is driven by a screw propeller actuated by the electric motor. As it moves it pays out cable so that it has no cable to draw after it through the water, the cable lying stationary in the water behind it. This avoids frictional resistance to its motion. The maintenance of the torpedo at a proper depth is one of the advantages of the system over other methods.

Electric Transmission of Energy, Long Distance. An electric transmission of energy obviously occurs when the relay of a Morse telegraph circuit, or the sensitive mirror used in submarine cable telegraphy, responds to the feeble current impulse originated at the transmitting end of the wire. It is also obvious that we have the electric transmission of power in the ordinary use of electric light or electric motors even when the generator is stationed in the building in which that light or power is used. But generally speaking the term, electric transmission of energy, denotes the transmission of energy on a large scale by means of overhead or underground conductors or cables, and its transformation into light, heat, chemical energy or mechanical power, at the remote end of the conductors. When the distance to which this electric power is transmitted exceeds say 15 or 20 miles it is usually spoken of as the long distance transmission of electric energy or power.

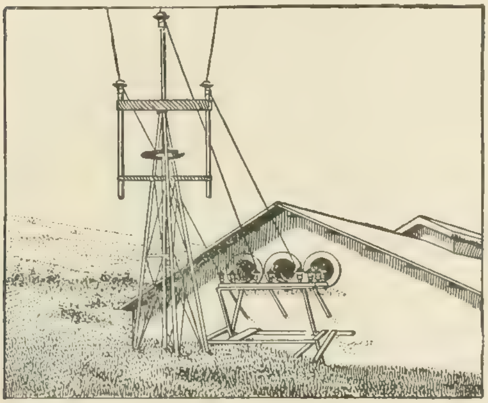
In cities like New York where electric energy for lighting, power and railway traction is transmitted distances ranging from less than a mile to 15 or 18 miles from the power house, the conductors are usually placed in cables in underground conduits and the maximum electro-motive force transmitted is about 11,000 volts. This pressure is directly generated by a steam driven alternating current generator and is transmitted over the conductors to sub-stations, where by means of step-down transformers the pressure is dropped to say 600 volts alternating current which by rotary converters is converted into direct current for the street mains, the feeders of the railway system, and for charging storage batteries which in turn give out direct current at times of heavy demand or when otherwise required. When water power, or, as it is termed in Italy, "white coal," is available, as at Niagara Falls and innumerable other places in this and other countries, the distance to which electric energy is transmitted in large quantities is largely increased, so that to-day the electric transmission of power on a large scale to distances of 25, 50, 100 and even 200 miles from its source is not uncommon.

In order that electric power may be transmitted economically to long distances the use of high electric pressure or tension is essential, since otherwise the cost of copper in the conductors would be excessive. For example: It has been calculated, on the basis of 5,000 volts as the maximum permissible pressure, that to transmit 2,356 kilowatts to a distance of 100 miles would require about 22,862,737 pounds of copper in the conductors, assuming a line drop of 750 volts, or 15 per cent of the total pressure, whereas with a pressure of 40,000 volts the total amount of copper required would be about 357,230 pounds. Even doubling the pressure quarters the amount of metal required for a given distance and given line drop.

That electric transmission of energy to long distances may be successfully carried out it is at present customary to employ the alternating current, and transformers are utilized for raising the pressure on the transmission line and for reducing it at the points of distribution. When the line pressure does not exceed say 10,000 volts generators developing that voltage are usually employed. When that voltage is exceeded on the line the station voltage adopted is about 2,300 volts; this being stepped up by transformers to the desired pressure on the line. This so to speak medium voltage at the station admits of the use of lighter copper in the station apparatus than lower voltages would necessitate and at the same time does not involve extraordinary precautions in the insulation or in the switching apparatus. Modern usage in the matter of type of alternating current employed leans largely toward three phase. (See ELECTRIC ALTERNATING CURRENT MACHINES.) For each circuit this requires three conductors which are arranged on the poles and cross-arms usually in an equilateral triangle, the wires being separated from one another by a distance of 6 or 8 feet. The wires are in some cases transposed on the poles, to form in effect a long horizontal spiral. This is generally done to prevent inductive effects on the telephone wires used for signaling on the same or adjacent poles, although some engineers also think that spiralling the conductors diminishes the impedance of the circuit. So far as the telephone line belonging to the transmission company is concerned the simplest way to avoid inductive effects is to spiral the telephone circuit. While, as just intimated, the long-distance transmission of energy is carried on chiefly by means of the alternating current, transformers, etc., high potential transmission in at least one instance in Europe is being effected with continuous current. In this instance the line pressure is 60,000 volts, which is generated directly on the line by six dynamo machines in series, each generating 10,000 volts. At the point of distribution six motors are connected in series and each motor is caused to drive a generator, which in turn develops electrical energy of a desired potential and current output.

For the supports of the transmission line opinion is divided between the use of wood poles or metal towers. In the majority of cases, however, the preference is at present given to wooden poles. The kind of wood employed for the poles varies somewhat with the locality, cedar being used in the northern states and redwood in the Pacific coast states. These poles must be of sufficient height to afford ample clearance from ground and sufficiently strong to withstand wind strains, etc. Poles fitted to meet these requirements and to carry two three-wire circuits should be at least 35 to 40 feet in height, set 5 to 6 feet in the earth and be 12 to 14 inches in diameter at the butt and at least 8 inches at top. The use of metal towers permits longer spans and consequently diminishes the total number of insulators necessary. With wooden poles the maximum length of span is 180 feet; minimum 80 feet. With iron towers using 12 to the mile the span between towers is 440 feet. On one long distance transmission the towers are made up of four galvanized angle iron posts 40 feet in length, 3 inches by 6 inches with three-sixteenths inch angles, the posts being stayed with suitable angles and cross rods.

For the high potentials used on long distance transmission lines it is apparent that extra precautions as to insulation are requisite, both where the wires leave the power houses, and on the poles. For insulating the wires from the



Power House Terminal of Transmission Line.

pole large petticoat porcelain insulators are commonly utilized. These insulators for 40,000 to 60,000 volt lines are about 12 inches in diameter across the top, 12 inches in height and weigh 18 to 20 pounds. They are supported on the cross-arms or on the pole itself by wooden or iron pins. For pressures up to about 25,000 volts wooden pins are found fairly satisfactory, but above that pressure they are found to char by a peculiar action of the current, and it is advisable on this account, as well as for mechanical reasons, to employ cast iron or metal composition pins. These pins are from 15 to 17 inches in height and they maintain the insulator about 12 inches from the pole or cross-arm. (See illustration, which shows an iron tower, a three-wire circuit, with cross-arms, pins and porcelain insulators; also the openings in the gable of power house by which the high tension conductors pass out.)

The choice of metal for the conductors in this service lies between copper and aluminum. It is known that there is a tendency to a brush discharge in the air between conductors conveying currents at high pressures that leads to a waste of electric energy when with wires of given diameter a critical electro-motive force is reached. The critical electro-motive force also varies with the distance between the wires. It was at one time thought that this effect would constitute the limiting factor in the long-distance transmission of electric power, but in Prof. Harris J. Ryan's paper, 'Conductivity of the Atmosphere at High Voltages' (see 'Proceedings' American Institute Electrical Engineers, Vol. XXI., No. 3), he shows that, regardless of the metal employed, by increasing the diameter of the conductors, whereby the electric gradient is kept below the breaking down point of the air in the vicinity of the wire, this effect is avoided. For example, to avoid atmosphere losses between conductors separated by an air space of four feet, with barometric pressure of 29.5 inches of mercury, temperature 70° F., the conductors must have, for an operating pressure of 50,000 volts, a diameter of at least .058 inch; for 100,000 volts, .192 inch; for 150,000 volts, .430 inch; for 250,000 volts, .990 inch. On this account it may be found desirable in some cases to employ aluminum conductors, since weight for weight its diameter is much greater than that of copper. The effect of wind strains on the larger wire has, however, to be considered.

In a number of cases aluminum conductors are already employed on high tension transmission lines. For instance on a 150 mile line in California transmitting 745 kilowatts (10,000 horse-power) at 40,000 volts, aluminum conductors seven-eighths inch in diameter are used. In a 100 mile, 60,000 volt transmission line in Mexico a copper wire three eighths inch in diameter is used. The transmission line from Shawanigan Falls to Montreal, Canada, employs aluminum conductors carrying 12,000 horse-power at 50,000 volts.

To provide a system that will be as nearly absolutely reliable as practicable duplicate circuits are in the majority of cases constructed, in order that if one circuit becomes inoperative the other may immediately be brought into service. In some cases the two circuits are erected on one set of poles. In others two separate pole lines are built.

Wherever possible private rights of way are obtained for the transmission line and it is of advantage to have this way so wide that danger from falling trees shall be avoided. Rights of way along steam railway tracks are not considered desirable for the reason that the smoke from the engines very soon so impairs the insulating quality of the insulators that frequent cleaning and washing of the insulators is rendered necessary. Even on private routes the cleaning of the insulators is at times essential to maintain the insulation.

The distance to which electric energy can be profitably transmitted from a source of electric power is not yet definitely determined. Much depends on the cost of fuel at the distributing points, and the amount of energy to be delivered. In California, where coal is dear, electric energy is now being commercially transmitted from a number of water-power plants in that State, to an amount exceeding 100,000 horse-power, at a pressure of 40,000 to 60,000 volts, and to distances ranging from 50 to 230 miles. In Switzerland electric energy from water power is transmitted to the point of consumption and sold at $20 per horse-power hour per annum. There the price of coal is $6 to $8 per ton, but labor is cheap. Electric energy generated by the force of falling water and transmitted 85 miles by wire is sold in Montreal, Canada, at $15 per horse-power per annum at a profit. But while as stated the distance to which electric energy may be commercially transmitted is yet undetermined, calculations have been made by reputable electrical engineers which indicate that under proper conditions electric power may ultimately be profitably transmitted in large quantities, say 200,000 kilowatts, and at a pressure of 170,000 volts to a distance of 500 miles.

This transmission would entail the employment of copper wires of a diameter so large that the dissipation of energy by brush discharges between the conductors would be avoided. Should this conception be realized it would obviously bring New York, Chicago and other large cities within reach of the electrical energy developed at Niagara Falls. Indeed the calculation just referred to was based upon the amount of mechanical power utilized in New York. Consult 'Proceedings American Institute of Electrical Engineers, December 1904.' See POWER, ELECTRIC TRANSMISSION OF.

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Electric Underground Cables and Conduits. In the first attempts to operate the electric telegraph, over 60 years ago, both in this country and in Europe, the wires were placed in cables underground; but owing to the imperfection in the methods of insulating the wires, as well as in the type of conduit or pipe employed, and of the manner in which the conduits were laid in the earth, the cables and conduits failed after comparatively short service and the use of overhead wires supported on poles was resorted to and became the universal practice, a practice which continued almost without interruption for a quarter of a century.

Within the past 20 years, however, there has been a movement in all the principal cities of America and Europe to place all electric wires underground in order that the streets may be freed from the encumbering poles and overhead wires. In New York city especially, the movement to this end was carried on vigorously and persistently, with the result that for many years there has not been a pole supporting telegraph, telephone, electric light, or trolley wire in any part of the city, such wires all being placed in cables in conduits under the surface of the streets. While New York is perhaps the only city that has insisted on placing the "trolley" wires of the electric street traction service underground, in many other cities the telegraph, telephone, and electric light and power circuits are now being operated in underground cables.

Electric Underground Cables.—The type of underground cable used for telephony, telegraphy, and electric light and power purposes varies as greatly as do the potentials and currents used in the operation of these arts. For example, the conductors used in telephony have a diameter of .040 inch; those for telegraph purposes about .080 inch; those for electric light and power range from one quarter of an inch to one inch and over in diameter. The smaller electric power wires are employed in "high" potential and comparatively light current work; the larger wires in "low" tension and heavy current work. It is thus feasible to place about 400 telephone conductors, or 100 telegraph conductors, in one cable in a three-inch underground duct or pipe, while it is only practicable to place two, three, or, at most, five electric light or power conductors in a similar duct. The insulating material used for telephone conductors is usually a wrapping of tissue paper in narrow strips, laid on spirally over each conductor. The insulating material of telegraph underground cables is usually a rubber compound or strips of paper saturated with oils, the thickness of the *wall* of which is about .038 inch. The insulating material of electric light and power cables is usually a rubber compound, oil paper, or varnished cambric, the wall of which is from one eighth of an inch to nearly half an inch thick, depending on the electric pressure to be withstood, which, in the case of "low" potential circuits, is about 220 to 600 volts, and in the case of "high" potential circuits may range from 1,000 to 30,000 volts. Gutta-percha, which has been used very extensively for the insulation of long submarine cables, is not used for underground cables, owing chiefly to its low softening point under heat, 120° F., which temperatures are not infrequently encountered in subways in cities.

Cables designed for underground work are usually encased in a lead envelope to protect the insulating material from water, moisture, and the effects of gases, acids, etc., in the underground conduits. For crossing rivers these cables are also armored with iron wires in addition to the lead covering, as a mechanical protection.

The term cable includes the conductor ("core"), the insulating material, the lead covering, and the armor when the latter is employed. Copper is practically the only metal used for the conductors of electric cables. Aluminum is not used because of its bulk for a given conductivity, which bulk is about 1.6 greater than copper. The increased amount of insulating material and lead covering that would be required in the case of aluminum for a given conductivity would be virtually prohibitive of its use for underground cables.

The copper wire used in cables is drawn to the required size in the wire factory. If the wire is to be insulated with a rubber compound it is "tinned" to prevent any chemical action between the sulphur used in the rubber compound and the copper. When the covering is paper, linen, or fibre, the wire is not tinned. The tinning process consists in passing the wire through a vat of molten tin. For electric light and power cables, when the conductors do not exceed .204 inch diameter, they are usually solid, or of one wire; above that size they are generally stranded to obtain flexibility. The wires are stranded in a stranding machine in one process, the wires being wound on reels, which are held on suitable spindles on the frame of the machine. A single wire is held in the centre of the frame and is slowly drawn through a guide. The wires for the first layer are wound spirally around the central wire; the wires for the second layer are held on another frame and are laid over the first layer in an opposite direction, and so on for the additional layers required. The completed strand is wound upon a drum when it is ready for the insulating process.

Rubber Insulation.—The rubber used in the insulating material for cables is pure Para rubber. After the rubber has undergone treatment by washing and kneading to remove the impurities which it always contains in its crude state, it is then mixed, by suitable machinery, with the ingredients that go to make up the compound, such as litharge, whiting, blue lead, and sulphur. The compound is then ready for placing over the wire. There are two general methods, termed the seam and seamless methods, respectively, by which this is done. In the seam process the rubber compound is calendered into a sheet of any required thickness, which is then cut into long strips. These strips are then passed between two grooved rollers having sharp cutting edges. The wire to be covered also passes in the centre of the grooves of these rollers, and as it does so the rubber strips are pressed closely around it, the knife edges of the rollers cutting off the surplus rubber strip. The

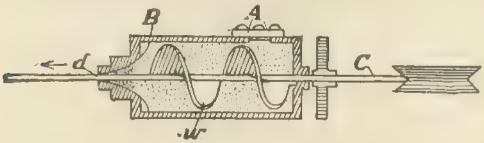

Fig. 1.—Rubber Covering Machine.

wire thus insulated is frequently wrapped spirally with a tape, after which it is placed in a vulcanizing oven and vulcanized. In the seamless method the compound is placed in a plastic condition around the conduits by pressure, while passing through a die. The conductor C, Fig. 1, is drawn through a metal chamber or box, B, which contains the plastic compound. A worm gearing, W, within the chamber, pushes the compound toward the opening or die, D, in the end of the chamber. The compound is fed into B at the aperature A. The chamber is kept at a desired temperature by a hot water or steam jacket. After leaving the chamber the insulated wire is drawn slowly along a table through

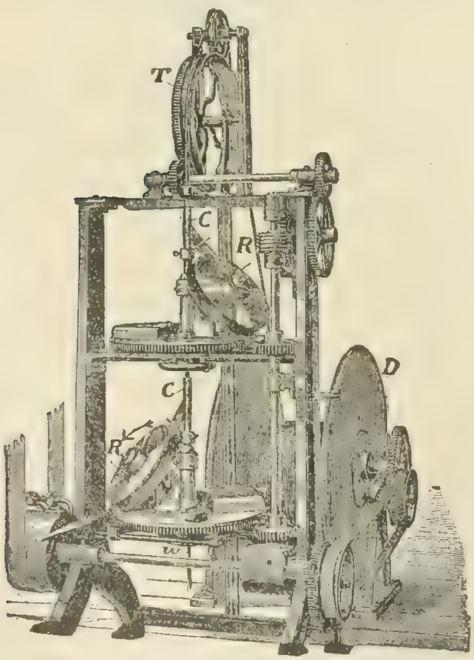

Fig. 2.—Taping Machine.

powdered talc to prevent sticking, to a drum, on which it is then taken to the vulcanizing box or receptacle, unless it is first to be taped. The taping process is somewhat analogous to that of stranding the wire. A vertical taping machine is shown in Fig. 2, in which the insulated wire W is seen coming through the flooring to the guides C C, in each of which there is a slot through which tape from the small reels R R passes to and around the wire. The wheels on which the reels R R are carried revolve in opposite directions, this action laying the tapes on the wire in reverse spirals. The wire thus taped passes to the "take up" drum T, thence to the reel D. In the case of rubber-covered wires the next proceeding is to immerse them in a water tank for 12 or 24 hours, after which they are tested for defects in the insulation that may be due to air-holes, foreign substances in the insulation, or any other cause.

The vulcanizing process consists in placing the insulated wire in an oven, where it is kept at a temperature of 250° F. to 300° F. until the compound is brought to a desired degree of hardness and tenacity, the proper time for effecting which is a matter of experiment and varies with different compounds. Sulphur is the chief ingredient in the compound that brings about these results. The compound usually enters the oven a yellowish compound and comes out a dark-blue color. This color may be varied by using different ingredients in the compound, and in some cables certain of the conductors are colored by this means to act as "markers," or distinguishing wires for testing purposes.

Paper Insulation.—The conductors intended for telephone work are covered very loosely with two layers of dry, soft paper, laid on spirally, in practically the manner in which tape is placed over the rubber insulated wire. This type of insulation is found to be the most satisfactory yet devised for telephone cables, its capacity being quite low, about .080 microfarad per mile of conductor. The insulation resist-

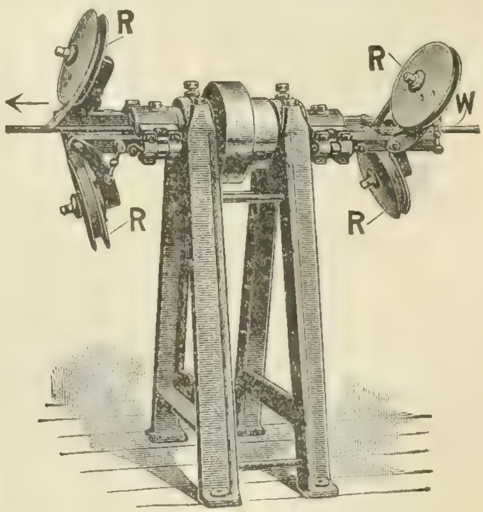

Fig. 3.—Paper Covering Machine.

ance of each conductor is about 500,000,000 ohms per mile. The wires thus insulated are twisted in pairs with a lay of about three inches, the pairs being laid up in reversed layers and built up into cables of 50, 100, and 200 pairs, after which they are lead covered as a protection against moisture. Paper cables for electric light and power and telegraph service are made up of reversed layers of strips of manila paper to a desired thickness by means of a paper-covering machine such as is indicated in Fig. 3. In this figure W is the wire moving in the direction of the arrow. By suitable motive power the reels R carrying the paper strips are revolved in opposite directions around the wire.

When thus covered the conductor is wound on a reel and placed in an oven until all moisture is driven out of the paper. The reel, with the insulated conductor, is then immersed in a vat of boiling oil for several hours, until the paper is thoroughly impregnated with the oil.

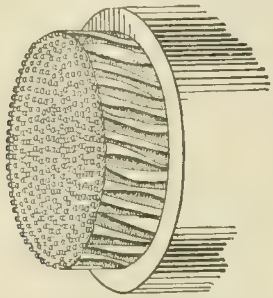

Fig. 4.—Telephone Cable, Paper Covered.

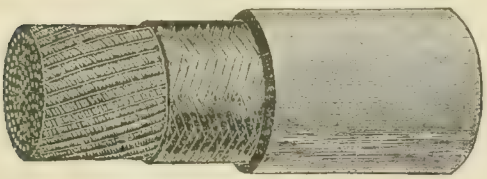

Fig. 5.—Telegraph Cable.

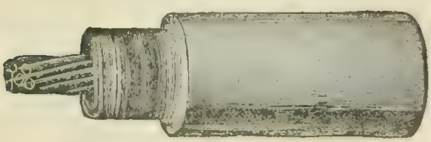

Fig. 6.—High Tension Cable.

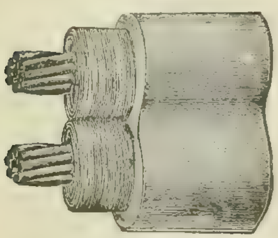

Fig. 7.—Duplex Cable, Electric Light.

Varnished cambric insulation consists of strips of varnished and oiled linen cambric, which are placed over the conductor in as many layers as may be desired, varnish being applied between the layers.

When thus insulated the conductors are ready for their lead covering, if to be used as single conductors; or if to be employed in cables, they are now ready for cabling. In the latter case the number of conductors in a cable will vary with the purpose for which the cable is designed. Telephone cables for underground use may consist of as many as 400 conductors, which are first twisted in pairs and are then cabled by a cabling machine virtually similar to a stranding machine. For telegraph uses the conductors, to the number desired, are laid up spirally in the cable.

For electric light and power purposes, especially for high potential circuits, three conductors in one cover are now generally used. These conductors are laid up spirally and taped, the spaces between the conductors being filled in with jute rope in the act of cabling. In other instances the three conductors are bunched and a "jacket" of paper, rubber compound, or varnished cambric is laid over them. This is termed a jacketed cable, or "split" insulation. The cable thus laid up is then taped, after which it is ready for the lead covering.

The process of lead-covering cables is somewhat akin to that by which lead pipe is made. The cable is drawn through a die in a die-block, and, as it passes through this die, hot lead in a semi-plastic state is pressed in a uniform thickness around the insulating material by pressure

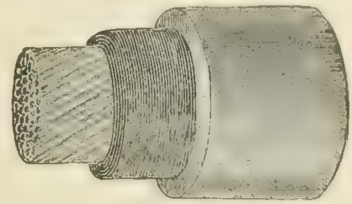

Fig. 8.

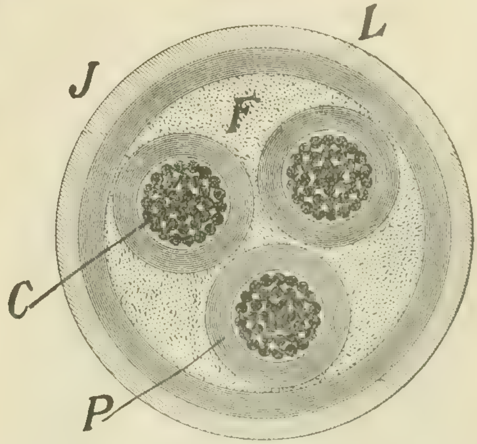

Fig. 9.—A Jacketed 7,000 to 10,000 Volt Paper Cable.

from a hydraulic ram. The pressure exerted on the end of this ram sometimes amounts to 500 tons.

Illustrations of various types of underground cables are given in the accompanying figures. Fig. 4 represents a telephone cable, Fig. 5 a telegraph cable, Figs. 6 and 7 a one-conductor and two-conductor cable for high tension electric light and power circuits, respectively; Fig. 8, a low tension, heavy current cable for electric light and power; Fig. 9, a three-conductor electric power cable for 11,000-volt circuits. In this cable each conductor C is made up of a strand of 37 copper wires, each .082 inch in diameter. P is the oil-saturated paper or varnished cambric around the conductor, .17 inch thick. F is the jute filling. J is the paper jacket, also .17 inch thick. L is the lead covering, .13

inch thick. The lead is usually alloyed with 2 or 3 per cent of tin. The outside diameter of this cable is 2.56 inches. The weight of each conductor is 4,000 pounds per mile; the weight of the lead covering is about 13 tons per mile.

Rubber and paper cables are now made to withstand pressures of 25,000 volts, and some miles of cable carrying current at this pressure are to-day in operation in underground conduits, but the ordinary operating pressure to-day is from say 2,000 to 11,000 volts for underground cables.

Electric Underground Conduits.—The most obvious method of placing wires underground would be to provide a tunnel under the streets, in which not only the electrical conductors but also the gas and water pipes of a city might be placed. This method is, however, so expensive that it has only been adopted in two or three places in the world, and then for only comparatively short distances in very crowded thoroughfares. For instance, there are several such tunnels in London, England, namely, the Holborn Street tunnel, about 7 feet in height by 12 wide; the Queen Victoria Street subway and the Victoria Embankment tunnel, 7 feet by 9 feet. The total length of these London tunnels is about six miles and they cost approximately $140,000 per mile, including ventilators, side passages, and entrances. In some of these tunnels, water and gas pipes, pneumatic tubes, and telephone, telegraph, and electric-light wires have been placed. In Paris at one time some of the sewers were utilized for the same purpose, but this plan was not greatly favored and has not been followed elsewhere. Tunnels for electrical conductors were also built in Detroit, Mich., the longest of which is about 232 feet in length. It is 6 feet 6 inches by 3 feet 6 inches in the cross-section.

Solid Conduits.—Another plan which has been utilized for this purpose is one in which the conductors are well insulated and laid directly in the earth; or in which the conductors are laid in notches in a tube or duct, by which means they are kept apart. The tube is then filled with an insulating compound, which, when it hardens, holds the conductors securely in position. This is termed a "solid" conduit. One of the earliest forms of solid conduit was that used by Morse, between Washington and Baltimore. This consisted of five wires insulated with cotton and placed within a lead tube which was laid directly in the earth. In different parts of Europe, in the middle of the last century and afterward, wires were laid directly in the earth without other covering than the insulating material around them, which was usually a bitumen compound or gutta-percha. Insulation laid in this way is not long lived. One of the first solid conduits used in this country for electric lighting was one in which a lead-covered cable is laid directly in a wooden trough, the cable being uncoiled directly from a cart reel, the box being then filled with an insulating compound. To protect the cable from injury, a thick plank was placed over the box.

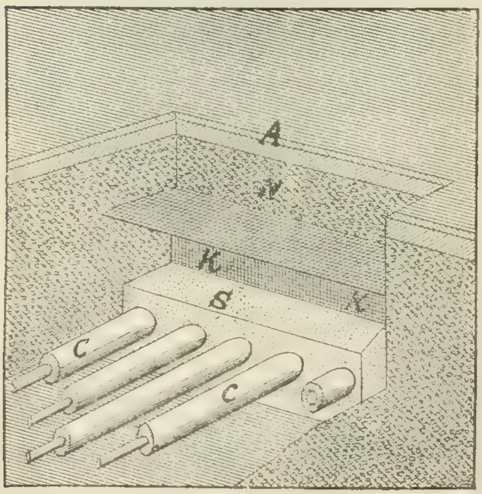

Fig. 10.

In many European cities solid conduits are placed under the sidewalks. The cables C are laid on a bed of sand, S, as indicated in Fig. 10. A galvanized iron wire netting, K, is placed over the sand, separating it from a bed of concrete, N, upon which the asphalt, A of the sidewalk is laid. The object in using the wire netting is to warn workmen of the presence of the cables.

Edison Solid or Iron Tube Conduit.—This is the conduit adopted by Edison for the distribution of electric current by the three-wire system, for light and power in cities. It consists of an iron tube about 20 feet in length, into which the three conductors, usually copper rods, separated from one another by hemp or jute cords, are inserted. An insulating compound is then forced, under heavy pressure, into the tube at a temperature of about 300° F. The copper rods project about two inches at each end out of the tube. The tubes are laid end to end in the earth, when the conductors in one tube are

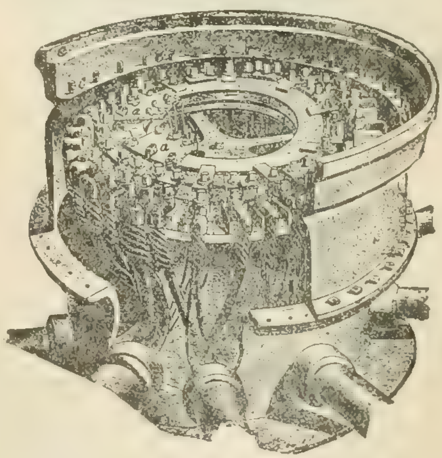

Fig. 11.—Edison Junction Box.

connected to those in the next by a flexible copper strand. A split iron box is then jointed and clamped over the ends of the tube and the box is then filled with an insulating compound through an opening, which is then closed by a screw plug. In this system no manholes are employed, but instead, at suitable distances, water-tight junction boxes are used, into which the conductors are led, as outlined in Fig. 11. This is really a switch-box, by means of which the current from the "feeder" conductors is distributed to the "mains" or "service" conductors. These boxes are also utilized to break up the mains into shorter sections; to open the circuits for testing and other purposes.

The disadvantage of "solid" conduits is that in case of defects in the cables there is no means of repairing them short of tearing up the streets. Neither is it convenient to add to or take from or to increase or diminish the size of conductors used in the "solid" system. These disadvantages do not exist in the case of what is termed the "drawing in" conduit system, to be described presently.

Bare-wire Conduits.—Still another plan utilized in some parts of Europe, and known as the "bare wire" conduit, consists of uninsulated, or bare, strips or rods of copper placed in tubes underground, and held in position by insulators, or else the conduit itself is composed of an insulating material and is protected from moisture. This plan is not in extensive use.

Drawing-in Conduit.—The method which is now most generally employed in this country

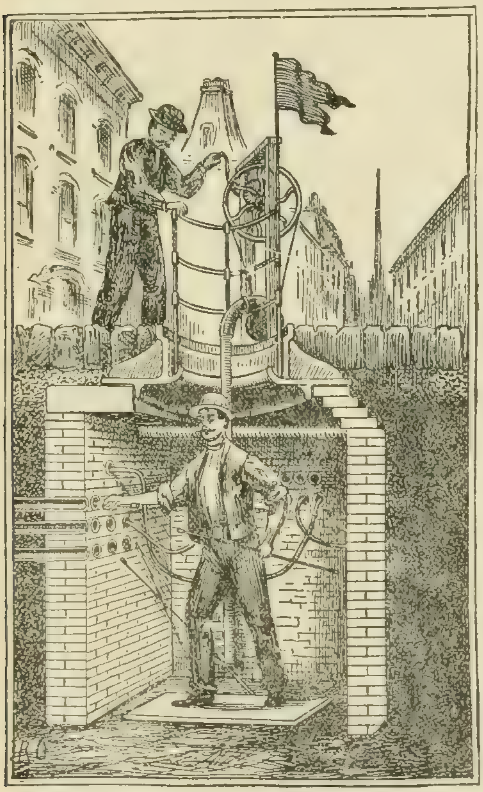

FIG. 12.—Standard Manhole.

is that known as the "drawing-in" conduit. In this system as many ducts as may be necessary are laid in a trench side by side and in layers, and manholes are built at intervals of 200, 300, or 400 feet to give access to the conduits and to afford means by which the cables may be drawn into the ducts. In a "drawing in" conduit system the ducts containing the "feeder" cables or cables for arc circuits are termed "trunk" ducts, and are usually the lower tier or layer of ducts. The ducts carrying the distributing cables are termed "distributing ducts" and are placed at the top. So-called "hand-holes" are laid flush with the surface of the street every 40 or 50 feet to give access to the distributing ducts and cables for electric light and power service. One type of manhole is shown in Fig. 12. This is a brick manhole; others are made of concrete. The hand pump shown is used to provide fresh air where gas is prevalent in the streets. The size of the manholes and number of ducts varies with the requirements of a given locality. Some manholes are from 4 to 5 feet square; others are 12 to 15 feet deep and 6 to 8 feet wide. The number of ducts in a conduit may range from 2 to 3 ducts to 200 or 300 ducts; the larger number usually being near the power-house or the telephone or telegraph headquarters. The manholes and hand-holes are provided with double iron covers. Some of the covers are designed to make the manholes air- and water-tight; other covers are perforated to ventilate the conduits, to prevent the accumulation of gas from adjacent gas-mains, which occasionally causes explosions in the subways. The respective conductors in the cables are joined together by twisting or by copper sleeves, in the manholes; the conductors being separated from one another by insulating material. A lead sleeve is then placed over the joints and soldered to the main cable. A hot insulating substance, as wax or paraffin, is poured into the sleeve through a small hole in the sleeve, the hole being soldered thereafter.

The cables are drawn into the ducts by means of a rope and windlass; they are usually too heavy to be drawn by hand. Electric motors carried on wagons are also used to draw in the cables, the current for the motor being supplied by a storage battery. In order to get the rope through the duct, a wire is sometimes placed in the duct as it is laid. More frequently, however, the ducts are rodded by means of a stiff steel wire, or by means of screw and socket rods, similar to those used by chimney sweeps, one rod being screwed into its predecessor, which is then pushed along the duct until the distant manhole is reached, when a rope is attached to one end of the rods and drawn through the duct. For telegraph and telephone distribution, pipes are run from the manholes into the vaults of an adjacent building, from which point the wires are led to the subscribers' offices in the block.

For the ducts used in the drawing-in system different material and varying lengths of pipe or tube are employed. At one time, wrought-iron pipe, 3 inches in diameter and 20 feet in length, joined together by thread couplings and laid in hydraulic cement, was extensively used in this country. About 5,000,000 feet of such pipe were laid and are still in service, but in recent years earthenware, terra-cotta or vitrified brick, stone, and cement-lined pipe are mostly employed. The iron pipe and cement-lined ducts are round, about 3 inches in diameter. Many of the holes in the vitrified brick ducts are square, with an opening of about 3 inches. Fig. 13 illustrates a section of cement-lined pipe under construction. These tubes are of riveted sheet wrought-iron and lined with five eighths of an inch of pure cement. The tubes are 6 to 7 feet long, and 2 to 3 inches in diameter, as required. A large quantity of these

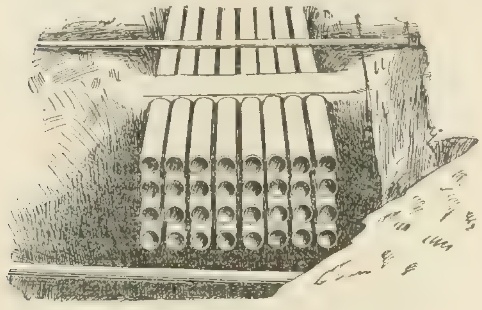

Fig. 13.—Cement-lined Conduit.

tubes are in use in this country and Great Britain.

In Fig 14 is shown a 12-duct vitrified clay conduit entering a manhole. Conduits of this type are made in blocks of two, three, four, and six ducts. The four- and six-duct blocks are six feet long; the two- and three-duct blocks are three feet in length. These blocks are laid in cement, end to end, and are held in position relative to one another by dowel pins. The

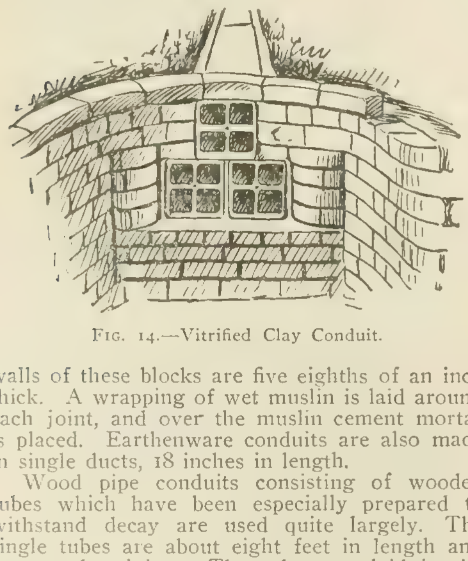

Fig. 14.—Vitrified Clay Conduit.

walls of these blocks are five eighths of an inch thick. A wrapping of wet muslin is laid around each joint, and over the muslin cement mortar is placed. Earthenware conduits are also made in single ducts, 18 inches in length.

Wood pipe conduits consisting of wooden tubes which have been especially prepared to withstand decay are used quite largely. The single tubes are about eight feet in length and have socket joints. The tubes are laid in the trench in tiers, the lower tier resting on planking. In the various types of underground conduits mentioned and others the ducts are "broken" to add strength to the structure. Care is taken in laying these ducts to exclude cement, stones, or any other obstacle that would obstruct or injure the cables in the "drawing in" process.

In the case of conduits for electric traction, the ducts are laid at the side of the tracks, underground, and wide manholes are provided at street intersections. For the "feeders" and other cables of the New York subways, conduits are laid in the wall of the structure, and access is given by openings in the wall at suitable intervals.

It is well known that frequent interruptions to overhead telegraph and telephone lines are occasioned by severe wind, snow, and sleet storms in this country and Europe, and in consequence the question of placing such wires in underground conduits has frequently been raised. The great cost of such an undertaking on a large scale, however, together with the fact that the speed of telephoning and telegraphing would be greatly diminished, owing to the increased electro-static capacity of the cables as compared with overhead lines, combined with other electrical obstacles, has been prohibitory of the attempt to carry out such a plan in this country. In Great Britain, where the population and business is more concentrated than in this country, an underground cable system has been laid for the greater portion of the distance between Birmingham, London, and Edinburgh, to tide over temporary prostrations of the overhead telegraph wires due to storms. For this purpose an iron pipe containing a 76-conductor telegraph cable, with openings at certain intervals to give access to the cable, is employed.

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Electric Vegetable Gardening. Experiments carried on at the government agricultural station at Amherst, Mass., since 1900, show that the use of electricity by the farmer is a distinct and valuable stimulus to nature and exerts a marked influence upon the germination of seeds and the growth of farm products. Scientists argue that roaming around loose in the atmosphere there is a vast fund of electrical force, which, by means of specially devised apparatus, can be attracted to the earth and distributed through the ground where the gardener has sown his seeds. The apparatus by means of which the electricity is caught and harnessed has been tested at Amherst and has proved to be a complete success. Briefly described it consists of a number of copper spikes which are elevated at the top of a 50-foot metallic pole. These spikes gather the electric fluid from the atmosphere and convey it to the foot of the pole, where it is caught by wires buried a few feet beneath the ground and distributed over as large a section as the gardener desires. Each of the poles will gather and distribute enough electricity to cover several acres of ground. With this apparatus experiments have been made which may be summarized as follows: After seeds have been subjected to the electric treatment for a period of 24 hours, it was found that over 30 per cent more seeds were germinated by the aid of electricity than in a like quantity of seeds sown in ground that lacked the electrical stimulant. As the scientists in charge of the experiments wished to make a very complete test, the electric current was applied to seeds that were allowed to stay in the ground for 48 hours. In this case it was found that 20 per cent more seeds had germinated in the electrified ground than in the soil where the seeds had been left to sprout under normal conditions, and in 72 hours this percentage had dropped to 6, thus showing that the use of the current for the purpose of stimulating germination under all the tests was a decided success.

In the various tests seeds subjected to only a temporary current of electricity have been found to show the effect for a few hours and then resume their normal growth. In one instance, to produce a constantly beneficial effect it was necessary to apply the electricity every hour to germinate growing plants or seeds.

Another interesting experiment, made in 1902, was planting in two sections of ground, the soil in both of which had been carefully selected to ensure it being exactly alike, seeds of the following varieties: parsnip, lettuce, carrot, turnip, radish, and onion. To one of the sections of ground a mild current of electricity was applied. The following day the plants in the electrified plot began to appear, the turnips sprouting first. The rapidity of growth of those planted in the electrically treated ground was far in advance of those treated in the ordinary ground. The second day plants broke through the surface in both plots, those in the electric garden showing considerably the more rapid growth; the foliage was rank, and when harvested was nearly twice as high as that of the non-electric plot. The roots also were larger and showed a marked difference in favor of electricity. One peculiarity was that in the electric plot for every pound of roots very nearly a pound of tops was produced, while in the other case for every pound of tops there grew 1.43 pounds of root, but the difference in the total was all in favor of electricity. With reference to the other vegetables, the lettuce proved a failure in both plots. The carrots showed a marked superiority in the electric bed over those in the non-electric. The onion plants came up in both beds and grew finely for a time, then blasted and not one developed, neither electric nor non-electric.

Besides the electric treatment of the soil, experiments have been made with the electric light for stimulating the growth of plants, and the general effect has been to hasten the maturity of lettuce, spinach, and similar products. It has been found that the electric light has the stimulating effect of daylight upon the plants, and crops thus encouraged by light from arc lamps have showed 50 to 60 per cent increase. In short it has been clearly demonstrated that by means of electricity nature can be forced to do double duty without lessening the worth of her products. See ELECTRO-CULTURE OF PLANTS.

Electric Waves. See LIGHT.

Electric Welding. There are at least three different processes by which electric welding may be brought about, namely, the electric arc process, the aciduiated water process, and the process in which an electric current is passed through the metals. In the arc process the metals to be welded are placed in or near the arc formed between two carbon rods or electrodes somewhat similar to those of the arc lamp. This process is readily applicable to welding and brazing small materials like bicycle frames, copper steam pipes, and rivet heads. In the use of the apparatus, which may be portable, a flame like that from a powerful blow pipe is projected from the arc upon the metals to be heated. For brazing work a voltage of 45 to 50 volts is used. For heavy welding and filling up flaws in iron and steel castings 50 to 55 volts are employed. Owing to the brightness of the arc and for the protection of his face otherwise, the operator of the apparatus must wear a mask with small colored glass windows.

For an instance of the acidulated water process of raising the metals to the welding point, see ELECTRIC ANNEALING.

In the current heating process of which that known as the "Thomson" is in most extensive use, currents are caused to pass through the abutting ends of the pieces to be welded. This raises the temperature uniformly throughout the mass of the metals to the welding point, pressure being applied by mechanical means until a complete union of the metals is effected. Continuous or alternating current may be used. Machines are in use for this work varying in power from 2 to 80 horse-power and more, equipped with the necessary apparatus for regulating the current and the mechanical pressure, and for clamping the pieces to be welded. In some welding machines of this type the current varies from 500 to 20,000 amperes and the electromotive force from 20 to 30 volts. The time consumed in making welds by this time ranges from 2 seconds to 60 seconds, depending on the size of the materials welded, and the electrical horse-power used. See WELDING.

Electric Wireless Telegraph. See DEFOREST; MARCONI; TELEGRAPH; WIRELESS TELEGRAPH.

Electricity is a form of energy (q.v.) like mechanical energy or energy of motion, heat, radiating energy as light, chemical energy, etc. Electric energy is the form of energy most recently introduced into everyday life and is, therefore, not yet quite familiar, so that we still ask, "What is electricity?" while ages ago mankind ceased to ask, "What is gravity?" or "What is light?" although the manifestations of electric energy are no more wonderful and inexplainable than those of gravity, that is the cause why a stone falls to the ground and water flows down hill. In nature electric energy manifests itself during atmospheric disturbances as lightning (q.v.), but the energy of lightning is too erratic for use. For the production of electric energy on a larger scale recourse must be had to the stores of energy afforded by nature. In large amounts energy is found in nature, first, as mechanical energy in the waterfalls and to a lesser extent the wind, and second, as chemical energy in coal, wood, oil, natural gas, etc.

Generation.— In the transformation of the mechanical energy of waterfalls into electric energy, the water-power is first converted into rotary motion by the turbine or water-wheel, the latter then converted into electric energy by the electric generator or dynamo. Chemical energy can be converted directly into electric energy only to a limited extent, as chemical energy of metals. This is done in the electric battery. (See BATTERY.) But due to the high cost of the chemical energy of metals, the production of electric energy by means of the battery is commercially feasible only where small quantities are required and the cost of the energy therefore secondary to the convenience of generation, as for signaling purposes, bells, annunciators, etc. The chemical energy of coal and other combustibles cannot be directly converted into electric energy, but is converted into heat energy by combustion, the heat energy transferred from the gases of combustion to the water in the steam boiler, converted into mechanical energy in the steam engine and the mechanical converted into electric energy in the electric generator. In the gas engine the heat energy of combustion is directly converted into mechanical energy. In any transformation of energy from one form to another a certain loss occurs by conversion into heat. This loss is moderate in the transformation of water-power into mechanical energy, very small in the transformation of mechanical into electric energy, but enormous in the transformation of heat into any other form of energy. Our modern theories consider all forms of energy as different modes of motion; of the masses in mechanical energy or of the molecules and atoms of matter with electric, chemical, etc., energy. Heat is the simplest form of energy, irregular motion of the molecules or motion without definite speed and direction. It is, therefore, intelligible that in any conversion of energy, that is of a regular motion into another regular motion, some of the energy is lost by losing its regularity of motion, that is converted into heat, the more the greater the difference between the two forms of motion, and that when converting irregular into regular motion, that is heat into other forms of energy, this loss is specially great. The cost of electric-power derived from water-power does not differ much from that derived from coal by the steam engine, the cost of coal in the latter case offsetting the interest on the greater investment required in developing the water-power and transmitting the electric-power to the place of consumption. Hence where coal is cheap the steam-power may be more economical where water-power is found which can cheaply be developed, or where coal is expensive water-power is more economical.

Use.— Electric energy is hardly ever used as such but only after transformation in other forms of energy, mainly mechanical energy, heat, chemical energy, and light. Since electric energy is generated from other forms of energy, it follows that it is used essentially as intermediary form of energy. For this it is better suited than any other form of energy, due to the high efficiency and simplicity of generation and re-conversion, and especially the almost unlimited flexibility which permits transmission over long distance, distribution with the simplest means, and unlimited subdivision and ease of control.

Mechanical Power.— The electric motor is a secondary and not a primary source of power, that is, it does not convert the stores of energy found in nature into mechanical energy as the steam engine, but mechanical power has to be extended somewhere to produce the electric power which is re-converted into mechanical power in the electric motor. The advantage of the electric motor is that the mechanical power can be utilized at a distance from the source of power; the factories and mills may be located far distant from the water power and the railroad train or street car receive the power from the distant station. The power generated at one place can be distributed efficiently to a large number of places, or all motors of the city may receive their power from one central generating station. Instead of an extended and inefficient system of belting, individual motors may drive the machines of the factory or mill. All the cars or trains of a railway system may receive their power from one generating system, perhaps a water-power as Niagara. The electric motor is under more perfect control than almost any other motor, and when not used consumes no power and requires no special care in starting and operation. Mechanical power in small quantities can be produced almost as efficiently as in large units and a great subdivision of power becomes thereby feasible. In the field of mechanical power generated by electricity also belong telegraphy and telephony, or the transmission of signals and speech over long distances.

Light.— For lighting, electric energy is first converted into heat and the light given by the incandescence of solid substances, exclusively carbon, the carbon filament of the incandescent lamp, or the glowing tip or crater of the arc lamp carbons. (See Electric Lighting.) Here again, especially with incandescent lamps, the main advantage lies in the absolute steadiness, control, and flexibility of the light, the simplicity of turning it on or off, and its relatively high efficiency, which gives a light with less heat than the gas flame or kerosene lamp. While due to the use of heat as intermediary form of energy only a very few per cent of the electric energy are converted into light, most being dissipated as heat, with the gas or kerosene flame the percentage of energy converted into light is still much less. Recently considerable work is being done and with great promise, of converting electric energy directly into light by electro-luminescence in luminous arcs, which promises an efficiency of light production very much greater than the incandescent or carbon arc lamp.

Heat.— The conversion of electric energy into heat means a degradation of energy from regular to irregular motion and in the heat production by electric energy only a very few per cent of the heat energy expended under the boilers of the steam engine driving the electric generator is recovered, so that electric heating is much more expensive than direct generation of heat by combustion and therefore commercially practicable only.

1. For the production of temperatures beyond those which can be reached by combustion. At very high temperatures chemical affinity and therefore combustion ceases and temperatures beyond this cannot be reached by combustion but are reached by conversion of electric energy into heat in the electric furnace. By this means chemical compounds have been produced for industrial purposes which were either entirely unknown or mere curiosities before, as the carbides, calcium carbide, carborundum, silicon metal, etc.

2. Electric energy is used for heating where the temperature has to be perfectly controlled.

3. Due to its convenience and cleanliness for domestic uses, to a limited extent, electric heating and cooking are coming into use.

Chemical Energy.— Electric energy is converted into chemical energy either directly in the electrolytic cell or indirectly with heat as intermediary in the electric furnace as discussed above. Electrolysis (q.v.), that is the chemical action of electric energy, is used exclusively for the production of aluminum metal, is used for copper refining, production of sodium, chlorates, soda, and bleaching powder, and many other compounds.

Storage.— Electric energy cannot be stored as such conveniently, but the ease and efficiency of conversion of electric energy into the chemical energy of metals and metallic oxides, and inversely, permits the storage of electric energy as chemical energy in the storage batttery. (See ELECTRIC STORAGE BATTERY.) Charging the storage battery means converting in it electric energy into chemical energy, discharging, the reconversion of the chemical energy into electric energy.

Measurements.— Since all forms of energy are convertible into each other they can be measured by the same measure. Heat being the simplest form of energy, the measure of heat is the universal measure of energy. It is the calorie, or the amount of heat required to raise one litre of water from 0° to 1° C. Chemical energy is exclusively measured in calories. All other forms of energy usually have some other measure convertible into calories. So, mechanical energy is measured in foot-pounds, or kilogram-meters, and the flow of mechanical energy, or mechanical power, in foot-pounds per second or horsepower, 1 horsepower = 550 foot-pounds per second, = 75 kilogram-meters per second = .176 calorie seconds. The value of electric energy or electric power is measured either in the mechanical measure, horsepower, or electric measure, watts, 746 watts = 1 horsepower. Usually the kilowatt or 1,000 watts = 1.35 horsepower, is used. 1 kilowatt = .238 calorie second. Most forms of energy are resolved into the product of two components; a quantity and a pressure component, as the power of a waterfall is the product of the quantity of water flowing and its head or fall. So electric power is resolved into a quantity component called "current" and measured in amperes, and a pressure component called "electromotive-force" or "potential difference" or "voltage," and measured in volts, and the electric power then is a product of volts and amperes, 1 watt = 1 volt × 1 ampere. Just as a small quantity of water under a high head may give the same power as a large quantity under low head, so a small current at high voltage may represent the same electric power as a large current under low voltage. The smaller the quantity and the higher the voltage the less the loss in transmitting the power. Therefore, for long distance transmissions high voltages are used, the higher the greater the distance, while relatively low voltages are employed for general use, due to the difficulty and danger of handling high voltages. The instrument measuring electric power is called the wattmeter, that measuring electric current or flow of quantity is the ammeter, that measuring electric pressure or voltage is the voltmeter.

Conductors and Insulators.— Some substances, as metals, carbon, salt solutions, etc., are conductors of electricity, others as air, glass, rubber, paper, oils, etc., are insulators. There is, however, no perfect conductor nor perfect insulator, but even the best conductors: silver, copper, aluminum, offer still some resistance to the flow of electric power and thereby cause a loss of energy which is proportional to the square of the current flowing and appears as heat in the conductor. For transmission of electric power conductors are therefore used to direct the flow of power, copper or aluminum, surrounded by insulators, as rubber, paper. It is not sufficient, however, merely to surround the conductor by insulating material, but the insulating material must have sufficient thickness to withstand the electric pressure or voltage, otherwise it is disrupted, that is, the electric power penetrates it as spark discharge. The ability to withstand electric pressures is called the dielectric or disruptive strength and is of foremost importance in insulating electric circuits of high voltage. Very good insulators are not necessarily of very high dielectric strength, for instance air, which is perhaps the best insulator, has rather low disruptive strength, that is, is easily penetrated by an electric spark, while mica and rubber, although not as good insulators as air, have very much greater dielectric strength.

Physiological Effects.— Electric energy is perceived by the senses either indirectly by transformation into other forms of energy, as light and sound in the spark discharge or lightning, or directly if the electric current passes through the body. A large current of very short duration: an electric discharge causes a shock which when very powerful, as in lightning, may be fatal. A current flowing continuously through the body causes a specific sensation which with increasing voltage and therefore increasing current, becomes unbearable, the muscles contract and become uncontrollable, so that in case of accidental contact with electric circuits the victim is unable to let go, and ultimately at high voltages death may result. (See ELECTRICITY, CAUSE OF DEATH BY.) The amount of current flowing through the body depends upon the electric pressure or voltage and the resistance of the body. This resistance is mainly the skin or surface resistance, therefore depends upon the nature of the contact between body and electric circuit. When loosely touched with dry hands a 100 volt circuit may hardly give any sensation, while grasped with wet hands a 50 volt circuit may be unbearable. Only at very high voltages the nature of the contact becomes of less importance and the electric current penetrates as arc. Electric pressures of 500 to 600 volts are considered as still safe, since only in cases of exceptionally good contact with such voltages serious results may occur. Much higher voltages are usually fatal, but instances are on record of contact with 10,000 to 12,000 volts without fatal results, in cases where the duration of the contact has been very brief.

The causes of death by electricity are:

1. The direct effect of large power exerted upon the body, causing destruction by heat, etc., as in electrocution where several horsepowers are used.

2. Mechanical destruction of vital organs by very heavy discharges, as lightning.

3. Paralysis of the nervous system, stoppage of the heart and respiratory organs. In these cases resuscitation by artificial respiration, etc., when immediately resorted to, is very promising.

Therapeutically electricity is used as stimulant by its action on the nervous system and for carrying substances through the skin into the body electro-chemically. It is very useful in the hands of expert physicians but like any powerful agent in the hands of a layman, is harmful and dangerous. The electric healing devices advertised broadcast, as electric belts, etc., are mere swindles and without any value. See ELECTROTHERAPEUTICS.

Prospect.—Only the very beginning has been made in the use of electricity as secondary form of power for transmitting energy from its natural source, waterfall or coal mine, to the place of consumption, factory, city, railway. Here very great strides are still to be looked forward to, resulting in a much more efficient use of the stores of energy afforded by nature. In the production of light from electric energy at present the efficiency is low, due to the use of heat as intermediary form of energy. A direct conversion of electric energy into heat giving an efficiency of 50 per cent or more would make electric lighting many times cheaper than any other form of illumination and so displace all other illuminants. In this direction fair promise of a gradual advance exists. The direct conversion of the stored energy of coal into electric energy and thereby the elimination of the enormous loss of energy between the chemical energy of the coal and the electric energy, is still entirely hopeless and no clue to its solution visible. In electro-chemistry (q.v.), that is, the transformation of electric into chemical energy, lies an enormous field which has hardly been touched, although it has already produced powerful industries, as the aluminum and carbide production and therefore holds out the hope of most wonderful advances in the future. See ELECTRO-CHEMICAL INDUSTRIES; METALLURGY; and various other articles in this volume on electrical subjects.

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Electricity, Its History and Progress. There is perhaps no better illustration of the slow growth of man's knowledge concerning physical things than the fact that the identity of lightning, and electricity in some of its other modes of manifestation, should have escaped detection for so many centuries of the world's history.

Lightning, of course, and certain other manifestations of electricity, were known to the philosophers of ancient times, but to them no thought was more remote than that these manifestations had a common origin. Pliny (61-115 A.D.) in his books writes: «The ancient Tuscans by their learning do hold that there be nine gods that send forth lightning and those of eleven sorts.» This was in general the early pagan idea of lightning. The property of amber when rubbed of attracting light bodies, such as particles of feathers, a property now known to be electrical in its nature, must have been familiar to philosophers hundreds of years before the Christian era, although Thales of Mileta (640-548 B.C.) one of the seven sages of Greece, is mentioned as having been the first to observe this phenomenon. Pliny has several references to this peculiar property of amber. (Pliny's 'Natural History,' trans. Philemon Holland, London 1634, p. 606.) He quotes Niceas as saying that «in Syria the women make wherves of it (amber) for their spindles, where they use to call it Harpax, because it will catch up leaves, straws, and fringes hanging to cloaths» . . . Again Pliny writes (ibid. 608), «To come into the properties that amber hath if it be well rubbed and chaufed between the fingers, the potential faculties that lies within is set on work and brought into actuall operation, whereby we shall see it to draw chaffe, strawes, dry leaves, yea and thin rinds of the Linden or Tillet tree, after the same sort as the loadstone draweth yron.» . . . . «The froward peevishness of some authors who have written of Lyncurium (tourmalin) liken it to amber.» . . . «Neither, by their saying, doth it catch at leaves only and straws, but thin plates also of brass and yron, and of this opinion was Dimocles and Theophrastus» (The latter of Lesbos 373-288 B.C.) (Ibid 609).

The peculiarity of the torpedo in defending itself by means of a property now also known to be electrical which it possesses whereby it can stun an enemy was also known to Pliny and other early writers. (Consult Cavallo's 'Philosophy,' p. 536, Phila. 1829.)

The property of the magnet or loadstone in attracting iron was, as just indicated in the quotation from Pliny, likewise known to the enlightened men of that early period, but neither in the case of electricity nor of magnetism had these philosophers any conception of the real nature of the phenomena involved, attributing the peculiar properties of the substances named to some occult vitality possessed by them.

It is not, however, much to be wondered at that the philosophers of long past ages should have failed to observe any relationship between the phenomena of lightning, amber and the torpedo, when as we shall see, many who may be termed modern philosophers—those of the 17th and 18th centuries—failed for years to discover this identity, even when in possession of electric machines capable of producing many of the effects of lightning in miniature, and for long after the knowledge of the electrical properties of amber had been extended to wax, glass, and other substances. Even the co-relationship of electricity and magnetism escaped particular notice for some years after the affinity of these phenomena had been demonstrated. Possibly the earliest and nearest approach to the discovery of the identity of lightning, and electricity from any other source, is to be attributed to the Arabs, who before the 15th century had applied the Arabic word for lightning (raad) to the torpedo.

The Greek word for amber, however, is elektron, and it is due to the fact that this substance was the first known to possess the property mentioned that the word electricity is derived, «and the reason why the name was named electrum is this: because the sun in old time was usually called elector in Greek» (Pliny).

Centuries passed after the discovery of frictional and animal electricity before any advance appears to have been made in the production of electricity artificially or before any important developments of value were made in the art.

Toward the latter part of the 16th century a physician of Queen Elizabeth's time, Dr. William Gilbert (1540-1603), undertook a number of careful electrical experiments, in the course of which he discovered that many substances other than amber, such as sulphur, wax, glass, etc. (consult Priestley's 'History of Electricity,' London 1757), were capable of manifesting electrical properties. Gilbert also discovered that a heated body lost its electricity and that moisture was detrimental to the electrification of all bodies. He also noticed that electrified substances attracted all other substances indiscriminately, whereas a magnet only attracted iron. The many discoveries of this nature earned for Gilbert the title of founder of the electrical science. Since Gilbert's time scarcely a year has passed in which some new discovery or improvement relating to the science and art of electricity and magnetism has not been made.

Amongst the experimenters immediately following Gilbert one of the most notable was Dr. Wall of England (1650). During one of his experiments on approaching his fingers to an electrified rod, Dr. Wall saw a spark, accompanied by a noise which he likened to lightning and thunder. Wall's contemporaries and some comparatively recent writers have thought that this was the first time an artificially produced electric spark had been observed. This, however, is doubtless an erroneous view. Archbishop Eustathias, of Thessalonica, Greek scholar and writer of the 12th century, for instance records that Woliver, King of the Goths, was able to draw sparks from his body. The same writer states that a certain philosopher was able while dressing to draw sparks from his clothes, a result seemingly akin to that obtained by Symmer in his silk stocking experiments, a careful account of which may be found in the 'Philosophical Transactions,' 1759.

It would indeed have been surprising if the electric spark had not been observed prior to Dr. Wall's time (although its origin may not have been recognized) when it is considered that any one shuffling across a carpet in dry, crisp weather, or if whipped with a piece of fur while his body is insulated, will accumulate a charge of electricity upon his person that will discharge with a spark into any other person or piece of metal that he may touch. The present writer has even noticed electric sparks passing from his knuckles to the metal fixings of a hand bag that he was carrying while walking on a stone pavement in cold, dry weather.

Robert Boyle was another of the experimenters in electricity of this period (1650). One of his important discoveries was that electrified bodies in a vacuum would attract light substances, this indicating that the electrical effect did not depend upon the air as a medium. He also added resin to the then known list of electrics. (Consult Boyle's 'Experiments on the Origin of Electricity,' and Priestley's 'History of Electricity.') Up to about the year 1682 the only known way in which electricity could be developed was virtually that known to the ancients, namely, by rubbing rods of amber, glass, wax, resin or similar substances. The amount of electricity thus producible was very small. At this time Otto von Guericke of Magdeburg (also the inventor of the air-pump) invented an electric machine consisting of a sulphur globe or ball, suitably mounted on a shaft and rotated by a handle. Using his hand as a «rubber» (see ELECTRIC MACHINES), von Guericke obtained electricity in fairly large quantities, the production of which «was accompanied by light and sound.»

The electric machine was subsequently improved by Hawkesbee or Haukesbee, Litzendorf, and by Professor George Mathias Boze, about 1750. Litzendorf substituted a glass ball for the sulphur ball of Guericke. Boze was the first to employ the «prime conductor» in such machines. this consisting of an iron rod held in the hand of a person whose body was insulated by standing on a cake of resin. Dr. Ingenhousz, in 1746, invented electric machines made of plate glass (Consult Dr. Carpue's 'Introduction to Electricity and Galvanism,' London 1803).

Experiments with the electric machine were largely aided by the discovery of the property of a glass plate, when coated on both sides with tin foil, of accumulating a charge of electricity when connected with a source of electromotive force. This property, now and for many years availed of in the electric condenser, was, according to Priestley ('History of Electricity,' 3d ed. Vol. I, p. 102), first observed by Von Kleist of Leyden in 1754. Von Kleist happened to hold a small bottle, in the neck of which there was an iron nail, near his electric machine. Touching the iron nail accidentally with his other hand he received a severe electric shock. In much the same way Professor Pieter van Musschenbroeck assisted by Cunaens received a more severe shock from a somewhat similar glass bottle. The severity of this shock may be judged from the fact that Musschenbroeck wrote to Reaumer that he would not expose himself to such another for the Imperial Crown of France. Sir Wm. Watson of England greatly improved this device, by covering the bottle, or jar, outside and in with tin foil. This piece of electrical apparatus will be easily recognized as the well-known Leyden jar, so called by the Abbot Nollet of Paris, after the place of its discovery. The electric machine was soon further improved by Professor Andrew Gordon, a Scotchman. of Erfurt, who substituted a glass cylinder in place of a glass globe; and by Giessing of Leipzig who added a «rubber» consisting of a cushion of woolen material. The «collector,» consisting of a series of metal points, was added to the machine by Benjamin Wilson about 1746, and Mr. John Canton of England (also the originator of the first pith ball electrometer) in 1762 made a notable improvement in the efficiency of electric machines by sprinkling an amalgam of tin over the surface of the rubber.

If any surprise should be evoked by this somewhat detailed reference to the early growth of the electric machine it must be remembered that at the time under consideration, it was, as previously intimated, the only known means by which electricity could be generated artificially in quantities that were not almost infinitesimal.

In the second quarter of the 18th century (1729) Stephen Gray in a series of interesting experiments for the first time demonstrated the difference between conductors and non-conductors (insulators) showing amongst other things that a metal wire and even pack thread conducted electricity, whereas silk did not. In one of his experiments he sent an electric current through 700 feet of hempen thread which was suspended at intervals by loops of sil thread. Subsequently Du Fay transmitted a current through a wet hempen string to a distance of 1,256 feet, the string being insulated by means of glass. In 1741 Mr. Ellicott «proposed to measure the strength of electrification by its power to raise a weight in one scale of a balance while the other was held over the electrified body and pulled to it by its attractive power» (Carpue).

The Sir William Watson already mentioned, conducted numerous experiments about 1749, to ascertain the velocity of electricity in a wire, which experiments although perhaps not so intended, also demonstrated the possibility of transmitting signals to a distance by electricity. In these experiments an insulated wire 12,276 feet in length was employed and the transmission of a signal from one end of the wire to the other appeared to the observers to be instantaneous. Monnier (q.v.) in France had previously made somewhat similar experiments, sending shocks through an iron wire 1,319 feet long.

About 1737 Hawkesbee and Du Fay independently discovered that there were apparently two kinds of frictional electricity, namely that which is developed by rubbing glass and resin, respectively. The former electricity Du Fay termed "vitreous," the latter "resinous" electricity. Later, these electricities were termed "positive" and "negative" electricity, respectively, by Franklin, Dr. Watson, Lichtenberg and others.

Theories regarding the nature of electricity were quite vague at this period, and those prevalent were more or less conflicting. Franklin considered that electricity was an imponderable fluid pervading everything, and which, in its normal condition, was uniformly distributed in all substances. He assumed that the electrical manifestations obtained by rubbing glass were due to the production of an excess of the electric fluid in that substance and that the manifestations produced by rubbing wax were due to a deficit of the fluid. This theory was opposed by the "two-fluid" theory due to Robert Symmer, 1759. By Symmer's theory the vitreous and resinous electricities were regarded as imponderable fluids, each fluid being composed of mutually repellent particles while the particles of the opposite electricities are mutually attractive. When the two fluids unite by reason of their attraction for one another, their effect upon external objects is neutralized. The act of rubbing a body decomposes the fluids one of which remains in excess on the body and manifests itself as vitreous or resinous electricity.

About 1750 various tests were made by different experimenters to ascertain the physiological and therapeutical effects of electricity. Mainbray (or Mowbray) in Edinburgh examined the effects of electricity upon plants and concluded that the growth of two myrtle trees was quickened by electrification. These myrtles were electrified "during the whole month of October, 1746, and they put forth branches and blossoms sooner than other shrubs of the same kind not electrified." (Priestley's 'History of Electricity,' p. 138.) The Abbé Menon tried the effects of a continued application of electricity upon men and birds and found that the subjects experimented on lost weight, thus apparently showing that electricity quickened the excretions. The efficacy of electric shocks in cases of paralysis was tested in the county hospital at Shrewsbury, England, with rather poor success. ('Philosophical Transactions,' p. 786, 1754.) In one case reported a palsied arm was somewhat improved, but the dread of the shocks became so great that the patient preferred to forego a possible cure rather than undergo further treatment. In another case of partial paralysis the electric treatment was followed by temporary total paralysis. A second application of this treatment was again followed by total paralysis, whereupon the further use of electricity in this case was stopped. For further accounts of the early use of electricity as a remedial agent the reader may consult De la Rive's 'Electricity.' See also article ELECTRO-THERAPEUTICS.

Up to the time of Franklin's historic kite experiment (see ELECTRICITY, ATMOSPHERIC) the identity of the electricity developed by rubbing and by electric machines (frictional electricity), with lightning had not been generally established. Dr. Wall, 1807, Abbot Nollet, Hawkesbee, Gray and Winckler had indeed suggested the resemblance between the phenomena of "electricity" and "lightning," Gray having intimated that they only differed in degree. It was doubtless Franklin, however, who first proposed tests to determine the sameness of the phenomena. In a letter to Peter Conlinson, London, 19 Oct. 1752, Franklin, referring to his kite experiment, wrote, "At this key the phial (Leyden jar) may be charged; and from the electric fire thus obtained spirits may be kindled, and all the other electric experiments be formed which are usually done by the help of a rubbed glass globe or tube, and thereby the sameness of the electric matter with that of lightning be completely demonstrated." (Franklin, 'Experiments and Observations on Electricity.') Dalibard, at Marley, near Paris, on 10 May 1772 by means of a vertical iron rod 40 feet long, obtained results corresponding to those recorded by Franklin and somewhat prior to the date of Franklin's experiment.

Franklin's important demonstration of the sameness of frictional electricity and lightning doubtless added zest to the efforts of the many experimenters in this field in the last half of the 18th century, to advance the progress of the science. Amongst those workers may be mentioned Watson, Boze, Smeaton, Le Monnier, De Romas, Jallabert, Beccaria, Cavallo, John Canton, Robert Symmer, Nollet, Winckler, Richman, Dr. Wilson, Kinnersley, Priestley, Aepinus, Delaval, Cavendish, Coulomb, Volta and Galvani. A description of many of the experiments and discoveries of these early workers in the fields of electrical science and art will be found in the scientific publications of the time; notably the 'Philosophical Transactions,' *Philosophical Magazine, Cambridge Mathematical Journal,* Young's 'Natural Philosophy,' Priestley's 'History of Electricity,' 'Franklin's Experiments and Observations on Electricity,' Cavalli's 'Treatise on Electricity,' De la Rive's 'Treatise on Electricity.' Among the more important of the electrical experiments and researches at this period were those of Francis Aepinus, a noted German scholar (1724-1802) and Henry Cavendish of London, England. To Aepinus is accorded the credit of having been the first to conceive the view of the reciprocal relationship of electricity and magnetism. In his work 'Tentamen Theoria Electricitatis et Magnetismi,' published in Saint Petersburg, 1759, he gives the following amplification of Franklin's theory, which in some of its features is measurably in accord with present day views: "*The particles of the electric fluid repel each other and attract and are attracted by the particles of all bodies with a force that decreases in proportion as the distance increases; the electric fluid exists in the pores of bodies; it moves unobstructedly through non-electrics* (insulators), *but moves with difficulty in insulators; the manifestations of electricity are due to the unequal distribution of the fluid in a body, or to the approach of bodies unequally charged* *with the fluid.*" Aepinus formulated a corresponding theory of magnetism excepting that in the case of magnetic phenomena the fluids only acted on the particles of iron. He also made numerous electrical experiments, amongst others those apparently showing that in order to manifest electrical effects tourmalin requires to be heated to a temperature between 37.5°C and 100°C. In fact, tourmalin remains unelectrified when its temperature is uniform, but manifests electrical properties when its temperature is rising or falling. Crystals which manifest electrical properties in this way are termed pyro-electrics, amongst which, besides tourmalin are sulphate of quinine and quartz.

Cavendish independently conceived a theory of electricity nearly akin to that of Aepinus ('Philosophical Transactions,' 1771). He also (1784) was perhaps the first to utilize the electric spark to produce the explosion of hydrogen and oxygen in the proper proportions to produce pure water. The same philosopher also discovered the inductive capacity of dielectrics (insulators) and as early as 1775 measured the specific inductive capacity of beeswax and other substances by comparison with an air condenser. Unfortunately much of the work of Cavendish was not for many years available to his contemporaries and successors, although on record.

About 1784 C. A. Coulomb, after whom is named the electrical unit of quantity, devised the torsion balance, by means of which he discovered what is known as Coulomb's law;—*The force exerted between two small electrified bodies varies inversely as the square of the distance;* not as Aepinus in his theory of electricity had assumed, merely inversely as the distance. According to the theory advanced by Cavendish "the particles attract and are attracted inversely as some less power of the distance than the cube."

With the discovery, by the experiments of Watson and others, that electricity could be transmitted to a distance, the idea of making practical use of this phenomenon began, about 1753, to engross the minds of "inquisitive" persons, and to this end suggestions looking to the employment of electricity in the transmission of intelligence were made. The first of the methods devised for this purpose was probably that due to Lesage (1774). This method consisted in the employment of 24 wires, insulated from one another and each of which had a pith ball connected to its distant end. Each wire represented a letter of the alphabet. To send a message, a desired wire was charged momentarily with electricity from an electric machine, whereupon the pith ball connected to that wire would fly out; and in this way messages were transmitted. Other methods of telegraphing in which frictional electricity was employed were also tried, some of which are described in the article on the Telegraph (q.v.).

Hitherto the only electricity known was that developed by friction or rubbing, which was therefore termed frictional electricity. We now come to the era of galvanic or voltaic electricity. The first mention of voltaic electricity, although not recognized as such at the time, was probably made by Sulzer in 1767, who on placing a small disk of zinc under his tongue and a small disk of copper over it, observed a peculiar taste when the respective metals touched at their edges. Sulzer assumed that when the metals came together they were set into vibration, this acting upon the nerves of the tongue, producing the effects noticed.

In 1790 Professor Luigi Alvisio Galvani of Bologna on one occasion, while conducting experiments on "animal electricity," as he termed it, to which his attention had been turned by the twitching of a frog's legs in the presence of an electric machine, observed that the muscles of a frog which was suspended on an iron balustrade by a copper hook that passed through its dorsal column, underwent lively convulsions without any extraneous cause; the electric machine being at this time absent. To account for this phenomenon Galvani assumed that electricity of opposite kinds existed in the nerves and muscles of the frog; the muscles and nerves constituting the charged coatings of a Leyden jar.

Galvani published the results of his discoveries, together with his hypothesis, which at once engrossed the attention of the physicists of that time; the most prominent of whom, Alexander Volta, Professor of Physics at Pavia, contended that the results observed by Galvani were due to the two metals, copper and iron, acting as "electromotors," and that the muscles of the frog played the part of a conductor, completing the circuit.

This precipitated a long discussion between the adherents of the conflicting views; one set of adherents holding with Volta that the electric current was the result of an electromotive force of contact at the two metals; the other set adopting a modification of Galvani's view and asserting that the current was due to a chemical affinity between the metals and the acids in the pile. Michael Faraday wrote in the preface to his 'Experimental Researches,' relative to the question whether metallic contact is or is not productive of a part of the electricity of the voltaic pile: "I see no reason as yet to alter the opinion I have given; . . . but the point itself is of such great importance that I intend at the first opportunity renewing the inquiry, and, if I can, rendering the proofs either on the one side or the other, undeniable to all." Even Faraday himself, however, did not settle the controversy, and while the views of the advocates on both sides of the question have undergone modifications, as subsequent investigations and discoveries demanded, up to the present day diversity of opinion on these points continues to crop out.

Volta made numerous experiments in support of his theory and ultimately developed the pile or battery (see VOLTAIC PILE), which was the precursor of all subsequent chemical batteries, and possessed the distinguishing merit of being the first means by which a prolonged continuous current of electricity was obtainable.

Volta communicated a description of his pile to the Royal Society of London and shortly thereafter Nicholson and Cavendish (1880) produced the decomposition of water by means of the electric current, using Volta's pile as the source of electromotive force. Davy in 1806, employing a voltaic pile of approximately 250 cells, or couples, decomposed potash and soda, showing that these substances were respectively the oxides of potassium and sodium, which metals previously had been unknown. These experiments were the beginning of electro-chemistry (q.v.) the investigation of which Faraday took up, and concerning which in 1833 he announced his important law of electro-chemical equivalents, viz.: "*The same quantity of electricity—that is, the same electric current—decomposes chemically equivalent quantities of all the bodies which it traverses; hence the weights of elements separated in these electrolytes are to each other as their chemical equivalents.*" Employing a battery of 2,000 elements of a voltaic pile Humphry Davy in 1840 gave the first public demonstration of the electric arc light (q.v.) using for the purpose charcoal enclosed in a vacuum.

Somewhat singular to note, it was not until many years after the discovery of the voltaic pile that the sameness of animal and frictional electricity with voltaic electricity was clearly recognized and demonstrated. Thus as late as January, 1833, we find Faraday writing ('Philosophical Transactions,' 1833) in a paper on the electricity of the torpedo. "After an examination of the experiments of Walsh, Ingenhousz, Cavendish, Sir H. Davy, and Dr. Davy, no doubt remains on my mind as to the identity of the electricity of the torpedo with common (frictional) and voltaic electricity; and I presume that so little will remain on the mind of others as to justify my refraining from entering at length into the philosophical proof of that identity. The doubts raised by Sir H. Davy have been removed by his brother, Dr. Davy; the results of the latter being the reverse of those of the former. . . . The general conclusion which must, I think, be drawn from this collection of facts (a table showing the similarity of properties of the diversely named electricities) is, that electricity, whatever may be its source, is identical in its nature."

It is proper to state, however, that prior to Faraday's time the similarity of electricity derived from different sources was more than suspected. Thus, William Hyde Woolaston (another noted and careful experimenter in electricity and the discoverer of palladium and rhodium, b. 1766; d. 1828), wrote in 1801 (*Philosophical Magazine*, Vol. III, p. 211): "This familiarity in the means by which both electricity and galvanism (voltaic electricity) appear to be excited in addition to the resemblance that has been traced between their effects shows that they are both essentially the same and confirm an opinion that has already been advanced by others, that all the differences discoverable in the effects of the latter may be owing to its being less intense, but produced in much larger quantity." In the same paper Woolaston describes certain experiments in which he uses very fine wire in a solution of sulphate of copper through whch he passed electric currents from an electric machine. This is interesting in connection with the later day use of almost similarly arranged fine wires in electrolytic receivers in wireless, or radiotelegraphy.

In the first half of the 19th century many very important additions were made to the world's knowledge concerning electricity and magnetism. For example, in 1819 Hans Christian Oersted of Copenhagen discovered the deflecting effect of an electric current traversing a wire upon a suspended magnetic needle. This discovery gave a clue to the subsequently proved intimate relationship between electricity and magnetism which was promptly followed up by Ampère who shortly thereafter (1821) announced his celebrated theory of electrodynamics, relating to the force that one current exerts upon another, by its electro-magnetic effects, namely: (1) "*Two parallel portions of a circuit attract one another if the currents in them are flowing in the same direction, and repel one another if the currents flow in the opposite direction.* (2) *Two portions of circuits crossing one another obliquely attract one another if both the currents flow either towards or from the point of crossing, and repel one another if one flows to and the other from that point.* (3) *When an element of a circuit exerts a force on another element of a circuit, that force always tends to urge the latter in a direction at right angles to its own direction.*"

Professor Seeback, of Berlin, in 1821 discovered that when heat is applied to the junction of two metals that had been soldered together an electric current is set up. This is termed Thermo Electricity. (See THERMO-ELECTRICITY.) Seeback's device consists of a strip of copper bent at each end and soldered to a plate of bismuth. A magnetic needle is placed parallel with the copper strip. When the heat of a lamp is applied to the junction of the copper and bismuth an electric current is set up which deflects the needle.

Peltier in 1834 discovered an effect opposite to the foregoing, namely that when a current is passed through a couple of dissimilar metals the temperature is lowered or raised at the junction of the metals, depending on the direction of the current. This is termed the Peltier "effect." The variations of temperature are found to be proportional to the strength of the current and not to the square of the strength of the current as in the case of heat due to the ordinary resistance of a conductor. This latter is the C^2R law, discovered experimentally in 1841 by the noted English physicist, Joule. In other words, this important law is that the heat generated in any part of an electric circuit is directly proportional to the product of the resistance of this part of the circuit and to the square of the strength of current flowing in the circuit.

In 1822 Sweigger devised the first galvanometer (q.v.). This instrument was subsequently much improved upon by Wilhelm Weber (1833). In 1825 William Sturgeon of Woolwich, Eng., invented the horse-shoe and straight bar electromagnet, and in recognition therefor received the silver medal of the Society of Arts ('Trans. Society of Arts,' 1825). In 1837 Gauss and Weber (both noted workers of this period) jointly invented a reflecting galvanometer for telegraph purposes. This was the forerunner of the Thomson reflecting and other exceedingly sensitive galvanometers once used in submarine signaling and still widely employed in electrical measurements. Arago in 1824 made the important discovery that when a copper disk is rotated in its own plane, and if a magnetic needle be freely suspended on a pivot over the disk, the needle will rotate with the disk. If on the other hand the needle be fixed it will tend to retard the motion of the disk. This effect was termed Arago's rotations. Futile attempts were made by Babbidge, Barlow, Herschel and others to explain this phenomenon. The true explanation was reserved for Faraday, namely, that electric currents are induced in the copper disk by the cutting of the magnetic lines of force of the needle, which currents in turn react on the needle. In 1827 George Simon Ohm (q.v.) announced the now famous law that bears his name, that is:

$$\text{Current} = \frac{\text{Electromotive force}}{\text{Resistance.}}$$

In 1831 began the epoch making researches of Michael Faraday (q.v.), the famous pupil and successor of Humphrey Davy (q.v.) at the head of the Royal Institution, London, relating to electric and electro-magnetic induction.

Faraday's studies and researches extended from 1831 to 1855 and a detailed description of his experiments, deductions and speculations are to be found in his compiled papers, entitled, 'Experimental Researches in Electricity.' Faraday was by profession a chemist. He was not in the remotest degree a mathematician in the ordinary sense—indeed it is a question if in all his writings there is a single mathematical formula. His writings are conspicuous for the simplicity, modesty and clearness of his language. An example of this may be given, taken from the closing words of a paper on 'Thoughts on Ray Vibrations': "I think it likely," he says, "that I have made many mistakes in the preceding pages, for even to myself my ideas on this point appear only as the shadow of a speculation, or as one of those impressions on the mind, which are allowable for a time as guides to thought and reasearch. He who labors in experimental enquiries knows how numerous these are, and how often their apparent fitness and beauty vanish before the progress and development of real natural truth."

The experiment which led Faraday to the discovery of electric induction was made as follows. He constructed what is now and was then termed an induction coil, the primary and secondary wires of which were wound on a wooden bobbin, side by side, and insulated from one another. In the circuit of the primary wire he placed a battery of approximately one hundred cells. In the secondary wire he inserted a galvanometer. On making his first test he observed no results, the galvanometer remaining quiescent, but on increasing the length of the wires he noticed a deflection of the galvanometer in the secondary wire when the circuit of the primary wire was made and broken. This was the first observed instance of the development of electromotive force by electromagnetic induction. He also observed the now well known facts that induced currents are established in a second closed circuit when the current strength is varied in the first wire, and that the direction of the current in the secondary circuit is opposite to that in the first circuit. He also discovered that a current is induced in a secondary circuit when another circuit carrying a current is moved to and from the first circuit. Also that the approach or withdrawal of a magnet to or from a closed circuit induces momentary currents in the latter. In short, within the space of a few months Faraday discovered by experiment virtually all the laws and facts now known concerning electro-magnetic induction and magneto-electric induction. Upon these discoveries with scarcely an exception, depends the operation of the telephone, the dynamo machine, and incidental to the dynamo electric machine (q.v.) practically all the gigantic electrical industries of the world, including electric lighting (q.v.) electric traction (q.v.), the operation of electric motors for power purposes, and electro-plating (q.v.), electrotyping (q.v.), etc.

In his investigations of the peculiar manner in which iron filings arrange themselves on a cardboard or glass in proximity to the poles of a magnet, Faraday conceived the idea of magnetic "lines of force" extending from pole to pole of the magnet and along which the filings tend to place themselves. On the discovery being made that magnetic effects accompany the passage of an electric current in a wire, it was also assumed that similar magnetic lines of force whirled around the wire. For convenience and to account for induced electricity it was then assumed that when these lines of force are "cut" by a wire in passing across them, or when the lines of force in "rising" and "falling" "cut" the wire, a current of electricity is developed, or to be more accurate, an electromotive force is developed in the wire that sets up a current in a closed circuit.

Faraday also advanced what has been termed the molecular theory of electricity which assumes that electricity is the manifestation of a peculiar condition of the molecules of the body rubbed, or the ether surrounding the body. Faraday also, by experiment, discovered paramagnetism and diamagnetism, namely that all solids and liquids are either attracted or repelled by a magnet. For example, iron, nickel, cobalt, manganese, chromium, etc., are paramagnetic (attracted by magnetism), whilst other substances, such as bismuth, phosphorus, antimony, zinc, etc., are repelled by magnetism, or are diamagnetic ('Phil. Trans.' 1845). Brugans of Leyden in 1778 and Le Baillif and Becquerel 1827 had previously discovered diamagnetism, in the case of bismuth and antimony. Faraday also rediscovered specific inductive capacity in 1837, the results of the experiments by Cavendish not having been published at that time. He also predicted (*Phil. Mag.*, March, 1854) the retardation of signals on long submarine cables due to the inductive effect of the insulation of the cable, in other words, the static capacity of the cable.

The twenty-five years immediately following Faraday's discoveries of electric induction were fruitful in the promulgation of laws and facts relating to induced currents and to magnetism. In 1834 Lenz and Jacobi independently demonstrated the now familiar fact that the currents induced in a coil are proportional to the number of turns in the coil. Lenz also announced at that time the important law that, *in all cases of electromagnetic induction the induced currents have such a direction that their reaction tends to stop the motion that produces them*, a law that was perhaps deducible from Faraday's explanation of Arago's rotations.

In 1845 Joseph Henry, the American physicist, published an account of his valuable and interesting experiments with induced currents of a high order, showing that currents could be induced from the secondary of an induction coil to the primary of a second coil, thence to its secondary wire, and so on to the primary of a third coil, etc. (*Philosophical Magazine* 1840). Abria published the results of some researches into the laws of these induced currents, but owing to their complexity the investigation was not productive of very notable results. ('Ann. de Chimie III,' i, 385.) About 1850 Kirchoff published his laws relating to branched or divided circuits. He also showed mathematically that according to the then prevailing electrodynamic theory, electricity would be propagated along a perfectly conducting wire with the velocity of light. Helmholtz investigated mathematically the effects of induction upon the strength of a current and deduced therefrom equations, which experiment confirmed, showing amongst other important points, the retarding effect of self-induction under certain conditions of the circuit ('Poggendorf Ann.' 1851). In 1853 Sir William Thomson (now Lord Kelvin) (q.v.) predicted as a result of mathematical calculations the oscillatory nature of the electric discharge of a condenser circuit. To Henry, however, belongs the credit of discerning as a result of his experiments in 1842 the oscillatory nature of the Leyden jar discharge. He wrote ('Proc. Am. Phil. Soc.' Vol. II, pp. 193, 196): *The phenomena requires us to admit the existence of a principal discharge in one direction, and then several reflex actions backward and forward, each more feeble than the preceding, until the equilibrium is obtained.* These oscillations were subsequently observed by Feddersen (1857) who using a rotating concave mirror projected an image of the electric spark upon a sensitive plate thereby obtaining a photograph of the spark which plainly indicated the alternating nature of the discharge. Sir William Thomson was also the discoverer of the electric convection of heat (the 'Thomson" effect). He designed for electrical measurements of precision his quadrant and absolute electrometers. The reflecting galvanometer and siphon recorder as applied to submarine cable signaling, are also due to him, and in general the names Thomson-Kelvin, stand out prominently amongst the foremost practical and theoretical electric engineers as well as scientists and philosophers of two generations. Of him Mr. John Perry has written: "While it is useless to speculate on what might have occurred had Sir William Thomson condescended to write in 1857 a text-book on electricity such as he was then capable of producing, it may safely be said that it is very seldom that a man's inability to comprehend how ignorant his contemporaries are, has produced such evil effects in retarding the progress of industrial invention." ('Electricity in the Service of Man,' p. 22.)

About 1876 Professor H. A. Rowland of Baltimore demonstrated the important fact that a static charge carried around, produces the same magnetic effects as an electric current. The importance of this discovery consists in that it may afford a plausible theory of magnetism, namely that magnetism may be the result of directed motion of rows of molecules carrying static charges.

After Faraday's discovery that electric currents could be developed in a wire by causing it to cut across the lines of force of a magnet, it was to be expected that attempts would be made to construct machines to avail of this fact in the development of voltaic currents (See DYNAMO-ELECTRIC MACHINERY and ELECTRIC DIRECT CURRENT). The first machine of this kind was due to Pixii, 1832. It consisted of two bobbins of iron wire, opposite which the poles of a horseshoe magnet were caused to rotate. As this produced in the coils of the wire an alternating current, Pixii arranged a commutating device (commutator) that converted the alternating current of the coils or armature into a direct current in the external circuit. This machine was followed by improved forms of magneto-electric machines due to Ritchie, Saxton, Clarke, Stohrer, 1843, Nollet, 1849, Shepperd, 1856, Van Maldern, Siemens, Wilde, and others.

A notable advance in the art of dynamo construction was made by Mr. S. A. Varley in 1866 (see his British patent of that year) and by Dr. Charles William Siemens and Mr. Charles Wheatsone (see 'Royal Society Proceedings,' 1867) who independently discovered that when a coil of wire, or armature, of the dynamo machine is rotated between the poles (or in the "field") of an electromagnet, a weak current is set up in the coil due to residual magnetism in the iron of the electromagnet, and that if the circuit of the armature be connected with the circuit of the electromagnet, the weak current developed in the armature increases the magnetism in the field. This further increases the magnetic lines of force in which the armature rotates, which still further increases the current in the electromagnet, thereby producing a corresponding increase in the field magnetism, and so on, until the maximum electromotive force which the machine is capable of developing is reached. By means of this principle the dynamo machine develops its own magnetic field, thereby much increasing its efficiency and economical operation. Not by any means, however, was the dynamo electric machine perfected at the time mentioned. In 1860 an important improvement had been made by Dr. Antonio Pacinotti of Pisa who devised the first electric machine with a ring armature. This machine was first used as an electric motor, but afterwards as a generator of electricity. The discovery of the principle of the reversibility of the dynamo electric machine (variously attributed to Walenn, 1860; Pacinotti, 1864; Fontaine, Gramme, 1873; Deprez, 1881; and others) whereby it may be used as an electric motor or as a generator of electricity has been termed one of the greatest discoveries of the 19th century. In 1872 the drum armature was devised by Helfner-Altneck. This machine in a modified form was subsequently known as the Siemens dynamo. These machines were presently followed by the Schuckert, Gulsher, Fein, Brush, Hochhausen, Edison and the dynamo machines of numerous other inventors.

In the early days of dynamo machine construction the machines were mainly arranged as direct current generators, and perhaps the most important application of such machines at that time was in electro-plating, for which purpose machines of low voltage and large current strength were employed. (See ELECTRIC DIRECT CURRENTS.) Beginning about 1887 alternating current generators came into extensive operation and the commercial development of the static transformer, by means of which currents of high voltage and low current strength are transformed to currents of low voltage and large current strength, in time revolutionized the transmission of electric power to long distances. Likewise the introduction of the rotary converter (in connection with the "step-down" transformer) which converts alternating currents into direct currents (and vice versa) has effected large economies in the operation of electric power systems. (See ELECTRIC ALTERNATING CURRENT MACHINERY.)

Before the introduction of dynamo electric machines, voltaic, or primary, batteries were extensively used for electroplating, and in telegraphy. There are two distinct types of voltaic cells, namely the "open," and the "closed," or "constant," type. The open type in brief is that type which operated on closed circuit becomes, after a short time, polarized; that is, gases are liberated in the cell which settle on the negative plate and establish a counter electromotive force that opposes the normal electromotive force of the cell. After a brief interval of open circuit these gases are eliminated or absorbed and the cell is again ready for operation. Closed circuit cells are those in which the gases in the cell are absorbed as quickly as liberated and hence the output of the cell is practically uniform. The Leclanché and Daniell cells, respectively, are familiar examples of the "open" and "closed" type of voltaic cell. The "open" cells are used very extensively at present, especially in the dry cell form, in telephony, and in annunciator and other open circuit signal systems. Batteries of the Daniell or "gravity" type were employed almost generally in the United States and Canada as the source of electromotive force in telegraphy before the dynamo machine became available. Batteries of the "gravity" and the Edison-Lalande types are still much used in "closed circuit" systems.

The possibility of obtaining the electric current in large quantities, and economically, by means of dynamo electric machines gave impetus and incentive to the development of incandescent and arc lighting. Before these machines had reached a commercial basis voltaic batteries were the only available source of current for electric lighting and power. The cost of these batteries, however, and the difficulties of maintaining them in reliable operation were at that time prohibitory of the use of the electric current for practical lighting purposes. The date of the employment of arc and incandescent lamps may be set at about 1877. Even in 1880, however, but little headway had been made towards the general use of these illuminants; the rapid subsequent growth of this industry is a matter of general knowledge. (See ELECTRIC LIGHTING.) The employment of storage batteries (q.v.), which were originally termed secondary batteries or accumulators, began about 1879. Such batteries are now utilized on a large scale as auxiliaries to the dynamo machine in electric power houses and sub-stations, in electric automobiles, in fire alarm telegraphy and other signal systems.

In 1871 the electric telegraph had grown to large proportions and was in use in every civilized country in the world, its lines forming a network in every direction over the surface of the land. The system most generally in use was, then as now, the electromagnetic telegraph due to S. F. B. Morse of New York, or modifications of his system. (See TELEGRAPH.) Submarine Cables (see CABLES) connecting the Eastern and Western hemispheres were also in successful operation at that time. When, however, at the present day (1907) one views the many and great applications of electricity to electric light, electric railways, electric power and other purposes (all it may be repeated made possible and practicable by the perfection of the dynamo machine) it is difficult to believe that no longer ago than 1871 the author of a book published in that year, in referring to the state of the art of applied electricity at that time could have truthfully written: "The most important and remarkable of the uses which have been made of electricity consists in its application to telegraph purposes" (Miller's 'Magnetism and Electricity,' p. 460). The statement was, however, quite accurate and perhaps the time could have been carried forward to the year 1876 without material modification of the remarks. In that year the telephone (q.v.), due to Alexander Graham Bell (q.v.), was invented, but it was not until several years thereafter that its commercial employment began in earnest. Since that time also the sister branches of electricity just mentioned have advanced and are advancing with such gigantic strides in every direction that it is difficult to place a limit upon their progress. For a more adequate account of the use of electricity in the arts and industries see ELECTRIC MANUFACTORY INDUSTRIES.

Perhaps without exception the greatest advance in the world's knowledge of electricity past or present was made when James Clark Maxwell of Edinburgh—the "heaven sent" Maxwell, as his contemporaries have spoken of him—announced that "undying masterpiece," the electromagnetic theory of light. (Consult Maxwell's 'Electricity and Magnetism,' Vol. XI., Chap. xxii.)

As already noted herein Faraday, and before him, Ampère and others, had inklings that the luminiferous ether of space was also the medium for electric action. It was known by experiment and calculation that the velocity of electricity was approximately 186,000 miles per second, that is, equal to the velocity of light, which in itself suggests the idea of a relationship between electricity and "light." A number of the earlier philosophers or mathematicians, as Maxwell terms them, of the 19th century held the view that electromagnetic phenomena were explainable by action at a distance. Maxwell, following Faraday, contended that the seat of the phenomena was in the medium. The methods of the mathematicians in arriving at their results were synthetical while Faraday's methods were analytical. Faraday in his mind's eye saw lines of force traversing all space where the mathematicians saw centres of force attracting at a distance. Faraday sought the seat of the phenomena in real actions going on in the medium; they were satisfied that they had found it in a power of action at a distance on the electric fluids. (Maxwell's 'Electricity and Magnetism,' preface.)

Both of these methods, as Maxwell points out, had succeeded in explaining the propagation of light as an electromagnetic phenomenon while at the same time the fundamental conceptions of what the quantities concerned are radically different. The mathematicians assumed that insulators were barriers to electric currents; that for instance, in a Leyden jar or electric condenser the electricity was accumulated at one plate and that by some occult action at a distance electricity of an opposite kind was attracted to the other plate. Maxwell looking further than Faraday, reasoned that if light is an electromagnetic phenomenon and is transmissible through dielectrics such as glass, the phenomenon must be in the nature of electromagnetic currents in the dielectrics. He therefore contended that in the charging of a condenser, for instance, the action did not stop at the insulator, but that "displacement" currents are set up in the insulating medium which currents continue until the resisting force of the medium equals that of the charging force. In a closed circuit conductor an electric current is also a displacement of electricity. The conductor offers a certain resistance akin to friction to the displacement and heat is developed in the conductor, proportional as already stated herein to the square of the current, which current flows as long as the impelling electric force continues. This resistance may be likened to that met with by a ship as in its progress it displaces the water. The resistance of the dielectric is of a different nature and has been compared to the compression of multitudes of springs, which, under pressure yield with an increasing back pressure, up to a point where the total back pressure equals the initial pressure. When the initial pressure is withdrawn the energy expended in compressing the "springs" is returned to the circuit, concurrently with the return of the springs to their original condition, this producing a reaction in the opposite direction. Consequently the current due to the displacement of electricity in a conductor may be continuous, while the displacement currents in a dielectric are momentary and, in a circuit or medium which contains but little resistance compared with capacity or inductance reaction, the currents of discharge are of an oscillatory or alternating nature (See OSCILLATORY CURRENTS; WIRELESS TELEGRAPHY). Maxwell expanded this view of displacement currents in dielectrics to the ether of free space. Assuming light to be the manifestation of alternations of electric currents in the ether, and vibrating at the rate of light vibrations, these vibrations by induction set up corresponding vibrations in adjoining portions of the ether, and in this way the undulations corresponding to those of light are propagated as an electromagnetic effect in the ether. Maxwell's electromagnet theory of light, first announced in 1865, obviously involved the existence of electric waves in free space, and his followers set themselves the task of experimentally demonstrating the truth of the theory. This honor was reserved for Prof. H. Hertz who in 1887 in a series of masterly experiments proved the actual existence of such waves. The discovery of electric waves in space naturally led to the discovery and introduction of that marvel of the closing years of the 19th century, wireless telegraphy (1894) various systems of which are now in successful use on shipboard and lighthouses throughout the world, notably those of Marconi, Slaby-Arco and De Forest. (See WIRELESS TELEGRAPHY.)

In 1801 notable additions to our knowledge of the phenomena of high frequency and high potential currents were contributed by Nikola Tesla (q.v.). (Consult 'Proc. Ann. Inst. El. Engrs.' 1001). Amongst the novel experiments performed by Tesla was to take in his hand a glass tube from which the air had been exhausted, then bringing his body into contact with a wire carrying currents of high potential, the tube was suffused with a pleasing bright glow. Another experiment was to grasp a bulb that was suspended from a single wire attached to a high potential, high frequency current circuit, when a platinum button within the bulb was brought to vivid incandescence, the experimenter at this time standing on an insulating platform. The frequency and potential of many of the experiments made by Tesla at this time were of the order of one or more million cycles and volts. For further information relative to these experiments the reader may be referred to Tesla's 'Experiments with Alternate Currents of High Potential and High Frequency.' This book also contains an outline description of Tesla's proposed method of transmitting electric energy without wires.

The place of electricity in leading up to the discovery of those beautiful phenomena of the Crooks Tube (due to Sir William Crooks), viz. Cathode rays (consult 'Proc. British Association,' 1879), and later to the discovery of X-rays, must not be overlooked, since without electricity as the excitant of the tube the discovery of the rays might have been postponed indefinitely. Radium and some of its emanations have been detected without the aid of electricity, but the most sensitive device available to determine the radio-activity of this and other radio-active elements is electrical, namely, the electroscope.

It has been noted herein that Dr. William Gilbert was termed the founder of electrical science. This must, however, be regarded as a comparative statement. Up to the middle of the 19th century, indeed up to about 1870, electrical science was, it may be said, a sealed book to the majority of electrical workers. Prior to this time a number of hand-books had been published on electricity and magnetism, notably Aug. de La Rive's exhaustive 'Treatise on Electricity,' 1851 and (in the French) 1835, Beer's 'Einleitung in die Electrostatik,' Wiedemann's 'Galvanismus,' and Reiss' 'Reibungsal-elektricitat.' But these works consisted in the main in details of experiments with electricity and magnetism, and but little with the laws and facts of those phenomena. About this time Fleeming Jenkin's work on 'Electricity and Magnetism' and Clark-Maxwell's 'Treatise on Electricity and Magnetism' were published. These books were departures from the beaten path. As Jenkin states in the preface to his work the science of the schools was so dissimilar from that of the practical electrician that it was quite impossible to give students any sufficient, or even approximately sufficient, text-book. A student he said might have mastered De la Rive's large and valuable treatise and yet feel as if in an unknown country and listening to an unknown tongue in the company of practical men. As another writer has said, with the coming of Jenkin's and Maxwell's books all impediments in the way of electrical students were removed, "the full meaning of Ohm's law becomes clear: electromotive force, difference of potential, resistance, current, capacity, lines of force, magnetization and chemical affinity were measurable, and could be reasoned about, and calculations could be made about them with as much certainty as calculations in dynamics" (Introduction to 'Electricity in the Service of

Man'). Since that time also the real science of electricity has rapidly advanced. Various units of electricity and magnetism have been adopted and named by representatives of the electrical engineering institutes of the world, which units and names have been confirmed and legalized by the governments of the United States and other countries. Thus the Volt, from the Italian Volta, has been adopted as the practical unit of *electromotive force*, the Ohm (from the annunciator of Ohm's law) as the practical unit of *resistance;* the Ampère (after the eminent French scientist of that name) as the practical unit of *current strength*, the Henry as the practical unit of *inductance*, after Joseph Henry, and in recognition of his early and important experimental work in mutual induction. See UNITS; ELECTRICAL TERMS.

The theories regarding electricity are also undergoing change. Indeed it may with truth be said that the trend of all scientific investigation now leads to the conclusion that matter in its final analysis is electrical in its nature—in fact is electricity; the theory upon which this view is based being termed the electronic theory, or the electric theory of matter. (See ELECTRON.)

This theory (or better, hypothesis) in a word assumes that the atom of matter, so far from being indivisible, as assumed under the older theories, is made up of smaller bodies termed electrons or corpuscles, that these electrons are electrical in their nature, and consequently all matter ultimately is electrical. This theory of matter though of comparatively recent origin in several of its important features is not altogether one of a day, nor is it due to the researches of one man or to the conception of one mind. Thus, as regards the view that the atom is not an indivisible particle of matter, but is made up of numerous electrons, many scientists have for years held that all the elements are modifications of a single hypothetical substance, protyle, "the undifferentiated material of the universe." Nor is the theory entirely new in its assumption that all matter is electrical. Faraday, Weber, Helmholtz, Clifford, and others had glimpses of this view; and the experimental work of Zeeman, Goldstein, Crooks, J. J. Thomson, and others had greatly strengthened this view. Over 35 years ago Weber predicted that electrical phenomena were due to the existence of electrical atoms, the influence of which on one another depended on their position and relative accelerations and velocities. Helmholtz and others also contended that the existence of electrical atoms followed from Faraday's laws of *electrolysis*, and Johnstone Stoney, to whom is due the term "electron," showed that each chemical ion of the decomposed electrolyte carries a definite and constant quantity of electricity, and inasmuch as these charged ions are separated on the electrodes as neutral substances there must be an instant, however brief, when the charges must be capable of existing separately as electrical atoms; while in 1887, Clifford (q.v.) wrote: "There is great reason to believe that every material atom carries upon it a small electric current, if it does not wholly consist of this current."

Whether the electronic theory will survive or itself will in turn be displaced by some more suitable theory remains for the future to determine. In the meantime, be that as it may, the practical application of electricity will go on apace. It is an every day saying of laymen that electricity is as yet in its infancy. This remark causes technical men to smile, for "electricity" is already a most prodigious infant. But in the sense that we may only be on the threshold of the possible utilizations of this most wonderful of nature's agents, the remark is perhaps true. Predictions that were with diffidence made but twenty years ago to the effect that within 100 years of that time people would probably speak to one another without artificial means of communication; that wires would be laid along every street and tapped into every house as gas pipes were then, for lighting and power purposes, have for a decade been facts accomplished. What the next twenty years shall bring forth with regard to the applications of electricity none can tell. Ten years ago it would have been difficult to find one steam railroad engineer willing to admit that application of electric traction to steam railroads was a possibility. To-day the entering wedge in this direction has been made for the improvement of railroad terminal facilities, and it is now difficult to find one steam railroad engineer who will deny that in twenty years hence all the important steam railroads of this country may not be operated electrically. In other directions the progress of events as to the utilization of electric power may be expected to be equally rapid. In every part of the world the power of falling water, nature's perpetual motion machine, which has been going to waste since the world began, is now being converted into electricity and transmitted by wire hundreds of miles to points where it is usefully and economically employed. It is already in contemplation to convey the power of the falling waters of Victoria Nyanza on the Zambezi in the heart of Africa, to points five and six hundred miles remote. But the extensive utilization of falling water will not be limited to natural water falls. In hundreds of places where a fall of 40 to 400 feet extends over 10 to 50 miles, and where in the aggregate hundreds of thousands of horse power, by suitable hydraulic methods are available, this power (already termed "white coal" in some parts of Europe) will be usefully employed, thereby in large measure conserving the limited quantity of the world's coal. It is, for instance, already proposed to dam Niagara river at the foot of the gorge whereby another source of water power equal to that at the present falls would be available. The Jehlun River in Kashmir, India, too, has a fall of 2,480 feet in 80 miles with a minimum flow of 30,000 gallons per second, and a beginning has been recently made to develop the one million electric horse power here represented, a considerable portion of which it is proposed to utilize in the production of nitrate of lime for fertilizer purposes, by combining by means of powerful electric currents the limestone that abounds in this region with the nitrogen of the air, a combination which Danish engineers have shown to be commercially possible, and which inexhaustible product may in time be economically available to replenish the failing powers of the farm lands of America and other countries. Within ten or twenty years also that dream of the electrical engineer, the direct production of electricity from coal without the intervention of the steam engine with its wasteful methods, may be realized. Other means, now unknown, of developing electricity may be wrested from nature's storehouse. Indeed in view of the past progress of electricity, and especially in view of its marvelous progress in the last two decades, theoretically and practically, it requires no great exercise of the imagination to conceive that the time may not be far distant when the universal artificial source of the world's heat, light, and power, will be electricity, and that what is now only surmise as to the sameness of electricity and matter will be demonstrated beyond reasonable doubt. Not only will wireless telegraphy be more perfected than at present, but wireless telephony, and «seeing by electricity» to a distance, may all be practically accomplished. Indeed, it is not even beyond the possibilities that the transference of thought directly from brain to brain with the ether as the medium—the suggestion of which is now regarded as the vagary of a disordered imagination—may then also be realized. In short our successors of twenty-five or thirty years hence may wonder at our obtuseness in not perceiving the obviousness of things which to them may then be self-evident, virtually as we now marvel at the simplicity of our cleverest ancestors in so long failing to recognize the identity of frictional, animal, and voltaic electricity, or the more simple fact that the wind, by them regarded as a phenomenon, is merely air in motion.

William Maver, Jr.,
Author 'American Telegraphy and Encyclopedia of the Telegraph.'

Electricity, Progress of (1800-1907). Before the year 1800, the world's knowledge of electricity was confined to observations on the attraction of electrified pith balls, and to a few facts in regard to electric sparks. Had it not been for lightning, no one could have felt respect for the feeble manifestations of an agency which was destined in less than 100 years to change the channels of trade, to revolutionize methods of communication, and to light the cities of the world. There was another force, too, of which the world in 1800 know something —the force of magnetic attraction. This was useful in the magnetic compass; but it was judged to be insignificant in other respects and totally unrelated to the force of electrical attraction, which was manifested in the case of the pith balls, or to the forces of lightning.

The marvelous development of electricity which we have all seen seems to carry with it the presumption that we have a clearer knowledge of what electricity is than Benjamin Franklin had; but this presumption is not entirely warranted. We certainly know its relations to other forms of motion, such as light and heat, better than he did. We believe that it is a wave motion; but still we cannot fully explain the fundamental experiment of the attraction of two electrified pith balls. To the philosopher, this confession of ignorance of an agency which he can use intelligently, which is highly serviceable, but the origin of which is completely veiled from us, is most suggestive. The question immediately arises, «To what do we owe our command of this mysterious servant?» The answer to the question is this: «We owe our advance in knowledge to the careful verification of phenomena, to the improvements in machinery produced by almost microscopic measurements, and to accurate calculation.»

The steps which led to our present knowledge of the manifestations of electricity can be quickly told. The first was taken by Galvani, who, just before the last century dawned, demonstrated that electricity could be produced by the contact of metals with fluids. His experiments suggested to Volta in 1800 the electric battery. Here was a means by which an electric current could be produced; and Oersted with this current showed a connection between electricity and magnetism. The current in passing through a wire near a compass needle could change the reading of the needle, and the changes depended upon the direction in which the current flowed. Oersted's discovery was made about 20 years after Volta constructed his battery. It was more than 10 years after Oersted that Joseph Henry and Michael Faraday discovered another relationship between electricity and magnetism which involved the possibility of producing currents of electricity by the motion of a magnet. This discovery was the converse of Oersted's; the series of phenomena which it revealed embraced the subject of electro-magnetism, and have led directly to the invention of the dynamo and electric motor. The world, however, did not realize in 1831 the importance of the steps taken by Henry and Faraday. Another 10 years elapsed before the electric telegraph became a success. Then in 1861—30 years from the date of the discovery of electro-magnetism—Paccinnoti invented the armature which Gramme improved, and we had the dynamo and the electric motor. Again, in a little more than 10 years, the telephone came, and the mechanical engineers and the mechanic, thoroughly aroused to the possibilities in the practical employment of electricity, took hold with astonishing energy.

When Tyndall came to the United States in 1870 to deliver lectures on light and electricity, he brought with him 100 Grove cells to produce an electric light for the purposes of demonstration. His assistant was obliged to spend two hours before each lecture in arranging these cells, filling them with acids and scraping the connections, retiring from each encounter almost asphyxiated by the irritating and poisonous fumes of nitrous oxide gas. At the present time no lecturer on science in the halls where Tyndall spoke need spend a moment in providing a source of electricity. It is on tap, so to speak, and can be obtained by touching a button. Tyndall in his highest flight of scientific imagination did not picture a development of electricity which would light the halls in which he spoke, which would convey him to and fro with great speed through the streets which he used in going to them, and would enable him to whisper from Boston across the great prairies of the West to Saint Louis.

The title of his lectures in Boston was suggestive—«Light and Electricity.» Yet his imagination, greater than that of most of his contemporaries in science, failed more completely in the subject of light than in the field of the great practical expansion of electricity. He had no inkling of the coming theory that light is but one of the manifestations of electricity, and in 10 years from the date of his lectures would be so regarded by the leaders of scientific thought. When we reflect upon how much this man saw and how much was withheld from him, a feeling of self-abasement comes over us who are students of electricity. Who can foretell what the next 100 years will unveil?

In reflecting on the rapid advances in the employment of electricity, we are apt to overlook the aid which has been given by the improvements in the mechanic arts. It can be maintained with a great show of reason that the modern lathe, the milling machine, together with the principle of interchangeable parts in machines, have made the dynamo and the electric motor. It is said that Joseph Henry spent months in wrapping wire with cast-off gowns to insulate it for his experimental electro-magnets. Much more powerful magnets can be wound to-day in half an hour. The mechanical means of trying experiments in the practical employment of electricity have multiplied to such an extent that every mechanic can enter a field which once was occupied by only one man in America, Joseph Henry; and can enter it with the most refined appliances in respect to tools and materials. Many of the men who have aided the practical development of electricity have known little of the subject of electricity. Some who have achieved distinction as electricians were ignorant of even elementary laws; but they saw how machines could be operated by what to them was a fluid analogous in its manifestations of flow and pressure to water. Just as men were ingenious in transmitting power by pulleys, belts, and chains, they now became apt in devising circuits, switches, armatures, keys, and the multitude of devices of which one gets a realizing sense in reading the advertisements in the thousand and one papers and periodicals devoted to practical electricity. In a similar manner mariners had become skilful in using the winds, the scientific laws of which they had not studied. The men who have made a lifelong study of electricity are amazed in reading the reports of meetings of electrical engineers to see the photographs of hundreds of men prominent as authorities at such gatherings — men who have suddenly sprung into notice in a field where only college professors once worked. A young man seeking to become an electrical engineer is told to-day, with reason, that he should first become a mechanical engineer. This development of practical electricity through the advancing improvements in machinery will continue, undoubtedly, to be a great characteristic of American industry. The first thought, apparently, of an American mechanic when he looks at a piece of foreign-made electrical apparatus is: "How can I improve it?" He speedily tears it to pieces, puts in screws that are interchangeable, takes out clumsy devices, reduces the weight, removes useless lacquer, and makes a new thing of it — if he does not throw the whole affair on a rubbish heap and proceed to build a machine on an idea which he has grasped.

To the American mechanic, who, having lost his corkscrew, inserts an ordinary screw through a piece of wood in the cork and pulls it, is due much of our national progress in practical electricity. I had occasion lately to buy a modern lathe for the Jefferson Physical Laboratory, and was surprised to find that I should be obliged to wait several months for its delivery. I was informed that 80 per cent of the products of the mills went to France, and Germany, and that foreign labor working 10 hours a day could not compete with American labor working 8 hours on these improved lathes. There is no need of a duty on foreign machinery, for we can trust to the ingenuity of American mechanics to hold the markets.

The efforts of inventors have been turned to electrical devices to such a degree that one has to wait months for a hearing at the Patent Office, and the examiners are so bewildered, apparently, by the claims that they grant patents in the expectation that litigation will settle points which require special study and training to consider properly. In addition to the honest inventor of electrical apparatus, we have another class, who seek to cover the ground of possible advance and to reap the fruits of subsequent study by patient investigators. They stake out claims and sit down, waiting for the worker. This class is not confined to the rank of inventors. There are sensation mongers who make predictions of what will be accomplished some day in electricity, in the hope that when arduous investigators have reached with almost superhuman patience the heights imagined, the suggesters will receive the rewards and the distinction. This is a phase of the use of the scientific imagination which was characteristic of the close of the 19th century. The workers of the next 100 years will find it hard to achieve all these outlined advances. But if the advances are not in the direction anticipated, there are other paths which the well-trained man will open, and which will lead to yet undiscovered domains richer than any hitherto attained.

We obtain a realizing sense of the importance of the advance in electricity when we reflect what changes it has wrought in the United States. The invention of the telegraph has falsified the predictions and estimates of many political economists. Sidney Smith, writing to Earl Grey after the acquisition of California, said that this marked the end of the great American republic, for a people spread over such a vast area, having such diversified interests, and separated by such natural barriers, could not hold together. He did not foresee how strongly a light iron wire could bind San Francisco to New York. The introduction of the ocean cable destroyed the class of East India merchants who went down to the sea in ships. Salem Harbor, in which great sailing vessels rode at anchor or drew up to busy wharves, is now deserted.

No longer can a merchant take extensive ventures in ships' cargoes, for the state of the market is throbbed every instant round the world. Thus a revolution has been caused in commerce by electricity. It is still progressing. When the invention of the telephone was made, it was a common remark that it could not supersede the telegraph, for the latter gave a merchant some evidence of a business transaction, while the telephone left no sign. Notwithstanding this lack of evidence, many kinds of business are now transacted over the telephone. Cotton, for instance, is bought and sold in immense quantities, without any written record of the transactions; for business honor is found to be essential, and without confidence in buyer and seller no transactions are possible. Thus electricity may be said to work for morality.

While there has been a remarkable extension in the communication of intelligence over great distances, there has been a no less remarkable one in the application of electricity to the conveyance of people and goods. Electric railroads are intersecting the United States in almost as many directions as the telegraph and telephone wires. One can travel from Boston to New York by means of such roads, and they bring a desirable element of excitement and the possibility of change of scene to the farmers' wives, once isolated on the dreary farms of New England. Here again electricity becomes an important agent in the spiritual as well as the material life of the nation. Electric motors have not yet superseded steam motors on any of the great lines, and there does not seem to be any immediate prospect of the change; for electric power cannot at present be transmitted economically 100 miles, and the electric motor suitable for the long-distance transmission of electrical power has not been sufficiently perfected. The accomplishment of the substitution of the electric motor for the present locomotive is something left over for the present century. When this substitution is made we shall not be troubled with cinders, and forest fires will be less frequent.

The chief source of electricity is coal, and the century just closed gives no hint of a possible rival to coal unless we except water power. There promises to be a great development in the use of waterfalls in places remote from tidewater, wherever the transportation of coal adds greatly to its cost. Thus, in Switzerland, water power from the numerous mountain sources supplies both light and electrical power for varied industries. The great plant at Niagara Falls for the transmission of power is watched with interest, for if electrical power can be economically transmitted from the falls to New York, the calculations in regard to the diminishing coal supply of the world would lose their ominous character — unless the geologist can show that the world is gradually drying up. The transmission of electrical power has led to a centralization of steam power in great cities. The small steam engines which were scattered about in numerous workshops have greatly diminished in number, and their place has been taken by electric motors supplied with current from a central station. In the same way the gas engines, which at one time seemed to be rising in importance, have largely given way to the electric motor. Thus the plans to pipe gas from central gas manufactories to all parts of a city for power is checked by the extension of a more subtle medium, far more flexible in its applications. No one will use a gas engine if he can obtain an electric motor; for the care and repairs on a gas engine are far more burdensome than in the case of its rival. Moreover, electrical power can be obtained or shut off by merely moving a switch or touching a button. The centralization of power in the physical world seems to be a counterpart of that taking place in the commercial world.

On the great battleships, electric motors are supplanting steam engines and hydraulic engines for moving the turrets, handling the anchors and the heavy guns. This change in the method of distributing power is one of the most remarkable in the development of industry in this century. Steam is still the great moving agency in the world of industry, and electricity is produced by it. Electricity may also be called its servant, for from a central station it generates and transmits what is like a vital fluid to every part of a great city. Steam is still the master of electricity, and there is no prospect of the economical production of electricity by any other agency. This is still the age of steam and not of electricity. The telegraph, the telephone, the electric light, and the electric motor constitute the great achievements in the practical employment of electricity. Great chemical industries are also being established, in which processes are carried on by electricity — notably the manufacture of aluminum, of calcium carbide, of the alkalies, and of carborundum.

In this brief account of the rapid progress in the practical employment of electricity, I have dwelt largely on the aid that the advances in the mechanic arts have given to the development of this employment. The work, however, of the scholars and theorists must not be overlooked. In 1800 there were the one-fluid and the two-fluid theories of electricity — neither of which is now believed by scientific men, though these theories prevailed till nearly the middle of the century. In 1843 Joule established the doctrine of the conservation of energy, by an exact measurement of the equivalent of heat, and this measurement led to the calculation by scientific men of the electrical units, which have made possible the advances by practical men. Without this system of units, founded strictly on the doctrine of the conservation of energy, and the quantitative transformation of steam power into electrical power, practical men would have floundered and business men would have lost heavily in electrical ventures, the expense of which could not have been calculated. After the establishment of the doctrine of the conservation of energy came Maxwell's great hypothesis of the electro-magnetic theory of light. This theory supposes that all forms of energy — light, heat, and electricity — come to us from the sun in the form of electrical and magnetic waves. On this hypothesis, electricity and magnetism are indissolubly connected. One can be transformed into the other — light and heat are electrical. The only difference between electricity and light is in the length of waves in the ether. The century has closed with this grand generalization, the truth of which the entire scientific world is engaged in testing. There is every prospect that it will form the most fruitful hypothesis in the century before us. The experiments of Hertz, who was the first actually to measure waves of electricity, have greatly strengthened the electro-magnetic theory of light. He showed that most of the phenomena of light waves could be repeated with electric waves. They can be reflected, refracted, and polarized. What explanation, however, can we give, on this hypothesis, of the simple experiment of the attraction or repulsion of two electrified pith balls — the apparently insignificant manifestation of electric force with which the century started? How can electro-magnetic waves explain this? It is, indeed, difficult to do this; and to give a reasonable supposition we have to theorize in regard to the molecular structure of matter, and the tension under which it exists when it is polarized — that is, when a positive and negative state, typified by a positively or negatively charged pith ball, exist in the neighborhood of other objects. Our new knowledge of the relations of electricity to other forms of energy is probably destined to come from a careful study of the fundamental experiments of the attraction of electrified bodies. We have already entered on this study with renewed vigor, stimulated by the discovery of the marvelous effect of the X-rays and of radium in penetrating matter and in making gases better conductors of electricity. Thus we started on the new century with investigation of the same phenomena that Benjamin Franklin considered, but with a far wider comprehension of extended relations, with immensely greater experimental resources, and with a well-trained army of investigators.

When we thus survey the progress of electricity we find in the applications of this mysterious source of energy a tendency to continually approximate to the method by means of which all energy is transmitted to us across the ocean of space between us and the sun; that is, to adopt to and fro or alternating electromotive forces instead of steady electromotive forces. The advantage in the employment of such alternating forces resides in the ability to overcome greater resistance when ordinary conductors of electric current are used; and to enable one, so to speak, to submit any transmitting medium like the ether to instantaneous pulses, as in the case of wireless telegraphy. The steady current dynamo cannot generate an electromotive force sufficient to transmit electric power economically to a distance of even 20 miles; while the alternating dynamo, with its transformers, transmits it to more than 100, and the practical distance at present will probably be greatly increased.

One can readily obtain an idea of the method of obtaining high electromotive force from an alternating dynamo by considering the effort of the last 40 years or more to construct a steady current dynamo out of the pulsating to and fro effects produced by revolving a coil between the poles of a magnet; and the effects of such to and fro currents in raising the electromotive force in neighboring coils of wire by suitably increasing the number of turns of wire in such coils. While the effort of inventors was once almost entirely directed to so constructing commutators that the steadiest current might be obtained from the, what can be termed natural, action of a revolving coil in a magnetic field, it is now largely turned to increasing and utilizing the to and fro effect; and when it was discovered that such alternating currents could be economically used with the old Ruhmkorf coil, we immediately had the modern step-up transformer. Such a coil consists merely of a coil of a few number of turns in close proximity to a surrounding coil of a greater number of turns; and it was formerly actuated by rapidly interrupting a battery current through the coil of lesser number of turns. The interrupted currents thus produced currents of higher electromotive force in the coil of more turns; but far less efficiently than the alternating currents from the alternating dynamo.

Now, a current which cannot produce a spark in air of an inch, can, by a suitable transformer, produce a spark of several feet; and such transformers are used in California and in Switzerland to transmit the power of waterfalls 70 to 80 miles. Alternating currents can drive a great variety of electric motors; and the use of such currents in transmitting the energy from reservoirs of water promises to be one of the marked features of the future applications of electricity.

I have said that in our employments of electricity we seem to be getting nearer nature's methods of propagation and transformation of energy. This electric dawn of intelligence is appropriately signalized by the advent of wireless telegraphy, in which the step-up transformer and the electric spark with its high electromotive force is utilized to send electric pulsations through space. Now the cycle seems to be complete; first the electric pulsations from the sun to the earth; then their transformation into sources of energy, and the retransformation into pulsations into the ether.

In the transmission of messages by wireless telegraphy (q.v.) the problem of so tuning the apparatus that it can receive only the message intended for it, and so that it will not respond to every train of waves started in the ether, has not been solved; but advances have been made in this direction. A popular idea of this problem of electric tuning can be gained by considering the fact that the spark from a charged Leyden jar or other receptacle of electricity can be made to evoke a spark from a distant Leyden jar unconnected with the first jar and uncharged, if the distant jar has the same size or same electrical capacity.

Thus we see that the attention of the practical worker in electricity is being directed to the employment of high electromotive forces which, in the time of Benjamin Franklin, was the chief study of electricians. Here is another cycle in the subject of electricity. The study started in the investigation of what is called static electricity; and its most striking manifestation of high electromotive force; and scientific men to-day have returned to this old field and an astonishing new field of inquiry has been opened, leading many to believe that all which appeals to our senses as matter is electrical in its nature. This electrical theory of matter is involved in what is called radioactivity (q.v.). The term radioactive substance is applied to elements or compounds like uranium, thorium, radium, which emit radiations capable of effecting photographic plates and dispelling electric charges. The phenomenon of the dissipation of electricity on charged bodies by X-rays and radioactive substances, together with a similar dissipation produced by ultra-violet waves of light, has led to a great extension of the theory of ionisation. The term ion was applied by Faraday to the constituent parts of a liquid conductor separated by an electric current; the new theory of ionisation of gases supposes that an ion consists of a charged point or centre of a cluster of molecules which travel with it: the process of ionisation of a gas is considered to be the removal of what is called the negative corpuscle from such a cluster of molecules. After the removal of the negative corpuscle a new cluster of molecules is formed with a positive charge. This negative particle is estimated to be one thousandth of the size of the hydrogen atom.

X-rays and the radioactive substances have the property of breaking up the clusters of molecules of a gas, and, by thus separating the negative corpuscle from the clusters, making a gas conducting; for the negative corpuscle carries a negative charge to one metallic terminal in the gas and the positive ion carries a positive charge to the other terminal. It is interesting to notice that the study of this theory of ionisation has been made possible by the use of the earliest instrument used in the study of electricity, the electroscope, which consists of two strips of gold foil suspended close together from a metallic support. When the metallic support is charged the gold leaves diverge, having charges of the same name, being either both positive or both negative. It is estimated that this old instrument is at least a million times more sensitive than even spectrum analysis in detecting minute changes in the condition of matter; and it is also curious to observe that the phenomenon of leakage of electrical charges, which has annoyed and puzzled workers in electricity from the earliest period of the subject, is now largely explained by the phenomenon of radioactivity; a bit of radium, for instance, in a compass case, or a galvanometer case, will dispel any electrification which tends to attract the needle to the side of the case. The new use of the electroscope or electrometer consists in utilizing the old annoyance of electrical leakage by connecting the electroscope to a metallic plate held above another plate connected to the earth and measuring the rate of leakage produced by X-rays or the radiations from radioactive substances.

The English writers speak of a negative corpuscle, and the continental investigators, in general, call both negative and positive carriers of electrical charges electrons. The tendency of thought is to believe that the mass of the electron is not material but is entirely electrical; and many also believe that we are coming to an electrical theory of matter. Such a theory has been advanced by Lamor, Abraham, Drude, and others. It is based upon the phenomenon of electric inertia, or so-called back electromotive force. One can get a popular idea of such electrial inertia by considering the sudden generation of an electromotive force which tends to keep an electric motor driving a trolley car in motion after the generating current is stopped, and also the electromotive force which opposes the starting of the motor when the driving current is applied. Sudden changes in electrical conditions can manifest a phenomenon closely analogous to ordinary inertia of matter. It has been shown that, according to the electromagnetic theory of light, a charge of electricity in motion behaves as if it possessed mass. Kauffman, therefore, has investigated the question whether the mass of the electron is made up of both ordinary matter and electrical matter, or whether it is altogether an effect of electricity in rapid motion. He found by direct experiment that, assuming the charge constant, the apparent mass of the electron increased with the speed. The identification of matter with the movement of electricity is the most remarkable generalization of modern physical science.

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Electricity, Atmospheric. Experiments have shown that there is always free electricity in the atmosphere, which is sometimes negative and sometimes positive, but most generally positive, and the intensity of this free electricity is greater in the middle of the day then at morning or night, and is greater in winter than in summer. In fine weather the potential increases with altitude at the rate, according to some writers, of about 30 volts per foot. To detect the presence of free electricity in the air a pointed metal rod projecting into the air several feet and connected at its lower end to a gold leaf electroscope may be used. When this rod is projected into the air a few feet the leaves diverge. Kites and balloons have also been used to detect and, so to speak, draw down the free electricity of the air. The origin of atmospheric electricity is still unknown. Some physicists have ascribed it to the friction of the air upon the ground, others to the gradual oxidation of plant and animal life, others again to evaporation, to induction from the sun, and to differences of temperature. Most authorities are agreed, however, that whatever may be the origin of free electricity in the atmosphere the electricity of enormous voltages that disrupts the air and produces the phenomena of lightning (q.v.) is due to the condensation of the watery vapor forming the clouds; each minute vapor drop as it moves through the air collecting upon its surface a certain amount of free electricity. Then as these drops of vapor coalesce into larger drops with a corresponding decrease in the total surface exposed the electric potential rises until it overcomes the resisting power of the air. This remark will be more clearly understood when it is considered that with a given charge of electricity its potential rises as the electrical capacity of the object holding the charge is decreased, which is the case when the minute vapor drops coalesce into larger drops. The similarity of lightning to the electricity developed by an electrical machine was demonstrated by Franklin in his memorable kite experiments.

Electricity, Cause of Death by. As is well known, one of the most important safeguards of the human body against the passage of electrical currents through it is its high degree of resistance. This degree of resistance, however, is subject to a considerable amount of variation. If the skin is dry the resistance is from 5 to 20 times as great as when the skin is wet. From what is known of the amount of electrical current necessary to cause death in man, it is probable that 1,600 volts of electromotive force, of a continuous current, is sufficient to bring about this end, and that an alternating current of half this voltage would probably be fatal. In fact, the general deduction has been drawn from the experiments conducted in electrocution work at the Sing Sing prison, that no human body can withstand an alternating current of 1,500 volts, and 300 has produced death, while for the continuous current it may be necessary that over 3,000 volts may be required to bring about fatal results. Some of the minor injuries due to lightning and electricity are severe burns, paralysis of some of the muscles, deafness, loss of smell and taste, hysterical phenomena, traumatic neuroses. Occasionally blindness has resulted, also insanities of the maniacal type have been known to occur, following lightning stroke. As to the cause of death by lightning and electricity, modern research has shown that there are marked changes in the blood vessels, of a hemorrhagic type, and minute alterations in the nerve cells, but these seem to be secondary to the physiological action that the electrical current has upon the fibres of the heart muscle. The electrical shock brings about a condition of delirium or fibrillary contraction of the heart muscle, causing a stoppage of that organ. This theory of the cause of death at present has the largest number of adherents.

As to what can be done for the treatment of electrical shocks, medical science is still somewhat in doubt. For all practical purposes, death, when it takes place, is instantaneous. The evidence derived from non-fatal cases is of great interest. In these, personal experience has shown that a number of individuals who have been rendered unconscious have recognized in the brief moments of consciousness the experience of a strange sensation. Some have even recognized what the character of the sensation was and the general experience has been that this sensation is not painful but is an exaggeration only of the uncomfortable feeling induced by the faradic battery. It seems more than probable that no painful sensations are felt by those who have died. Recoveries from the shock of electricity or lightning which have been severe enough to bring about unconsciousness are very common. As to the border lines which separate the recoverable from the fatal cases it seems difficult to determine. Promptness in the treatment is imperative. External heat to the body, artificial respiration and cardiac stimulants should be used simultaneously. It is of importance to remember that the body of the patient must not be touched by the rescuer with naked hands, but should be dragged away by his clothing, or removed from contact with the earth by slipping a board under him thus to break the connection with the live wires. Live wires may also be raised by a stick and thus take the body out of the circuit. Artificial respiration (q.v.) by the Sylvester method or by means of the Gibbon's pump should be performed and the body should be surrounded by hot bottles or bricks, and rubbed, and suitable cardiac stimulants should be utilized. Injections of large quantities of hot salt solution into the rectum may be of service and occasionally it may be necessary to infuse normal salt solution directly into the veins. Efforts at artificial respiration should not be discontinued under from three to six hours.

Consult: Jelliffe, 'Peterson and Haynes Textbook of Legal Medicine and Toxicology.'

Electricity, Contact Theory of, a theory which assumes that the electromotive force of a voltaic cell, and perhaps the electricity produced by friction, is due to the difference of potential assumed by two dissimilar substances when placed in contact.

Electricity, Diffusion of. Electricity diffuses itself on the surface of a conductor. This we may expect from the self-repelling character of the same fluid. An insulated spherical conductor has two hemispherical cups carefully fitted to it, each attached to an insulating handle. The conductor and its covering are charged with electricity, the cups are then removed, and the conductor is brought near an electroscope. No divergence of the leaves occurs, indicating that none of the electricity has passed into the conductor. If the conductor have a spherical shape, the electricity distributes itself equally over the surface; in other words, the density is the same in every part of the surface. We may conceive the electric fluid to surround the conductor as an ocean of equal depth. If the conductor be a brass disk, the electricity is found in greater quantity at the edges or rim. If it be a brass cylinder with rounded ends, the density is greatest at the ends. If the conductor have the shape of a cone, the density is greatest at the apex, and the sharper the apex the greater the density. Hence the remarkable effect of a pointed body in either drawing, or parting with, electricity.

Electricity, Dissipation of. The gradual loss of electricity from a charged body surrounded by non-conductors, which takes place by means of them, is called dissipation of the electric charge. A charged conductor, for instance, supported on a glass pillar, slowly loses its electricity. This is due partly to the creeping of the electricity along the surface of the glass, which even if it be free from dust and dirt, is never absolutely free from an invisible film of moisture; and partly to the air that surrounds the insulated conductor, the electrified body charging the particles of air with similar electricity and then repelling them, by which means a gradual loss of charge occurs. Experiments extending over a period of several years show this dissipation of electricity does not take place in a vacuum. Coulomb made a careful investigation into the laws of dissipation, by which he was able to allow for it in cases where he could not arrange his experiments so as to be undisturbed by it. Coulomb was led by his experiments to abandon the use of glass as a support for his conductors whenever it was possible, employing instead thin stems of shellac, and sometimes suspending small electrified bodies by well-dried silk fibres. He found that the amount of loss in a given time by means of the particles of air diminishes as the charge possessed by the conductor gets weaker and weaker, the losses in successive equal intervals of time being in geometrical progression.

Electricity, Experimental Researches in, by Michael Faraday (1839–55). A monumental work in the literature of science; not merely recording the results of experiment in what Tyndall called «a career of discovery unparalleled in the history of pure experimental science,» but enriching the record with thoughts, and clothing it in many passages in a style worthy of exceptional recognition. In devising and executing experiments for passing beyond the limits of existing knowledge, in a field the most difficult ever attempted by research, Faraday showed a genius and achieved a success, marking him as a thinker not less than an observer of the first order. In strength and sureness of imagination, penetrating the secrets of force in nature, and putting the finger of exact demonstration upon them, he was a Shakespeare of research, the story of whose work has a permanent interest. He made electricity, in one of its manifestations, explain magnetism. He showed to demonstration that chemical action is purely electrical, and that to electricity the atoms of matter owe those properties which constitute them elements in nature. In language of lofty prophetic conception he more than suggested that the physical secret of living things, the animal and the plant, is electrical. He particularly dwelt on the amount of electricity forming the charge carried by the oxygen of the air, which is the active agent in combustion and the supporter of life in both animals and plants, and only stopped short of definitely pronouncing vitality electrical. He urged very strongly as a belief, to which no test of experiment could be applied, that gravitation is by electrical agency, and that in fact the last word of discovery and demonstration in physics will show that electricity is the universal agency in nature. And among his far-reaching applications of thought guided by new knowledge, was his rejection of the idea of "action at a distance," in the manner of "attraction." If a body is moved, it is not by a mysterious pull, but by a push. The moving force carries it. These ideas outran the power of science to immediately understand and accept. But Maxwell, Hertz, and Helmholtz have led the way after Faraday, to the extent that his electrical explanation of light is now fully accepted. Fifteen years after his death, the greatest of his successors in physics, Helmholtz of Berlin, said in a Faraday lecture in London, that the later advances in electrical science had more than confirmed Faraday's conclusions, and that English science had made a mistake in not accepting them as its point of departure for new research. See LIGHT.

Electricity, Frictional. It was an observation made by the Greek philosopher Thales, 600 years before the Christian era, that, when amber was rubbed, it acquired the property of attracting light bodies. The cause of this attractive power was assigned to a principle to which the name of "electricity" was given — derived from the Greek word for amber. When a piece of wax is rubbed on the coat-sleeve, an attractive power is awakened in it; it is capable of attracting small pieces of light paper or particles of sawdust — a fact well known to every young person. Taking a warm glass tube closed at one end, and rubbing it with silk, the same thing is manifested. It is observed also that after contact with the wax or tube, the light bodies fall away, being seemingly repelled. If a stick of sealing-wax be rubbed with flannel and then balanced on a paper loop suspended by a silk thread and the knuckle be presented to it, the wax will in like manner follow the hand. We have, therefore, the fact that an electrified body attracts or is attracted by an unelectrified body. Another experiment of a simple character may be mentioned. Take a piece of warm brown paper or sheet of foolscap, place it upon a warm board and rub it well over with a piece of india-rubber, it clings to the board; or remove it from the board and apply it to the wall of the room, it adheres to the wall and remains in its position till its electricity is dissipated.

Frictional electricity has been extensively employed in connection with frictional electric machines, in electro-therapeutics. See ELECTRIC MACHINES; FRICTIONAL ELECTRIC MACHINES.

Electricity in Medicine. See ELECTROTHERAPEUTICS.

Electricity in Mining. See MINES AND MINING.

Electrine, (1) The principle of electricity; a kind of matter which manifests electrical phenomena. (2) Made of amber or electrum.

Electro-ballistic, pertaining to projectiles and to electricity. An electro-ballistic apparatus is an instrument for determining by electricity the velocity of a projectile at any part of its flight. The projectile passes through a wire screen, thus breaking an electric circuit and setting in motion a pendulum which is arrested on the passage of the projectile through a second screen. The distance between the screens being known, the arc through which the pendulum vibrates measures the time due to the flight of the projectile between the screens. See GUNNERY.

Electro-ballistic Machines. See GUNNERY.

Electro-biology, the science which treats of the electric currents developed in living organisms; also the department of knowledge which treats of the influence or control over the feelings, thoughts, and actions of a mesmerized person.

Electro-bronze. See ELECTROPLATING.

Electro-chemical Industries. The word electro-chemical is here used to include electro-metallurgy, as there is no generic term for the two subjects. Electro-chemistry may be defined as that branch of science relating to the electrical production of chemical substances and chemical action, or to the generation of electrical energy by chemical action. On the other hand electro-metallurgy is the branch of science that relates to the electrical production and treatment of metals.

Electrolytic Refining of Copper.— The largest and most important of all electro-chemical industries is the refining of copper, which is conducted at many places in this country and abroad. The process of refining copper electrolytically consists in the transfer of copper from the anode to the cathode, by the selective action of the electric current, and in leaving the impurities behind in the anode, electrolyte, and in the slime or sediment.

The material at present subjected to profitable electrolytic refining is crude copper containing from 96 to 98 per cent pure copper, and varying amounts of silver, gold, nickel, iron, arsenic, antimony, sulphur, etc. This crude copper is obtained from various copper ores by smelting, and is cast in iron molds into anode plates, which are about 3 feet long, 2 feet wide, and 1 inch thick, weighing approximately 250 pounds. The cathode plates are of electrolytically refined copper, practically the same in length and width as the anodes, but only 1-20 inch thick. The electrolyte, or bath, in which the plates are suspended is a solution of 12 to 20 per cent copper sulphate, and 4 to 10 per cent sulphuric acid, the latter being introduced to decrease the resistance of the bath which is kept at a temperature of about 40° C. The containing tanks are of wood, usually lined with sheet lead or carefully coated with a pitch compound, and of such dimensions that a distance of about 1 inch exists between the faces of the plates. In some cases the plates are arranged in series, and in others in parallel or multiple, as illustrated. The former has the advantage of requiring electrical connections to be made at the first and last plates only, whereas the parallel system requires a connection at every plate; but in the series system the leakage of current due to the short-circuiting action of the sediment and sides of the tank is from 10 to 20 per cent, so that the parallel is more generally used. The connections between the various plates to the circuit in the parallel systems are made by copper rods, which are run at two different levels along the edges of the tanks, one bar for each set of plates. In some instances these rods are of the inverted V shape, so that the edges will cut through any corrosion which may happen to form at the points of contact. The vats are arranged with respect to each other, so that each is accessible from all sides, and the circulation of the electrolyte is possible. This circulation may be obtained by blowing a stream of air through the electrolyte, but more frequently by arranging the vats in steps, and piping so that the electrolyte may pass from the top of one vat to the bottom of the next, as shown in the illustration. This maintains a uniform density of electrolyte which is necessary for the proper formation of the deposit. The electrical pressure required is from .2 to .4 volts per tank, with a current density of 10 to 15 amperes per square foot of cathode plate surface. The individual vats are connected in series, so that the total voltage required may be approximately the same as that which the generator furnishes, being usually 110 volts. In practice from 400 to 500 ampere-hours are required per pound of copper deposited, the theoretical amount according to Faraday's law being only 386.2 ampere-hours. The loss varies from 4 to 20 per cent according to the system employed.

The cost of refining copper by the electrolytic method is from ¼ to ¾ cent per pound. The following products of refining are marketed: Commercial cathodes, which are sometimes shipped to consumers, but more frequently cast into wire bars, ingots, cakes, or slabs of standard dimensions and weight. They usually assay from 99.86 to 99.94 per cent pure copper. The yield in commercial cathodes is from 97 to 99 per cent of the anodes treated, excluding the anode scrap which varies in weight from 7 to 15 per cent of the original anode in parallel plants, but this scrap is not a loss as it is collected and recast into anode plates. Besides electrolytic copper, most plants secure gold, silver, and nickel salts in the slime, from which the metals are recovered. The electrolytic refineries in the world are now producing copper at the rate of 322,295 tons annually, valued at $96,688,500, with copper selling at $300 per ton, in addition the by-product in recovered gold and silver is valued at $20,000,000 per annum. There are now in active operation 33 electrolytic refineries, with a total generator capacity of 20,000 kilowatts, 10 of these are in the United States, and supply about 86 per cent of the world's product; 6 plants are in England and Wales, producing about 9 per cent; while the remaining plants are on the continent of Europe.

Aluminum.— Practically the output of this metal for the entire world is now produced electrolytically. The only process used on a large scale is that invented independently in 1886 by Charles M. Hall in the United States and by Paul L. V. Héroult in France. This process consists in electrolyzing alumina dissolved in a fused bath of cryolite. The alumina is obtained from the mineral bauxite which occurs abundantly in Georgia, Alabama, and other regions. The natural material, being a hydrated alumina containing silicon, iron and titanium, must be treated in order to drive off the water and eliminate the impurities. Formerly this was accomplished by a chemical process, but now it is effected more simply and cheaply by heating the material mixed with a little carbon in an electric furnace. The impurities are thus reduced and collect as a metallic regulus in the bottom of the mass. This leaves the alumina nearly pure and it may be tapped off while fused or easily separated by breaking it up after cooling. In practice it requires two pounds of alumina for each pound of aluminum produced. The flux or bath in which the alumina is dissolved consists of cryolite, a natural double fluoride of aluminum and sodium ($Al_2F_6.6NaF$) found in Greenland. This is melted in a large carbon-lined, sheet-iron tank which constitutes the negative electrode, a group of suspended carbon rods forming the positive electrode. A current of several thousand amperes at 6 to 7 volts is used. Only a portion of this voltage is required to decompose the alumina, the balance amounting to about 4 or 5 volts represents the heat produced which keeps the bath melted. The passage of the current causes the aluminum to deposit on the bottom of the tank as a fused metal, being drawn off periodically. The oxygen set free combines with the carbon of the positive electrodes and passes off as carbonic oxide. The reaction is $Al_2O_3+3\ C=2Al+3\ C\ O$. About one pound of carbon is consumed for one pound of aluminum produced. When the alumina becomes exhausted from the bath, the voltage rises and lights a lamp shunted across the electrodes, thus giving notice that more material is needed. Each electrical horsepower produces about one pound of aluminum per day of 24 hours. According to Faraday's law the weight of aluminum deposited by 1,000 amperes is .743 pound per hour. The actual yield of metal by the Hall process is about 85 per cent of this theoretical amount. The total power used by the various works employing the Hall process, is very large and amounts to more than 15,000 horsepower in the United States and Canada. The total power employed in European plants operating under the Héroult patents is nearly as great. The metal when drawn from the tanks is cast into rough ingots which are afterwards remelted and converted into commercial shapes, such as sheets, rods, wires, etc.

Electrolytic Production of Caustic Soda.— The production of caustic soda ($NaOH$) and chlorine (Cl) by the electrolysis of common salt ($NaCl$) is readily realized experimentally ($NaCl + H_2O = NaOH + Cl + H$), but its successful accomplishment on a commercial basis is difficult because of the secondary reactions which take place, forming a mixed product of caustic, salt, and hypochlorite of soda. These difficulties are avoided by separating the caustic soda or sodium that is formed, either by a porous diaphragm, by drawing it off as soon as formed, or by absorbing the sodium deposited in mercury or melted lead.

The two most successful systems for the electrolytic production of caustic soda and chlorine from common salt, are the Castner-Kellner and the Acker processes, one operating at moderate temperatures (40° C.) and the other at high temperatures (850° C.). The Castner process employed in this country at Niagara Falls is as follows: The electrolytic tank consists of a slate box, 4 feet long, 4 feet wide, and 6 inches deep, the joints being made by means of a rubber cement. Two slate partitions reaching within 1-16 inch of the bottom (under which are grooves) divide the cell into three compartments, each 15 inches by 4 feet, sealed from each other by a layer of mercury covering the bottom of the tank to a considerable depth. The outside chambers through which the brine is passed are provided with carbon anodes, shaped like a rail section, the broader flange being placed about half an inch above the mercury. These compartments are provided with tight covers and exhaust pipes of rubber and lead, to lead the chlorine away. The central compartment has an iron cathode, of 20 upright strips, and is supplied with pure water, which is drawn off whenever its specific gravity increases to 1.27 due to the presence of the manufactured caustic, while the liberated hydrogen is led from this chamber by means of pipes and used as a fuel for the concentration of the caustic. The tank is pivoted at one end on a knife blade and rests at the other on an eccentric, which raises and lowers that end of the tank about half an inch every minute and causes a circulation of the mercury between the outer and middle compartments. The current passes into the outer chambers, splits up the sodium chloride (common salt, NaCl) into sodium and chlorine (Na and Cl), the latter is liberated at the carbon anodes and passes through the exhaust pipe to the absorption chambers where it combines with slacked lime to form bleacning powder. The sodium combines with the mercury forming sodium amalgam, which by the tilting of the tank passes to the centre chamber, where it serves as the anode, and combines with the water to form caustic soda (NaOH) and hydrogen (H), which appears at the iron cathode. Each of these tanks uses 630 amperes at 4.3 volts. The theoretical voltage required is but 2.3, the remainder being utilized in overcoming the ohmic resistance of the electrolyte and in keeping it warm. The output of this process per horsepower per day is 12 pounds of caustic and 30 pounds of bleaching powder for each cell. The product of this process contains from 97 to 99 per cent caustic, 1 to 2 per cent sodium carbonate, .3 to .8 per cent of sodium chloride, and traces of sodium sulphate and silicate of sodium.

The Acker process, also used at Niagara, to obtain caustic soda and chlorine from salt, is similar to the Castner-Kellner process just described, but differs in that it employs molten lead in place of mercury as a seal, fused salt instead of brine as the electrolyte and operates at a temperature of 850° C. which is required to maintain the fused condition of the electrolyte. The containing tank is a cast iron vessel 5 feet long, 2 feet wide and 1 foot deep, the sides above the molten lead being covered with magnesia so that the current must pass from the carbon anodes to the lead which acts as the cathode. At one end of the tank is a small compartment separated from the remainder of the vessel by a partition dipping into the lead to such a depth that nothing but this fused lead can pass from one compartment to the other. In the smaller compartment the lead is subjected to a stream of steam, which acting upon the lead sodium alloy forms caustic soda and liberates hydrogen. At various intervals the caustic, which is in a fused state, is drawn off and allowed to solidify, thus avoiding the evaporation of the water which is necessary in the Castner-Kellner process. The current employed per vessel in the Acker process is 2,100 amperes at from 6 to 7 volts, of which energy 54 per cent is used in chemical action, and the remainder in maintaining the temperature.

Potassium Chlorate is produced electrochemically in considerable quantities, both here and abroad. The Gibbs process, used at Niagara Falls, consists in the electrolysis of potassium chloride solution, using a copper or iron cathode and a platinum anode. The current density is high, being 500 amperes per square foot of anode. Each cell uses about 4 volts, of which 1.4 is required to convert chlorid to chlorate, and the remainder produces the heat that maintains the electrolyte at from 50° to 70° C., which is necessary for the proper reaction.

Electrolytic Chemical Effects, such as bleaching, have been produced through the action of chlorine or other matter set free by an electric current. It is possible in this way to cause substances to act while in the nascent state, and therefore more powerful. Disinfecting and deodorizing of sewage has also been accomplished in a similar manner.

Calcium Carbide.—This compound is produced by the electrothermal process, invented by Willson in 1891, the total output throughout the world being about 300,000 tons in 1902. Its value lies in the fact that 1 pound of this substance mixed with water produces theoretically 5.5, and actually about 5 cubic feet of acetylene, equivalent in illuminating power to about 70 cubic feet of ordinary gas. The reaction producing acetylene is $CaC_2 + H_2O = CaO + C_2H_2$. Various forms of electric furnace have been employed in the production of calcium carbide. One type invented by King and represented in the illustration, consists of an iron car A, which holds the materials and carbide at the same time acting as one electrode. It can be run into place or removed as desired, and being provided with trunnions its contents may be tipped out. The other electrode consists of a bundle of carbon plates carried by a heavy rod C, composed of a copper strip strengthened by iron side bars. The material, which is fed through the channels G F, consists of a mixture of 1 ton of burnt lime and ¾ ton of ground coke to produce 1 ton of carbide, the reaction being $CaO + 3C = CaC_2 + CO$. An arc is first formed between the electrode C and the floor of the truck. The resulting high temperature converts the mixture into carbide, the electrode being gradually raised and more material added until the car is nearly filled with the product, when it is run out and replaced by another. At Niagara Falls a rotary form of furnace invented by C. S. Bradley is used, being operated continuously and producing about 2 tons in 24 hours when supplied with 3,500 amperes at 110 volts, or about 500 horsepower. Since no electrolytic action is required an alternating current is employed.

Barium Compounds.—The principal source of barium is barite or heavy spar, the natural sulphate. Processes for converting this material into barium hydrate, nitrate, chlorid and other soluble salts have been invented by C. S. Bradley and C. B. Jacobs. They consist in melting in an electric furnace a mixture of barium sulphate with a small quantity of carbon. If one part of carbon to 5 parts of sulphate be present, the sulphate would be all reduced to sulphid, but with one fourth as much carbon a corresponding amount of sulphid is produced which reacts upon the unchanged sulphate and the oxid is obtained, the two reactions being as follows:

$$BaSO_4 + 4C = BaS + 4CO \text{ and}$$
$$3BaSO_4 + BaS = 4BaO + 4SO_2$$

The carbonic oxide (CO) and sulphurous acid (SO_2) pass off as gases, the latter being used to make sulphuric acid. The fused barium oxide (BaO) is tapped off, cooled, broken up and then digested with hot water. On cooling, barium hydrate [$Ba(OH)_2,8H_2O$] crystallizes out. This is used in extraction of sugar, making of white paints, "softening" water, and producing other barium compounds.

Cyanides of Potassium and Sodium are produced electro-chemically by the process of C. S. Bradley, C. B. Jacobs and others. A mixture of barium oxide or carbonate is heated in an electric furnace to produce barium carbide (BaC_2). While the mass is still hot, nitrogen gas is passed through it and barium cyanide is formed, the complete reaction being:

$$BaO + 3C + N_2 = BaC_2N_2 + 3CO$$

The barium cyanide thus produced is treated with sodium carbonate, the result being a mixture of sodium cyanide and barium carbonate. The former is separated by dissolving it in water, the insoluble barium carbonate being used over again. Potassium cyanide is made in a similar manner, and either salt is suitable for gold extraction and other purposes for which cyanides are employed.

Carborundum is a commercial name for carbon silicide, which is produced in large quantities according to the inventions of A. G. Acheson and his assistants. It is used as an abrasive, being hard enough to scratch ruby. It is formed by intensely heating in an electric furnace, a mixture of 3½ tons of ground coke, 6 tons of sand, and about 1½ tons of sawdust and salt, the yield being 3 or 4 tons of crystalline carborundum and about as much more of the amorphous material. The furnaces used at Niagara Falls consist of simple brick hearths 16 feet long and 6½ feet wide, with solid brick walls at each end, about 2 feet thick and 6 or 8 feet high as illustrated. In the middle of each of these walls there are iron frames through which the current is led to a core composed of carbon, weighing about 1,000 pounds, and extending the entire length of the furnace. This core is raised to a very high temperature by passing through it for 36 hours, an alternating current of about 1,000 electrical horsepower at 190 decreasing to 125 volts. The heat from the core permeates the mass and converts it into carbon silicide which is broken up after the furnace has cooled and used to make hones, wheels for grinding, etc.

Artificial Graphite.—As an outgrowth of the carborundum process, Mr. Acheson has developed on a large scale the manufacture of artificial graphite. The material ordinarily used is anthracite coal ground to about the size of rice, which is raised to an exceedingly high temperature in a long electric furnace in the form of a trough about 2 feet square and 30 feet in length. An alternating current of about 1,000 horsepower at 220 to 80 volts is passed for 20 hours longitudinally through the mass, which becomes converted into graphitic carbon. Another line of manufacture consists in graphitizing moulded articles of carbon, such as blocks and rods for electrodes, which are piled in a furnace similar to that described for converting coal into graphite. By using different materials and conditions the two methods produce different kinds of graphite suitable for lubrication, crucibles, pencils, stove polish, electrodes, etc.

Electric Smelting.— One of the earliest commercial processes in electro-chemistry was that devised by E. H. and A. H. Cowles in 1884. A mixture of about 2 parts of alumina, 1 or 2 parts of granulated copper and 1 or 2 parts of carbon was introduced in a brickwork chamber. Bundles of carbon rods inserted at the ends formed the electrodes between which a current of 3,000 amperes at 50 volts was maintained. At a very high temperature the alumina was reduced ($Al_2O_3 + 3C = Al_2 + 3CO$) and the resulting aluminum combined with the copper to form aluminum bronze.

Iron and Steel can be produced by reducing iron ore with carbon in an electric furnace. For example, a mixture of magnetite and carbon can be heated by passing a current through it as in the Cowles aluminum bronze process, through a carbon core in contact with the material as in the carborundum process, or by the action of an arc as in the carbide process. The reaction is simply $Fe_3O_4 + 4C = 3Fe + 4CO$. Pure (that is wrought)iron, cast iron or steel may be produced, depending upon the proportion of carbon. The chief advantages are the directness of the process, and the fact that the impurities in the fuel (sulphur, silicon, etc.) are not introduced. On the other hand it is a question whether the electric furnace can compete in economy with the blast furnace and Bessemer converter.

Alundum, the trade name for artificial corundum, is an abrasive made by a process due to C. B. Jacobs. Bauxite, a natural hydrated alumina, the same material as used in the Hall aluminum process, is calcined to drive off the water and then fused in an electric furnace using 80 volts and 2,000 amperes of alternating current. The mass is allowed to cool and then broken up, having a blue or red color and being of the nature of sapphire and ruby, in fact it is chemically identical with these gems. It makes excellent emery wheels, emery paper, etc.

Nitrogen and Oxygen Compounds are produced by the electrical process of C. S. Bradley, and D. R. Lovejoy. The apparatus consists of a cylindrical chamber through which a number of electrodes, E E, are introduced as illustrated. The ends of the radial arms A A carried by a revolving spindle S pass very close to the electrodes. A pressure of 6,000 to 8,000 volts maintained by the generator G, between the arms and the electrodes, produces arcs 4 to 6 inches long that are drawn momentarily. The current is unidirectional, but being pulsating, an induction coil C in series with each electrode, cuts the current down to about .005 ampere per arc. There are 180 stationary electrodes in each chamber, and as the arms revolve 500 or more times per minute, at least 18,000 arcs are formed in each chamber in that time. Ordinary air, after being dried, is passed through the chamber, where the arcs cause a certain percentage of the nitrogen and oxygen to combine. This compound absorbed in caustic soda forms sodium nitrite or nitrate, with potassium hydrate it forms potassium nitrite or nitrate, and by absorption in water nitric acid may be produced.

Ozone is produced in chambers through which a silent electric discharge is caused to pass from a static electric machine, induction coil or very high voltage transformer. If air circulates through the chamber a certain portion of its oxygen is converted into ozone.

Organic Compounds, such as dyestuffs, vanillin, iodoform, chloroform, are also produced electrically. See ELECTRO-CHEMISTRY; ELECTRIC FURNACES; ELECTROLYSIS; METALLURGY.

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Electro-chemical Series, the arrangement of a number of chemical substances in the order of their affinity for the positive or for the negative pole of a battery.

Electro-chemical Society. The American Electro-chemical Society was founded in Nov. 1901, at Philadelphia. The second general meeting was held at Niagara Falls during October 1902, and the third in New York in 1903. The society has now about 500 members. It was organized to promote the interests of theoretical and applied electro-chemistry and electro-metallurgy, and its influence has already been felt in that new and rapidly growing industry. Its membership includes most of the prominent electrical engineers and electro-chemists in this country.

Electro-chemical Telegraph, a telegraph which records signals upon a paper sheet or strip moistened with a chemical solution, which is decomposed by the electric current. See TELEGRAPHY — *Automatic Chemical System.*

Electro-chemistry, that branch of chemistry in which the reactions that occur are instituted or maintained, either directly or indirectly, by electrical agencies. The electric furnace (q.v.) affords an example of the indirect application of the electric current to the manufacture of chemical substances; the adjective «indirect» being applied in this case, because in most of the uses to which the electric furnace is put, the current does not itself perform chemical work, but merely serves to produce the high temperatures that are essential to the chemical reactions that are desired. The highest temperatures that were known previously to the invention of the electric furnace, were those that prevail in the flame of the oxy-hydrogen blow-pipe. The temperature that is attainable by the combination of oxygen and hydrogen, however, is limited by the fact that water-vapor (which is the product formed by the combination of these gases) has a definite, though high, temperature of dissociation, above which it cannot exist as water-vapor, but is resolved again into a mixture of hydrogen and oxygen. Hence this temperature of dissociation cannot be exceeded by the oxy-hydrogen blow-pipe flame, since the gases cease to combine when it is attained. In the electric furnace no such theoretical limit exists. The heat is produced, here, by the conversion of the electrical energy into heat energy; and so long as the generation of heat within the furnace exceeds that which is lost by radiation in other ways, the temperature will continue to rise without limit, or until some essential part of the furnace itself melts or volatilizes. Calcium carbide is formed, at these high temperatures, by the direct union of carbon and lime, and is now made, commercially and in large quantities, by this process; but the combination does not occur at the comparatively low temperature of the oxy-hydrogen flame. Carborundum (carbide of silicon) is also made in the same way.

The direct action of electricity in promoting chemical combination is exemplified by the «ozonizer,» which consists of a pair of glass tubes, placed one within the other, and separated by an annular space. Coatings of tin-foil, or of something equivalent to it, are applied to the inner surface of the inner tube, and also to the outer surface of the outer one; the apparatus being then connected with the terminals of an induction coil, after the manner of a Leyden jar. The annular space between the two tubes is thus exposed to a rapid alternation of electric stresses, though no actual sparking takes place through it. Gases which ordinarily show no tendency to combine with each other often will do so with greater or less readiness when mixed in suitable proportions and exposed to the alternating electric stress (known, technically, as the «silent discharge») in the annular space between the two tubes. The apparatus is called an «ozonizer,» because it is chiefly used for the production of ozone from oxygen, or from air; but it has also been used, in the laboratory, for the production of many other substances. As an example of the singular power of the silent electric discharge to effect syntheses, it may be noted that hydrogen and carbon dioxid, when mixed in the proper proportions, combine directly under its influence, with the formation of formic acid. $CO_2 + 2H = H.COOH$. The combination does not occur explosively, but, like most of the other combinations under the influence of the silent discharge, it progresses quite slowly and uniformly.

The synthesizing action of the silent electric discharge has a great theoretic interest, but it has never been found to be of any particular importance for the commercial production of chemical substances. Electrolysis of dissolved salts has been found to be far more promising, and a corresponding amount of attention has been given to it. (See ELECTROLYSIS.) A large part of the copper of commerce is now refined by electrolysis, and practically all of the aluminum that is produced is reduced to the metallic form by this same method. (See ALUMINUM; COPPER; ZINC.) Common salt (sodium chlorid) is electrolyzed in large quantities in connection with the manufacture of bleaching powder (q.v.) and caustic soda; the chlorine that it contains apearing in the form of bubbles at the anode, while the sodium goes to the cathode, where it combines with a molecule of water at the instant of its liberation, generating sodium hydroxid, or caustic soda. The free chlorine thus obtained is used in the manufacture of bleach, or of chlorate of potassium or chlorate of sodium; and the caustic soda that is simultaneously formed at the cathode may be recovered and brought into marketable form. In mills where wood pulp is manufactured in large quantities it is not uncommon to meet with auxiliary electro-chemical plants for the manufacture of the bleach liquor that is needed for whitening the pulp; but in these plants no attempt is usually made to recover the caustic soda, nor to utilize it in any way, since the pulp-mills are often far from any market at which the soda could be sold, and the freight rates would make its recovery unprofitable. In regions that are more favorably situated, however, caustic soda is now produced by the electrolytic method in vast quantities. Barium hydrate is also manufactured in quantity by electrolysis, and its market price has been materially reduced, in consequence, within the past few years. Great attention has been paid to the electrolysis of organic substances in recent times, especially in Germany, and results that are of much value have already been obtained. Several of the great chemical works of Germany and Switzerland are now preparing certain of the coal-tar colors by electrolysis (q.v.) on a commercial scale; but the details of the processes are not made public. Goppelsroeder has given special attention to the electrolytic preparation of these bodies, and with an encouraging measure of success. Among his results of fundamental importance we may specially note the preparation of alizarin by the electrolysis of anthraquinone and caustic potash, and of aniline black (together with other coloring matters) from aniline.

The literature of electro-chemistry and of electrolysis is already extensive, and periodicals devoted to the subject, as well as societies for its study and further development, exist in several countries. The American Electro-Chemical Society, which now includes most of the workers in this field in the United States, was organized 1 Nov. 1901 in Philadelphia. Some idea of the magnitude to which the electro-chemical industry has grown may be had from the fact that the value of the annual output of electro-chemical products, in the United States alone, exceeds $100,000,000. Germany is second, with an annual output of more than $15,000,000.

More or less information on the subject of electro-chemistry and electrolysis may be had in any work on physical chemistry. A valuable and suggestive mass of material, bringing the subject down to about 1889, will be found in Tommasi's ‹Traité d'Electrochimie.› An excellent elementary exposition of the principles of electro-chemistry is given in Lüpke, ‹The Elements of Electro-Chemistry Treated Experimentally›; and Löb's ‹Electrolysis and Electrosynthesis of Organic Compounds,› translated into English by H. W. F. Lorenz, is equally good for the special applications to organic chemistry. See ELECTRO-CHEMICAL INDUSTRIES.

Electro Chronograph. See CHRONOGRAPH.

Electrocides, the amber islands of Greek mythology, at the mouth of the river Eridanus. The name was applied also to the islands on the northern coast of Europe.

Electroculture of Plants, the employment of electric light in agriculture and horticulture. It was determined at the Agricultural Experiment Stations of Cornell University and of West Virginia, in experiments made with the arc and the incandescent lights, respectively, that certain crops are forwarded by the light. The most remarkable instance is that of lettuce, which was brought to maturity from 5 to 10 days earlier than other plants grown in the same house, and under otherwise identical conditions. This discovery has led to the commercial application of the arc light, if not of the incandescent also, to the forcing of lettuce under glass in several of the larger New England forcing houses with the result that a gain of about three weeks' time is calculated upon for the season, thus enabling the gardener to devote his benches to one more crop than formerly, or to follow his lettuce crops with cucumbers, the favorite successor, much earlier than would otherwise be possible. Several flower crops, such as Easter lilies and sweet-peas, have been experimented upon with the result that they were forced into bloom several days in advance of others grown without the stimulus. In such cases the plants are always grown without the light until within about a month of maturity, when the light is applied for about half the night. It has been found that unless the light pass through a glass globe or pane there is a noticeable «scorching» of the foliage or flower. It is concluded that this is due to the action of the ultra-violet rays of the spectrum rays, which do not pass through the glass.

Consult various bulletins of the Massachusetts Hatch, Cornell University, and West Virginia, Experiment stations. See ELECTRIC VEGETABLE GARDENING.

Electrocution, capital punishment by the agency of Electricity. See ELECTRICITY, CAUSE OF DEATH BY.

Electrode (Greek, *hodos*, «a way»), a term introduced by Faraday to denote the conductors by which electricity either enters or leaves an electrolytic bath or solution. He termed the electrode by which the current enters the bath, the anode (positive terminal), and the electrode by which the current leaves, the cathode, sometimes spelled kathode (negative terminal). The terms anode and cathode have been introduced generally in metallurgical practice, and also in connection with Crooke's tube, X-ray work, and the term electrode has become common in the more extended sense of signifying either of the terminals of an electric source, instrument, or electrolytic bath or cell.

Electro-dynamics, that branch of electrical science which treats of the attractions and repulsions exhibited between wires or other conductors along which currents are passing. If two wires are parallel they will attract each other when currents are passing the same way along them both, and will repel each other when the currents are opposite. If the wires are inclined to each other at any angle there is not only an attraction or repulsion but a still more marked tendency to rotation which is not satisfied till the wires have become parallel and the currents flow in the same direction along them both. When there are only two straight wires these forces are feeble and require delicate apparatus for their exhibition, but by employing coils of wire the forces are multiplied and an instrument constructed on this principle called the electro-dynamometer has been much employed for the measurement of currents. The basic principles of electro-dynamics were discovered by Ampere in 1821 by many ingenious experiments, the results of which he expounded in a series of statements known to this day as Ampere's Laws.

Electro-dynamometer, an instrument used for the measurement of electric currents by means of the mechanical forces which they exert on each other. It contains two coils of wire, one fixed and the other movable; the latter being either larger or smaller than the other so as to be able to pass either outside it or through it. The coils are set up in vertical planes at right angles to each other; they have a common centre and round the common central diameter of the coils the movable one can revolve. The terminals of the movable coil dip in cups of mercury, one of which is in connection with one end of the fixed coil and the other with one of the binding screws of the instrument. The other binding screw is in connection with the other end of the fixed coil. Hence, when the two binding screws are connected with a battery or other source of electricity, the current has to pass through both coils, and in such a manner that the current will circulate the same way round both coils. Its effect is exhibited by a tendency in the movable coil to set its plane in coincidence with that of the fixed coil. This tendency is resisted by mechanical means provided for the purpose — usually by the torsion of a wire from the end of which the movable coil hangs, and the measurement is usually made by applying torsion till the planes of the two coils are at right angles. See ELECTRIC ALTERNATING CURRENT; ELECTRO-DYNAMICS.

Electro Kinetics. See ELECTRIC DIRECT CURRENT; ELECTRIC ALTERNATING CURRENT; ELECTRICITY.

Electroly'sis, in the strict sense, is the resolution of a fluid into its proximate constituents by the direct chemical action of the electric current; but the word is now commonly applied to all chemical operations, whether analytic or synthetic, which are performed by the direct action of the current. The phenomena that occur in the electric furnace (q.v.) are often incorrectly said to be "electrolytic"; but in most cases they are not so, electricity being used, in this instance, merely as a means for the production of high temperatures. Most of the chemical reactions that are observed in the electric furnace would occur equally well without the use of electricity, if the same high temperatures could be realized by other means; though in some cases, as in the reduction of metallic aluminum by the Hall process (see ALUMINUM), the fundamental operations really are electrolytic, and the high temperature is required merely to keep the electrolyte in the fluid state. The first recorded observation of a distinctively electrolytic action was made in 1800 by Nicholson and Carlisle, who observed that when the terminal wires of a galvanic battery are immersed in water, bubbles of gas arise from them. The correct explanation of this phenomenon was shortly afterward given by Sir Humphry Davy, who carried out an exhaustive series of experiments which laid the foundations for the practical knowledge of electrolysis that we have to-day. Davy demonstrated the tremendous importance of the electrolytic method of analysis, by applying it to study of the alkaline earths and the caustic alkalies. The nature of these substances was not previously understood; but he proved them to be the oxids of previously unknown metals, and prepared the metals themselves in the free state. By passing the electric current through melted potash, for example, he found that bubbles of free oxygen gas were liberated at one of the electrodes, while silvery globules of what is now known as potassium appeared at the other electrode. A few days later he isolated the metal sodium in the same manner, by the electrolysis of soda; and he succeeded, afterward, in demonstrating the compound nature of lime and magnesia also, by the aid of the electric current. As may be imagined, the new method aroused the keenest interest in the scientific world. Napoleon, then at the zenith of his power, offered valuable prizes for discoveries along the same lines, and had large voltaic batteries constructed, in order that French investigators might have every opportunity to carry on the work. The two great Swedish scientists, Berzelius and Hisinger, discovered many new phenomena, and elaborated a general theory of the constitution of chemical substances, based largely upon their behavior under the action of the electric current; and Faraday (q.v.) established the fundamental quantitative laws that hold true in electrolytic decomposition.

Some slight evidence has been adduced which indicates that in certain cases the passage of electricity through solids may be accompanied by slight chemical changes of an electrolytic nature, and phenomena allied to those of electrolysis have been observed in connection with high-tension electrical discharges through gases (see Thomson, 'Recent Researches in Electricity and Magnetism,' chapter 2 and appendix); but in general, electrolysis is observed only in liquids. All liquids may be divided into three classes, according to their behavior when the attempt is made to pass electricity through them. In the first class belong mercury and the other molten metals, which conduct the current readily, and without any noticeable chemical effects. In the second class belong such substances as carbon disulphid and absolute alcohol, which do not conduct the current at all, and hence are not subject to decomposition by it. Absolutely pure water probably belongs to this class, though it becomes a conductor when the smallest quantities of certain impurities are present. Water that is ordinarily called "pure" conducts electricity fairly well, but its conductivity falls off as the purity increases, and Kohlrausch and Heydweiler have shown that water that is distilled in a vacuum, and collected in a glass vessel which has been kept full of distilled water for 10 years in order to dissolve out all the soluble constituents of the glass, has a conductivity almost too small to be measured. The third class of liquids includes all those (such as aqueous solutions of the various metallic salts) in which electric conduction is always accompanied by a definite chemical change. In the present article attention will be confined to this third class, whose constituents are known as «electrolytes,» and in which the current is said to flow by «electric conduction.»

It is necessary, in the discussion of electrolytic phenomena, to distinguish between the primary effects of the passage of the electric current through an electrolyte, and the various secondary effects that may also occur; and while it is not always easy (nor even possible), in actual work, to determine, definitely, what the primary effects are, one or two cases may be cited which will serve to illustrate the difference between primary and secondary effects sufficiently for present purposes. If a current of electricity is passed through melted chloride of lead, $PbCl_2$, the primary effect of the electrolysis is the resolution of the chlorid into its constituent elements, in accordance with the equation $PbCl_2 = Pb \times 2Cl$, metallic lead being deposited upon the cathode. If carbon electrodes are used, free chlorine will also appear at the anode; but if platinum electrodes are used, little or no free chlorine will be obtained, because the gas will combine with the metal of the anode in this case, with the formation of platinum tetrachlorid. The combination of the chlorine with the platinum is an example of secondary action. Again, in the electrolysis of sulphuric acid, H_2SO_4, it is known that the primary effect is the resolution of the acid into hydrogen and the radical «sulphion,» SO_4, in accordance with the equation

$$H_2SO_4 = 2H + SO_4.$$

The hydrogen goes to the cathode, where it is set free. The sulphion goes to the anode, but it is not capable of existence in the free state, and hence some secondary reaction is inevitable. If the acid is dilute, and the anode is of platinum, the sulphion combines with water at the instant of its liberation, according to the equation $SO_4 + H_2O = H_2SO_4 + O$. In this case, therefore, the effect of the secondary action is to regenerate a molecule of sulphuric acid, and simultaneously set free an atom of oxygen; and the evident products of the electrolysis are merely hydrogen and oxygen, which appear at the cathode and anode, respectively. If the acid is concentrated instead of dilute, the secondary action just described will still occur to some extent so long as the acid is not absolutely anhydrous, but free sulphur dioxid is also liberated at the anode in this case; and finally, under certain conditions, sulphur itself may be obtained at the cathode. The secondary chemical changes that occur in an electrolytic cell depend upon the nature of the electrolyte, upon the concentration of the solution, upon the temperature, and upon the strength of the current to which the primary chemical effects are due. They are often complicated and of an unexpected nature; and it is to the study of these secondary changes, under varying conditions, that industrial electrolytic chemistry must look for its further advancement.

No primary chemical changes whatever are to be observed, in an electrolytic cell, save at the electrodes; though secondary changes may occur elsewhere, on account of the diffusion of the immediate products of decomposition through the liquid of the cell. The primary changes do not depend in the smallest degree upon the size of the electrodes, nor upon any other factor save the total quantity of electricity that passes through the cell. If a series of cells, containing electrodes of various sizes and filled with a given solution in different states of concentration, be placed simultaneously in the same circuit, so that the same identical current traverses them all, the primary products of decomposition will be the same in all, both in nature and in quantity. Moreover, if the same experiment be repeated when the several cells are filled with solutions of diverse natures, the primary products will necessarily be different from one another in kind, but when their quantitative relations are examined, it is found that they are liberated in precisely equivalent proportions. For example, if one cell contains chlorid of sodium and another contains nitrate of silver, then the quantity of chlorine liberated in the first cell is precisely sufficient to unite with the metallic silver liberated in the second one, so as to produce chlorid of silver without excess of either chlorine or silver. This statement needs one simple qualification, however, before it can be applied universally. If the two cells considered contain mercuric nitrate, $Hg(NO_3)_2$, and mercurous nitrate, $HgNO_3$, respectively, then for every ounce of mercury that is deposited from the mercuric salt, two ounces will be deposited, simultaneously, from the mercurous salt. Obviously the quantities of Hg and of NO_3 that are liberated in the two cases cannot both be the same; and it is the NO_3, and not the Hg, which is liberated in equal quantities. In general, the «chemical equivalent» of an element is defined as the atomic weight of the element, divided by the valency that the element has, in the compound under consideration; and the quantities of the various elements that are liberated by a given quantity of electricity are proportional to the «chemical equivalents» of the elements, as they occur in the compounds that are submitted to electrolysis, rather than to the «atomic weights» of these elements. The number of grams of an element that are liberated, electrolytically, by one C. G. S. unit of electricity, is called the «C.G.S. electro-chemical equivalent» of that element. The electro-chemical equivalent of silver is known by experiment to be about 0.01118; and the electro-chemical equivalent of any other element may be found from this by simple proportion, as explained above. For many purposes it is more convenient to know what weight of a given element will be deposited in one minute, by a current whose intensity is one ampere. This is given, in the accompanying table, for the more important elements. The elements are here divided, for convenience, into those that are electro-positive, and those that are electro-negative; the former being those that usually appear at the cathode, and the latter those that usually appear at the anode. This classification is not very valuable in the case of complicated compounds, but it answers for the simpler ones. The data given in the table refer to the primary products of decomposition; but it is sufficiently evident that they apply equally well, so long as the visible product of the decomposition is all of one kind, whether it is primary or secondary. In the electrolysis of sulphuric acid, for example, «sulphion» is the primary product at the anode; but sulphion is incapable of independent existence, and the only visible product at the anode is oxygen, so long as the acid is sufficiently dilute. In this case the quantity of oxygen that is liberated can be computed precisely as though the oxygen were itself the primary product. When, as in the electrolysis of concentrated sulphuric acid, more secondary products than one are obtained, the

GRAMS LIBERATED PER AMPERE PER MINUTE.

Element	Atomic Weight	Valency	Chemical Equivalent	Grams per Ampere per Minute
Electro-positive:				
Aluminum	26.9	3	8.97	0.00562
Copper (cupric)	63.1	2	31.6	0.0198
" (cuprous)	63.1	1	63.1	0.0395
Gold	195.7	3	65.2	0.0408
Hydrogen	1.0	1	1.00	0.000626
Iron (ferric)	55.6	3	18.5	0.0116
" (ferrous)	55.6	2	27.8	0.0174
Lead	205.4	2	102.7	0.0643
Mercury (mercuric)	198.8	2	99.4	0.0023
" (mercurous)	198.8	1	198.8	0.1245
Nickel	58.3	2	29.1	0.0182
Potassium	38.9	1	38.9	0.0244
Silver	107.1	1	107.1	0.0671
Sodium	22.9	1	22.9	0.0143
Tin (stannic)	117.6	4	29.4	0.0184
" (stannous)	117.6	2	58.8	0.0368
Zinc	64.9	2	32.4	0.0203
Electro-negative:				
Bromine	79.4	1	79.4	0.0497
Chlorine	35.2	1	35.2	0.0221
Iodine	125.9	1	125.9	0.0789
Nitrogen	13.9	3	4.63	0.00290
Oxygen	15.9	2	7.95	0.00948

case is more involved. In general, however, we must remember that it is only with reference to the primary products that the electrolytic nature of the decomposition need be considered; for the secondary reactions are merely those of ordinary chemistry.

The most generally accepted theory with regard to the nature of electrolytes is that which is known as the «ionic theory,» and which teaches that a salt whose solution is capable of electrolysis becomes more or less completely dissociated when it is dissolved, the respective parts into which its molecules subdivide being known as «ions.» This aspect of the phenomena of solution is considered in the article SOLUTION (q.v.), and in the present place we need dwell only on those features of the ionic theory which have an immediate bearing on the subject of electrolysis. The ions into which the electrolyte is resolved, upon solution, are supposed to be associated with definite charges of electricity, which cling to the ions so long as the dissociation persists, and can only be neutralized by causing the ions to come together again so as to re-form a molecule of the original salt, or to enter into other chemical combinations with one another; neutralization being effected, in such cases, by the actual discharge of the equal and opposite electricities into one another, as the re-combining ions come together. What the ions are, into which a given salt dissociates when it is dissolved, can only be discovered by inference from certain kinds of experiments for which reference must be made to the books cited in the article SOLUTION. Our knowledge on this point is still far from complete, but we know what the ions are in most of the simpler electrolytes. When potassium hydroxid, KOH, is dissolved in water, it becomes dissociated, or «ionized,» into the ions K and OH. At first thought it appears to be impossible to admit that potassium, which has so great an affinity for water, can exist in the free state in a solution; but it must be remembered that the potassium «ion» differs from the ordinary potassium atom by the possession of a definite and considerable electric charge, which modifies its chemical behavior profoundly. As the solution is concentrated by evaporation, the potassium ions and the hydroxyl ions (OH) come together, discharge into each other, and unite to form potassium hydroxid, KOH, which is deposited in the solid form. (Some of the hydroxid remains in solution as such, the dissociation never being complete except in exceedingly dilute solutions; but this point is not essential to our present purpose, and for its further elucidation reference must be made to the article SOLUTION.) In the ionized state, the potassium is charged positively and the hydroxyl negatively; and, in general, any ion which appears at the cathode during electrolysis is charged positively in the free solution, and any ion which appears at the anode is charged negatively. Moreover, the phenomena of electrolysis prove that any given ion is always associated with the same identical charge of electricity, no matter what the salt may have been from which the ion was obtained, provided the ion has the same valency in each of the salts that are compared. The potassium ion in a solution of potassium chlorid, for example, carries precisely the same charge as the potassium ion in a solution of potassium nitrate, or of potassium carbonate. We may therefore regard the free ions in a solution as so many little buckets filled with electricity, all the buckets having identically the same capacity.

According to this view, the ions act as mere carriers of electricity, and electrolysis is not simply an accompaniment of conduction through an electrolyte, but the very means by which this conduction is effected. The electric circuit in which the electrolysis occurs may be likened to a brook. If the metallic circuit is interrupted by the insertion of a solution of some kind, the solution so inserted corresponds to a dam in the brook, through which no water can pass by direct flow. The analogy is fairly complete when the solution does not contain free ions, for then it will not act as an electrolyte, and no current can pass. Sugar, for example, does not dissociate to any appreciable extent when it is dissolved, and hence a solution which contains nothing but pure water and pure sugar cannot conduct electricity, and merely acts as an impassable barrier to the current. When the solution contains a salt (such as sodium chlorid) which is largely or wholly dissociated, the free ions act like a molecular bucket brigade, passing the water across the dam in the brook, or the electricity across the gap between the two electrodes in the electrolytic cell. In the electrolysis of copper sulphate, for example, the phenomena are as follows: The formula of the sulphate is $CuSO_4$, and the free ions in the solution (and hence also the primary results of the decomposition) are copper and «sulphion,» SO_4; the copper ion being charged positively, and the sulphion ion negatively. The electrodes that are immersed in the electrolytic cell are also kept continuously charged by the battery (or dynamo) with which they are connected; the cathode being negative and the anode positive. The positively charged copper ions in the solution are therefore attracted by the negatively charged cathode, just as a positively charged pith ball is attracted by a negatively charged body in the air. Hence they move towards the cathode, and when they reach it they discharge their electricity upon it, thereby ceasing to be ions, and becoming transformed into atoms of ordinary copper, which are perforce deposited upon the cathode. The sulphion ions simultaneously move toward the anode, upon which they discharge the negative electricity that they carry. The ionic charge is essential to the continued existence of the sulphion, however, and when this charge is lost, the sulphion must either break up into sulphur dioxid and free oxygen, or else combine with some other substance to form a new compound. If the anode is made of platinum or carbon, the sulphion usually combines with a molecule of water with the liberation of free oxygen, as already explained in connection with the electrolysis of dilute sulphuric acid; but if the anode is made of a material that is less resistant to chemical action, the sulphion may combine with the anode itself instead of with a molecule of water. For example, when the anode is of copper, the sulphion, at the moment that it loses its electric charge, combines with an atom of the anode so as to form a molecule of copper sulphate.

The solvent, according to this theory, is to be regarded as an insulator, through which the electricity is passed by the ionic bucket-brigade. There is no real «conduction» through an electrolyte; but the positive charges that the ions bring to the cathode diminish the charge of the cathode so that more negative electricity must flow to it from the battery (or the dynamo), in order to maintain its potential; and, similarly, the negative charges that the ions carry to the anode require a constant supply of positive electricity from the battery, in order that the potential of the anode may be maintained. The general effect upon the circuit, therefore, is the same as though there were an actual conduction of electricity through the electrolyte. (For a further elaboration of the ionic theory of electrolysis, consult Whetham, 'Solution and Electrolysis.' See also SOLUTION.

By a detailed study of the secondary chemical actions that occur when salt solutions are electrolyzed, it has been found to be possible to isolate many of the metallic elements by electrolysis, when they are present in a mixed solution; and a promising system of «electro-chemical analysis» has been based upon this fact. Copper may be separated from cadmium, for example, by electrolyzing a solution of their mixed salts, in which free nitric acid is present, the copper being obtained in the metallic form, while the cadmium remains in solution. If the same solution is neutralized by potassium hydroxid, and then electrolyzed after the addition of potassium cyanide, the cadmium is deposited, while the copper remains in solution. The successful application of the principles of electrolysis to analysis requires an extensive knowledge of the secondary reactions that occur at the electrodes, however, as well as a full understanding of various practical conditions that must be carefully attended to. For these consult: Smith, 'Electro-Chemical Analysis' (1903), together with the references therein given. See ELECTRIC FURNACES: ELECTRO-CHEMICAL INDUSTRIES; ELECTRO-CHEMISTRY; ELECTRON; SOLUTION.

Electrolysis of Gas and Water Mains. In the system of street railway traction in which an overhead trolley wire is employed, with direct current, in which the tracks are utilized as a return circuit for the current to the power house, it has been found that damage has almost invariably ensued to the gas and water mains adjacent to the tracks, from electrolysis. This is due primarily to the electric current leaving the tracks and following the gas or water mains for some distance. At the points where the current leaves these pipes to return to the tracks or to the power house, if the soil is damp and contains soluble chlorides of magnesium, sodium or potassium, the current sets free acids or chlorine which attack the iron of the pipes; the rapidity and extent of the damage done thereby being proportional to the strength of the current, the duration of its application, and the constituents of the soil. The electrolytic action results in «pitting» the pipes, and bursting of water pipes and leakage of gas pipes is not uncommon from this cause. See illustration. Experiments have shown that with as low

Electrolytically Pitted Water Pipe.

a potential as .5 volt and a current of .03 ampere, noticeable electrolysis of an iron pipe has occurred in sand moistened with sea water. A current of 5 amperes acting for one year on an iron pipe would result in serious damage. Pipes on which the difference of potential was founds to be about 6 volts have burst in a few years. To prevent electrolysis due to this cause greater precautions are now taken, and with considerable success, to preserve the continuity of the rails by bonding, welding them *in situ* by electricity, by providing separate metallic return circuits and by connecting the water and gas mains by means of heavy copper wire at places where the current would otherwise return to the tracks via the earth.

Electrolyte, a compound which is decomposable, or is subjected to decomposition, by an electric current. See ELECTRIC STORAGE BATTERY.

Electro-magnetic Induction. See INDUCTION.

Electro-magnets. *Electro-magnetism.* The fact that when a current of electricity flows in a coil of insulated wire surrounding a bar or rod of soft iron, the iron becomes a magnet, was discovered in 1825 by William Sturgeon of England. He also discovered and pointed out in a paper read by him before the Society of Arts in that year, that the polarity of the magnet depended upon the direction of the current around the iron bar, and that it ceased to be a magnet when the current ceased to flow in the circuit. His two first electro-magnets were made in the shape of a horseshoe and a straight bar. The former was made of a bent rod of iron one foot in length and half an inch thick, around which a bare copper wire was wound 18 times, the iron having been previously covered with varnish to insulate the wire from the iron. The current was supplied by one large primary cell. This magnet was able to sustain a weight of nine pounds, though weighing itself only seven ounces. Subsequently Sturgeon constructed a horseshoe electromagnet 18 inches in length, 2¾ inches thick, and wound with 980 feet of copper wire one twelfth of an inch in diameter, which upheld 1,386 pounds.

The phenomena of electro-magnetism may be briefly described as follows. It is known that when iron filings are strewn over a cardboard or glass, if a bar or horseshoe magnet be placed under the cardboard the filings will tend to arrange themselves symmetrically when the cardboard is tapped. This it is assumed is due to the existence of so-called magnetic lines of force which are assumed to flow from the north to the south pole of the magnet, and the iron filings, becoming magnetized by these magnetic lines of force, tend to set themselves parallel thereto. Similarly, when an electric current flows in a wire (electro) magnetic lines of force surround the wire in circles or hoops which increase in density with the strength of the current. It is known that iron is a much better conductor of magnetic lines of force (or magnetism) than air, in the ratio of 1 to 100 or 150, depending on the quality or "permeability" of the iron. Hence when the wire is made in the form of a coil into which is inserted a soft iron bar, the magnetic lines of force, so to speak, use the iron as a circuit and the latter becomes a magnet having north and south poles.

The space between the poles of a magnet or wherever its magnetic lines of force extend, or in the space around a wire conveying a current of electricity, is termed a magnetic "field." The substances through which the lines of force pass, including the iron of the magnet, constitute the magnetic circuit. The expression *number of lines of force per square centimetre* in the material, is at present used as a measure of magnetic density. The total number of lines of force in a magnetic circuit is termed the *magnetic flux*, and is obtained by multiplying the total cross sectional area of the field in square centimetres by the density of a square centimetre of the circuit. The *magneto-motive force* (that is, the force that, as it were, drives the lines of force through the circuit) is equal to the product of the strength of current in amperes in the coil by the number of convolutions of the coil. This is also termed the *ampere turns*. The magnetic flux may be increased by increasing the magneto-motive force or by decreasing the resistance (termed the *reluctance*) of the magnetic circuit. Hence the relation between the foregoing terms to one another is analogous to electro-motive force, resistance and current, in an electrical circuit, and may be expressed by the equation:

$$\text{Magnetic flux} = \frac{\text{Magneto-motive force}}{\text{Reluctance.}}$$

It is to be noted, however, that the reluctance of a magnetic circuit containing iron is not a constant, but increases, in other words, its permeability to magnetization decreases, after a certain degree of magnetization, which is termed *saturation*, has been reached.

Electro-magnets are extensively used in telegraph and telephone apparatus, in dynamo machines, electric motors (q.v.), and for many other purposes. See UNITS.

Electro-metallurgy and Electric Smelting. See ALUMINUM; COPPER; GOLD; METALLURGY; PLATINUM; SILVER; ZINC.

Electrometer, an instrument for measuring differences of electric potential between two conductors through effects of electrostatic force, and not through certain electro-magnetic effects of electric currents produced by them. See ELECTRIC BALANCE.

Electro-motive force, a term used in connection with batteries and other sources of electric supply to denote the differences of potential existing between the plates or terminals, in consequence of which there is a tendency for a current to flow when the plates are connected by a conductor. See BATTERY; PRIMARY BATTERIES.

Electro-motograph, a name given to a peculiar telephone receiver invented by Edison, and constructed virtually as follows. A short metal strip, fastened at one end to the centre of a mica diaphragm, rests on a rotating cylinder, the surface of which is composed of moist gypsum impregnated with mercuric acetate and potash. The strip and cylinder are placed in series in a telephone circuit. When variations in current pass through the gypsum surface it is found that the friction between the strip and the cylinder varies directly with the current. When the current is weak the strip is drawn along in the direction of the cylinder's rotation against the natural tension of the mica diaphragm. When the current increases, the strip slips back in response to the pull of the diaphragm, and in this way the diaphragm is set into vibrations corresponding to those set up by the telephone transmitter. An explanation of this phenomena is that the current electrolytically sets free a thin layer of gas between the cylinder and strip, reducing the natural friction.

Elec'tron, one of the ultimate particles of which (according to the views now tentatively held by physicists) the atoms of matter are composed. The "electron hypothesis" is still in its infancy, and years will probably elapse before its truth or falsity can be demonstrated with any degree of certainty. It teaches that the atoms, which were formerly supposed to be simple bodies that are incapable of subdivision, or bodies which at all events do not undergo division in the ordinary processes of nature, are really systems of some considerable complexity, built up of thousands of still tinier "electrons," each of which is endowed with a permanent electric charge. The definite development of the electron hypothesis originated with the study of electric discharges through highly rarefied gases. Crookes, for example, boldly took the position that the luminous streams ("cathode rays") that proceed from the cathodes of highly exhausted vacuum tubes are composed of tiny material particles that are moving away from the cathodes like storms of projectiles. In support of this view he exhibited many ingenious and beautiful experiments, in which the corpuscular torrents were caused to turn paddlewheels and heat targets to whiteness within a vacuum. He did not definitely commit himself to any theory as to the precise nature of the corpuscles, but he recognized them as being somehow different from the ordinary molecules of matter, and he consistently and persistently maintained that the matter in these tubes is in a "fourth state," which is essentially different from the familiar gaseous, liquid and solid states, which matter has long been known to be capable of assuming. This fourth state he called "radiant matter." His views were opposed by many competent authorities, who adhered to the view that the cathode rays are wave-like phenomena, due in all probability to the extraordinary electrical stresses that are set up in the luminiferous ether within the tube, by the induction coil that is used to produce the discharge. As further experimental evidence has accumulated, however, the substantial correctness of Crookes' views has become increasingly evident, and the corpuscular nature of the cathode rays is now generally admitted. Numerous experiments have been made to prove that these corpuscles (electrons) carry electrical charges, and for determining the mass of the electrons and the magnitude of the electrical charges they carry. Let m be the mass of the electron, v the velocity with which it moves in the cathode stream, and e the electric charge associated with it. It can be shown that a magnetic field acting at right angles to the direction of the stream will cause the electron to describe a curved path instead of its normal straight one. If the magnetic force thus acting at right angles to the direction of the stream be a circle of radius $\frac{mv}{eH}$. By observing the actual curvature of the cathode stream under the influence of a known magetizing force H, we can therefore find the value of the expression $\frac{mv}{e}$. It is also known that the tendency of the magnetic force to produce curvature of the path of the electron can be neutralized by so arranging the experiment that the cathode stream is simultaneously exposed to a static electrical force of a particular intensity F, and acting in a direction that is perpendicular both to the cathode stream and to the magnetic force; the intensity, F, of the static force being such that the relation $Fe = Hev$ is fulfilled. By experiment, it is possible to find the numerical value of F by varying the electric force acting across the cathode stream until, under the combined influence of the static and magnetic forces, it is seen that the cathode stream is perfectly straight. When this condition is fulfilled, the equation just given shows that the velocity of the electron can be found by merely dividing the observed value of F by the observed value of H. The results obtained in this way indicate that the velocity of the electrons in the cathode stream is pretty much the same, whether the tube contains air, hydrogen, or carbon dioxid; it being about 2,500,000,000 centimetres per second (that is, about 15,000 miles), or something like one twelfth the velocity of light. The value of v being known, and the ration of mv to e being also known by a previous experiment in which the static field is omitted and the magnetic force allowed to act alone, we are at once in position to calculate the value of $\frac{e}{m}$ or the charge that is carried by the electron, per unit of its mass. The numerical result so obtained (and which is sensibly the same for all gases) is that each gram of the electron's mass, in the cathode stream, carries a charge of about 10^8 coulombs. Now in electrolysis (q.v.) the ions of hydrogen carry a charge of about 96,000 coulombs per gram of their mass; or, in round numbers, 10^5 coulombs per gram. Hence if the electrons in the cathode stream have a mass equal to that of the hydrogen ion in electrolysis, they must carry an electric charge that is 1,000 times as great as that carried by the hydrogen ion; and conversely, if (as many authorities consider probable) they carry the same electric charge as the hydrogen ions carry in electrolysis, it follows that the electron has a mass only about one one-thousandth as great as that of the hydrogen ion (or atom). The reasoning given above appears to be beyond reproach, and it is substantiated by other methods of experiment that cannot be here considered. J. J. Thomson, who has been especially prominent in connection with the development of the electron hypothesis, endeavored to determine which of the alternatives suggested above corresponds with the real facts of the case. His method for doing so is described in full detail in the 'Philosophical Magazine' for December 1898, but is too technical to be given in the present article. His general conclusion is, that the charge is the same upon the electron as it is upon the hydrogen ion in ordinary electrolysis; and hence that the mass of the hydrogen atom is 1,000 times as great as the mass of an electron. It is not certain that this conclusion will be fully sustained by future investigations, because some of the assumptions and observations upon which it is based have not yet been established beyond controversy. It may yet be found that the electron and the hydrogen atoms are not greatly different in mass, but that the electron carries a far larger charge of electricity than the ion that is concerned with electrolysis. Assuming the correctness of Thomson's views, certain physicists have elaborated fascinating hypotheses as to the constitution of matter, and have even attempted to explain the genesis of the definite species of matter that we call elements. (See ELEMENT.) It is not at all improbable that matter really is of only one fundamental kind, and that we shall one day know how the elements differ from one another. It is even possible that the electron hypothesis is the key that is to unlock this secret; but the subject is still too new for any definite and valuable judgment to be passed upon this phase of it. In general, there is a tendency towards the belief that the electrons are the fundamental units of which the atoms are composed; and according to this view they may be likened to the bricks with which buildings are constructed in human architecture. The electrons of all bodies are supposed to be identical with one another, and the atoms of any two elements, such as hydrogen and iron, for example, are supposed to differ only in the number of the electrons that they contain, and in the way in which these electrons are grouped. It is known that a swiftly-moving charge of electricity would show inertia-like effects, even if it were not associated, in its motion, with any body possessing true mass. Hence it has been thought probable, by many authorities, that the inertia of matter is capable of explanation in this way, if it is admitted that atoms are really composed of electrons flying around in orbits, about a mean configuration that is essentially stable so long as it is not subjected to external disturbances of too great a magnitude. These speculations, and others of the same sort, are given in Sir Oliver Lodge's interesting lecture "On Electrons," as published in the 'Scientific American Supplement,' beginning with the issue for 16 May 1903 (No. 1428). It is probable that the views now held upon these and other allied subjects will soon undergo a substantial modification of some sort, for it is next to impossible for the human mind to conceive of any such thing as a disembodied electric charge moving about in an orbit; and while such a description of the ultimate nature of the electron may serve well enough as a starting point upon which to base mathematical equations that shall explain the phenomena that we can observe and measure in the laboratory, it can never satisfy the craving of the physicist for a definite mental image of what is really going on in the atom. Whether such a mental image is possible or not, or whether or not it is logical to strive for its attainment, are fair questions for discussion; but it is certain that the general trend of physics has been in this direction in the past, and there is no reason to suppose that the same tendency will not be equally manifest in the future. See ELECTRO-CHEMISTRY; ELEMENTS.

Electro-optics, a branch of electrical science treating of the relation of electricity to light. See LIGHT.

Electrophorus (Greek *pherō,* "to bear.") See ELECTRIC MACHINE.

Electro-photo Micrography, the art of photographing by means of the electric light, certain objects magnified by the microscope.

Electro-photography. See PHOTOGRAPHY.

Electroplating. Given a solution of the salts of a metal, say, for instance, sulphate of copper (the constituents of which are sulphuric acid and copper oxide), in which are immersed a copper plate connected with the positive pole of a source of electro-motive force, and a metal plate connected with the negative pole; when an electric current is passed through the solution an action takes place which may be described as follows: First, the salt is decomposed into sulphuric acid and oxide of copper. At the same time a portion of the water of the solution is also decomposed, setting free hydrogen and oxygen. The oxygen of the oxide of copper is drawn to the negative pole, where it unites with a portion of the hydrogen just freed, forming water, and the metallic copper thus set free is deposited uniformly on the negative metal plate. Simultaneously with this action sulphuric acid and oxygen arrive at the positive plate, where the oxygen unites with a particle of the copper plate, forming oxide of copper, with which the sulphuric combines, forming sulphate of copper; which process is continued as long as there is any metal left in the positive plate. For each atom of copper thus dissolved at the positive plate another is set free at the negative plate. Actions analogous to these underlie all electroplating and electrotyping operations. If it is desired to deposit nickel, silver, gold, or other metal on the object, salts of those metals instead of copper will be used in the solution or *bath,* as it is termed.

The art of electroplating and electrotyping (q.v.) is now extensively practised. The current for the decomposition of the electrolyte, or solution, is usually supplied by continuous-current dynamo machines which are designed to give large currents at electro-motive forces, rarely exceeding three to five volts. Sufficient electro-motive force must be provided to decompose the solution, but the amount of chemical decomposition depends altogether on and is proportional to the strength of the current. If too high electro-motive force or too large currents are used, the plating is uneven and granular. Storage or primary batteries may also be used for this purpose, and are so used for plating on a small scale. Much care and special knowledge is required to obtain the best results in electroplating. The process is begun by thoroughly scouring the article to be plated to remove all trace of oxide or other impurity from its surface. In the case, for instance, of gold, silver, or nickel plating, the bath or solution employed by some electroplaters consists of 100 parts water, 10 of cyanide of potassium, and 1 of the cyanide of gold, silver, or nickel, as the case may be. Plates of either of these metals are suspended in the bath as the positive pole, while the article to be plated is suspended in the bath as the negative pole. When the plating has proceeded to the desired depth or thickness the articles are taken out and burnished. Such parts of the article as it may not be desired to plate are covered with grease, oil, or wax. When non-metallic articles are to be plated they are first given a coating of wax, over which is laid a film of powdered plumbago, upon which the plating then takes place. See 'Brunor's Electroplater,' a text-book on the subject.

Electropoion, a mixture of sulphuric acid, bichromate of potash, and water used as the liquid for batteries in which zinc and carbon are the poles. See BATTERY.

Electropyrometer. See PYROMETER.

Electroscope. This is an instrument used to indicate the presence of electricity in a substance, and may be used to show whether the electricity is negative or positive. In one form it consists of a wide-mouthed vial stoppered with a cork, through the centre of which a metal rod passes into the middle of the vial. There is a brass knob at the top of this rod, and its lower end is bent or hooked to support a narrow strip of gold foil, which is folded in equal lengths over the hook. When a rubbed glass rod is brought near the brass knob, positive electricity is attracted and negative electricity is repelled to the gold leaves, which diverge by reason of the repulsion of the similar electricity on the leaves. To show the kind of electricity with which the leaves are charged, or with which another body may be charged, a finger is placed on the brass knob while yet the glass rod is near it. This allows the negative electricity to escape. When next the finger and then the rod are removed, the positive electricity is dispersed over the gold leaf system and the leaves again diverge. If now, while the leaves are charged with positive electricity, a positively charged rod be brought near the knob, the leaves tend to diverge still farther. If a negatively charged rod is used, the positive electricity in the leaves is attracted and the leaves tend to collapse.

Electroscopes of this general type are now utilized on account of their great susceptibility to the presence of electricity, to detect and measure the radioactivity of weakly radiating substances like uranium and thorium, advantage being taken of the ionizing properties of such substances by which the particles of gases become carriers of electric charges proportional to the radioactivity of the substances. For this purpose the gold leaf system is placed in metallic connection with the upper plate of a small air condenser, on the lower plate of which is spread a layer of the radioactive material. A source of electro-motive force is connected with the lower plate and the movement of the gold leaf is noted, the rate and extent of which, varying with the radioactivity of the substance, comparisons can be readily made of different substances connected with the lower plate, and the movement of the gold leaf is noted. As the rate and extent of this movement vary with the radioactivity of the substance, comparisons can be readily made of different substances or with a standard.

Electrostatics is the part of the science of electricity that treats of the phenomena of electricity at rest. See ELECTRICITY.

Electrotaxis. See ELECTROCULTURE OF PLANTS.

Electro-therapeutics. The treatment of disease by electricity dates back at least to the middle of the 18th century, about which time the electric spark and frictional electricity were employed for that purpose. In 1753 Franklin utilized shocks from Leyden jars (charged by electric machines) in the treatment of paralysis and other ailments. In 1775 the effects of the Franklinic current (high potential static electricity) upon the human system was in some respects almost as well known as it is to-day. Thus, in 1777 Tiberius Cavallo, the well-known philosopher and writer of that time, records, with respect to communicated electricity, that its application either as simple electrization or in the form of sparks and shocks to the human body has been unquestionably serviceable in various disorders, some of which have resisted every other medical application.

The discovery of voltaic or galvanic electricity (primary battery) in 1800, and of induced or faradic electricity (induction coil) about the middle of the last century opened up a new field as regards the use of electricity in the treatment of disease, by affording a more gentle treatment than the shocks and sparks from Leyden jars, and for long intervals static electricity was but little used. The improvements in apparatus and methods of application in later-day practice have however made it possible to use static electricity with little or no inconvenience to the patient.

The currents used in therapeutics are commonly known as the galvanic, faradic, and franklinic currents, named respectively after Galvani, Faraday, and Franklin. These terms refer to the prime source of the current. Thus the galvanic current is due to a primary or storage battery, the faradic current is derived from induction coils or from small magneto-electric machines with a rotating armature; the franklinic current is developed by static electric machines (influence or frictional).

In a proposed new nomenclature relating to electro-therapeutics it has been suggested to term these currents voltaic current, induced current, and static current, respectively. Currents induced by induction coils are frequently termed coil currents. In the new classification of currents, also, a direct current is a current in one direction only, which may at times have a zero value. A continuous current is also a direct current, one that may vary in strength, but does not reach a zero value. A constant current is one which does not vary in strength, (a constant current presupposes a constant electro-motive force and resistance in the circuit). A pulsating current is an interrupted direct current which varies from zero to maximum periodically. It may be set up by interrupting a direct current at regular intervals. The form of the pulsating current will vary with the nature of the circuit. The direct, the continuous, the constant, and the pulsating current may be supplied by a primary or storage battery, or a direct current dynamo machine; these currents may be either positive or negative in direction, uniformly.

An alternating current is one which rises from zero to, say, positive maximum, falls to positive zero, then passes to negative maximum and back to negative zero, in regular periods or cycles. When the positive and negative maximums are equal, and the rise and fall are uniform and gradual, the current may be represented by a sine curve, and is termed a sinusoidal current. Special machines are manufactured to generate sinusoidal currents for use in therapeutics. Alternating currents developed by induction coils are not of uniform positive and negative strength, and may be represented by an unsymmetrical curve or wave. Alternating currents are also obtained from alternating current dynamo machines or generators, including the specially made sinusoidal machines referred to, and from induction coils. See DYNAMO MACHINES; WIRELESS TELEGRAPHY.

An oscillating current is one which alternates in direction at a given rate or frequency, but whose amplitude of vibration falls in a given ratio. Oscillating currents are set up by Leyden jars or condensers in discharging. See WIRELESS TELEGRAPHY; OSCILLATING CURRENTS; also ELECTRIC STATIC MACHINE.

Direct Current in Therapeutics.—The direct current is used in therapeutics for its electrolytic and cataphoretic action on the constituents of the body.

As the human body is one which conducts electricity by virtue of its salts in solution (chiefly chloride of sodium, or common salt), it is virtually an electrolyte in its relation to an electric current; hence the passage of a direct current through the body causes a decomposition of the salts of the body, to which is primarily due many of the valuable therapeutic effects of the electric current.

Concurrently with electrolysis, phoresis also takes place in the electrolyte. In an electrolyte the second action of the current is to draw or move along with it the ions of the fluids in its path, which action is termed phoresis. When the ions move toward the cathode the effect is termed cataphoresis; when toward the anode, anaphoresis. Advantage is taken of this action, usually the cataphoric, to introduce into the body, through the skin or mucous membrane, by means of the direct current, certain drugs — iron, quinine, cocaine, morphine, etc.— in solution, to the parts to be acted on. This is termed cataphoric medication. By cataphoric action cocaine is successfully employed as a local anæsthetic in dentistry. By the use of heavy currents and amalgamated zinc needles cataphoresis is employed with success in the destruction of malignant tumors and to sterilize surrounding tissues.

The electrolytic effects of the direct current are at least of two kinds, termed polar and interpolar electrolysis. In the first, the effect is mainly at the electrodes (needles); the acids and alkalis set free by the current attacking and recombining with the molecules of the tissues, which, by this secondary chemical effect, assist in their own destruction, as in the case of tumors treated by this method. In interpolar electrolysis the effect is distributed over a larger area, the known beneficial results being presumably due to the reactions set up by the current, which reactions assist in the absorption of morbid tissues, thereby tending to increased nutrition and thus aiding in the formation of normal tissue.

The electrical resistance of the body may range from 500 ohms to 10,000 or more ohms, according to the nature of the contact at the electrodes. The current may be applied, percutaneously by means of electrodes moistened with water, to which a little bicarbonate of soda has been added to improve the conductivity; by electrodes applied to mucous membrane; or by the insertion of needle electrodes in the tissues. For percutaneous applications comparatively high voltages are necessary, 30 to 60 volts. The current strength used is small and is measured in milliamperes (thousandths of an ampere) by a milliammeter. The average percutaneous application is about 7 milliamperes for one square inch of electrode surface; about 15 milliamperes for two square inches. The amount of current employed must be varied according to the purpose for which it is employed; in some cases, as near the brain or eye, only a fraction of a milliampere, or two to three milliamperes at most, are required. Vertigo and flashes of light are produced and taste is excited by the passage of weak direct current through the brain from moistened electrodes. It is not advisable or safe to apply more than 100 milliamperes direct current through any vital part of the body, as from hand to hand. In gynæcological work, currents of 50 to 500 milliamperes are utilized, a large moistened electrode being applied externally while a small metallic electrode is employed internally. The direct current does not produce shocks except at the opening and closing of circuits. Some practitioners have obtained favorable results by the use of 40 to 100 milliamperes direct current passed through the body by means of large electrodes placed on the abdomen and lumbar regions to influence the abdominal viscera. Similar current strengths have also given favorable results in gastro-intestinal disorders, malnutrition, and neuralgia.

In Fig. 1 is illustrated a 30-cell voltaic battery of dry cells employed in direct current therapeutics. In the figure A is a milliammeter; C is a cell selector, by means of which the number of cells in use may be quickly regulated. The current flow may also be regulated by the rheostat R, consisting of carbon or fine coils of wire. P is a pole-reversing switch, by means of which the direction of the current in the external circuit may be reversed as desired. This battery will give an electro-motive force of about 45 volts. Batteries of the Grenet type (bichromate of potash) will give an electro-motive force of about 2 volts per cell, and 30 such cells may be used in the treatment of fibroid tumors, according to Apostoli's method.

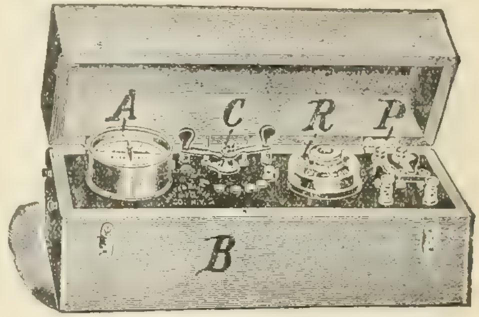


Fig. 1.—Voltaic Battery Apparatus.

Alternating Currents in Therapeutics.—For portable use the induction coil, or faradic apparatus, as it is commonly termed, is virtually the only present means of obtaining alternating currents, sinusoidal machines and static interrupters being by their weight limited to office use. A portable faradic apparatus is illustrated in Fig. 2, with induction coil I, vibrators V, elec-

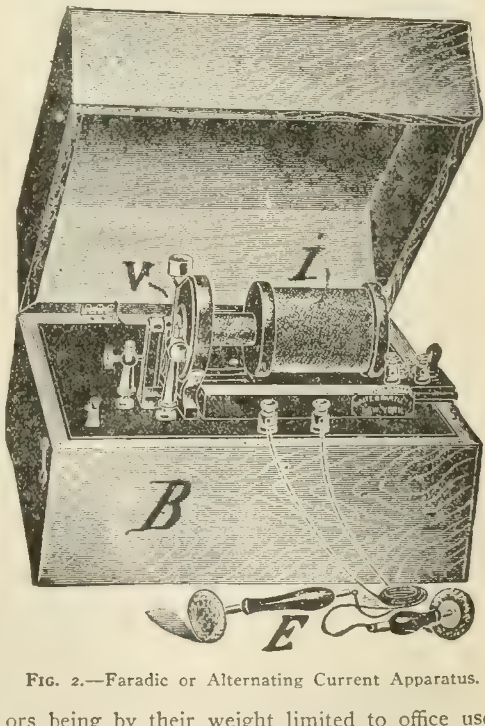


Fig. 2.—Faradic or Alternating Current Apparatus.

trodes E, etc. The battery, usually two large, dry, voltaic cells, are contained within the case B. In this apparatus the low voltage and comparatively high current of the primary circuit are transformed to a high voltage and low current in the secondary circuit. The rate of interruptions of the current is variable by means of quick (or fine) and slow vibrators, or interruptors, of the primary circuit. The vibrators for this work should operate uniformly steadily to avoid unpleasant jerks and shocks to the patient. A contact is also provided in the apparatus by means of which single impulses may be given. Other types of such apparatus are made with two or more secondary coils to give different values of potential and current. Slow vibrations include those from 50 to 150 per minute, at which rates the muscles contract and relax between each contraction; above 150 vibrations per minute the muscles remain contracted during the application of the alternating current. By means of quick vibrators 12,000 to 18,000 interruptions per minute are obtainable.

When the alternating currents are sinusoidal they do not produce permanent electrolysis, since the effect of a current in one direction is presumably at once neutralized by a current in the opposite direction. When the current of one polarity preponderates in strength or duration over the other current, electrolysis may ensue. In either case, however, there may be a tendency to decomposition or splitting of the molecules, which action accelerates or stimulates metabolism with beneficial results. The application of an alternating current or of an interrupted direct current for a short time (20 minutes daily), with intervals of rest, has by experiment been found to stimulate muscles and improve nutrition in a somewhat equal degree, primarily by electrolysis "and the subsequent dispersion of the products of the electrolytic decomposition by the shocks." The stimulating property of alternating currents is utilized in the treatment of diseases of the neuro-muscular system. The tetanizing, or sedative, effect of rapidly alternating coil currents on the striated and non-striated muscles has led to their use to allay pain in pelvic disorders. According to Morton, the sedative property of such currents is perhaps due to a mechanical action of the current upon the nerve filaments, producing a commotion resembling that accompanying cerebral concussion.

To obtain the sedative effect from this current, the fine vibrator of the apparatus (Fig. 2) is used; for tonic effects and massage the slow vibrator is employed.

Sinusoidal Current in Therapeutics.—As this is a symmetrical current, its positive and negative polarities are of equal strength and duration: hence it is not supposed to possess electrolytic or cataphoretic properties. Therefore certain of the beneficial results derived from the use of this current may be ascribed to the excitement of the normal functions to greater activity. An important characteristic of the sinusoidal current in therapeutics is its uniformly graduated rise and fall of current strength and potential, whereby the unpleasant effects of the shocks that frequently accompany the application of ordinary coil currents are largely avoided.

This current is also extensively employed for the alleviation of pain in cases of uterine inflammation, vaginal prolapsus, ovaritis, and other pelvic troubles. It is also used advantageously in local paralysis, and diminished intestinal peristalsis, when these ailments are due to vasomotor debility or lack of muscular tone.

In some types of sinusoidal machines, 10,000 alternations per second are obtainable with an electro-motive force that varies with the speed of rotation of the machine, from 30 to 100 volts.

Static Electricity in Therapeutics.—The use of high potential static electricity in therapeutics has had several waves of popularity during a period of 150 years. For years at a time it has enjoyed a vogue and then has fallen into comparative disuse. At the present time, and for the past quarter of a century, it has been on a rising wave, although even yet its curative and remedial properties are frequently questioned. It has been pointed out, however, by various writers that the doubters regarding the beneficial effects of static electricity in therapeutics are generally from the ranks of those who have had little or no experience with its effects, whilst its foremost advocates are among those who have had a large experience therewith.

High potential static electricity is produced for therapeutical purposes almost exclusively by electric static machines (q.v.). These machines give a very high electro-motive force (in the case of a machine giving a 12-inch spark, about 100,000 volts), but very low current, namely, less than 1 milliampere. It is to this fact that some authorities attribute the small degree of danger that accompanies the application of static currents, the diffusion of currents of such low strength producing mechanical effects with little or no electrolytic effects.

The current from a Holtz static machine is a continuous direct current, as much so as the current from a voltaic battery, when the machine is run at constant speed and when other conditions are stable. The current from these machines is applied to the patient in a number of ways, in several of which the current is supposed to be oscillatory or pulsatory, owing to the introduction of a Leyden jar in series or in shunt with the patient; or because of the fact that the patient and the surrounding objects provide capacity, which discharges as a more or less oscillatory current.

A modern static machine, together with a number of the electrodes employed in practice, are shown in Fig. 3. Machines of this type are made in sizes ranging from 8 stationary plates and 8 30-inch revolving plates, to 18 stationary and 18 revolving plates, 32 inches in diameter. The machine is driven by a small electric motor *m*. The exciter is a small Wimshurst machine *w*, rotated by means of the hand-operated pulley P. C C are the prime conductors; *n n* are sliding rods; J J are Leyden jars. Two additional pairs of smaller Leyden jars are shown on insulated stand S. The patient is usually placed on this stand, which is removed two to three feet from the machine. K is the concentrator used to concentrate the static current on any desired part of the patient's body, for which purpose it is connected by a chain or other metallic connection to one pole of the machine or to the ground. *A* is a wood-point electrode; *b* is a brass-point electrode; *c* is a brass brush; *d* is a chain holder; *e* is a carbon point; *f* is a massage roller; *g* are cords, handles, and sponges; *h* is a wood ball; *i* is a brass ball.

Different applications of static electricity are termed the breeze, the spray (or brush), the spark, general electrification, etc. The therapeutic applications of the direct and alternating current are of a local nature. Applications of static electricity are of the nature of a general electrification, even when applied locally, by reason of the electrified condition of the surrounding atmosphere when the static machine is in operation.

General electrification may be given by placing the patient on the insulated platform, which

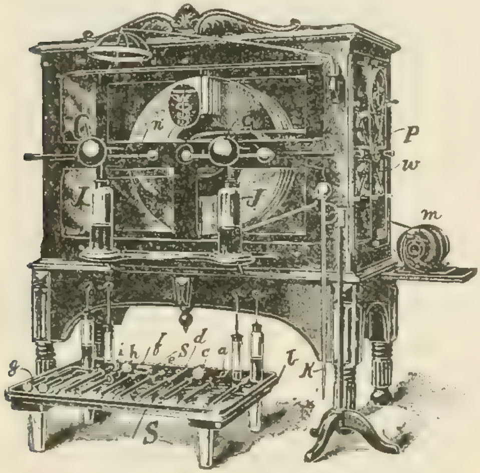


Fig. 3.—Modern Static Electric Machine.

is connected with one pole of the machine by means of a metallic rod, the other pole of the machine being grounded, and the sliding poles *n n* (Fig. 3) being widely separated. Or the patient may hold the chain connecting with one pole of the machine while the other pole is grounded. In this electrification (also termed the static bath) the Leyden jars are not employed.

To give the breeze application the patient is seated on the platform, to which one pole of the machine is connected by the metallic rod; the other pole of the machine being grounded by a chain touching the floor, or, preferably, connected to the water- or gas-pipe. On the approach of a pointed brass rod (concentrator) suitably connected to the grounded pole of the machine, an electric breeze of electrified air particles is set up. When the concentrator is brought still nearer to the patient a visible spray or breeze discharge passes from the metallic point to the body, but no sense of shock is perceived. By means of a metallic crown placed at a proper distance above the patient's head, an electric breeze streams to the body, causing the patient's hair to rise and imparting a feeling of well-being. This pleasant feeling, however, depends in some cases on the polarity of the electrification, and therefore that polarity which ensures best results should be selected. An extension of the breeze treatment consists in placing the patient within a metallic cage, by which a general breeze is diffused over the entire body.

To give the static spark, the concentrator is displaced by a brass ball electrode, which is approached toward a desired part of the patient's body, with a quick movement, to within the sparking distance of the current. The spark, properly applied, gives a not unpleasant shock and produces very strong and widespread muscular contraction. The spark treatment should, however, be used with great caution upon highly sensitive or nervous patients. Static massage is given by passing the electrode *f* (Fig. 3) over the parts which are to be treated. The electrode may be connected to the negative or positive pole, the patient being insulated from the opposite pole.

The arrangement of circuits to produce the greatest benefit and least discomfort to the patient has been a matter of much experiment. One of the approved methods is outlined in Fig. 4. It gives what is known as the Morton Static-Induced current of high frequency. Here the patient is in a shunt circuit with the spark gap of the prime conductors or electrodes and is protected by the spark gap s from unpleasant or dangerous shocks. c c are condensers of small capacity that tend to the setting up of rapidly oscillating currents, if the electrical resistance of the patient be small. For the production of the electric breeze, the spray or brush discharge the arrangement may also be as indicated in Fig. 5, in which a metal crown is connected with one prime conductor and is held over any desired portion of the body of the patient. In general it may be said that the currents from electric machines now most used in therapeutics are the brush, the spark, and the wave; the wave being applied by replacing the crown, Fig. 5, with a piece of metal foil, which is held against the patient's body; the other electrode resting on the insulated platform.

The strength and potential of current or

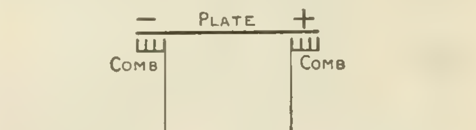


Fig. 4.—Static Induction, High Frequency Arrangement.

dosage with a given machine may be regulated, among other ways, by varying the rotation of the plates; also by varying the distance of the chain (that rests on the platform) from the feet of the patient, or by increasing the conductivity of the surface of the platform by resting the patient's feet on a metallic plate connected with the said chain. Where the patient is in shunt circuit with the condensers J J (Fig. 3), the dosage may be varied by adjusting the position of the rods $n\ n$ relatively to one another, the minimum effect being produced when the rods are together. See also Fig. 4.

As already remarked, high potential oscillatory currents are obtainable by means of condensers placed as shown in Fig. 4. To insure, however, that the currents shall be oscillatory it is necessary that R^2C must be less than 4L where R is resistance of the oscillating circuit in ohms, C its capacity in farads, and L its inductance in henrys. It has been thought by some practitioners for several years that the beneficial results obtained by means of static induced currents have been due to the assumed oscillatory character of the current; but, owing to the fact that the resistance of the circuit is frequently sufficient to make the current non-oscillating, and possibly a pulsatory current of very short duration, it has been suggested by Messrs. Jenks and Clarke that the salutary therapeutic effects obtained by means of the static machine currents in connection with condenser action may be due merely to the rapidly variable electric effects upon the human system, and not necessarily to an oscillatory character of the currents. For an elaboration of this question by the gentlemen named, the reader may be referred to 'Transactions of the International Electrical Congress, 1904,' p. 184, Vol. III.

Quite high frequency currents are also obtained by means of an induction coil arranged

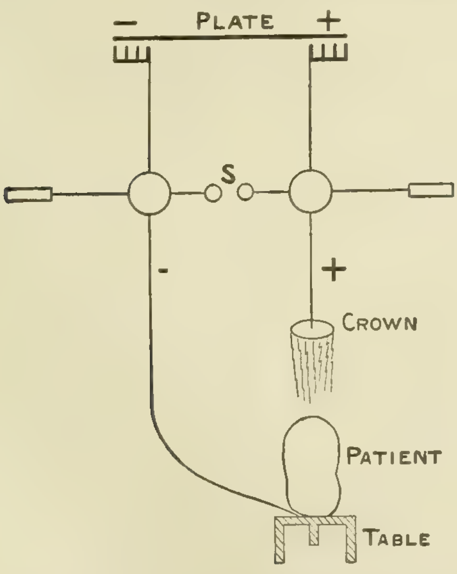


FIG. 5.—Arrangement for Breeze Discharge.

as outlined in Fig. 6, known as the D'Arsonval high frequency apparatus. The secondary terminals of the coil are connected to condensers C C as indicated. A coil of thick copper wire w, with a few turns, is connected to the outer castings of the condensers. One electrode is connected to one end of w; the other electrode may be connected to any desired turn of the wire by a sliding contact s, by means of which the current diverted to the patient P may be regulated at will. The effect may also be varied by adjusting the spark-gap G. According to D'Arsonval, a frequency of 1,000,000 per second is obtainable with this apparatus. This arrangement is somewhat like the Tesla high frequency device. A static machine may be used in place of the induction coil in Fig. 5.

The physiological effects of static electricity are many. The fact that the body loses weight while undergoing static electrification, and that an abnormal pulse or temperature are raised or lowered, as the case may be, was known over 100 years ago. Tests of the excretions of the body shows that this is due to increased functional activity. In the language of a committee of the American Electrotherapeutics, on 'Standard Electrostatic or Influence Machines,' "the physiological effects of static electricity are pretty much all that are produced by electricity; it sets free the potential energy of the cells of the human organism, it causes contraction of protoplasm, it excites nerve-fibres, nerve-cells, and nerve-centres, all of them are excited to functional action and caused to produce their separate effects — motor, sensory, special sense, secretory, sympathetic, vaso-motor, etc. It has a mechanical action. It disturbs the molecular arrangement of tissues and causes a new arrangement, resulting in modification of nutrition. It promotes nutrition of every part it excites; it produces marked local and general circulatory effects and stimulates the vaso-motor system.

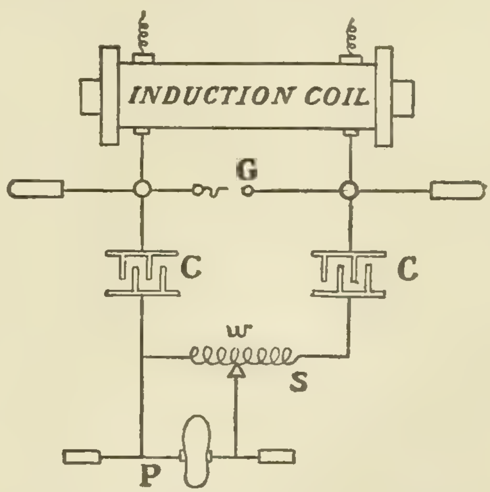


FIG. 6.—D'Arsonval High Frequency Apparatus.

It promotes metabolism and tissue metamorphoses, creates a feeling of refreshment to the system, and causes the reabsorption of exudative material of a chronic nature, and has a revulsive action of the skin."

Static electricity has been found effective in the treatment of lumbago, spastic paralysis, locomotor ataxia, chronic and muscular rheumatism, neuritis, progressive muscular atrophy, insomnia, congestion of the liver, and sciaticas. It controls nervous headaches, hysteria, neurasthenia, and is an excellent general tonic. It has been found especially beneficial in the prompt reduction of sprains, the application of the wave current by means of a metallic foil electrode over or around the part effecting remarkable curative results, presumably by a massage or mechanical effect. The effective use of the spark from this machine to ionize the air to produce nitrous oxide for the treatment of external ulcers may also be noted. Neither static electricity, however, nor electricity in any of its forms, is a panacea for every ill — such a claim may be left to charlatans — but their remedial effects are now too well established to leave any question as to their great therapeutic value in the hands of intelligent and skilful therapeutists. The importance of a high degree of skill and intelligence on the part of the operator in the use of these modalities cannot, however, be too strongly emphasized. The possible ill effect, for instance, upon a certain class of patients of increased blood pressure, which, it is well established, occurs under static electrification, is perhaps alone sufficient to warrant this caution and to make it apparent that a thorough course in the use of the apparatus employed in electro-therapeutics, and of the effect of electricity upon the human system in health and disease, should be regarded as essential on the part of every physician prior to undertaking the employment of this remedial and curative agent in his practice. If the skill and knowledge just indicated may properly be regarded as requisite on the part of the trained physician, it is obviously very questionable whether the application of electricity therapeutically should be allowed indiscriminately in the hands of laymen. Indeed certain writers of authority on this subject insist that, in view of the foregoing considerations, none but regularly graduated physicians should be permitted to apply electricity therapeutically.

The applications of electricity in therapeutics are much too numerous to discuss fully in a brief article; in the foregoing only a mere outline of them has been attempted. The use of electricity as a source of heat in electric cautery and as a source of light for illuminating the human body is not touched upon herein; its use in X-ray work is referred to elsewhere.

William Maver, Jr.

Electrotint, a method of tracing drawings, etc., for printing by the action of electricity on a copper plate. The design is drawn in some varnish not affected by acid and placed in an electro-bath, the lines being thus brought out in relief.

Electrotrophism. See Electroculture of Plants.

Electrotype, a copy of a form of type, made by means of electricity. A page of the type is covered with wax, which is driven into the interstices by powerful pressure. The face of the wax mold is covered with plumbago to give it a conducting surface to which the metal will adhere. The negative pole of a battery is attached to the mold, and the positive to a copper plate, and both are placed in a bath of sulphate of copper in solution. The copper is deposited on the face of the mold in a thin film, which increases in thickness as the process continues. The shell having attained the thickness of a stout sheet of paper, the mold is removed from the bath, the shell detached and strengthened by a backing of type-metal. The back of the shell is first coated with tin, and the shell is then placed face downward on a plate, and over a bath of molten type-metal. When it has attained the requisite heat, a quantity of the metal is dipped up and floated over the back of the shell. When cold, the plate is reduced to an even thickness by a planing-machine. For printing, it is mounted on a wooden backing. Another mode of obtaining electrotype plates from a letter-press form is by a mold of gutta-percha, brushed with graphite and immersed in the electro-plating bath. Gutta-percha is also used for obtaining intaglio molds and then cameo impressions from woodcuts, for printing. See also Electro-chemistry, Industrial; Photo-Engraving; Printing.

Elec'trum, a substance mentioned by Greek and Latin writers, with regard to the nature of which there has been much discussion. The term was used with different meanings; it originally meant gold, and was then applied specially to native gold, containing quantities of silver, copper, and other metals. The term employed for this native alloy was transferred to the artificial alloy of gold and silver, afterward made, and was also applied to amber on account of its color and inferior lustre.

Elegy, properly, a poem of mourning. The Greeks and Romans, however, employed the term to denote a poem written in elegiac verse, whatever its character. This elegiac verse was the distich, consisting of the hexameter alternating with pentameter. In modern times the term elegy is usually applied to any serious piece in which a tone of melancholy pervades the sentiments, as in Gray's 'Elegy Written in a Country Churchyard.'

Elegy Written in a Country Churchyard, a poem by Thomas Gray, and published in 1751. Its sincerity and simplicity of thought and language made it immediately popular, and it rapidly passed through a number of editions, and has since been often reprinted. It is thought that the churchyard is that of the parish church at Stoke Pogis.

El'ement, in chemistry, a substance that cannot be decomposed into other substances. Something like 77 different substances are now admitted by chemists to be elements, and a number of others are tentatively assumed to be so, until further evidence, for or against their elemental character, is accumulated. (A list of those that are now admitted is given under Atomic Theory.) Much speculation has been indulged in, concerning the fundamental structural differences that subsist between the atoms of the different elements, but no universally acceptable explanation has yet been offered to account for the fact that the thousands of compounds that have been studied are all composed of so small a number of essentially different constituents. The alchemists believed that every apparent "element" can be modified, or "transmuted," into every other one, and much labor was expended in the effort to transmute the baser metals into the "nobler," or more valuable ones. We now know that the problem of transmutation, if it is capable of solution at all, is at any rate far more serious than it was believed to be in the early history of chemistry. But there are numerous indications which suggest a relationship among the substances that are now accepted as elements, and it may yet prove to be possible to transform lead into gold, or tin into platinum. For some years past Sir William Crookes has been a consistent advocate of the theory which teaches that all matter is fundamentally the same, and he has shown that some of the "elements" can be resolved, by fractionation, into substances which exhibit spectra that differ from one another in a marked manner, any two consecutive members of the series showing close similarity in their spectra, while the extreme members of the series are totally dissimilar. (See his lecture before the Berlin Congress of Applied Chemistry, entitled 'Modern Views on Matter,' in 'Science' for 26 June 1903.) The theory of matter which is in favor at the present writing teaches that all atoms are composed of electrons (q.v.), which are all alike, but which are grouped together in various ways, and in various numbers, to form the atoms of the elements. If this view stands the test of further research, the possibility of transmuting the elements into one another may not be altogether fanciful. The newly discovered element radium (q.v.), which appears to possess the singular power of continuously emitting streams of free electrons, occurs in nature in certain varieties of the mineral uraninite. It is notable that the inert gas helium (q.v.) also occurs in this same mineral, though it appears to be present in the free state, and never in actual chemical combination. It has been suggested that we are here face to face with a real case of transmutation of elements, the electrons that are emitted by the radium being slowly built up, within the uraninite, into new systems, which are nothing less than atoms of helium. See MOLECULAR THEORY; PERIODIC LAW; RADIATION; RADIUM.

Elemental Spirits, beings who, according to the popular belief of the Middle Ages, presided over the four elements, living in and ruling them. The elemental spirits of fire were called salamanders; those of water, undines; those of the air, sylphs; and those of the earth, gnomes. Paracelsus wrote a treatise upon them, and they play a part in Pope's 'The Rape of the Lock.'

El'emi, a name given to fragrant resinous extracts obtained chiefly from trees of the order *Burseraceæ.* The hard elemi, most abundant in the West Indies, is obtained from species of *Bursera,* and is either yellowish or greenish, sometimes opaque and sometimes translucent, has a fatty lustre, is easily pulverized, and very fusible. It is heavier than water, in which it is insoluble, although it is readily dissolved in either turpentine or alcohol. African elemi is an extract of *Boswellia freereana* or *Santiriopsis balsamifera;* Manila elemi a product of *Canarium commune;* and the Mauritius variety is obtained from *Canarium paniculatum.* A large part of the elemi of commerce is produced from trees of different genera of the same family growing in tropical America. Elemi is a regular constituent of spirit varnishes, and the Manila kind is used in plasters and ointments. In Eastern countries it is also used as incense. Its active principle is a volatile oil obtained by distillation.

Elephant, the largest of living land animals, the two species of which constitute the family *Elephantidæ,* of the sub-order *Proboscidea.* The better-known species (*Elephas asiaticus*) is native to the jungles of India; while the other species (*E. africanus*) is found in the forests of Africa.

The elephant is a huge ungainly creature with an enormously heavy body, mounted on four short, columnar legs, the hinder ones bending like knees when he lies down, as he doubles them behind, and not under him; his tail is long and tapered, ending in a bunch of coarse hair; otherwise the wrinkled bluish-gray hide is quite hairless. His head is large, with big pendulous ears, small eyes, and a nose, prolonged into a proboscis or "trunk," which reaches quite to the ground when he stands erect. The average male elephant is 8 or 10 feet high, and weighs 5 tons or more. The incisors of his upper jaw are prolonged into tusks, which are, however, less useful to him, as weapons, than is his trunk. This organ enables the animal to pick up things from the ground, and to reach fruits or leaves many feet above his head, and it also conveys water to the mouth. Indeed, so great is the tactile sense of this singularly flexible proboscis that it has been likened to a hand. It is also its owner's chief weapon of offense and defense; for with it he can catch and crush a man with ease, or hurl aside the tiger. The age which this huge creature attains is proportionate to its size; for captive specimens have been known to live a hundred years, and scientists believe that, in a wild state, it may live many years longer.

The Indian elephant (*Elephas asiaticus*) differs from the African in having a longer head with concave forehead and smaller eyes and ears; in this species, also, the hind feet are often five-toed, whereas in the African they are never more than four-toed. Though the two species present some differences as to dentition, the special peculiarity in the structure of the molars is common to both. These teeth are of great size, and are formed of vertical plates of dental bone, separately covered with enamel, and welded together by a bony "cement," so that each tooth looks like a number of teeth, cemented together. In both species, also, there are no canine teeth, and no incisors in the lower jaw; while the incisors of the upper jaw are developed into tusks, often weighing 150 to 200 pounds each. These tusks furnish the ivory (q.v.) which is so much esteemed for ornamental purposes.

The Indian elephant has been for thousands of years the servant of man. From the earliest ages he has borne the Oriental warrior into battle, has hauled his stores and ammunition, and has even been taught to wield weapons. In peace he has piled logs and huge blocks of stone as unremittingly as a derrick, and has been the main feature in the processions of the native princes. In these last and always spectacular functions, the elephant's anklets, saddlecloth, and trappings are often encrusted with gold and jewels; and the prince who sits in the canopied howdah on his back, is not more gorgeously attired than his elephant. In this connection, also, the albinos of the elephant are prized far more highly than the ordinary sort; in Siam, indeed, the white elephant is royal and venerated. The catching of these elephants singly, or in herds, is by no means an easy task. In former years they were caught in pitfalls, but this practice has been abandoned, because the creatures were frequently injured. Modern methods are varied. Sometimes male elephants are decoyed by tame females trained for that purpose, until they are in close proximity to the hunters. These entangle their unconscious victim's legs in stout ropes, and when, eventually, he finds himself trapped, he fights until exhausted. When, however, herds are hunted, they are driven by an ever narrowing circle of hunters toward the mouth of a strongly built stockade, or "keddah." When, after many days, surrounded and enclosed by their pursuers, they rush into the stockade, the great gate is shut upon them. They are then tamed by a variety of methods, which differ, as the stockades do, according to locality. Once caught, the elephant is easily trained, a few months being, usually, sufficient to teach him all he needs to know. Methods of training vary in detail; but, after the first severe lessons, the trainer usually finds gentleness effective. The driver or mahout sits upon the elephant's neck and manages him by words and by the use of a small iron-pointed stick. Once tamed, elephants, except in cases where they become "bad," and have to be shot like mad dogs, are so gentle that children may be trusted to play with them.

Besides the differences between the two species, already noted, the African elephant is not as amenable to domestication and confinement as the Asiatic, and is the chief source of the world's supply of ivory. Indeed, the African elephant generally succumbs to disease and dies in confinement, while the only change noted in the Asiatic under the same circumstances, is that the species generally does not breed in captivity. The African elephant is peculiar in that the great tusks, twice as large as those of the Asiatic species, are present in both male and female, while in the Asiatic species they are found only in the male. Because of the demand for these, the African natives have made war upon the female as well as the male, and this leads naturally to a diminution of the species, as the number of tusks shipped has increased rather than decreased each year. The African elephant is now never used as a beast of burden, though in ancient Egypt he may have been so utilized.

Elephants generally live in large herds, each herd led, and apparently governed, by a leader, usually the largest of the party. So marked a family resemblance exists between members of the same herd that, in India — where they are classed as "high caste" and "low caste" — different herds are easily distinguishable. The African elephants live in mountainous regions, the Asiatic ones in deep forests, whence they can issue to play in and drink of the waters in which they find so much enjoyment. Here, too, their trunks are serviceable. They are used to squirt water over the creatures' backs, or to spout it, playfully at their neighbors. Elephants also caress each other by means of their trunks.

The anecdotes illustrating the docility, affection, sagacity, irritability, capriciousness, and revengeful spirit of the elephant, are innumerable, and may be found in various well-known books on natural history. The natural enemies of the elephant, beside man, are the tiger and the rhinoceros, and the nasal horn of the latter often proves a more formidable weapon than the trunk and tusks of the elephant, and the sight of even a dead tiger is said to be enough to excite most elephants into a transport of fury.

Fossil Elephants.— Mammoths, whose remains have been dug up, frozen or fossilized. The two living species of elephant are the last survivors of a group which formerly spread over all the great continents, and inhabited temperate and arctic as well as tropical regions. Various extinct species of the elephant, commonly called mammoths (q.v.), have been found in every country of Europe, in Asia, and Africa, and in the New World, from Alaska to Argentina. In Siberia their remains are so abundant that fossil ivory forms a considerable article of commerce. The mastodons (q.v.) distinguished from the true elephants by less specialized grinding teeth, had an almost equally extensive range, but inhabited more especially the temperate regions during the Pliocene and Pleistocene epochs. Primitive mastodons lived in Europe and North America during the Miocene Epoch; they were of smaller size than the later mastodons, and had two small tusks in both upper and lower jaws; these tusks have a band of enamel on the outer surface, and in the oldest species the upper tusks curve downward and the lower ones upward in a manner that indicates their origin from chisel-shaped incisors like those of rodents. The trunk in these primitive mastodons appears to have been much shorter than in the present elephant, and in every respect they were much less specialized. From this stage up to the present elephant a complete evolutionary series can be traced, but the earlier stages in the evolution of the *Proboscidea* are not known. It appears certain that they did not originate either in North America or Europe, but migrated to those regions during the Miocene Epoch, from some other continent. Prof. Osborn has considered them as probably of African origin; while Prof. Ameghino has recently announced his discovery of the early stages of their evolution in Argentina. The dinotherium (q.v.) of Europe was a side branch of the *Proboscidea,* contemporary with the primitive mastodons, and more primitive in the grinding teeth, but with more specialized tusks, the upper tusks being lost and the lower ones enlarged, while the reverse is the case in the mastodons and elephants.

Elephant, Order of the, an ancient Danish order of chivalry. It is said to have been instituted about the end of the 12th century by Canute VI. to perpetuate the memory of a Danish crusader who had killed an elephant in the Holy Land. It was renewed by Christian I. in 1462, and placed on its present footing in 1693 by Christian V. It is the highest of the Danish orders. The number of members, not counting those of the royal family, is restricted to 30. Foreign sovereigns are exempted from these restrictions. The fête of the order is held on 1 January, when the knights meet in the chapel of the order in the castle of Fredericksburg, taking rank by seniority upon seats over which are suspended their arms and devices. The insignia of the order are an enameled white elephant, with a negro mahout, bearing on a blue housing, bordered with gold and crossed with white, a sculptured tower. On state occasions the elephant is worn attached to a chain composed of elephants and castles of gold, with a letter D in gold to represent *Dania* (Denmark). The device of the order is *Magni animi pretium.*

Elephant-apple, a large and handsome East-Indian tree (*Feronia elephantum*). It be-

ELEPHANT BEETLE.

longs to the orange family, and produces a large gray-colored fruit with a very hard rind.

Elephant Beetle, one of the great cetonian beetles of the genus *Megasoma* of Central and South America; specifically *M. elephas.* It reaches a length of three to four inches, and is black, delicately pitted. A related species (*M. thersites*) occurs in California.

Elephant Fish (*Callorhynchus antarcticus*), a fish of the sub-class *Chimœroidea* or *Holocephali* (q.v.), found in southern seas, where it is the sole representative of its kind. The name alludes to the prominent projecting appendage of the snout. The young remain until an advanced stage of development within the remarkable horny egg-cases, where they are supplied by a current of water which enters and leaves by two pairs of orifices. The fish attains a considerable size and is sometimes eaten in New Zealand.

Elephant River, a river of Cape Colony, running into the Atlantic after a course of 140 miles.

Elephant Seal, the largest of the eared seals (*Macrorhinus leoninus*), usually over 20 feet long, with a circumference of 12 feet around the thickest part of the chest. The female is much smaller than the male. In color, this seal is grayish; its body is covered with short hair, growing in patches, which gives a spotted look to the animal. The head is proportionately large, with prominent eyes and thick eyebrows; the whiskers are long; and the canine teeth are so large as to form heavy tusks. The nose of the males is prolonged into a proboscis about a foot long, which, seemingly useless, hangs loosely over the face. When this is dilated, it gives a new character to the creature's voice. This species has been almost exterminated, owing to the demand for its oil, though less than a century ago it was plentiful in the southern hemisphere. The skin is not valued for its fur and the flesh is not edible. The herds migrate southward in summer and northward in winter to avoid the extremes of temperature.

Elephant-shrew, the typical species *Macroscelides,* of the family *Macroscelididæ,* belonging to the order of insect-eating mammals. The body, in general appearance and size, resembles that of the common rat. The popular name alludes to its peculiar, elongated nose, which looks like an elephant's trunk. The hind legs, which are long, and out of all proportion to the length of the fore legs, fit the animal for jumping, giving it the additional name of jumping-shrew. This insect-eater is confined to Africa. It moves by jumps, lives on the sandy plains, makes burrows in the sand, and finds its prey among the grass and bushes.

Elephanta, ĕl-ĕ-făn'tä, or **Elephant Isle,** called by the natives *Gharipur,* a small island in the Bay of Bombay, seven miles northeast of Bombay. It consists of two long hills and an intervening valley. It is celebrated for a cave temple 130 feet long, 123 broad, and 18 high, supported by pillars cut out in the rock. Many of these were cut down by the Portuguese. There are eight pillars or pilasters and in the centre is a gigantic trimurti or three-formed god — Brahma the creator in the middle, with Vishnu the preserver on one side, and Siva the destroyer on the other. There are other pieces of sculpture, and also several other rock-caves. The date of these constructions is not known. A large stone elephant, which once stood near the landing place, gave name to the island.

Elephantiasis, properly speaking, a peculiar and rare disease, sporadic or endemic in warm climates, and characterized by a chronic thickening of the skin and the underlying tissues, usually limited to a definite area, and subsequent to an impairment of the lymphatic circulation. The disease is of great antiquity, and exhibits a great variety of forms, by reason of which it has received a large number of names, medical as well as popular. The term is now applied by the best dermatologists to one disease, and not to several as heretofore. Elephantiasis exists in an endemic form in Africa, India, the Indian Archipelago, the West Indies, and South America. The recent territorial acquisitions of the United States bring this disease in their train. The endemic form of the disease commences rapidly. There is pain, heat, swelling, and temperature. The lymphatics and blood-vessels soon become involved, and the part affected seems to be attacked by erysipelas. In a few days the acute symptoms may subside. A recurrence of the attack leaves the arm, or leg, or scalp, or face, or genitals somewhat thicker, and repeated attacks may result in enormous deformities of the affected parts. In the most characteristic cases of the tropical countries the disease seems to be due to a blood parasite, the *Filaria sanguinis hominis.* This worm gets into the blood, at times through the agencies of mosquito bites, and blocks up the lymphatic channels. In other cases the disease is regarded as a form of chronic erysipelas. In a few instances it is congenital. The treatment will depend largely on the type of the disease. Rest in bed, elevation of the limb, quinine for the *Filaria,* and prompt medical attendance are the essentials. See FILARIASIS; PARASITES.

Elephantine, ĕl-ẹ-făn-tī'nē (Arabic, *Djezi-ret-ez-Zaher,* «isle of flowers»), a small island in the Nile, opposite Assouan (Syene), remarkable for the ruins with which it is covered. The island is almost covered with ruins piled up on each other — Egyptian, Roman, Saracen, and Arabic. At the beginning of the present century there were the remains of two temples in Elephantine, one a very interesting one built by Amunoph III. They were destroyed in 1822 by the governor of Assouan in order to obtain stone for building a palace. The greater part of the Nilometer, mentioned by Strabo, which stood at the upper end of the island, shared the same fate. The quay built of blocks taken mostly from older monuments, is from Roman times. Many fragments of pottery with inscriptions in Greek have been found, some of these being receipts for taxes.

Elephant's-ear, a name frequently given to plants of the genus *Begonia* (q.v.). It is applied specifically to a Hawaiian plant commonly known as *Caladium esculentum.*

Elephant's-foot, or **Hottentot's-bread** (*Tamus* or *Testudinaria elephantipes*), a plant of the yam order (*Dioscoreaceœ*), of which the rootstock forms a large fleshy mass, curiously truncate, or somewhat resembling an elephant's foot, and covered with a soft, corky, rough and cracked bark, recalling the shell of a tortoise, whence its other name. From this springs annually a climbing stem, which bears the leaves and flowers, these being small and yellow. The starchy rootstock is used as food by the Hottentots. The plant is not unfrequent in hothouses. The American plants known as elephant's-foot belong to the genus *Elephantopus* of the *Compositæ*. The genus comprises 14 species, natives of tropical or warm regions. Three are found in the United States, mostly to the south of Delaware. The best known is the Carolina elephant's-foot (*E. carolinianus*). This is an erect hairy herb, with thin oval leaves and bracted heads of blue or purple flowers in branching corymbs. It grows as far north as southern New Jersey, and west to Kansas, and is abundant in all the region to the south. Another species is known in the Southern States as tobacco-weed and devil's grandmother.

Eleusine, ĕl-ū-sī'nē, a genus of grasses comprising six species, all natives of the Old World. The genus is represented in America by *E. indica,* the crab-grass or yard-grass, which is found in waste places all over North America except in the extreme north, naturalized from Asia. In its native places it is an important article of commerce. *E. corocana,* called in the west of India natchnee, nagla, ragie, and mand, forms a principal article of diet among the hill people of the western Ghauts in India. It is cultivated also in Japan. *E. stricta* is also used for food.

Eleusin'ian Mysteries, festivals held annually at Eleusis, a town of Attica, in honor of the goddess Demeter, or Ceres, the patroness of agriculture, and procreative power of nature. The usual opinion is that they were begun by Eumolpus, the first hierophant, 1356 B.C. Great secrecy was observed in the celebration of the festivals, consisting of the greater and lesser mysteries. The greater mysteries were celebrated toward the end of September and 1 October, lasting nine days. The lesser mysteries took place at Agræ on the Ilissus during spring time. See Walter Pater, 'Greek Studies; Demeter and Proserpina'; Jacob Cooper, 'The Eleusinian Mysteries.' It was a capital offense to reveal any of the rites. They existed about 18 centuries, and ceased during the invasion of Alaric I., in 396.

Eleusis, ĕ-lū'sĭs, a ruined village of Attica, but in ancient times a city of Greece, 12 miles from Athens. It was celebrated as the chief seat of the worship of Ceres (Greek Demeter), whose temple here was the largest sacred edifice in Greece. The Greek government began here an elaborate system of excavations in the year 1882, with the result that many remarkable ruins have been discovered. A little village, poor and mean looking, called Leusina, stands on the site of what was once powerful Eleusis. Consult: Diehl, 'Excursions in Greece.'

Eleuthera, ĕ-lū'thĕ-ra, one of the largest of the Bahama Islands. It is like most of the islands of the group, long and narrow, its length being about 70 miles; area, 234 square miles. Its chief production is pineapples. Its chief town is Governor's Harbor. Pop. 7,200.

Eleutheria, ĕl-ū-thē'rĭ-a (Gr. ελευθερια, freedom), among the ancient Greeks, a festival commemorative of deliverance from the armies of Xerxes. It was instituted after the battle of Platæa (479 B.C.), and celebrated annually at that place in the month Maimacterion, nearly corresponding to our September. At the dawn of day a procession marched through the town, at the head of which trumpeters blew the signal for battle. At midday a chariot was driven toward the altar crowned with myrtle and various garlands, and leading behind it a black bull. In front of the altar the archon of Platæa immolated the bull to Jupiter and Mercury, eulogized the heroes who had fallen at Platæa, and sprinkled the ground with wine. Every fifth year these solemnities were attended by contests, chaplets being the reward of the victors.

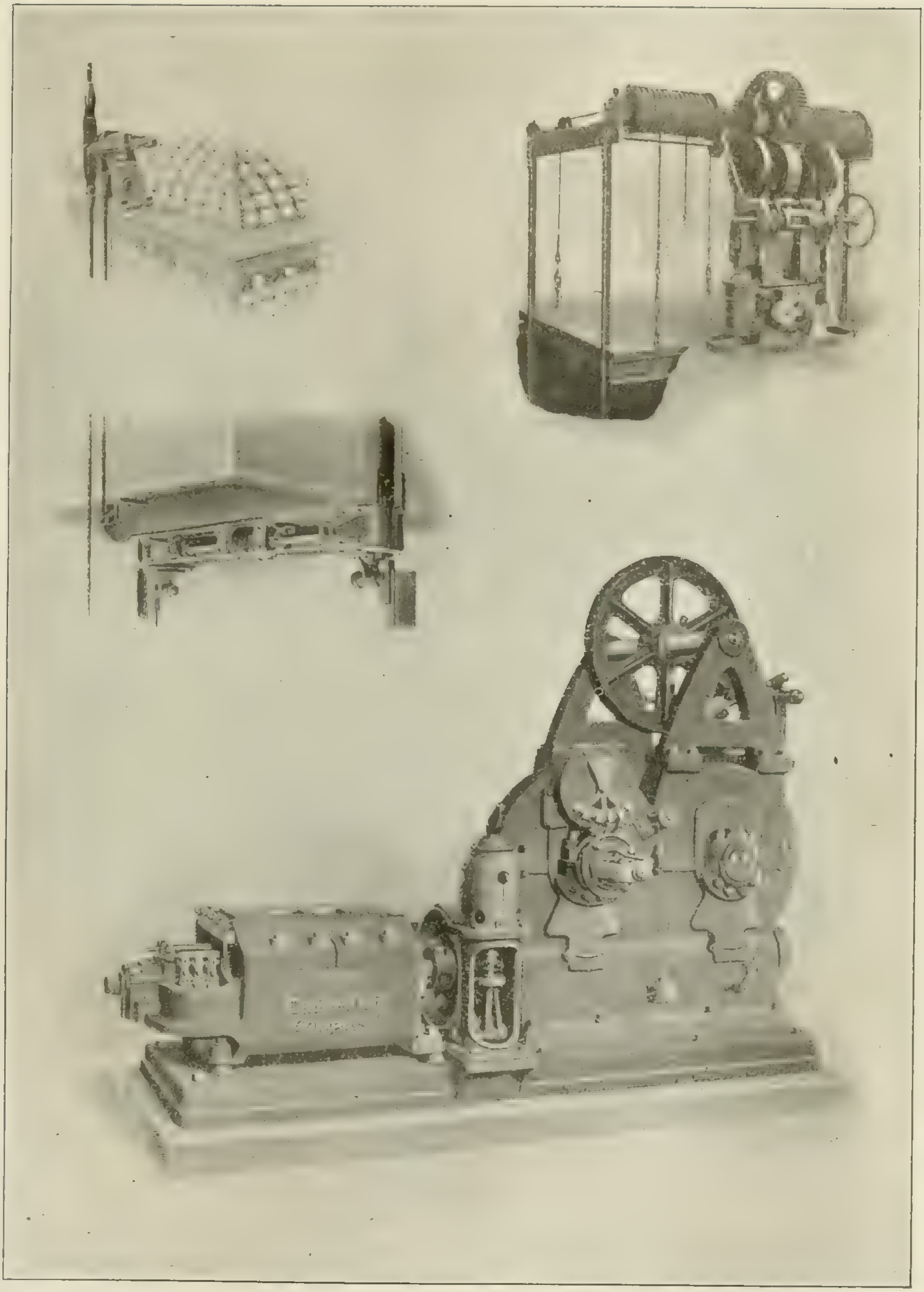
Elevated Railways. See RAILWAYS, ELEVATED.

Elevation, in the liturgy of the Roman Catholic Church, the act of lifting up by the celebrating priest and presenting to the sight of the faithful, the Host and the Chalice immediately after the consecration; this is the Elevation by eminence. There is both in the Latin and in the Greek Church liturgies another Elevation shortly before the communion. Prior to the promulgation and condemnation of the teaching of Berengarius in the 11th century, the Elevation after consecration appears to have had no place in the Latin liturgy; but from the beginning of the 12th century, when this custom was introduced, it spread rapidly and became universal and obligatory. It was the Church's way of confessing her faith in the truth of transubstantiation attacked by Berengarius. In the Latin Church in the 12th century began, and in the next century became universal, the custom of ringing a small bell at the moment of the Elevation, as is the present usage. But the ringing of the great bells in the church steeples and towers at the Elevation, which was pretty general in the 13th century, is now not common.

Elevation, in astronomy and geography, means generally the height above the horizon of an object on the sphere, measured by the arc of a vertical circle through it and the zenith. Thus, the elevation of the equator is the arc of a meridian intercepted between the equator and the horizon of the place. The elevation of the pole is the complement of that of the equator, and is always equal to the latitude of the place. The elevation of a star, or any other point, is similarly its height above the horizon, and is a maximum when the star is on the meridian. In architecture, a geometrical delineation of the front or any face of a building in which all the parts are drawn according to scale and not shown as they would appear in perspective. It is one of the three designs necessary in outlining any work of architecture, the other two being the plan and the section.

Elevators. The modern elevator is a direct evolution from the machine which Elisha G. Otis exhibited in 1853 at the World's Fair in the Crystal Palace, New York. Hoists of various kinds had been built before that time, but this was the first elevator wherein provision was made for stopping the fall of the car in the contingency of the breaking of the hoisting cables. During the next five years, a number of machines were built similar to that exhibited, all being driven by belts from line shafting. In 1859 the same inventor introduced an

ELEVATORS.



For explanation, see article.

independent reversible engine directly connected to the hoisting machinery, and from that date the era of the elevator as a separate institution of the age began. In 1871 the hydraulic elevator was introduced, and thereafter was developed side by side with the steam machine. Finally in 1888, the electric elevator engine was introduced. There are, therefore, four general classes of elevators in use — hydraulic, electric, steam, and belt-driven. The great varieties of conditions encountered in elevator installation and operation has resulted in the development of a number of modifications of each of the four general types.

The type of elevator which is installed in greater numbers than any other is the vertical cylinder hydraulic machine. In this type, a cylinder of a diameter of, say from 8 to 24 inches (according to the water pressure and the load to be lifted), is placed in a vertical position in the elevator shaft or in any other convenient location. Within this cylinder works a piston. Attached to the upper end of the piston rods are the sheaves over which pass the hoisting cables. The length of the cylinder will, of course, depend upon the car travel and on the gearing. (See Fig. 1.) The car here shown is geared 4 to 1, although gears of 6 to 1 and 8 to 1 are quite common. For the ascent of the car, water under pressure admitted above the piston. For the descent of the car the pressure is shut off and the car descends by its unbalanced weight, the water above the piston flowing to the lower part of the cylinder through the pipe at the side known as the circulating pipe. The car is stopped at any desired point by closing a valve which both shuts off the water under pressure and closes up the path through the circulating pipe. Near the top of the circulating pipe is a simple device which limits to a predetermined maximum speed the rate at which water can flow into and out of the cylinder and therefore there is no possibility of the car moving at greater than the maximum speed in either direction.

The desired water pressure is generally obtained by suitable pumps which deliver through a pressure tank which takes up the pump pulsations. The method of controlling the valve from the car may be traced in the illustration. It will be seen that the hydraulic elevator engine is single-acting only — in fact, all styles of hydraulic machines possess this same characteristic, the car descending by its unbalanced weight (except in the pulling plunger type later to be described). It is customary with hydraulic elevators to partially counterbalance the weight of the car, leaving uncounterbalanced only sufficient weight to enable the car to descend at a proper speed.

Continuing the discussion of hydraulic elevators — in certain situations it is desirable to place all of the elevator machinery in the basement, and in such instances the cylinder is placed in a horizontal position. The horizontal cylinder hydraulic engine may be of either the "pushing" pattern wherein the car is raised during the outward stroke of the piston or the "pulling" pattern wherein the work is performed while the piston is being forced inward.

In the design of the modern city building it is highly desirable that as little space as possible be lost for rental purposes and the elevator builders have responded to this requirement (which is continually becoming more urgent) by designing a high pressure machine which is much more compact than any other type of hydraulic elevator. By using a high pressure — 700 to 800 pounds per square inch — the size of the entire apparatus including the hydraulic system and pipes can be greatly reduced. The cylinder is suspended in an inverted position so that the plunger, which works therein, on being forced downward causes the car to ascend, as may readily be seen by inspection of the illustration. The high pressure hydraulic engine is also made with horizontal cylinder designed to be placed in the basement. In fact, the horizontal high pressure type is the latest development in elevator engineering. To maintain the pressure necessary for the operation of this system an accumulator of the weighted type is substituted for the pressure tank used in the low pressure systems. The motion of the accumulator governs the pumps, controlling the delivery of water in accordance with the requirements of the service. This is accomplished either by mechanical connections to the steam valves, or by a series of switches when the pumps are driven by electric motors.

The pulling plunger type of hydraulic elevator differs from any other in that when lifting the load it does not consume water, but discharges it from the cylinder. In this elevator the weight of the plunger itself, which is of solid steel, lifts the load, the plunger descending into the cylinder as the car rises in the hatchway. For the descent of the car, the water is admitted at the required pressure under the plunger and, assisted by the weight of the car, raises the plunger and the car descends. The remaining class of hydraulic elevators is the plunger or direct lift type. In this type, a cylinder of a length equal to the car travel is set vertically in the ground. In this cylinder works a plunger of the same length, carrying the car on its top. Water is admitted to and discharged from the cylinder at the top, the annular space around the plunger affording ample passageway for the water. As usual, water under pressure is admitted to the cylinder for the ascent of the car and for the descent is allowed to run out.

Electric Elevators.— The construction of a modern electric elevator engine may be described as follows: A motor is connected to suitable winding machinery by means of a worm shaft (a continuation of the armature shaft) engaging with one or two worm wheels, the latter being rigidly connected to the winding drum (in the case of elevators for ordinary freight or passenger service) or connected by means of suitable gearing (for hoists of very large capacities). On the armature shaft and worm shaft a brake wheel is mounted. A brake band is normally held tightly against this wheel by a heavy spring, thus locking the elevator engine. On starting the motor, current is also admitted to a solenoid, the action of which removes the tension from the brake band, allowing a free movement of the motor shaft. On the stopping of the current, the brake is instantly applied by the spring.

Various electric controlling devices have been used with electric elevators. The one most generally used as being the most perfect, operates on the following principle:

On starting the car, the attendant therein moves the lever or switch (as the case may be). This movement admits starting current only to the motor, and thereafter the operations are entirely automatic. As the motor accelerates, the starting resistance is cut out step by step automatically by a series of magnets and thus the current is absolutely prevented from increasing above the amount for which the motor is designed, and a gentle and uniform acceleration is secured. Fig. 2 shows a standard magnet controller for passenger service. In machines of the smaller capacities, there is but a single worm wheel and the end thrust is taken up by ball bearings at the extremity of the worm shaft. In the larger machines, there are two worm wheels, the thrusts of the two compensating each other. Fig. 3 shows a standard electric elevator engine for high-speed passenger service. By proper proportioning of the capacity of the motor and by using a suitable train of gears electric engines may be designed for special, heavy service, and numerous incline railways in various parts of the country for handling teams, passenger cars, and hoists for heavy mine and blast-furnace work, etc., are operated by electric engines working on a principle similar to that above outlined.

The electric elevator with push-button control, is a type designed particularly for private residences. (See Fig. 4.) No attendant is required and the elevator is always ready for service. A passenger desiring to use the elevator presses a button placed near the elevator shaft, and the car, if not in use, immediately travels to that floor and stops automatically. When the car has come to rest at that floor, the door can be opened.

After having entered the car and closed the door, the passenger presses a button corresponding to the floor to which he wishes to travel and the car at once proceeds thereto and the door at that floor can then be opened. After the passenger has left the car, and closed the door, the car may again be summoned from any of the floors as before. In addition to its wide-spread use in private residences, this type of elevator is frequently used in hospitals and apartment houses where it is desired to dispense with an operator.

In the duplex motor electric elevator (Fig. 5) the drum is dispensed with and a sheave is placed on the end of each of the two armature shafts and endless cables pass round these sheaves and are connected to the car and also to the counter-weights by running sheaves. The motors run in opposite directions, and as one or the other of the motors accelerates, the car moves up or down in the hatch-way, its speed being proportional to the difference of speed of the two motors. When both motors are running at the same rate of speed the car is stationary. This type of electric elevator is particularly suitable for the service in which long car travel, fast car speed and rapid reversals are essential features.

Steam machines may be dismissed with simply a reference, as machines of this class are seldom installed now except for freight purposes, having been replaced for passenger service by the newer hydraulic and electric types. In Fig. 6 is shown a new type of steam hoist designed particularly for use on board ships. A marked economy in loading and unloading has resulted in those vessels where these hoists have been installed. The particular hoist illustrated herewith has a capacity of 4,000 pounds net load at a speed of 100 feet per minute, the size of the platform being 7 by 10 feet. Hoists of this character, however, can be made any desired power. The engine can be fitted with an automatic device whereby, at the beginning of a loading operation, the engine is automatically brought to a stop when the platform reaches the lowest deck. When this deck is completely loaded, the device is readjusted to stop the engine automatically, when the platform is lowered to the next deck, and so on. When all the decks are completely loaded, the platform is lowered to the bottom of the hatchway. The main winding drums are then thrown out of gear and the auxiliary hoist, which can be seen in the illustration, becomes operative. The hatchway may then be filled with cargo by means of this auxiliary hoist. In unloading, these operations are, of course, reversed. Belt elevators consist of winding machinery geared to pulleys whereby they may be driven from a countershaft. Machines of this type are comparatively inexpensive and are used extensively for freight purposes in factories.

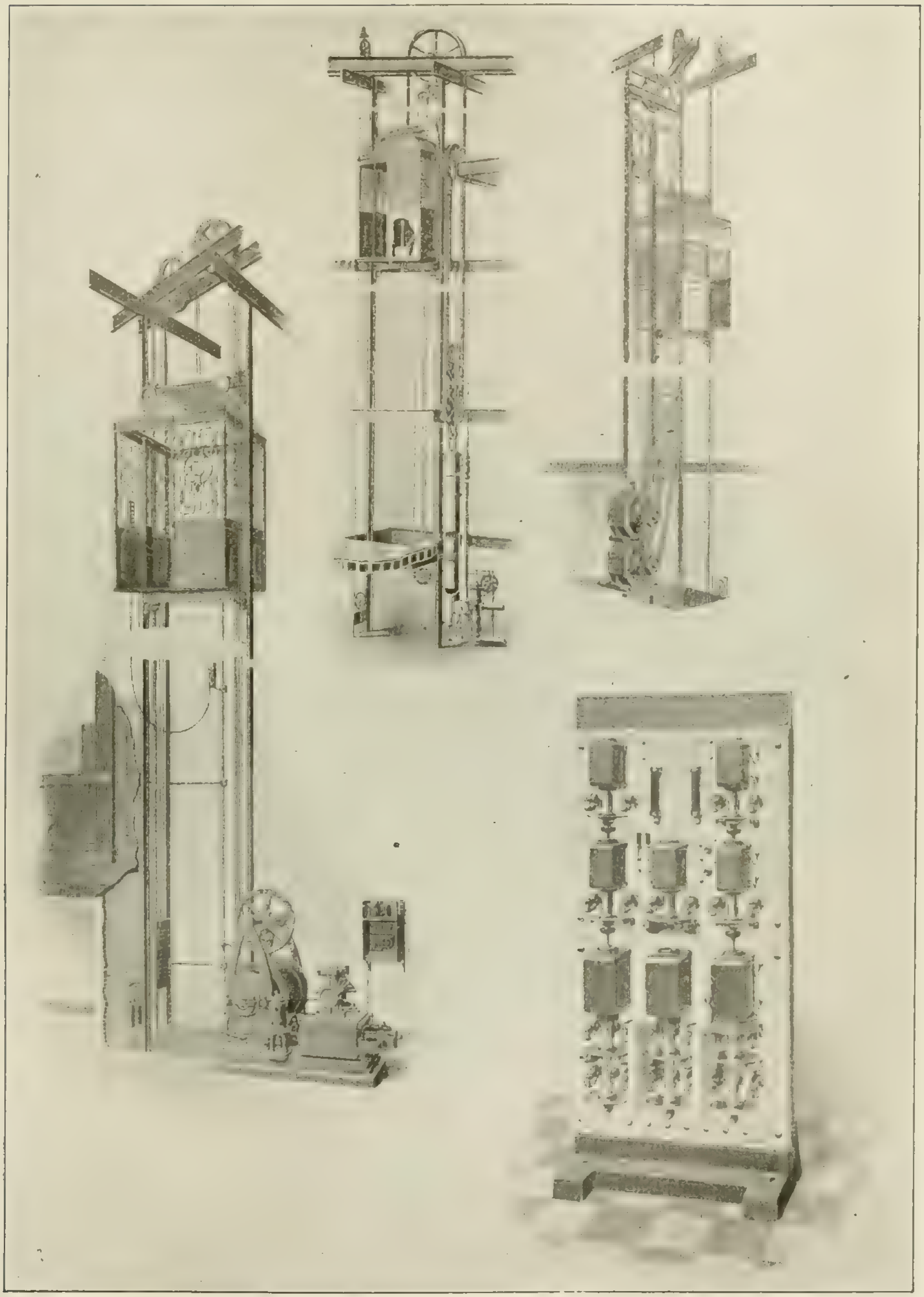
While the factor of safety in the standard make of elevators is such that accidents very rarely occur and practically never where proper attention is paid to the elevator machinery, still all elevators are equipped with standard safety devices. The safety devices consist primarily of a governor of the centrifugal type which is connected to the car entirely independently of the hoisting cables. In the contingency of the car, for any reason, exceeding the speed for which the governor has been set, the governor rope which normally runs freely is tightly clasped and the drum under the car is rotated and the powerful grips such as may be seen in the illustration (Fig. 7) come into play, bringing the car to a safe and easy stop.

THOMAS E. BROWN,
Chief Engineer Otis Elevator Co.

Elf, a little sprite of human form supposed to inhabit wild and desolate places, and to exercise a mysterious power over man; a fairy, a goblin.

Elf-arrows, Elf-bolts, Elf-shot, are the names given to implements of stone, especially flint, of various sizes and forms, which are found abundantly in many countries, and are the remains of arrow-heads, darts, and other rude ancient weapons from the Palæolithic Period. They belong to the same class of ancient implements as are described in our article CELTS (stone hatchets). These rude and ancient implements are objects of some extraordinary superstitions. The names given above are, of

ELEVATORS.



For explanation, see article.

course, of popular and comparatively modern origin, and imply that those who gave them were completely ignorant of the real origin and use of those weapons. These names are found independently among the peasantry in Scotland, England, and Ireland, and the superstitions associated with them are much more widely spread. Acording to the popular belief the stones are of supernatural origin, and various virtues are attributed to them. They are worn as charms, and used as a protection against lightning; but they are chiefly suspected of mischievous consequences. A cavern has been pointed out where the archfiend carries on the manufacture with the help of attendant imps, who rough-hew them while he finishes the work. Similar superstitions prevail in Italy, Africa, and Turkey. Consult: Evans, 'Ancient Stone Implements of Great Britain.'

Elgar, Edward William, English composer: b. Broadheath, Worcestershire. Among his compositions are: 'The Black Knight' (1892); 'Choral Suite: from the Bavarian Highlands' (1895); 'Lux Christi,' produced at the Worcester Festival (1896); 'Te Deum,' sung at the Hereford Festival (1897); 'Caractacus,' produced at the Leeds Festival (1898); 'Sea Pictures,' for the Norwich Festival (1899); 'Dream of Gerontius,' for the Birmingham Festival (1900); 'Coronation Ode' (1902).

Elgin, ĕl'gĭn, **James Bruce,** 8TH EARL OF, and 12TH EARL OF KINCARDINE, English statesman: b. London 20 July 1811; d. Dhurmsala, North India, 20 Nov. 1863. He was educated at Eton and Oxford; in 1841 entered Parliament as member for Southampton, and in the same year succeeded to the earldom. In 1842 he was appointed governor of Jamaica. His rule in Jamaica was so successful that in 1846 he was appointed governor-general of Canada, and there he succeeded by a conciliatory policy in allaying the discontent which had broken out and for some time continued. In 1849 he was raised to the British peerage as Baron Elgin; was sent in 1857 as special ambassador to China, where in the following year he succeeded in concluding the Treaty of Tientsin. He also concluded a treaty with Japan. In 1860, the Chinese emperor having manifested unfriendliness, Lord Elgin was sent to enforce the treaty, which he did by entering Peking in state and destroying the imperial summer palace. Immediately thereafter, in 1861, he was appointed governor-general of India. He maintained internal peace, and exerted himself unceasingly for the development of the country.

Elgin, Thomas Bruce. See BRUCE, THOMAS; ELGIN MARBLES.

Elgin, Ill., a city of Kane County, 36 miles west by north of Chicago. Two railroads supply adequate shipping facilities, the Chicago, M. & St. P., and the Chicago & N. It is also the terminus of the Aurora, Elgin & Chicago Railway, which is a third-rail electric line between these cities, and is the finest road of its kind in existence.

Industries, etc.— Two products make Elgin famous — butter and watches. The dairy interests have probably had more to do with the development of the community than any other factor. Early in its history, The Borden Condensed Milk Company located a large plant here and since that time has established many more in the immediate vicinity. The current quotations of the Elgin Board of Trade fix the market price of high grade butter throughout the entire country. The other industry to which Elgin largely owes its growth and prosperity is the making of fine watch-movements. The watch factory was started in the spring of 1864, and has been a success from the beginning. There are many other industries in Elgin, all of which are prosperous concerns. Two watch-case factories and as many shirt factories distribute their products throughout the country. Besides these, there are shoe, pipe-organ, automobile, coffin-fixtures, canning, malted-milk, and rug factories. Two large publishing houses are located here, and there are several machine shops and foundries.

Public Institutions, Buildings, etc.— Elgin is sometimes called the "City of Churches." Nearly all denominations are represented and the various houses of worship are large and handsome. The city is noted for its public school system, which is highly developed and very efficient. The buildings are handsome in architecture and a new high school is in the process of construction. The Elgin Academy of the Northwestern University is a well-known preparatory school for the latter institution, which is located at Evanston, Ill. Saint Mary's Academy is also well known throughout the State and bears a high reputation as a place of learning. The Illinois Northern Hospital for the Insane is located in Elgin. The Elgin Woman's Club has built and now operates a hundred-thousand-dollar hospital, which is famed throughout the country and State for its high standing and great efficiency. Three daily papers are published in the city, the *Daily News* leading in circulation and standing. The banks are six in number, four national and two savings. They have a combined capital of $650,000 and are prosperous and strong financial institutions.

History, Government, etc.— Founded in the spring of 1835, Elgin has grown rapidly in size and importance until it now is the most beautiful and the second largest city in Kane County. Elgin was incorporated in 1854 and Dr. Joseph Tefft was chosen the first mayor. The waterworks and sewer system and an electric lighting plant are the property of the municipality and its bonded indebtedness is small. Property is in great demand, owing to the number of Chicago people who, on account of good transportation facilities, are seeking more room and pleasanter homes within the confines of the beautiful city on the Fox. Pop. (1890) 17,823; (1900) 22,433.

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Elgin Marbles, the name given to a peerless collection of antique sculptures brought from Athens to England by Thomas Bruce, 7th Earl of Elgin, in the early part of the 19th century. While ambassador at Constantinople (1799–1802) he conceived the plan of securing some portion of the ruins of ancient Athens, and to that end secured permission of the Porte to take "any stones that might appear interesting to him." At his own expense (the British government having refused any aid) he set a corps of artists to work who toiled for 10 years detaching various specimens from the

Parthenon, consisting chiefly of the colossal statues on the tympana of the pediments, the metopes and the frieze around the cella. Among the best preserved examples which this splendid effort brought forth were the tympanum representing the birth of Minerva, the 15 metopes showing in high relief the combats of the Centaurs and Lapithæ and the slabs from the cella frieze depicting in low relief the great Panathenaic procession. In addition to these Lord Elgin procured the colossal statue of Bacchus from the choragic monument of Thrasyllus, one of the caryatides from the temple of Pandrosus, a portion of the frieze from the Erechtheum, and fragments of the columns of the Parthenon and Erechtheum; also numerous inscriptions, urns, etc., found in the neighborhood. When these treasures of antiquity arrived on the English shores they were received with a mixture of admiration and indignation — the latter because of supposed vandalism. It is said that Lord Byron was so outraged by the alleged depredations that when he visited the Parthenon he inscribed conspicuously: *Quod non fecerunt Gothi, hoc fecerunt Scoti.* However, as it afterward proved, had not Lord Elgin obtained these sculptures they would have been destroyed in the subsequent war of Greek independence, and especially in the last siege of Athens in 1826–7. After much hesitation, and bickering as to the price, in spite, too, of their value vouched for by experts, the British Parliament purchased the marbles from Lord Elgin for £35,000, easily a third less than he had expended upon them. They are now to be seen in the British Museum as priceless examples of the highest in Greek art which matured under the glorious genius of Phidias. Many casts have been taken of these unsurpassed relics of which the city of New York possesses a set.

Eli, ē'lī, Hebrew judge and high-priest of Israel. After a turbulent rule of 40 years, he died 1116 B.C. Failing to punish the misdoings of his sons, Phineas and Hophnai, the downfall of his house followed.

Eli Perkins. See LANDON, MELVILLE D.

Elia, ē'lĭ-a. See LAMB, CHARLES.

Elie de Beaumont, Jean Baptiste Armand Louis Léonce, zhŏṅ bäp-tēst är-mäṅ loo-ē lā-ôṅs ā'lē dė bō-môṅ, French geologist: b. Canon, France, 25 Sept. 1798; d. there 22 Sept. 1874. He was educated in the Polytechnic School; became professor at the School of Mines 1829; professor of geology in the College of France 1833; chief engineer of mines 1833; member of the Institute 1835; and perpetual secretary of the Academy of Sciences 1853. He published 'Carte géologique de France' (1843); 'Notices sur les systèmes de montagnes' (1852), etc.

Eligius, ĕ-lĭj'ŭs, or **Eloi**, ā-lwä, **Saint**, bishop of Noyon: b. Cadillac, near Limoges, 588; d. Noyon 1 Dec. about 660. Having in boyhood shown a decided aptitude for fine art he was placed by his parents under the direction of the master of the mint at Limoges, and there acquired skill in the goldsmith's craft. Appointed coiner to the Frankish king, Clotaire, and to his son and successor, Dagobert, he executed at their order the bas-reliefs on the tomb of St. Germanus, bishop of Paris, and other works in the precious metals which were regarded as the masterpieces of decorative art in that time. He was a favorite at court, which he was obliged to frequent because of his connection with the king; but he took more pleasure in relieving the needy than in the society of the worldly. He daily fed a large number of poor people, he buried the bodies of malefactors, and he ransomed captives, especially the Saxon slaves who were often sold in the markets. Both Clotaire and his son Dagobert bestowed costly presents upon Eligius, but they could not make him rich, he gave so much to the poor and to the founding of charitable institutions. At about the age of 50 he decided to abandon the world entirely and devote himself to the conversion of the pagans. Two years later he was ordained priest and in 546 was made bishop of Noyon. As bishop he gave special attention to the conversion of the Flemings and Frisians, and the greater part of Flanders was converted through his efforts. See Lebeuf, 'Histoire du diocese de Paris'; Fleury, 'Vita S. Eligius.'

Elijah, whose name («Jehovah is God») indicates his mission and his work, was one of the greatest prophets of Israel. His prophetic activity began in the days of Ahab of Israel, and ended in the days of his son, Ahaziah, or, as is on the whole, more probable, in the days of his son-in-law, Jehoram of Judah. His first appearance is strange; the end of his life on earth still more strange. Throughout his career he comes and goes in an unusual and remarkable way. His special work was to save his nation from falling into heathenism, and thus making impossible the great history which has resulted in the Christian civilization of our own days. Ahab, the king of northern Israel, had married Jezebel, the daughter of Ethbaal, king of Tyre, and formerly a priest of the Tyrian religion. Among the Semitic peoples an alliance of nations meant a mutual honoring of gods. Thus the marriage of Ahab and Jezebel introduced into the kingdom of Israel the worship of the Tyrian Baal. Gradually, through the determined efforts of Jezebel, who was a fanatic for her faith, the worship of Baal displaced that of Jehovah, and seemed likely altogether to destroy it. Later, by the marriage of Athaliah, the daughter of Ahab and Jezebel, to Jehoram, king of Judah, the same course of things began in the kingdom of Judah (2 Kings viii. 18). To bring back the nation to the worship of Jehovah, and to the recognition of him as God, was the work of Elijah. This work began with the sudden appearance of the prophet to Ahab, to announce to him the coming drought and famine, which the nature god Baal would be powerless to prevent (1 Kings xvii. 1). The life of the prophet up to this time had probably been spent in the lonely and wild region on the eastern side of the Jordan, although it is uncertain where his birthplace was. During the three years and more of drought and famine which followed Elijah's first appearance to Ahab, the prophet found a home and the means of life, first by the brook Cherith, and afterward in the home of a widow in Zarephath, a city of Phœnicia. At the end of this time he had his great contest with the prophets of Baal on Mount Carmel, where, in answer to his prayer, Jehovah revealed himself by fire, and was acknowledged by the people to be God. The same day the

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CHARLES WILLIAM ELIOT

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falling rain ended the drought and the famine (1 Kings xviii.). The triumph of the prophet was followed by a flight to Mount Horeb to escape the wrath of the angered Jezebel. On this mountain he received from God a revelation in regard to the real part his work had in the history of his nation, and was commanded by God to call Elisha to be his successor in the work for the nation. In obedience to this command, he went from Horeb to Abel-meholah, the home of Elisha. Having given to Elisha the call to be his successor, he disappeared for a time from the view of men (1 Kings xix.). About six years later, the prophet again appeared to Ahab in the vineyard of Naboth, in Jezreel, to denounce him for his wicked disregard of the rights of his brother, made sacred by the law of Jehovah (1 Kings xxi. 17–24). The final work of the prophet on behalf of his people is recorded only in the book of Chronicles (2 Chron. xxi. 12–15). This was the sending of a letter to Jehoram, the king of Judah, to tell him that, because he had endeavored to introduce the Baal worship of the northern kingdom into Judah, and because he had cruelly murdered his brothers to make his own throne more secure, Jehovah would send great evils upon his people, his family, and himself.

How long the prophet lived we do not know; but, at the last, the man of storm and whirlwind was, by a whirlwind and without death, taken up to his God (2 Kings ii. 1–12).

Consult: Milligan, 'Elijah: His Life and Times,' in 'Men of the Bible'; Farrar, 'First Book of Kings,' chaps. xxxiii.–xlviii., in the 'Expositor's Bible' (1893); and 'Second Book of Kings' in the same, chaps. i. and ii. (1902); Strachan, article 'Elijah' in Hastings' 'Dictionary of the Bible' (1899).

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Elijah, The, an oratorio by Mendelssohn, first performed at Birmingham, England, 26 Aug. 1846. It is one of his best-known works and is more popular in England and America than any other oratorio, with the exception of Handel's 'Messiah.'

Elimina'tion, the separation and exclusion of some particular substance from a compound, or of some particular symbol from an algebraic expression, thus simplifying the compound or expression, and rendering it capable of further analysis and use. It is a process by which, where we have a number of statements concerning several quantities, we can obtain a separate statement concerning each. Thus, in mathematics, broadly speaking, elimination is the operation which consists in getting rid of a common quantity. See 'Theory of Equations' (1901), Burnside and Panton.

Eliot, Charles William, American college president: b. Boston, Mass., 20 March 1834. He was graduated from Harvard in 1853, was tutor in mathematics there 1854–8, and assistant professor of mathematics and chemistry in the Lawrence Scientific School, Harvard, 1858–63. After spending two years in Europe investigating educational methods he was professor of analytical chemistry in the Massachusetts Institute of Technology 1865–9. In the last-named year he became president of Harvard University, which position he still holds. He is one of the foremost writers and speakers of the day upon educational and social problems and has exerted a strong influence upon the trend of American thought. He has published 'Manual of Qualitative Chemical Analysis' (with F. H. Storer); 'Manual of Inorganic Chemistry' (with F. H. Storer); 'Five American Contributions to Civilization and Other Essays'; 'Educational Reform.'

Eliot, George (pseudonym of Mary Ann or Marian Evans Cross), English novelist: b. Arburyfarm, near Nuneaton, Warwickshire, 22 Nov. 1819; d. Chelsea, England, 22 Dec. 1880. She received her early education at Attleborough, Nuneaton, and Coventry, and sooner or later, either under the tuition of masters or by teaching herself, acquired a knowledge of Greek, Latin, French, German, and Italian; she also studied Hebrew, and for some time devoted herself to the study of music, becoming an excellent piano player. She was also a constant and omnivorous reader. Shortly after her 21st year she came into personal contact with friends who held rationalistic views in regard to religious matters, and though she had previously been attached to the doctrines of the evangelical school (she had an aunt who was a Methodist preacher), her religious views now underwent such a change as to cause a breach between her and her father which seems never to have been entirely closed up. Her first literary undertaking was the continuation of a translation of Strauss' 'Life of Jesus,' commenced by her friend Mrs. Hennell, and completed by Miss Evans in 1846. In 1849 she went abroad, returning to England next year, and in 1851 took up her abode as a boarder in the house of John Chapman, editor of the 'Westminster Review.' This connection led to her being attached to that periodical as sub-editor. Various articles in the 'Review' from 1852 onward have been attributed to her, but her principal work appears to have been the writing of the summaries of contemporary literature. It was not, however, until January 1857 that she came prominently into public notice, when the first of a series of tales entitled 'Scenes from Clerical Life' appeared in 'Blackwood's Magazine.' These tales immediately arrested attention, and obtained the praise of the editor, who was informed that he was to know the author as George Eliot. Mr. John Blackwood was as ignorant of the author's identity for a considerable time as was all the world except George H. Lewes (q.v.), and one or two others. The 'Scenes' came to an end in November 1857, and in the February following, the first chapters of 'Adam Bede' were in the publisher's hands, the whole work being completed and sent in by October. The success which attended the publication of this powerful story of English rural life was unmistakable, and public curiosity was greatly excited as to the personality of the author. The credit of authorship was openly ascribed to various persons of more or less note and was claimed by others of more or less modesty and honesty. The secret soon began to leak out. Months before her second novel, 'The Mill on the Floss,' was published (1860) it was well known, among literary circles at least, that George Eliot was none other than Marian Evans, the Westminster reviewer. By this time was established that close association and literary fellowship with the talented philosophical writer, George H. Lewes, which terminated only with the death of the latter but a little more than two years before her own. In 1861 was published 'Silas Marner,' another story of humble country life, a painful, but powerful and interesting tale. Two years later she gave to the world 'Romola,' an historical novel of Italian life in the time of Savonarola, which is considered by a select few as her greatest intellectual achievement. This was followed by 'Felix Holt,' a story dealing with political, social, and religious peculiarities (1866); 'Middlemarch,' somewhat weak and diffuse as a story, but replete with pregnant thought and clear delineation of character (1871); and 'Daniel Deronda,' containing some striking and original sketches of Jewish life and character (1876). Previous to this she had acquired some renown as a poet through the publication of several volumes of poems, among which may be mentioned: 'The Spanish Gypsy' (1868); 'Agatha' (1869); and 'The Legend of Jubal' (1874). Her last work was a series of essays, entitled the 'Impressions of Theophrastus Such' (1879). In May 1880 she married Mr. John Cross, but died rather suddenly at Chelsea on 22 December of that year. Her 'Life, as Unfolded in Her Letters and Journals,' was published in 1885 by her husband. See also: Dowden, 'Studies in Literature' (1878); Blinde, 'George Eliot' (1883); James, 'Partial Portraits' (1888); Parkinson, 'Scenes from the George Eliot Country' (1888); Stephens, 'George Eliot' (1892); Myers, 'Essays Modern' (1883); Hutton, 'Modern Guides of English Thought' (1887).

Eliot, Sir **John,** English orator and states-clergyman: b. 7 Nov. 1685; d. 22 April 1763. He was a grandson of John Eliot, the «Apostle to the Indians,» and was long pastor at Killingworth, Conn. He was an able preacher, a botanist, and a scientific and practical agriculturist, was the first to introduce the white mulberry tree into Connecticut, and discovered a process of extracting iron from ferruginous sands. He was also regarded as the first physician of his day in the colony; and such was his success in the treatment of insanity and chronic complaints, that he was sometimes sent for to Newport and Boston, and was more extensively consulted than any other physician in New England.

Eliot, Sir **John,** English orator and statesman: b. Port Eliot, Cornwall, 20 April 1592; d. London 27 Nov. 1632. He entered Parliament in 1614 as member for St. Germans, winning immediate reputation as an orator. As vice-admiral of Devon he was energetic in suppressing piracy. In the three parliaments of 1623, 1625, 1626, he made his way to the front of the Constitutional party, joined Hampden and the rest in refusing contributions to the forced loan, and took a prominent share in the impeachment of Buckingham and in drawing up the 'Remonstrance and Petition of Right.' He was imprisoned in the Tower in 1629, and died there three years later. During his imprisonment he wrote a work on constitutional monarchy, entitled the 'Monarchy of Man,' and several other works, including an account of the first Parliament of Charles I. under the title 'Negotium Posteriorum' a vindication of his public conduct, entitled 'An Apology for Socrates'; and 'De Jure Majestatis,' a treatise on government. Eliot was not a Republican, but believed in constitutional monarchy, and all through his career boldly maintained the privileges of Parliament both in its individual members and as a legislative and executive body. See 'Life' by Forster (2d ed. 1871).

Eliot, John, American colonial missionary, «the Indian Apostle»: b. probably at Widford, Hertfordshire, 1604; d. Roxbury, Mass., 20 May 1690. He was graduated at Cambridge in 1622, and, after taking orders in the Church of England, quitted his native country for conscience's sake, and landed at Boston, New England, in 1631. In 1646, after two years study of the Indian language, he delivered a long sermon in the native dialect at Nonantum, and other meetings soon followed. He shortly after began to establish his converts in regular settlements, his work meeting with approval both in the colony and at home; in England a corporation was founded in 1649 «for the promoting and propagating the Gospel among the Indians of New England,» which defrayed the expenses of the preachers and the cost of printing translations. At one time there were over a dozen townships of «praying Indians» within the bounds of Massachusetts, and many more outside these limits, with numbers estimated in 1674 at 3,600; but, although the organization survived until the death of the last native pastor in 1716, the decay of the «praying towns» was rapid after the war with King Philip (1675), in which the converts suffered equal cruelties at the hands of their countrymen and of the English. There are monuments to Eliot's memory in the Indian burying-ground at South Natick, and at Newton, near the scene of his first Indian sermon. A man of earnest piety and devotion, warm-hearted, and of a singularly attractive manner, he has left a memory that is honored among the first in the history of New England. With Thomas Weld, and Richard Mather, Eliot prepared an English metrical version of the Psalms, the 'Bay Psalm-book' (Camb. 1640), as the first book printed in New England. He was also the author, among other works, of: 'The Christian Commonwealth' (Lond. 1659), suppressed by the general court, and now extremely rare: 'The Communion of Churches' (1665), the first book privately printed in America; and of translations into the Indian tongue of Baxter's 'Call'; Bayly's 'Practice of Piety' (abridged); and Shepard's 'Sincere Convert.' But the great work of his life was the translation of the Bible into the tongue of the Indians of Massachusetts (Algonquin), of which the New Testament appeared in 1661, and the whole work, with a version of the Psalms in metre, and a page of «catechism» in 1663. The longest single word in it is «Wutappesittukqussunnoohwehtunkquoh,» signifying «kneeling down to him,» in Mark i. 40; which illustrates the jest of Cotton Mather, who said he thought the words of the language must have been growing ever since the dispersion at Babel. Only 14 complete copies of the first and second editions are known to be in existence. A scientific study of Eliot's Indian Bible was made by J. H. Trumbull (q.v.), and his MS. published 1903 as 'Bulletin 25' by the Bureau of American Ethnology, Washington. Its title is the 'Natick

From the etching by Rajon

GEORGE ELIOT.

Dictionary,' and it is divided into two parts, the first giving the Natick words with English definitions and the second giving the English words with Natick definitions. In other words, the volume contains two dictionaries, one Natick-English and the other English-Natick. While it is devoted to the Natick language it is practically a dictionary of all the Algonquin languages of Massachusetts, for the tribes of that part of the country spoke practically the same language, though each had its dialectic variations. Eliot's 'Indian Grammar Begun' was printed in 1666; his 'Indian Primer' in 1669. The finest collection of unique and scarce copies of Eliot's works is in the Lenox Library, New York; many of them have been reprinted. The best 'Life of Eliot' is that by Francis in Volume V. of the first series of Sparks' 'American Biography' (1836); the earliest that by Cotton Mather 1691; consult also articles in the 'Cyclopædia of American Biography' (Vol. II. 1887); and the 'Dictionary of National Biography' (Vol. XVII. 1889).

Eliot, Samuel, American educator and historian: b. Boston, Mass., 22 Dec. 1821; d. Beverly, Mass., 14 Sept. 1898. He filled the chair of history and political science in Trinity College, Hartford, Conn., 1856–64; was president of Trinity College 1860–4; and overseer of Harvard 1866–72. Among his publications are: 'The History of Liberty' (1853); 'The Liberty of Rome' (1849); 'Life and Times of Savonarola' (1856); 'Manual of United States History Between the Years 1492 and 1850' (revised ed. 1873); and 'Stories from the Arabian Nights' (1879).

Eliot, Samuel Atkins, American Unitarian minister: b. Cambridge, Mass., 24 Aug. 1862. He was graduated at Harvard College 1884; was pastor of Unity Church, Denver, 1889–93, and of the Church of the Saviour, Brooklyn, 1893–8. He was secretary of the American Unitarian Association 1898–1900, becoming its president at the latter date.

Elis, ē'lĭs, (1) A country in the west of Peloponnesus, where Olympia was situated. It was bounded on the east by Arcadia, on the south by Messenia, and ran along the coast, watered by the river Alpheus. Elis and Archaia now form a monarchy of Greece. (2) Elis, the capital of Elis, is now called Kaloskopi. See OLYMPIA; OLYMPIC GAMES. Consult: Curtius, 'History of Greece.'

Elise, or **San Antonio Colony,** Paraguay, an agricultural settlement started in 1890, situated in the department of San Lorenzo de la Frontera, on the left bank of the Paraguay River, about nine miles from Asunción. Products: tobacco, sugarcane, coffee, ramié grass, etc. See PARAGUAY.

Elisha, a member of the tribe of Issachar, a citizen of Abel-meholah, was a disciple of Elijah, and his successor in the prophetic office. His prophetic ministry, which was exercised, as was that of Elijah, in northern Israel, began in the reign of Ahab, and continued through the reigns of Jehoram, Jehu, Jehoahaz, and during a part of the reign of Joash, thus covering a period of more than half a century. He was a man of very different character and mode of life from Elijah, although master and disciple seem to have been most warmly attached to each other. Elijah was a son of the desert; Elisha came from a quiet farm in the Jordan valley. Elijah lived apart from men; Elisha, for the most part, dwelt in the city, either at Jericho among the sons of the prophets, or in his own home at Dothan or Samaria. Elijah had nothing to do with kings except to rebuke them; Elisha was their friend and counsellor. Yet it is easy to make too much account of their difference of character and life, and to suppose that it affected essentially the prophetic aim and religious attitude, so that these were quite different in the case of each prophet. But to claim that the work and spirit of Elisha were in marked contrast to those of Elijah would be to claim too much. The declaration of Jehovah to Elijah on Mount Horeb, "Him that escapeth from the sword of Jehu, shall Elisha slay" (1 Kings xix. 17), shows that it was Elijah's work of vengeance and destruction which Elisha was to continue. It was Elisha, moreover, who devised the plan for the destruction of the house of Ahab (2 Kings ix. 1–3). It was Elisha, also, who reproved King Joash for his lack of zeal for the utter overthrow of Syria (2 Kings xiii. 19). It is to be remembered in this connection that the accounts which we have concerning the career of Elisha, whatever the cause may be, relate rather to his deeds as a man, than to his work as a prophet.

For some six or seven years after his call to the office of prophet by Elijah at Abel-meholah (1 Kings xix. 19–21), he was a helper and disciple of Elijah. But we do not know just where he was in all this time, or the exact nature of his work. At the close of this time, after the ascension of Elijah, he began his own independent work as a prophet (2 Kings ii. 13–22). The character of the narrative in the Second Book of Kings makes it impossible to arrange the events of his life in chronological order. It is better, therefore, to group them under two headings: (*a*) his deeds in private life; (*b*) his deeds in public life.

Under the first class, we may put (1) the healing of the waters of Jericho (2 Kings ii. 19–22); (2) the punishment of the lads of Bethel (2 Kings ii. 23–25); (3) the saving of a widow's son from slavery (2 Kings iv. 1–7); (4) the restoring of the Shunammite's son to life (2 Kings iv. 32–36); (5) the rendering of some poisonous pottage harmless (2 Kings iv. 38–41); (6) the miraculous feeding of a hundred men (2 Kings iv. 42–44); (7) the healing of Naaman the leper (2 Kings v.); (8) the causing of the iron head of an axe to swim (2 Kings vi. 1–7).

Under the second class we may put (1) his helpful work in the campaign against Moab (2 Kings iii. 11–24); (2) his bringing of the Syrian army into Samaria, where they were made prisoners (2 Kings vi. 8–23); (3) his activity in the siege of Samaria (2 Kings vi. 24, vii. 2); (4) his visit to Damascus to announce to Hazael that he shall be king of Syria (2 Kings viii. 7–13); (5) the sending of a messenger to anoint Jehu to be king of Israel (2 Kings ix. 1–3); (6) the assuring of King Joash that Israel should be victorious over Syria (2 Kings xiii. 14–19).

But the power of Elisha for good did not end with his life. Of him alone of all the prophets it is recorded that he wrought a miracle after his death. A dead man who was hastily cast into the sepulchre of the prophet, on touching the prophet's bones, came to life, and stood upon his feet (2 Kings xiii. 20–21).

Consult: Grove, article 'Elisha' in Smith's 'Dictionary of the Bible' (1868); Strachan, article 'Elisha' in Hastings' 'Dictionary of the Bible' (1899); Farrar, 'Second Book of Kings,' chaps. iii.–xvii., in the 'Expositor's Bible' (1902).

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Elixirs, in pharmacy, are aromatic, sweetish, spirituous preparations, containing small quantities of active medicinal drugs. They are now mostly used as vehicles, and have very little potent action save that of the alcohol which they contain. Elixir aromaticum and Elixir phosphorus are the only two elixirs sanctioned by the 1890 revision of the United States Pharmacopœia.

Elizabeth, the wife of Zacharias and mother of John the Baptist. An angel foretold to her husband the birth of a son to her old age; and it was also foretold by the angel Gabriel to the Virgin Mary, as an assurance of the birth of the Messiah.

Elizabeth, Saint, of Hungary, daughter of Andrew II., king of Hungary, and Gertrude, daughter of the Duke of Carinthia: b. Presburg 1207; d. Marburg 19 Nov. 1231. Early in life she displayed a dislike for things worldly, as the pomp with which she was surrounded, ambition, avarice, and vain pleasures, and began to cultivate humility, piety, and great charity. According to the custom of the times, when she was only four years old she was betrothed by her parents to Louis, the son of the landgrave of Thuringia, who was about her own age. When Elizabeth was 14 years old they were married. Her husband admired his wife's piety and approved her great charity, especially during the famine in Germany in 1225, although members of his own family severely censured her. She founded hospitals in Marburg and other places within her husband's dominion. (Louis' father died the year after the betrothal, and he was the landgrave when he married Elizabeth.)

In 1227 Louis left home with Frederick Barbarossa to engage in the war for Palestine; but before reaching the Holy Land Louis died from fever. Great misfortunes soon befell Elizabeth. She was deprived of her regency by the brother of her deceased husband, and driven out of her dominion on the plea that she wasted the treasures of the state by her charities. The inhabitants of Marburg, whose miseries she had frequently relieved, refused her any asylum, for fear of the new regent. At last she found refuge in the monastery of Kitzingen, where her aunt was abbess, and later with her uncle, bishop of Bamberg, and when the warriors who had attended her husband in the Crusade returned from the East with his body, she gathered them around her, and recounted her sufferings and the wrongs done to her three children. Steps were taken to restore to her her sovereign rights. She declined the regency, however, and would accept only the revenues which accrued to her as landgravine. The remainder of her days were devoted to almsgiving, mortifications, and prayer. She became a member of the Third Order of Saint Francis, and in pictures she is often represented clothed in the Franciscan habit. She was canonized by Gregory IX. four years after her death. Consult: Montalembert, 'Life of Saint Elizabeth of Hungary'; Starr, 'Patron Saints'; Butler, 'Lives of Saints'; Bonaventure, 'Sermon on St. Elizabeth'; Theodoric, and Montague of Spire. There are extant manuscripts on her life, by contemporaries, Conrad of Marburg, Siegfried of Mentz, and others.

Elizabeth, queen of England: b. Greenwich 7 Sept. 1533; d. Richmond, Surrey, 24 March 1603. She was the daughter of Henry VIII. and of Anne Boleyn. After her mother had been beheaded (1536) both she and her sister Mary were declared bastards, but finally she was placed after Prince Edward and the Lady Mary in the order of succession. Thus, while the first two marriages of King Henry were both still held to be illegal, the children of both were legitimized. Elizabeth received a classical education, as was customary with women of rank in her time, and under her tutor, Roger Ascham, is said to have attained very considerable proficiency in Latin and Greek. During her father's life, as well as in the reign of her brother, various negotiations were entered into for her marriage. The Duke of d'Angoulême and Philip of Spain, who afterward married her sister, were among the matches proposed for her; but the only affair of this kind in which she may be supposed to have been personally interested was the suit of Lord Seymour of Dudley, the Protector Somerset's brother. It is certain that even during the life of Catharine Parr, the widow of Henry VIII., whom he married, his attentions to the Lady Elizabeth were only too well encouraged. Both before this marriage and after the death of his wife he was a suitor for the hand of the princess; but his ambitious designs in this and other matters were not countenanced by the council, and ultimately cost him his life.

On the death of King Edward Elizabeth vigorously supported the title of Queen Mary against the pretensions of Lady Jane Grey, by which her own title as well as her sister's were barred. She rode to meet her sister, accompanied by 1,000 horse, and this bold proceeding was of no small service in confirming the doubtful in their allegiance; but Elizabeth gained little for herself by a policy in which it was well understood she had her own interest in view. After Wyatt's conspiracy her life was in great danger, and was probably saved only by the intercession of Philip. She was committed to the Tower, from whence she was removed to Woodstock, where she was confined with great strictness. She afterward, through Philip's intercession, obtained greater liberty; but throughout the whole reign continued an object of suspicion and surveillance. The danger she now incurred developed a trait in her character which ever after continued conspicuous, her power of dissimulation. She made every demonstration not only of conformity, but of zealous adherence to the established religion. Her conduct in this must not be judged from the point of view of rigid Protestantism, which Elizabeth never professed; but there were some at least among the

Roman Catholic ceremonies and customs to which she could not be supposed to give a sincere adherence. Nevertheless, her false zeal must have been well and ably sustained, for her conduct was not left to the report of friends, but carefully watched by spies and informers. Philip was most anxious to have her married out of the kingdom; and if the Duke of Savoy, whom he proposed, was unacceptable from his Roman Catholicism, there was Eric, son of the king of Sweden, who long after continued to press his suit; but Elizabeth refused both. She felt in herself a capacity for rule, and her sister's ill health opened up for her an early prospect of the throne, which she was unwilling to peril. Mary's reign was not without advantage to Elizabeth. It tried her councilors as well as herself, and gave her the opportunity of selecting them to advantage. Her adviser throughout the whole of it was William Cecil, afterward Lord Burleigh, who had already been a minister under Edward VI., and continued for the rest of his life to be one of the chief councilors and ablest ministers of Elizabeth, to whom he was in many respects a congenial spirit.

On 17 Nov. 1558 Mary's disastrous reign came to a close, and Elizabeth was immediately recognized queen by Parliament. On entering London she was met by the bishops, whom she permitted to kiss her hand, with the exception of Bonner, "whom she omitted for sundry severities in the time of his authority." It was now that the caution and secrecy characteristic equally of Elizabeth and Cecil, and which enabled them to do such great things, appeared in spontaneous exercise. The Roman Catholic religion was still predominant in the House of Lords, and any attempt to overthrow it suddenly might have been attended with the greatest danger. Elizabeth made no immediate change in her habits. For a full month the ceremonies of the Roman Catholic Church were retained in all their state. A solemn funeral service was held for Queen Mary in Westminster Abbey, at her interment on 13 December. The queen even intimated her accession to the Pope. She retained the greater part of her sister's council, choosing only seven new councilors, who were Protestants, it is true, but not then known as such. Like Cecil and herself, they had all conformed, and possessed the necessary qualification for Elizabethan councilors of accomplished hypocrisy. Such were her difficulties, notwithstanding her great prudence, that at her coronation only one of all the bishops, Oglethorpe of Carlisle, could be found to set the crown on her head. The obstacle, it is said, was her refusal to permit the elevation of the host. She had also before this authorized the reading of the liturgy in English. The first great object of her reign was the settlement of religion. A Parliament was immediately called, to which this work was assigned. It met on 25 January, and was dissolved 8 May, but its object was already accomplished. The nation was prepared for a return to the reformed faith, and the Parliament was at the bidding of the court. The reformation of religion in England was the work of Cranmer, and had already been accomplished in the reign of Edward VI.; the reestablishment of the ecclesiastical system of the national Church on the basis on which it has remained to the present day was the work of Cecil and Elizabeth, and it was nearly completed in this Parliament. Elizabeth had less extreme opinions than many supporters of the new faith. She was tolerant, for instance, in regard to images, and is said to have entertained scruples as to the extent of the royal supremacy in spiritual matters; but if she did, they must have been purely speculative. They certainly vanished on the first taste of power.

If the formal establishment of the reformed religion was easily completed, the security and defense of the settlement was the main object of the policy and the chief source of all the struggles and contentions of her reign. What made the position so difficult was the intolerance by which at this period and for long after all religious sects were characterized. No sooner were the Puritans freed from the restrictive measures of Mary's reign than they began to claim predominance for their own dogmas. But it was far from the intention of the queen and the supporters of the Established Church, notwithstanding the common persecutions they had endured, to grant them even liberty of worship. Elizabeth's own determination, as expressed by herself, was that none should be allowed to turn aside either to the right hand or the left from the drawn line of prescribed duty, and in insisting upon uniformity of worship she was not singular, but was acting in the spirit of her age. This principle was not less firmly held in her reign than in her sister's; and Roman Catholics on the one hand, and Puritans on the other, restrained only by their dread and hatred of each other, were made the irreconcilable enemies of the existing order. Moreover, from the necessities of the struggle the severities of Elizabeth's reign went on increasing as time advanced. At first no one suffered death for his opinions; but eventually many were executed for this cause. The struggle against Roman Catholics was the most severe, chiefly because they were supported by foreign powers; so that while their religion was wholly prohibited, even exile was forbidden them in order to prevent their intrigues abroad. Simple non-conformity, from whatever cause, was pursued with the severest penalties. The fine imposed for non-attendance at church was £20 per month, while so strait were the lines of conformity drawn, that many more clergymen were driven out of the Church by differences about the position of altars, the wearing of caps, and such like matters, than were forced to resign by the change from Rome to Reformation. These stringent measures were, however, the rigid consequences of the false position assumed.

Elizabeth's first Parliament approached her on a subject which, next to religion, was the chief trouble of her reign, the succession to the crown; they requested her to marry. She replied in a long speech, declaring her intention to live and die a virgin. It is certain, from her conduct both before and after, that this declaration was only a convenient affectation of prudery, which at once served to flatter her vanity and to veil her real indecision. She saw too clearly for her own interest the restraints to which each particular marriage might subject her, and therefore, she shunned them all, thus leaving open the question of the succession.

On Elizabeth's accession the country was at war with France. Peace was easily concluded

1559; but the assumption by Francis and Mary of the royal arms and titles of England led to an immediate interference on the part of Elizabeth in the affairs of Scotland. She entered into a league with the Lords of the Congregation, or leaders of the Reformed party; and throughout her reign this party became distinctively an English one, and was frequently serviceable in furthering her policy. She also gave early support to the Huguenot party in France, and to the Protestants in the Netherlands, so that throughout Europe she was looked on as the head of the Protestant party. This policy roused the implacable resentment of Philip, who strove in turn to excite the Roman Catholics against her, both in her own dominions and in Scotland. After the detention of Mary queen of Scots in England, he fomented the various rebellions in her favor formed in England and Ireland, and at her death declared himself her avenger. Mary, as is well known, was imprisoned 19 years in England, whither she fled to the protection of Elizabeth. Her imprisonment was followed by a series of conspiracies, beginning with that under the earls of Northumberland and Westmoreland, and ending with the plot of Babington, which finally determined Elizabeth to make away with her captive. The execution of Queen Mary was, nevertheless, the chief political blunder of Elizabeth's reign. If the death of Mary did not raise up new enemies to Elizabeth on the continent it at least gave a just cause of scandal to those she already had. Elizabeth had for some time been engaged in a negotiation for marriage with the Duke of d'Alençon (afterward d'Anjou); and in 1580 the Duke arrived in London to pursue his suit, which had lasted nearly 10 years, in person. He was well received, but still the queen hesitated. She was now 47. The following winter the Duke paid another visit, and the marriage was all but concluded, but she finally informed him she could never marry.

The state of France, as indicated by the change of government consequent on the accession of Henry IV., who was assisted by Elizabeth, obviated any danger that might have arisen from the indignation which the execution of Queen Mary had caused in that country. Nowhere, however, was that event more meekly borne than by King James. The Scottish Solomon had thought his mother's danger a favorable opportunity for sententious observations about the strangeness of her case, and now his philosophy was nonplussed. His awe of Elizabeth and his dread of interfering with his own right of succession to England made him powerless, and he accepted an addition to his pension in full of all grievances. Philip was not to be so appeased. He had other grievances, to which the execution of Mary lent edge. The fleets of Elizabeth had galled him in the West Indies, her arms and subsidies had helped to deprive him of the Netherlands; the Armada was already in preparation. Therefore he called the queen of England a murderess, and refused to be satisfied even with the sacrifice she seemed prepared to make of her Dutch allies. The Armada sailed on 29 May 1588. Its fate is too well known to need recapitulation. The war with Spain dragged on till the close of Elizabeth's reign.

During her long rule Elizabeth showed her judgment in nothing so much as in the councilors she trusted. But while the splendor of her government at home and abroad was sustained by such men as Burleigh, Bacon, Walsingham, Throgmorton, and Davison, who served her with a zeal which did not always spare even their own reputations, she had personal favorites of less merit who were often more brilliantly rewarded. It is sufficient to name Dudley, whom she created Earl of Leicester; and Essex, who was still more a personal favorite, though much less a courtier. The latter had some merit as a soldier; but his violent temper, ill-suited to the queen's haughty disposition, brought about his ruin. He was beheaded in 1601, and Elizabeth never forgave herself his death. Her own health soon after gave way, and she died, naming James of Scotland as her successor.

Besides its political glories, the reign of Elizabeth was the golden age of English literature. If all else could be forgotten, it would be remembered as the age of Spenser and of Shakespeare, not to mention a host of minor names. The naval achievements of Drake and the discoveries of Raleigh concurred to do it honor. Thus everything conspired to throw a halo round the name of Elizabeth, when regarded as a sovereign, and seen as she would be in her own day, especially by foreign beholders, through the drapery of state. If a minute criticism has exposed some of the weakness of the individual woman who bore this burden, it must be remembered that the process is only half fair. As a sovereign she is entitled to her surroundings, and as an absolute ruler, as to a great extent she undoubtedly was, she must have her share of praise for the good that was done in her name. It is no small merit to select good councilors and to adhere to them. Elizabeth knew how to do both; and yet she was no puppet in the hands of her advisers. Though haughty and imperious to the Commons, she knew both when and how to yield. She studied with rare sagacity the temper of the people; and high as were her notions of prerogative, she may fairly be considered the first constitutional monarch of England.

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Elizabeth, empress of Austria: b. Possenhofen, Bavaria, 24 Dec. 1837; d. Geneva 10 Sept. 1898. She was the daughter of Duke Maximilian Josef of Bavaria, and married her cousin, the Emperor Franz Josef on 24 April 1854. Together they were crowned with the insignia of St. Stephen when the inauguration of the dual system was solemnized. She was greatly admired by Austrians and Hungarians alike.

While visiting Geneva, Switzerland, she was assassinated by an Italian anarchist.

Elizabeth Farnese, fär-nā'zĕ, queen of Spain: b. 25 Oct. 1692; d. 1766. She was a daughter of Edward II., Prince of Parma. On becoming the second wife of Philip V. she surprised those who had counseled the marriage by assuming the practical headship of the kingdom; her ambition and that of her minister, Alberoni, disturbed the whole of Europe.

Elizabeth, Madame (ELISABETH PHILIPPINE MARIE HÉLÈNE), French princess: b. Versailles 3 May 1764; d. Paris 10 May 1794. She was a sister of Louis XVI. She was the faithful friend and companion of the royal family in their flight to Varennes, and during their imprisonment was executed, on the pretense of corresponding with her other brothers, afterward Louis XVIII. and Charles X.

Elizabeth, Pauline Ottilie Luise, queen of Rumania (pseudonym «CARMEN SYLVA»): b. Neuwied 29 Dec. 1843. She married Charles of Rumania, 15 Nov. 1869. She is well known as a writer over the signature «CARMEN SYLVA,» her works including ‹Sappho› (1880); ‹Hammerstein› (1880); ‹Stürme› (1881); ‹Leidens Erdengang› (‹Sorrow on Earth›) (1882); ‹Les pensées d'une reine› (1882); ‹Pelesch Märchen› (1883); ‹Le pic aux regrets› (1884); ‹Es klopft› (1887); etc.

Elizabeth Petrow'na, empress of Russia: b. 29 Dec. 1709; d. 5 Jan. 1762. She was the daughter of Peter the Great and Catharine, and ascended the throne on 7 Dec. 1741, as the result of a conspiracy, in which Ivan VI., a minor, who had reigned only one year, was deposed. Elizabeth is said to have rivaled her mother in beauty, and to have surpassed her in her love of pleasure. Her reign was stained both by her unbridled licentiousness and the tyranny of her government, which was conducted by favorites. Banishment to the mines of Siberia and imprisonment in dungeons were awarded for the slightest political offenses. She was a patron of literature, and corresponded with Voltaire, to whom she supplied materials for his ‹Life of Peter the Great.› She also founded the University of Moscow and the Academy of Fine Arts of St. Petersburg. Elizabeth sent an army, in 1748, to assist Maria Theresa in the war of the Succession, which contributed to bring about the Peace of Aix-la-Chapelle; and she joined in the Seven Years' war against Prussia.

Elizabeth Stuart, queen of Bohemia: b. Falkland Palace, Fifeshire, 16 Aug. 1596; d. London 13 Feb. 1662. She was a daughter of James I. of England, and was married to the Palatine Frederick at Whitehall, 14 Feb. 1613. Her husband was then at the head of the Protestant interest in Germany, and in 1619 he accepted the crown of Bohemia offered to him by the revolted Protestants of that country. This he was only able to retain for a very short period; and after his defeat by the Imperialists at the battle of Prague in 1620, he and his wife were obliged to flee, first to Breslau and Berlin, and then to The Hague. Elizabeth had 13 children, several of whom died early. Charles Louis, the eldest surviving, was reinstated in the palatinate by the Treaty of Westphalia in 1648. His daughter, Elizabeth Charlotte, was the second wife of Philip, Duke of Orleans, brother of Louis XIV. Her descendants were excluded by their Catholicism from the crown of England, but one of them was regent of France during the minority of Louis XV.; and another, Louis Philippe, ascended the throne after the revolution of 1830. Her sons, Princes Rupert and Maurice, distinguished themselves in the civil war in England. Her daughter, Sophia, married into the house of Brunswick, became electress of Hanover, and mother of George I. Elizabeth Stuart's cause was extremely popular with the English nation, and after her husband was deprived of the crown of Bohemia she still retained among them the endearing epithet of «Queen of Hearts.» She returned to England at the Restoration with her nephew, Charles II.

Elizabeth of Valois, vä-lwä, or **Isabella,** Queen of Spain: b. Fontainebleau, France, 22 Nov. 1545; d. Madrid 3 Oct. 1568. She was a daughter of Henry II., of France, and Catharine de Medici. She was destined to be the wife of the infante, Don Carlos, but his father, Philip II., being left a widower, became fascinated and married her himself. The story of a romantic relationship between Elizabeth and Don Carlos has furnished tragic subjects to Otway, Campistron, Chénier, Schiller, and Alfieri.

Elizabeth, Cape. See CAPE ELIZABETH.

Elizabeth, N. J., city, county-seat of Union County; on Newark Bay and the Arthur Kill; and on the Pennsylvania, Lehigh Valley, Baltimore & O., Philadelphia & R., and New Jersey C. R.R.'s; 14 miles southwest of New York. The chief articles manufactured are sewing-machines (one of the shops of the Singer Manufacturing Company employing about 10,000 people being located here), oilcloth, hats, saws, mill-machinery, stoves, hardware, edge-tools, harness, cordage, and combs. A large business is done in the shipment of anthracite coal. The shops of the Central Railroad, employing about 1,000 hands, and the Crescent Steel Works and shipyard are located here. There are three banks, one savings bank and a trust company with a combined capitalization of $700,000 and deposits of $7,154,000, and building and loan associations. Among public institutions are the Alexian Brothers Hospital, General Hospital, Saint Elizabeth Hospital, Orphan Asylum, Old Ladies Home, and Public Library. The educational institutions include the Battin and Pingry high schools, the Vail-Deane School, a business college, and 11 public schools. The city has electric lights and street railways, many handsome churches, and contains an old tavern where Washington stopped on his way to New York for his inauguration. Gen. Winfield Scott's home, the Boudinot House and the old Livingston Mansion. It was settled in 1664 as Elizabethtown and was the state capital from 1755 to 1757. It became a borough in 1748 and was incorporated as a city in 1855. The present form of government is by mayor and council of 24 members elected for two years. Pop. (1900) 52,130.

Elizabeth City, N. C., town, county-seat of Pasquotank County; on the Pasquotank River, and the Norfolk & S. R.R.; about 145 miles northeast of Raleigh. A State normal school is located here. The region about is adapted for agriculture, lumbering, and cotton raising. The manufactures of the town are varied, including cotton, flouring-, saw-, and planing-mills, ship-building, and brick yards, carriage and wagon factories. The town was founded in 1793, and now has a government consisting of a mayor and a municipal council. A naval victory was gained here by the Federals under Commodore Rowan, 10 Feb. 1862. Pop. 6,500.

Elizabeth Islands, a Massachusetts group, 16 in number, forming the town of Gosnold, in Dukes County. They are situated between Vineyard Sound and Buzzard Bay; area, 14 square miles. In 1602 the first New England settlement was made on one of these islands, Cuttyhunk, by Bartholomew Gosnold; but after a residence of a few weeks it was abandoned, and Gosnold returned to England (see GOSNOLD, BARTHOLOMEW). The islands are now favorite summer resorts. Pop. 164.

Elizabethan Architecture, a style of architecture, which began to prevail in England during the reigns of Elizabeth and James I. It was a mixture of inferior Gothic with debased Italian, often very picturesque, but without purity and unity of design. It was characterized by deeply embayed windows, galleries of great length, very tall and elaborate chimneys, strap work in the parapets and window-heads, and many dormented details of surface-carving characteristic of the bizarre influence of the combined Renaissance forms from Germany and Holland. The names of Holbein and John of Padua are associated with this style of architecture in which they had hoped to revive classic models. The mansions erected for the nobility during the reigns of Elizabeth and James I. are examples of this style of architecture, particularly the palace erected in the mixed style for Protector Somerset by John of Padua and the mansion of Longleat for his secretary Sir John Thynne. Others which may still be seen near London and which represent the architecture of the 17th century are: Knowle, belonging to the Duke of Dorset, the Marquis of Salisbury's at Hatfield, Holland House, Campden House in Surrey, Bramshill in Kent, Sir T. Willow's at Charlton, Burton Agnes, Blicking, Montacute, Audley End, Mogus Park, Aston, etc. This style was succeeded by the Jacobean in which Gothic details disappeared. Consult Gosch and Brown, 'Architecture of the Renaissance in England' (London 1894); Richardson, 'Architectural Remains of the Reigns of Elizabeth and James I.' (London 1840); Blomfield, 'History of Renaissance Architecture in England' (London 1897).

Elizabethan Literature.—The Drama. At the beginning of the reign of Elizabeth the conflict between mediævalism and humanism was rife in the drama as in other forms of literature. For the preceding half century there had been a confusion of types; miracle, morality, interlude, and farce existing side by side and exhibiting various differentiations, and there had been a confusion of theatrical conditions, play-acting still remaining largely in amateur hands. Neo-latin imitations of the classics were being succeeded by academic attempts in the vernacular. 'Ralph Roister Doister,' written by Nicholas Udall for a school performance had already in 1552 marked the appearance of comedy as a distinct form after the Plautian model; and 'Gorboduc,' by Sackville and Norton, performed in 1562 before the queen, was the first vernacular tragedy. Two other extant plays written within the next few years and performed by amateurs, 'Jocasta' and 'Tancred and Gismunda,' were, like 'Gorboduc,' attempts by Englishmen of culture to imitate the tragedies of Seneca in accord with the practice of Italian humanists. Meantime 'Apius and Virginia' and 'Damon and Pithias,' mixtures of tragedy and comedy, exhibited the persistence of popular methods combined with classical borrowings, while 'Cambyses' and 'Horestes' were formless chronicles of atrocities without any perceptible classical decorum. The building of the first London theatre in 1576 was the sign of the speedy triumph of the professional companies as the chief purveyors of the drama. A dozen years later the advent of a group of gifted poets prepared the way for Shakespeare by determining the course of a popular drama that was to be literary though disregardful of classical restrictions.

Comedy, where the departure from mediæval forms required by the humanists was far less than in tragedy, was the first to attract literary talent to the public stage. The plays of Wilson revealed a satirical comedy of manners emerging from the morality, and the entertainments devised by Lyly for the children companies, combined lyrical and spectacular attractions with a refined wit and a certain graceful courtliness. Later Green introduced sentimental comedy with its averted tragedy and its idealization of women. Such hasty summarizing, however, does scant justice to the variety and ingenuity of the experiments that preceded Shakespeare, drawing their material from every field from classical myth to native folk lore, and essaying and amalgamating every department of comedy from the Plautian to the pastoral. Most characteristic, perhaps, of all was romantic comedy, usually based on Italian *novelle* and offering a medley of fun, sentiment, and adventure.

In tragedy Kyd adapted Seneca to the conditions of the popular theatres, discarding most of his structural scheme but retaining the story of revenge, the accompanying ghost, the horrors and the moralizing; and thus in the 'Spanish Tragedy' (c. 1587), creating a special type destined to a vigorous existence. Marlowe (1564-93) turned his back on Senecan methods and brought to the rambling and discordant structure of the current popular history plays his splendid blank verse and his soaring imagination. 'Tamburlaine,' 'Faustus,' the 'Jew of Malta,' and 'Edward II.,' the chief plays of his half dozen years of dramatic activity, delighted the vulgar by their violence and spectacle, and at the same time made the public stage the abode of noble noetry and genuine passion. His genius, though never fully developed, remade tragedy and history, giving to the chronicle structure the unity of a protagonist, possessed by extraordinary ambition and engaged in tragic conflict with overpowering opposition.

In Marlowe, as in the other early Elizabethans, there is much that is fantastic, crude, and absurd. The primary aim of each dramatist was to present a story so as to delight a motley audience; hence the tendency was naturally toward stories of sensational crimes for tragedy and of romantic adventures for comedy, without much care for the isolation of either species. Like Marlowe, however, the other dramatists were poets as well as playwrights, stimulated by that imaginative idealism so nobly characteristic of the national temper in the years of Elizabeth's greatness, and in their exuberant and somewhat over fantastic verse reflecting the audacity, adventurousness, emotional extravagance, and undaunted aspiration of the age.

Shakespeare's apprenticeship was served in this period, and his early plays naturally follow the forms then current and exhibit the qualities most prominent in other dramatists. The 'Comedy of Errors' is an adaptation of Plautus; 'Love's Labours Lost' follows Lyly; the 'Two Gentlemen of Verona' recalls the sentimental comedy of Greene; 'Titus Andronicus' is a melodrama of atrocities after the fashion of Kyd; 'Henry VI.' is dominated by Marlowe; and 'Richard III.,' following the Marlowean formula, surpasses the master in the vigorous delineation of the villain protagonist and in the stage effectiveness of his part. But Shakespeare soon left his fellows far behind. The 'Midsummer Night's Dream' and the 'Merchant of Venice' transcended the romantic comedies that had made them possible on the London stage, and 'Romeo and Juliet' as completely surpassed the prevailing tragedy of blood. By 1600 Shakespeare had created his great series of comedies and in the Falstaff plays had wrought a union of comedy and history such as the early chronicle plays had only dimly foreshadowed.

By 1600 new forces were manifest in the drama. A young poet, Marston, was following his successful satires by a series of plays, in part tragedies of blood on the Kydian model, and in part satirical tragi-comedies, which aimed to be searching studies of evil. In 1599 Ben Jonson's 'Every Man in His Humour,' acted by Shakespeare's company, was prefaced with a declaration of war on the absurdities of chronicle history and romantic plays, and with the promise of the creation of a comedy dealing with contemporary manners. Jonson, indeed, continued a powerful force in the drama for the next 25 years. His preaching was all directed toward the establishment of a more conscious and painstaking art, and its regularization by classical examples, while his practice resulted in a noteworthy series of satirical comedies, presenting with powerful humor and realism the follies and vices of the day. Chapman and Middleton were also writing comedies of domestic manners, and the whole trend of the drama from 1600 to 1608 was away from romance and sentiment, resulting in a satirical and realistic treatment in comedy and a more searching analysis of evil in tragedy. Under these circumstances Shakespeare's great series of tragedies was produced. This is not the place to speak of their lasting significance, but merely to note that his genius, now in the full maturity of its powers, was still engaged in transforming the prevailing types of drama. Narratives from chronicle and *novella,* so often the sources of formlessness of structure, resulted in the splendid dramatic concentration of 'Macbeth' and 'Othello'; the absurd tragedy of blood, popular again through the efforts of Marston and others, became 'Hamlet' with its infinite suggestiveness of human tragedy; the grotesqueness characteristic of mediæval as well as Elizabethan drama had its final justification in 'Lear.'

By 1607-8 the success of the heroic plays of Beaumont and Fletcher had brought the romantic and idyllic again into favor and perhaps given the suggestion for Shakespeare's return to romantic tragi-comedy in 'Cymbeline,' a 'Winter's Tale,' and the 'Tempest.' Heroic romances, such as 'Philaster' and the 'Maid's Tragedy' succeeded not only because of their poetry and their sensational contrast of sentimental love and sensual passion, but even more because of the telling theatrical effectiveness of their situations and the clever alternations of suspense and surprise with which their ingenious plots were complicated. The comedy of Beaumont and Fletcher, especially in its later development by Fletcher, like their heroic plays, had a long continued influence on the drama. Possessing ready wit, great poetic facility, and an abundant invention, but without moral taste or any serious criticism of life, Fletcher marks a stage in the drama that may fairly be called decadent when we recall the sound moral sense and the artistic aspiration of the early plays. Yet the last decade of Shakespeare's life was the time of Jonson's greatest comedies, of the masterpieces of Beaumont and Fletcher, and of some of the best work of Chapman, Tourneur, Webster, and Middleton.

The very existence of these masterpieces was of itself a factor in the drama's decline. Webster, writing in 1612, made the first avowal of obligations to his great contemporaries; and henceforth the increasing recognition of the greatness of the immediate past seemed to stifle rather than to inspire innovation and experiment. Webster himself, borrowing freely from others, carried the tragedy of blood to its final development in the powerful and gloomy 'White Devil' and 'Duchess of Malfi.' Middleton in collaboration with Rowley created scenes of powerful tragic interest in 'A Fair Quarrel' and the 'Changeling.' Massinger, collaborating often with Fletcher and to a considerable extent borrowing Fletcher's methods, produced a body of tragedy and tragic-comedy, morally didactic, and rhetorically excellent, but in characterization and poetry somewhat deficient. These are only a few of the writers of tragedy during the reign of James I.; in the development of comedy, where less poetical excellence is demanded, the number of important contributors was much larger. Middleton's most characteristic work was a group of lively comedies that exposed contemporary manners with the frankest realism. Massinger, though on the whole deficient in humor, produced in 'A New Way to Pay Old Debts' the noteworthy character of Sir Giles Overreach that has attracted many great actors, including Kean. Dekker and Heywood, writers without great literary pretensions, wrote a large number of successful plays. Dekker ranged from the romantic idealism of 'Old

Fortunatus' and the sentiment and merriment of the 'Shoemaker's Holiday' to the painful realism of the 'Honest Whore.' Heywood, always a skilful and inventive playwright, likewise wrote plays of every kind, achieving a real masterpiece in his 'A Woman Killed with Kindness' This play may be classed as a sentimental tragic-comedy or as a domestic tragedy, a class which includes a number of plays depicting current crimes and goes back at least as far as 'Arden of Feversham' in Marlowe's day. One other dramatic form, extremely popular in the court of James I., must be mentioned, the court mask. For these scenic and musical entertainments many dramatists, and notably Jonson, wrote libretti; and the spectacles and dances in turn had an important influence on the popular theatres. The dramatic product of the reign of James I. (1603-1625) was indeed fully as large as that of the reign of Elizabeth, and, including as it did the last nine years of Shakespeare's career, vastly greater in value. But the enthusiasm and earnestness of the days of the Armada were succeeded by a time of immorality, corruption, and national weakness. The people were turning more and more to Puritanism, but the drama, following the court, grew less serious, more licentious, and gradually forgetful of its high calling.

During the reign of Charles I. the drama offered little that remains notable, outside of the continued work of the older writers and the plays of Ford and Shirley. Ford, a poet of original and lofty genius, ranks with the great dramatists in the intensity of his tragic crises, but he sought themes and motives, abnormal and decadent. The great dramatists of the preceding generation stimulated Shirley, who was their last worthy follower and who often recalls but never quite equals their best work. Of comic dramatists Brome, of "the tribe of Ben," and Davenant, who belongs to the Restoration, are possibly the most noteworthy. But the great majority of the many plays produced were mediocre. The drama no longer represented the nation; nor in the approach of the civil conflict could it longer command the interest and energy of great intellects or imaginations. It had little virility left when the Puritans closed the theatres in 1642.

Within a few years Chapman, Dekker, and Jonson, the last surviving dramatists of Elizabeth's time, had died. Their lives had spanned the entire course of the drama's development, its rapid rise, and its splendid culmination as well as its decline. The 30 years from Marlowe's first play to the death of Shakespeare include, in fact, all that is great in this amazingly rapid development. Incomparable as this period is because it contains the career of Shakespeare, it is hardly less astonishing because of the variety and range of the work of his fellows. Lacking, as even Shakespeare's plays lack, in the symmetry and unity of the Athenian drama; faulty, as his plays are often faulty, in the over exuberance of language and the violence and extravagance of scenes; suffering, as his genius suffered, from the crudity of a bare stage and an immature dramaturgy; these Elizabethan plays, taken as a whole, reveal, in however inferior measure, his great excellences, the untrammeled play of wit, sentiment, fun, and fancy; a splendid energy of diction and of dramatic treatment; a searching revelation of human character, and an abounding grace and power of poetic expression. See DRAMA.

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Elizabethan Literature — Non-Dramatic Poetry. Elizabethan poetry is the product of the Renaissance,—the flowering of the English stock under the fertilizing power of European thought. English literature at all points—in Alfred's time, in Elizabeth's, in the 18th and 19th centuries,—has owed its great moments to foreign inspiration, but this is true of no age so conspicuously as of the Elizabethan. The period is short, if it be measured strictly by Elizabeth's reign, 1558-1603; and even if the limits be broadened to include Wyatt and Surrey at the beginning and all of Shakespeare's work at the end, it is still but narrow room for the development of the crude religious play into the drama of Shakespeare and Jonson,—of the clumsy sonnets of Wyatt into the great sequences of Sidney, Spenser, and Shakespeare,—of the stiff Tudor music into the noble harmonies of the madrigals and the sweet melodies of the airs.

Perhaps because of this swiftness of development, the age illustrates with unusual clearness the transference of life to books. The rush of genius draws into its vortex most of the experience about it; Spenser's friends enter the 'Faërie Queene' unchanged, and in spite of the allegory, undisguised; Sidney's passion takes over the incidents of his wooing with an immediateness that the occasional bookishness of his inspiration cannot smother; history, scarce made, is subject for a play; the gossip of a ship-wreck becomes the 'Tempest'; and—perhaps most interesting of all—those first poets themselves, the type of the age, Surrey, Sidney, Greville, Raleigh, are caught up as they drop from life, and continue immortal in Shakespeare's young men—Biron, Valentine, Romeo. The contrast here suggested between the mass and power of its literary inheritance and the directness of its foundation upon life, is the distinction of Elizabethan poetry, and perhaps the source of most of its problems.

In this swift drawing-in of Continental Renaissance thought with English history and character, the age is set off by three great names—Spenser, Shakespeare, and Milton—for though Milton stands well outside the Elizabethan period, he is the last term in its development. The apparent remoteness of Spenser, his un-English quality, is due probably to the fact that he is nearest to the great wave; he takes over a larger quantity of unnaturalized material; he represents the early school of wholesale colonizers of Italian thought on English soil. Yet he takes over into his writings quite as much of English life, even of English incident, and quite as much of English character, as Shakespeare. The great dramatist, at first glance so natural, so near to his race, so untouched by the tyranny of books, is indeed all these things, yet his imagination starts always in some foreign suggestion. Aside from the different scale of genius, he is as English as Spenser—no more so; but he represents a more complete blend of the foreign themes with the native mind. So

Milton also, heir to the assimilated learning of the Renaissance — to humanism, yet draws on the most English sources of life — English experience, English character, English landscape. These three poets illustrate the Elizabethan age in that they are typically individual, typically English, and typically children of the Renaissance mind.

It is usual to take as the beginning of Elizabethan poetry the book in which the Elizabethans themselves saw the herald of their day —'Tottel's Miscellany' (1557). This book, a publisher's venture, contained the work of several courtly poets, notably of Sir Thomas Wyatt (1503–1542) and of Henry Howard, Earl of Surrey (1516?–1547). Though the selections were written before Elizabeth's reign, they unfolded already the characteristics of the new age. The sonnets, modeled after Petrarch or translated from him, foretold the later sonnet fashion, with its heavy draughts upon the Italian spring; the imitations of classical poetry showed that the English writers had found the feeding root of the Renaissance itself; and the translations as a whole pointed in the direction of the more notable transferrings of the world's imagination to English, Golding's (1536?–1605) Ovid, 1567, and Chapman's (1559?–1634?) Iliad, 1598, and Odyssey, 1616. So also the lighter lyrics, the best of them by Wyatt, foretold the song-books; Surrey's sonnet to Clare and his poem on Windsor witnessed the vitality of the Elizabethan theme of friendship — the nearness of the living incident in his verse; and Grimald's (1519?–1561?) 'The Garden' prophecied at long range the love of English country life that was to find noble expression in Marvell and Walton.

The fame of Tottel's book made the miscellany a fashionable vehicle of publication throughout the Elizabethan age, though the growing habit of general publishing tended to diminish its importance. 'The Paradise of Dainty Devices' (1576), is interesting for the work it preserves of Richard Edwards (1523?–1566), of Edward de Vere, Earl of Oxford (1550–1604), and of Sidney's friend, Sir Edward Dyer (——?–1607), whose fine "my mind to me a kingdom is," appears in this anthology. 'A Gorgeous Gallery of Gallant Inventions' (1578), illustrates the fashion of translation, and bears witness, in the names of tunes for the poems, to the growing invasion of poetry by music. 'A Handful of Pleasant Delights' (1584), is a weaker anthology, of practically no merit, but 'The Phœnix Nest' (1593), is noteworthy for the elegies on Sidney — one by Sir Walter Raleigh (1552?–1618), and for other poems by Raleigh and Thomas Lodge (1558?–1625). 'England's Helicon' (1600) includes selections from Sidney, Spenser, Breton, Lodge, Peele, and Barnfield, the great writers of the first Elizabethan period, strongly marked by the pastoral vein; the book would be notable for one poem alone, Marlowe's "Come live with me and be my love." 'England's Parnassus' and 'Belvidere, or the Garden of the Muses' (1600), are mere collections of quotations; 'Davison's Poetical Rhapsody' (1602), is of little more importance, though its selections reflect the sonnet vogue. An earlier and more important book, 'The Passionate Pilgrim, by William Shakespeare' (1599) is clearly a miscellany, as only part of its contents, some songs from 'Love's Labour Lost' and some sonnets, are by Shakespeare.

In subject matter the earlier part of the Elizabethan age was pastoral, following the tone set by Sidney's 'Arcadia' (1590). This Elizabethan pastoral, literary, and artificial as in Sanazzarro and other Italian models, left its impress on the incidental songs in the prose romances. Sidney himself was the most zealous experimenter in classical metres, in the general attempt that Gabriel Harvey fostered, to bring English verse under the laws of Latin prosody. Green and Lodge, the great writers of prose romance after Sidney, were less pedantic in their lyrics, yet their songs have the idyllic method of the pastoral, the method of painting.

The best representative of this pastoral period is Edmund Spenser (q.v.). His first book, 'The Shepherd's Calendar' (1579), was an imitation of the Virginian eclogue, with the same bookish flavor — here increased by Edward Kirke's commentary — and with the same allegorical treatment of contemporaries and events under the pastoral mask; but with an English setting and with English ideals that stamp the book as native. In 'The Faërie Queene' (1590–1596) and the 'Amoretti' (1595), Spenser speaks also through the pastoral convention — that subduing of all things to loveliness, which is the mark of the world of the Sicilian Muses. The 'Faërie Queene' especially, as might be expected from its ancestry in the Italian romantic epics, has the irresponsibility of pastoral romance — the arbitrary management of the facts of life as if those facts themselves were a flexible language. The paradox of the Renaissance, of Elizabethan literature, is illustrated here on the largest scale, in the gorgeous, archaic language, the unreal, un-English world of the story on the one hand, and on the other the stern English fibre of the ground theme. This same blending of Italian imagery and expression with English spirituality is seen in the 'Epithalamion' (1595) and in the 'Prothalamion' and the 'Four Hymns' (1596).

The pastoral convention, moulded by Spenser, remained popular, though less characteristic, in the succeeding decades. Michael Drayton (1563–1631), remembered now for his splendid 'Battle of Agincourt' (1605), and for his great sonnet, 'Since There's no Help' (1619), wrote much in the Spenserian pastoral, as did William Browne (1591–1643). In another way also the pastoral habit of beauty was transferred to poems not strictly pastoral, such as Shakespeare's 'Venus and Adonis' (1593), 'Lucrece' (1594), and Marlowe's 'Hero and Leander' (before 1593), where the convention of old-world beauty blends with the Elizabethan zest for a story, evidenced more popularly in the broadside ballads. The tradition of narrative poetry was strong throughout the Tudor period, from the 'Mirror for Magistrates' (1559) to Drayton's 'Baron's Wars' (1603).

As the first period of Elizabethan poetry is pastoral, so the second period, roughly from 1590 to 1600, is marked by the sonnet fashion. The Italian sonnet had been introduced in detached imitations and translations by Wyatt and Surrey, but the fashion of sonnet sequences was set by Sir Philip Sidney's (1554-1586) 'Astrophel and Stella,' published in 1591, but known much earlier. Sidney here followed Petrarch, after the example of the innumerable French sonneteers. His sonnets, however, derive vital and individual interest from the circumstances of his own love for Penelope Devereux, a passion as famed among his contemporaries as Petrarch's love for Laura. His poems have had the not unprecedented fate of being called merely literary in their inspiration, and it cannot be denied that his borrowings were probably many; yet in the mediæval way he considered himself sincerely original, and much in his work supports the claim. The amount of actual incident that he takes over from his own life is large, especially in the noble sonnets that deal with horsemanship and knightly exercise, and his story in one point was radically different from Petrarch's or Dante's. His love was known and returned; the bar between Penelope and himself was one of honor, since she was married to another; this lofty sense of this kind of honor was Sidney's characteristically English contribution to the world-theme of love.

In most cases the "love passionings" of Sidney's imitators were of the head rather than of the heart. This undeniable note of artifice has led to serious doubts as to the sincerity of the greater sequences—Sidney's, Spenser's, and Shakespeare's. With due allowance for the undoubted imitations in all three poets, it remains true that their sonnets, as distinguished from others, have the very tone of sincerity. It would be an interesting question, though hard to answer, whether through the impress of similar ideals of love and courtly behavior, the poets in England and their fellows in France had not acquired for the moment the same channels of thought—whether the similarities in their work are not frequently coincidences rather than borrowings.

Sidney's 'Astrophel and Stella' had been preceded by Thomas Watson's 'Hekatompathia' (1582), a series of pedantic poems on love themes, which had the respect but not the imitation of his contemporaries. In 1592 appeared Samuel Daniels' (1659-1731) 'Delia,' in honor of the Countess of Pembroke, Sidney's sister—a finely written series remembered for some charming lines and for the oft-imitated "Care-charmer Sleep," itself an imitation from Desportes. 'Parthenophil and Parthenophe' (1593) by Barnabe Barnes (1569-1609), though it contains in its enormous mass some poems of charm, is clearly literary in inspiration. Lodge's 'Phillis,' in the same year, reverts to the pastoral background of the romances; the sonnets have the same charm as Lodge's incidental lyrics.

Spenser's 'Amoretti' (1595) record his own love story, and should be read with his beautiful wedding song, the 'Epithalamion.' The sonnets exhibit almost in excess his sweetness of language and his idyllic, picture method; there is an all but fatal smoothness of surface that makes the thought elusive. But the noble tone, the Platonic emphasis on beauty of soul, indicates the true Spencer, and the sonnets rank third among Elizabethan series.

Shakespeare's 'Sonnets,' printed in 1609 but written much earlier, mark the supreme reach of this kind of writing. Some of the attention they have received comes from the poet's greater fame as a dramatist; some of it comes from the mystery that still on many sides envelopes the sonnets; but the story itself, the conflict of the two angels of friendship and of dark love, is the most striking of the sonnet themes, and the powerful directness with which the subject for the most part is treated, places the series above anything else of its kind in English. Natural as the sonnets seem, however, and spontaneous as the themes appear, yet comparison with other sequences shows that Shakespeare assimilated much of his predecessors; how much of his own life is in the story remains the puzzle of his biographers.

In the years immediately following the sonnet-writing, the characteristic vehicle of **Elizabethan** non-dramatic poetry was the **song-book.** The manuscript miscellanies of Henry VIII.'s time had contained the notes as well as the words of songs, and the Elizabethan period was rich in musicians as well as poets. In 1588 Nicholas Younge published his 'Musica Transalpina,' a collection of Italian madrigals with English words. The madigral was a strict musical form, a contrapuntal part song, built up on many repetitions of a musical theme, and so needing few words—only a short poem, or part of a longer one. With the development of the lute and the growing popularity of lute music, came the song built on a melody, with harmonized accompaniment — what the Elizabethan called an Air. John Dowland, the greatest of the lutanists, introduced this new kind of song in 1597, in his 'First Book of Songs or Airs,' and the form was perfected, in both words and music, by Thomas Campion (——?-1619) in several books of Airs. As the Air was but a short melody, repeated without change, it needed for words a short lyric of several stanzas. This need encouraged the composition of short, finely wrought songs, frequently in the lighter vein, such as Campion himself wrote, and such as became a model for Herrick (q.v.).

Beginning with Wyatt, there had been a vein of satire in Elizabethan poetry. Gascoigne (1525-1577) in his 'Steel Glass' (1576), Lodge in his 'Fig for Momus' (1595), Joseph Hall in his 'Virgidemiarum' (1597), and Marston in his 'Satires' (1598), and many lesser writers, kept the tradition alive. One other minor strain, which was destined to flower later into larger expression, was religious verse—often crude and moralizing, as in the miscellanies, often fantastic, as foreshadowing Donne (q.v.), but often devout. In Robert Southwell (1561-1595) this writing becomes passionate and of the first quality. His 'Saint Peter's Complaint' (1595), contains that one poem, "The Burning Babe," that Ben Jonson preferred to all his own work.

These are the main forms of Elizabethan non-dramatic poetry. If we except the 'Faërie Queene,' the genius of the age is perhaps best seen in the drama. But in these other forms the Elizabethan mind preserved for us a broad and varied record of its amazing power to absorb the literary past, and to feel deeply its own experience.

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Elizabethan Literature—Prose. Elizabethan prose has neither the significance nor the splendor of Elizabethan poetry. The greatest masters, Sidney, Lyly, Hooker, have no supreme interest of matter or style; and Bacon belongs in spirit to another age with other ideals and another *ethos*. But the shaping of English speech as an instrument for the science and thought of the 17th century was the result of the efforts of Elizabethan prosemen. Before the period itself commences, the work of More, Elyot, and Latimer, of Coverdale, Tyndale, and the editors of the English Prayerbook, had already brought a simple and vigorous vernacular into being; but the ancestors of Augustan prose were the group of Cambridge scholars, Cheke, Wilson, and Ascham, whose writings, with the exception of the 'Scholemaster,' antedate the accession of Elizabeth. This group devoted considerable attention to the study of English rhetoric; they aimed at plainness and purity of speech and the formation of a literary vernacular in emulation of the classics; they objected to archaisms and affectations of all sorts, and Wilson's condemnation of «ink-horn terms» is one of the significant *loci* of English criticism. The introduction of classical studies as a result of the revival of learning had necessitated a complete revision of the mediæval curriculum, and Ascham's 'Scholemaster,' published posthumously in 1570, follows the fashion set by the humanists of Italy, France, and Germany, in a very large number of pedagogical treatises. Like these humanists, it was his purpose to indicate the education necessary to a cultivated gentleman. His own prose style is simple and direct, borrowing the more inconspicuous excellences of Latin prose. But his mood is in some respects that of the Puritan; and in his suspicion of romance and of the growing Italian influence, he is at odds with the whole spirit of Elizabethan life and letters. Prose and poetry alike were to be saturated with the Italianate spirit which he contemns.

Ascham is in some measure the father of that whole school of Elizabethan stylists, whose model was «eloquence» in the classical and humanistic sense, and who disregarded the ornate and «aureate» tendencies of Continental prose. The full and rich notes of Hooker are the final culmination of this manner. The first four books of the 'Ecclesiastical Polity' were published in 1594: several schools of *Novella Elocutio* had intervened since the composition of the 'Scholemaster,' but they have not affected the purity and directness, the calm and judicious argumentation of Hooker's style and manner. In this great book, moderation and passion temper each other after the fashion of the best Latin prose; and Hooker realizes the ambitions of the earlier English humanists who had made this their ultimate goal. Other models and other ambitions could alone make it possible to arrive at a higher standard than that which Hooker achieves at his best. Much of the book is unreadable to-day, like the technical arguments of the Attic orators; but its soaring passages, like theirs, are monuments of the race and religion whose ardor and conviction they express.

Directness and vigor were also put to far different uses both in secular and in religious polemics. Of the latter, the Martin Marprelate Controversy relating to the problem of church discipline, which raged between 1587 and 1590, gave opportunities which secular pamphleteers only too soon made use of. The significance of 'Hay any work for Cooper?' and 'Pap with a Hatchet' has been greatly overrated; in them the instrument which the Cambridge group had prepared for use was blunted and used as a cudgel. Nor can much more be said of the controversial writings of Nash, Greene, and Harvey, in which is illustrated the nearest Elizabethan approximation to modern journalism, but with manners and morals untempered by a wholesome or cultivated public opinion. Other miscellaneous writings of these men, and of Dekker, Breton, and others, are concerned with every variety of subject, and their models include Aretino, Rabelais, Dedekind, as well as other Continental writers of a wholly different type.

Literary criticism began in this period and employed for the most part the prose style whose tradition goes back to Ascham. In content and structure its models were Italian, either directly or through the French; and its significance consists in the fact that it was the means of introducing literary ideas which had been current in Italy for nearly a century. The group of the Areopagus, which parallels the Pléiade of France in a few more or less important respects, found its highest critical expression in the 'Defence of Poesy' of Sir Philip Sidney, written about 1580, and published posthumously in 1595. Sidney's ideals of prose style are not those of Ascham, but his practice here is without those excesses and affectations which in the 'Aracadia' furnish the model for a whole school of imitators. His book is an impassioned apology for the poetic art against the onslaught of the Puritans; but the objections which it refutes are universal, and its answers to these questions have in themselves, too, the temper of universality. There are parallels for all its ideas in the almost contemporary works of Frenchmen and Italians. They, too, from the dawn of the Renaissance, as in Boccaccio's 'Genealogy of the Gods,' which Sidney doubtless knew, had written defences of poetry; but Sidney's is an English book, and in its passion, unity, and general spirit, seems the native product of Elizabethan genius. Puttenham's 'Arte of English Poesie' conforms more to the model of the formal treatises which the Italians devoted to the theory and practice of poetry. Its purpose, like theirs, is to consider the whole range of criticism; it deals with the history, dignity, forms, metre, and ornaments of poetry, continually illustrating the theory both by example and by anecdote. The critical work of Jonson belongs to the Jacobean age, and its ideals and its style indicate the great changes that had taken place since the 'Defence of Poesy.' It is impossible to date the 'Discoveries' with any degree of certainty, but no word it contains antedates the death of Elizabeth. Jonson, despite the fame of this work, enunciates no single original idea in regard to the art of literature; but the luminous utterances of the later Latin rhetoricians, and the rational classicism of the Dutch critics, are alike embedded in his robust prose, and become an influence on English criticism even after the Restoration.

The formal treatise or preface was the vehicle of criticism in the Elizabethan age; the chief vehicle which it was to use in future was introduced into England by Bacon at the very end of the 16th century. Montaigne is the father of the modern essay; and to him Bacon owed the name and a number of definite ideas. But in everything else no two works could differ more than theirs. The air of loquacity, the personal anecdote, the amused curiosity, the vivid imagery of Montaigne are not to be sought for in the essays of Bacon. The statesman utters his brooding thought in curt and clipt sentences; Seneca and Pliny here speak English; and the sententious manner enters our speech, destined to saturate prose and verse, and resulting after many changes in the pointed couplets of Pope. Each sentence is its own world and has its own message. Bacon, even in his scientific work, has been called a mere phrase maker by a modern scientist whose distinction in this respect is not unlike his own; in the essays this power is unrestrained by the need of argument and experiment. Emerson is the great American example of this dogmatic use of the disjointed sentence, and like Bacon he, too, has fed deeply on the thought of Montaigne.

A wholly different ideal of prose style, disdaining directness and simplicity, was current throughout the Elizabethan age, and found its most natural expression in the novel. Fenton's version of Bandello, adapted through the French, and the varied collection of Painter's 'Palace of Pleasure,' introduced the Italian *novella* into England. Their interest is almost wholly in the story, and Herodotus and Boccaccio are made to speak the same language of fiction. In Pettie's 'Petite Pallace of Pettie his Pleasure,' which is modelled on the work of Painter, a new element intrudes itself, and the style which culminates in Lyly may be said to have been inaugurated. The sources of Euphuism have been sought in individual works of Continental literature, notably in those of Guevara; but modern scholarship finds in it simply one manifestation of a disease which was rife throughout Europe at this period, as a result of the disintegration of Humanism. The excesses of the Ciceronians find a parallel in the antithetical balance of Lyly's sentences; and the absurd imagery was a natural result of a literature which had exhausted its content and sought for originality in affectation of manner. This explains the kindred writings on the continent; and although English prose was young, it could not fail to be affected by these influences. The well known marks of euphuism, the so-called «parisonic antithesis,» the «unnatural natural history,» and the like, may all be explained on these grounds. 'Euphues' itself is in some senses a novel of psychology and character rather than of incident; but its chief purpose is the fashioning of a perfect gentleman after the manner of Castiglione's 'Courtier.' Here Lyly's purpose meets Spenser's; and 'Euphues' may be considered as the connecting link between the purely pedagogical treatise like the 'Scholemaster' and the final poetic idealisation of Renaissance education in the 'Faerie Queene.' The vogue of Euphuism is indicated by the number of its imitators; but it is unnecessary to consider the forms which Euphuistic romance assumed at the hands of Lodge, Greene, and others.

Sidney is credited by his contemporaries, notably Drayton, with having put an end to this fashion; but if the 'Arcadia' is referred to, it can only be said that one affectation has succeeded another. The 'Arcadia,' which has come down to us as a large, posthumous fragment, is the chief representative in English of the pastoralized romance. It owes much to Herberay des Essarts's French version of the 'Amadis of Gaul,' and something to the 'Diana' of Montemayor; in it the Renaissance transmutations of Greek romance find a climax. The mannerisms of Sidney's style are not those of the archaic or affected word, nor of «unnatural natural history,» nor of alliterative antithesis; but the exaggerated imagery, the pomp, the prettiness of the Spanish romances are mingled in the 'Arcadia' in an inextricable jungle of sentence and paragraph. Its vices are those of *conceptismo* rather than of the parallel Spanish vice of *culteranismo*. The mild and modulated Ciceronianism of Hooker, and all of Latin *eloquentia* that Cheke and Ascham had hoped to introduce into English speech, are wholly absent. The 'Unfortunate Traveller' of Nash may be mentioned as an indication of a tendency antipodal to the chivalric pastoralism of Sidney; it introduces in a racier style a picaresque experiment in English fiction between the period of 'Guzman' and 'Lazarillo.' But the novelist and the preacher in general succumbed to the temptations of the ornate style: the novel throughout the period of its origins was tainted with Euphuism or Arcadianism, and pulpit oratory acquired a definite mannerism, which persisted until Eachard, Glanvill, and other pamphleteers ridiculed it out of existence.

With the accession of James I. Jacobean erudition and science superseded the creative impule of the Elizabethans. Bacon and Jonson represent the new sententious manner at its best; other writers lose themselves in a sea of detail; still others add a hectic fervor to thought or feeling. But these things do not properly belong to the Elizabethan spirit. The opposition of the vernacular and ornate styles; the inauguration of formal criticism and prose fiction; the passion for controversy; these are the main impulses of Elizabethan prose.

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Elizabethpol, ĕ-lē-zä-bet-poly, or **Yelizavetpol**, Russia, (1) a government of Transcaucasia, Asiatic Russia; area 16,721 square miles; pop. 890,563, of whom about 60 per cent are Azerbaijan Tartars, 30 per cent Armenians and the balance Kurds, Russians, etc. Chief town Elizabethpol. It is bounded on the north by Tiflis, Daghestan, and Zakataly, east by Baku, south by

Persia, and west by Erivan. It belongs partly to the region of the Little Caucasus and is partly covered with steppes, in the west consisting of high mountains whereas the east is more level. The Kur River and several smaller streams are the chief waterways. Agriculture is the principal industry, the valleys being fertile and well cultivated. Wine is produced in considerable quantities. The rearing of live stock is largely carried on in the steppes. The mountain slopes are well wooded and there are rich deposits of minerals, especially of copper, cobalt and iron ore which are found and mined in large quantities. The Transcaucasian Railway crosses the government, which is divided into eight districts, Elizabethpol, Zanglzur, Aresh, Jebrail, Jevanshir, Shusha, Kazakh and Nukha. (2) A city in the Caucasus, capital of the government of the same name; located on an affluent of the Kur River about 120 miles by rail southeast of Tiflis. It is situated in a rich agricultural region and in addition to raising agricultural products and fruit, the inhabitants are extensively engaged in the silk-worm industry. The city consists of two sections, the old and the new; the former is poorly built with crooked streets and low-roofed houses and is occupied chiefly by Mohammedans; the latter is well built and contains several handsome buildings, churches, mosques, etc. One of the mosques dates from early in the 17th century. There are also an ancient mausoleum and a bazaar. Ancient remains are found in the vicinity of the city and the old Turkish fortifications may still be seen. The city is very old and changed hands between Persians, Arabs and Khozars as early as the 7th century, later came into the possession of the Mongols, Georgians, Persians and Turks, was taken by the Russians in 1796 and finally annexed to Russia in 1813, receiving its name in honor of Elizabeth, daughter of Alexander I. In 1826 the Persians were defeated here. Pop. 35,129.

Elizabethtown, Ky., city, county-seat of Hardin County; on the Louisville & N., and the Illinois C. R.R.'s; about 40 miles south of Louisville. The city is the centre of the trade in asphalt for which the county is noted, and it does a large business in live stock and agricultural products. Pop. 2,000.

Elizabethtown, N. Y., village, county-seat of Essex County; on the Bouquet River, 12 miles west of Westport, the nearest railroad station. Westport is on Lake Champlain and on the Delaware & Hudson Railroad. Elizabethtown is in the Adirondacks, on a height overlooking several beautiful valleys. It is a famous summer resort, and has quite a population in July and August. Pop. (1900) 491.

Elk, or **Moose,** the largest living representative of the deer family, the genus *Alces,* in America, called the moose. It is six and one half to seven feet tall at the shoulder; weighs from 1,000 to 1,500 pounds; is grayish-brown in color with light underparts, and carries a pair of magnificently spread antlers. These are peculiar in that they grow at right-angles to the plane of the face, and are broadly palmate, in two portions, the anterior usually the larger of the two. These antlers have been known to weigh as much as 60 pounds. The elk is further distinguished by having long limbs, a short neck, long flapping ears, a long narrow head, terminating in a broad overhanging muzzle, and small, sunken eyes. The tail is merely rudimentary. In captivity, or even in comparison with other deer, the elk is ugly and rather ungainly. Yet, seen in the forest he presents a thoroughly majestic front to the hunter, and can move as swiftly and more noiselessly than the less bulky and more graceful members of the family. See MOOSE.

The elk of Europe is found on the continent, and to the far north in Scandinavia, northern Russia, and northern Prussia. In America, the moose has retreated to a great extent, toward the Northwest; and it is fairly common throughout Canada and Labrador. The summer home of the elk is near fresh water, where he can feed upon the succulent herbage. In winter he retires to the fastnesses of heavily wooded timber-land, where his food consists of twigs, leafbuds, and certain species of lichens. Like the red-deer, the elk fights for possession of his consort; and fierce combats are waged in the early autumn between stags whose antlers have matured during the retirement of summer. The peculiar blood-curdling challenge, uttered by the male at this season, is reproduced through a short trumpet of rolled birch-bark by both Indian and white hunters, who thus lure the eager elk within shooting distance of their ambush. On account of the power of endurance and strength of the creature, it is frequently made symbolic; and in many localities in Canada, persons of unusual physical power are said to be «As strong as a bull-moose.» It is easily domesticated and made to draw sledges.

Of fossil species, the best known is the Irish Elk, found in the Pleistocene strata, and distinguished by its enormous antlers, the tips of which are sometimes 11 feet apart, but which differ from those of living species in that the beam is flattened into a palm. To sustain their great weight, unusually large and strong limbs, and neck vertebra, were required. While found chiefly in the peat bogs of Ireland, its remains have been discovered also in Great Britain and throughout Europe in lacustrine deposits, brick clay, and ossiferous caves.

Consult: Lydekker, ‹Deer of all Lands› (London 1898); Aflalo, ‹Sport in Europe› (London 1901); Roosevelt (and others), ‹The Deer Family› (New York 1902), and general works on zoology and sport in North America.

Elkesaites. See ELCESAITES.

Elk'hart, Ind., city, in Elkhart County, at the confluence of the St. Joseph and Elkhart Rivers, and on the Cleveland, C., C., & St. L., the Lake Shore and the Elkhart & W. R.R.'s.; 101 miles east of Chicago. It is a railroad centre and shipping point for a large agricultural region. The rivers afford excellent water power. The Lake Shore railroad shops are located here and the manufacturing interests include brass, carriage, starch, bicycle, and paper factories. Elkhart is the seat of Elkhart Institute and has public schools, business colleges, and high school, daily and weekly newspapers, gas and electric lights, electric railways, waterworks and two national banks. Pop. (1900) 15,184.

Elk'horn, a river in Nebraska formed by the junction, in Madison County, of the North Fork, which has its rise in Brown County, and the South Fork which rises in Knox County. The general course is southeast, 260 miles, when it flows into the Platte River.

Elkin, William Lewis, American astronomer: b. New Orleans 29 April 1855. He was educated at the Royal Polytechnic School in Stuttgart, Germany, and was graduated in 1880 at the University of Strasburg. He then went to the Cape of Good Hope on the invitation of Sir David Gill, English astronomer there, and took part with him in observations with the heliometer for the determination of stellar parallax, these determinations being the most accurate of the kind ever made up to that time. He became astronomer in 1884 and director in 1896 of the Yale College observatory.

Elkins, Stephen Benton, American politician: b. Parry County, Ohio, 26 Sept. 1841. He removed to Missouri when a child; was graduated at the University of Missouri in 1860; and admitted to the bar in 1863. During the latter year he went to New Mexico, where he was a member of the Territorial legislature in 1864–5; and the Territorial delegate in Congress in 1873–7. Subsequently he removed to West Virginia. In 1891–3 he was secretary of war, and in 1894, 1000, and 1907 was elected to the United States Senate.

Elkins, W. Va., city and county-seat of Randolph County; on both sides of the Tygarts Valley River and on the West Va. C. & P. (Wabash) and its branches, the Coal & Iron and the Coal & Coke R.R.s; 60 miles south of Grafton and 130 miles northwest of Charleston.

Industries.— Elkins is in the centre of vast timber areas, and nearby are large deposits of coal, glass, sand, limestone, potter's clay, fire clay and shale suitable for the manufacture of pressed brick and tiling. The industries include railroad car and machine shops, brick works, ice plant, foundries and machine shops, tannery, boiler works, nail factory, several planing mills, etc.

Public Works, Banks, Etc.— The principal streets are paved with brick or macadamized limestone, and walks are laid with brick. The city owns the water-works, which pump the water from the Tygarts Valley River. The streets are lighted by electricity and natural gas is furnished for domestic and manufacturing purposes. There are a national bank and a trust company in the city, with combined capital of $300,000 and deposits of about $1,200,000.

Churches and Schools.— The city contains seven churches, representing the leading denominations. There are a graded public school and a high school. Elkins is also the seat of Davis and Elkins College. Pop. (1900) 2,016; (1906) about 5,000.

Elks, Benevolent and Protective Order of, a convivial, charitable, and benevolent organization founded by members of the theatrical profession in New York in 1868, but now admitting to membership men in other professions and occupations. The order has one grand lodge and 951 sub-lodges throughout the country. The membership in the United States numbered more than 200,000, including many prominent men. Though not a beneficial order, it is claimed that it expends more in unostentatious charity than any other organization in the world. The benefits disbursed since organization amount to $1,250,000, with an annual average distribution at present of upward of $150,000.

Ella'gic Acid or **Bezoardic Acid,** $C_{14}H_6O_8$, is separated from Oriental bezoars by dissolving them in cold strong potash, away from the air, passing a current of carbolic acid, collecting the ellagate of potassium, washing and recrystalizing it, and then liberating the ellagic acid by hydrochloric acid. It is insoluble in water, but dissolves in alcohol. It is a pale yellow, tasteless, crystalline powder, decomposed on heating. With the bases it forms salts, which are not very well known; they are crystalline, and insoluble or sparingly soluble in water. The lead and barium compounds are yellow. This acid can also be obtained from gallic acid, of which it is a product of oxidation.

Ellenborough, ĕl'lĕn-bŭr-ō, **Edward Law,** Lord, English lawyer: b. Great Salkeld, Cumberland, 16 Nov. 1750; d. London 13 Dec. 1818. He was educated at Cambridge, and was called to the bar in 1780. On the trial of Warren Hastings in 1785, Erskine having refused to undertake the defense, Law served as leading counsel. It required no little courage to encounter such opponents as Burke, Fox, Sheridan, and other eminent men of the time, who conducted the impeachment. Law, as is well known, obtained the victory. In 1801 he was made attorney-general, and in 1802 became lord chief justice of the king's bench, and was created baron. In Parliament he was opposed to the emancipation of the Catholics. He held the office of chief justice for 15 years.

Ellenborough, Edward Law, 1st Earl of, English statesman: b. 8 Sept. 1790; d. near Cheltenham 22 Dec. 1871. He was educated at Eton and Cambridge; entered Parliament as representative of St. Michael's in 1814, and in 1818 succeeded his father as second baron, and entered the House of Lords. He was lord privy-seal in 1828, and in 1841 accepted the governor-generalship of India. He arrived in Calcutta in time to take control of the Afghan war, which was brought to a successful issue. Scinde was conquered by Sir Charles Napier, and annexed in 1843. This was followed by the conquest of Gwalior. The conduct of the governor-general, however, gave great dissatisfaction at home. He was consequently recalled by the East India Company early in 1844. Under Lord Derby's government in 1858 he held the office of president of the board of control from February to June, during which he wrote a despatch censuring the policy of Lord Canning as governor-general of India, which caused much discussion, and led him to resign his office.

Ellenville, N. Y., village of Ulster County, at the foot of Shawagunk Mountain, on the main line and on the Ellenville and Kingston division of the New York, Ontario & Western R.R., 18 miles N. of Middletown. The first house was built in 1805, a post-office established in 1823, and the village incorporated in 1856. It has several denominational churches, a high school and other educational establishments, two national and one savings bank, and its industries include zinc mining, manufactures of cutlery, overalls, artificial stone, and wood wares, employing about 300 operatives. Pop. (1901) 2,879.

El'ler, Johann Theodor, German chemist: b. Plötzkau, in Anhalt-Bernburg, 29 Nov. 1689; d. Berlin 13 Sept. 1760. In 1721 he was appointed Anhalt-Bernburg physician; in 1724, professor of anatomy in Berlin; in 1735, physician to Frederick the Great; in 1755, privy councilor and director of the physical class of the Academy of Sciences. His papers were published in the 'Memoirs of the Berlin Academy,' and among them is a long and interesting review of the opinions held respecting the elements from the earliest times down to his own day. He also published a series of curious microscopic observations upon the change of blood corpuscles by the addition of different salts, tinctures of plants, and other solutions. Eller was undoubtedly a man of great learning and abilities, but his writings do not indicate a high degree of originality.

Ellerians, a sect of fanatics which arose in 1726, and had for its founder Elias Eller, a ribbon-weaver, who was born in 1690 at Ronsdorf in Berg. He was influenced in his religious beliefs by reading the works of Jacob Böhme, and other mystical writings. The sect committed great excesses, and became very numerous. See Böhme, Jacob.

Ellery, William, American patriot: b. Newport, R. I., 22 Dec. 1727; d. there 15 Feb. 1820. He sat in the Congress of 1776, and was one of the signers of the Declaration of Independence. From 1790 till his death, he retained the office of collector in his native place.

Ellesmere, ĕlz'mēr, **Francis Egerton,** Earl of, English author: b. London 1 Jan. 1800; d. there 18 Feb. 1857. His 'The Pilgrimage and Other Poems' (1856) constitutes his most valid title to fame, though he wrote much and well on biographical, historical, and literary subjects.

Ellesmere Land, the most northern region of the continent of North America, discovered by Baffin in 1616. The western part of this region was explored and mapped by Sverdrup, Otto (q.v.) in 1899. Ellesmere Land is a high plateau, without human inhabitants; a few reindeer, musk-oxen, and wolves find sustenance there. It is separated from Greenland by Smith Sound.

El'let, Charles, American engineer: b. Penn's Manor, Bucks County, Pa., 1 Jan. 1810; d. Cairo, Ill., 21 June 1862. He was educated at the Polytechnic School in Paris, and on his return to America held various responsible engineering posts. He built at Fairmount, Philadelphia, the first wire suspension bridge in the United States, and in 1845 declared that a bridge could be built at Niagara below the Falls adapted for railway purposes. In the Civil War he equipped nine Mississippi River steamboats as rams, and with them defeated a fleet of Confederate rams, but died of wounds on that occasion.

Ellet, Elizabeth Fries Lummis, American prose writer: b. Sodus Point, N. Y., October, 1818; d. New York 3 June 1877. She was popular in her day, and among her books are a translation of Silvio Pellico's 'Euphemia of Messina' (1834); 'Poems, Original and Selected' (1835); 'Characters of Schiller' (1842); 'Pioneer Women of the West' (1852); 'Novelettes of the Musicians' (1852); 'Queens of American Society' (1867); 'Court Circles of the Republic,' with Mrs. R. E. Mack (1869); 'The Practical Housekeeper'; 'Evenings at Woodlawn'; 'Women Artists in All Ages.'

Ellice, ĕl'ĭs, or **Lagoon Islands,** a group of coral islands, situated north of the Fiji and northwest of the Samoan group. They extend for 360 miles in a direction northwest to southeast, and form nine groups, the largest islands being Sophia or Rocky Island, Nukulailai or Mitchell, Ellice, Nukufetau, Vaitupu, Netherland, and Lynx. The inhabitants almost all speak a Samoan dialect, and have traditions of a migration from the Samoan islands. They have long been Christianized, and reading and writing are general. The cocoanut is widely cultivated. These islands were annexed by Great Britain in 1892. Area, 14 square miles. Pop. 2,400.

Ellichpur, ĕl-ich-poor', India, town in Ellichpur district, Berar, once large and prosperous. There is a military cantonment within two miles. The town contains many interesting ruins, including a palace, several fine tombs, and an old well. Pop. 36,240.

El'licott, Andrew, American astronomer and civil engineer: b. Bucks County, Pa., 24 Jan. 1754; d. West Point, N. Y., 28 Aug. 1820. His father founded the town of Ellicott's Mills, Maryland, where the younger days of his son Andrew were devoted to the study of the sciences and practical mechanics. The latter's scientific attainments early attracted public attention, and from the Revolution to the day of his death he was employed in the fulfilment of trusts conferred by the general or State governments. About 1785 he removed to Baltimore, and represented that city in the State legislature. In 1789 he was appointed by President Washington to survey the land lying between Pennsylvania and Lake Erie, and during that year made the first accurate measurement of the Niagara River from lake to lake, with the height of the falls and the fall of the rapids. In 1790 he was employed by the government to survey and lay out the federal metropolis. In 1792 he was made surveyor-general of the United States, and in 1795 superintended the construction of Fort Erie at Presque Isle (now Erie, Pa.), and was employed in laying out the towns of Erie, Warren, and Franklin. In 1796 he was appointed by President Washington commissioner on behalf of the United States under the treaty of San Lorenzo el Real, to determine the southern boundary separating the United States territory from the Spanish possessions. The results of this service, embracing a period of nearly five years appear in his 'Journal' (published 1803). Upon the completion of this service he was appointed by Gov. McKean of Pennsylvania, secretary of the State land office, the duties of which he performed to the year 1808, and in 1812 became professor of mathematics at West Point. In 1817, by order of the government, he proceeded to Montreal to make astronomical observations for carrying into effect some of the articles of the Treaty of Ghent.

Ellicott, Charles John, English Anglican prelate: b. Whitwell, Stamford, England, 25 April 1819. He was educated at St. John's College, Cambridge, and after being professor of divinity in King's College, London, Hulsean lecturer and professor of divinity at Cambridge, and dean of Exeter, was appointed bishop of Gloucester and Bristol in 1863. In 1897 the diocese of Bristol was separated from that of Gloucester, Bishop Ellicott remaining at the head of the latter diocese. He was for 11 years chairman of the scholars engaged on the revision of the New Testament translation, and has published commentaries on the Old and New Testaments, as well as 'Historical Lectures on the Life of Christ'; 'Modern Unbelief' (1877); 'Some Present Dangers of the Church of England' (1878); 'Spiritual Needs in Country Parishes' (1888); 'Sacred Study' (1892-4); 'The Revised Version of Holy Scripture' (1901); etc.

Ellicott, Henry J., American sculptor: b. near Ellicott City, Md., 1848; d. Washington, D. C., 11 Feb. 1901. His best-known works include bronze statues for the 1st and 2nd Pennsylvania Volunteers on the battlefield at Gettysburg, the equestrian statues of Gen. Hancock in Washington and Gen. McClellan in Philadelphia; and memorial monuments in various parts of the United States.

Ellicott City, Md., county-seat of Howard County; on the Patapsco River; eight miles west of Baltimore. St. Charles College (R. C.) in charge of secular clergy, and Rock Hill College, in charge of Brothers of the Christian Schools, are located here. The manufactures and trade are chiefly local. Pop. 1,408.

El'linwood, Frank Fields, American clergyman and author: b. Clinton, N. Y., 20 June 1826. He was graduated at Hamilton College in 1849; was ordained a minister in the Presbyterian Church in 1853; and became secretary of foreign missions for that denomination in 1871. His chief works are: 'The Great Conquest' (1876); 'Oriental Religions and Christianity' (1892); 'Questions and Phases of Modern Missions' (1899).

El'liot, Daniel Giraud, American zoologist: b. New York 7 March 1835. He made zoology a special study from his youth; traveled in Europe, Africa, and parts of Asia in 1856-78; subsequently in Canada, Alaska, South America, and the greater part of the United States. He afterward became curator of zoology in the Field Columbian Museum. He has published: 'The Pheasants'; 'Birds of North America'; 'The Grouse'; 'Birds of Paradise'; Hornbills'; etc. He has been decorated 10 times by various European governments for his researches in natural science.

Elliot, Sir **Gilbert,** Scottish philosopher and poet: b. Teviotdale September 1722; d. Marseilles 11 Jan. 1777. His song of 'Amynta' beginning "My sheep I neglected, I broke my sheep hook," is famous; he also wrote occasional philosophical papers.

Elliot, Henry Rutherford, American journalist: b. Woodbridge, N. J., 21 April 1849; d. New York City, 18 April 1906. He has published: 'The Basset Claim, a Story of Life in Washington' (1887); 'The Common Chord, a Story of the Ninth Ward' (1888); etc.

Elliot, Jane, Scottish poet, sister of Sir Gilbert Elliot: b. Teviotdale, 1727; d. there 29 March 1805. She wrote 'The Flowers of the Forest' (1756), a song of Flodden Field.

El'liott, Arthur Ralph Douglas, Scottish lawyer and author: b. 17 Dec. 1846. He was educated at Edinburgh and Cambridge, was called to the bar in 1880, and was a member of Parliament for Roxburghshire 1880-92, and for the city of Durham 1898-1900. He has been editor of 'The Edinburgh Review' from 1895 and is the author of: 'Criminal Procedure in England and Scotland'; 'The State and the Church' (1881).

Elliott, Charles, American Methodist clergyman: b. Glenconway, County Donegal, Ireland, 16 May 1792; d. Mount Pleasant, Iowa, 3 Jan. 1869. He came to the United States in 1814 and became prominent in the Methodist denomination. He was a professor of languages at Madison College, Uniontown, Pa., 1827-31, and president of Iowa Wesleyan University 1856-60 and 1864-7. He published: 'Treatise on Baptism' (1834); 'Sinfulness of American Slavery' (1851); 'The Bible and Slavery'; etc.

Elliott, Charles Loring, American painter: b. Scipio, N. Y., December 1812; d. Albany, N. Y., 25 Aug. 1868. His works consist almost exclusively of portraits, many of which are of eminent American citizens, and are remarkable for the fidelity of the likeness and their vigorous coloring. In 1846 he became a member of the National Academy of Design.

Elliott, Charles Wyllys, American novelist and historian: b. Guilford, Conn., 27 May 1817; d. 20 Aug. 1883. Settling in New York, he was one of the founders and trustees of the Children's Aid Society in 1853, and in 1857 was one of the commissioners for laying out Central Park. He published among other works: 'Cottages and Cottage Life' (1848); 'Mysteries, or Glimpses of the Supernatural' (1852); 'The Book of American Interiors'; 'Pottery and Porcelain'; 'Remarkable Characters and Places in the Holy Land'; 'St. Domingo, Its Revolution and Its Hero'; 'Wind and Whirlwind,' a novel; etc.

Elliott, Charlotte, English hymn-writer: b. 17 March 1789; d. Brighton 22 Sept. 1871. She wrote a number of religious poems, which were published under the titles: 'Hymns for a Week'; 'Hours of Sorrow'; 'Invalids' Hymn Book.' The last collection included 'Just as I Am,' a hymn which is widely used, and has been translated in "almost every living language."

Elliott, Ebenezer, English poet: b. Masborough, near Sheffield, 17 March 1781; d. Great Houghton, near Barnsley, 1 Dec. 1849. At first a foundry hand, his poetic gift was used in denouncing the exploitation of the proletaria' by a capitalistic oligarchy; yet the bitterness and exaggerated rhetoric one would expect under such circumstances are wholly absent from 'Corn Law Rhymes' (1831), and 'More Prose and Verse' (1850). He was famed in his day as "The Corn Law Rhymer."

Elliott, Sir **Henry Miers,** English historian: b. Westminster 1808; d. Simon's Town, Cape of Good Hope, 20 Dec. 1853. Long an Indian civil servant, he compiled 'Memoirs of the History, Folk Lore, and Distribution of the Races of the Northwestern Provinces of India' (1869), and 'The History of India as Told by Its Own Historians: The Mohammedan Period' (1867-77).

Elliott, Henry Wood, American naturalist and artist: b. Cleveland, Ohio, 13 Nov. 1846. In 1862-78 he was private secretary to Joseph

Henry, secretary of the Smithsonian Institution; in 1869–71 artist of the United States Geological Survey; and in 1872–4 and 1890 a special commissioner for the investigation of the Seal Islands of Alaska. His publications include: 'Monograph of the Seal Islands' (1881), and 'Our Arctic Province, Alaska' (1886); 'The Seal Islands of Alaska' (1894).

Elliott, Jesse Duncan, American naval officer: b. Maryland 1782; d. 1845. He entered the United States navy as a midshipman 1804, and in October of 1812 won the first American naval success on the lakes, capturing two British brigs, the Detroit and the Caledonia, near Fort Erie. He commanded the Niagara, in the battles of Lake Erie, September 1813, being second in command to Perry, whom he succeeded in October of the same year as commander of the Lake Erie fleet. In 1815, during the war against Algiers, he was in command of the sloop of war Ontario, under Decatur, being appointed captain in 1818.

Elliott, Maud Howe, American novelist: b. Boston, Mass., 9 Nov. 1855. She is a daughter of Julia Wood Howe (q.v.), and was married to John Elliott, an artist, in 1887. Her writings include: 'A Newport Aquarelle' (1883); 'The San Rosario Ranch' (1884); 'Atalanta in the South' (1886); 'Mammon' (1888); 'Honor'; and 'Phyllida.'

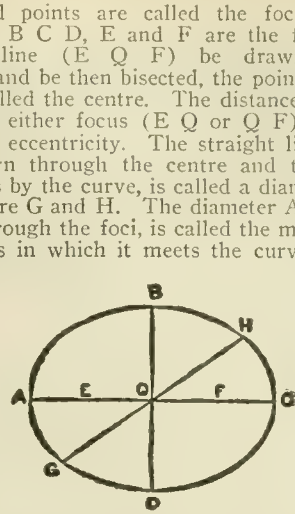
Elliott, Maxine, American actress: b. Rockland, Me. Making her début with E. S. Willard, she played Felicia Umfraville in 'The Middleman' (1890), and later in 'The Professor's Love Story.' She was with Rose Coghlan, and in 1895 went to London with Augustin Daly's company. A member of N. C. Goodwin's company 1896, she played in Clyde Fitch's 'Nathan Hale' (1898); was married to Mr. Goodwin that year, appeared with him in 'When We Were Twenty-One,' and played Portia in the 'Merchant of Venice' (1901).

Elliott, Sarah Barnwell, American novelist. She is a granddaughter of Stephen Elliott (q.v.). Her best-known works are: 'The Felmeres' (1879); 'Jerry'; 'John Paget'; 'Sam Houston'; 'The Durket Sperret' (1898); 'An Incident and Other Happenings' (1899).

Elliott, Stephen, American naturalist: b. Beaufort, S. C., 11 Nov. 1771; d. Charleston 28 March 1830. He was graduated at Yale College in 1791, and was president of the "Bank of the State" from 1812 till his death. His leisure hours were devoted to literary and scientific pursuits, and he cultivated the study of botany with enthusiasm. In 1825 he aided in establishing the medical college of the State, and was elected one of the faculty, and professor of natural history and botany. He was the author of the 'Botany of South Carolina and Georgia' (1821–4).

Elliott, William, American miscellaneous writer: b. Beaufort, S. C., 27 April 1788; d. there. He was educated at Yale, and devoted himself mainly to agriculture and rural sports. His published works include: 'Fiesco,' a tragedy (1850); and 'Carolina Sports by Land and Water' (1856).

Ellipse (Lat. *ellipsis,* from Gr. *elleipsis,* omission), a plane curve of such a form that, if from any point in it two straight lines be drawn to two given fixed points, the sum of these straight lines will always be the same; a geometrical term used in conic sections. These two fixed points are called the foci. In the ellipse A B C D, E and F are the foci. If a straight line (E Q F) be drawn joining the foci, and be then bisected, the point of bisection is called the centre. The distance from the centre to either focus (E Q or Q F) is called the linear eccentricity. The straight line (G Q H), drawn through the centre and terminated both ways by the curve, is called a diameter. Its vertices are G and H. The diameter A C, which passes through the foci, is called the major axis; the points in which it meets the curve (A and



C), the principal vertices. The diameter (B D), at right angles to the major axis, is called the minor axis. Practically, a tolerably accurate ellipse may be drawn on paper by sticking two pins in it to represent the foci, putting over these a bit of thread knotted together at the ends, inserting a pencil in the loop, and pulling the string tight as the figure is described. The importance of the ellipse arises from the fact that the planets move in elliptical orbits, the sun being in one of the foci — a fact which Kepler was the first to discover.

The equation to an ellipse, referred to its centre as origin, and to its major and minor axes as rectangular axes, is $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, where a and b are the semi-major and semi-minor axes respectively. From this equation it may be shown, by the integral calculus, that the area of an ellipse is equal to πab; or is got by multiplying the product of the semi-major and semi-minor axes by 3.1416. It may also be shown that the length of the circumference of an ellipse is got by multiplying the major axis by the quantity

$$\pi\left\{1-\left(\frac{1}{2}\right)^2\frac{e^2}{1}-\left(\frac{1.3}{2.4}\right)^2\frac{e^4}{3}-\left(\frac{1.3.5}{2.4.6}\right)^2\frac{e^6}{5}-\&c.,\right\}$$

to which there is an excellent practical approximation, namely: $\frac{\pi}{2}\left(a+b\sqrt{2(a^2+b^2)}\right)$

The eccentricity e, is $=\sqrt{1-\frac{b^2}{a^2}}$ and the ellipticity is the ratio $a—b$ to a.

Ellip'sis, in grammar, the omission of one or more words, which may be easily supplied by the connection. It is common, especially in colloquial language, for the sake of brevity, and frequently adds to the strength and perspicuity of the sentence. Hence a more extended use of the ellipsis in rhetoric and poetry. In the hands of a genuine poet or orator the ellipsis has a very telling value. In natural language, from the brevity it affords, the ellipsis becomes in all its phases the language of passion, and especially of sudden and intense emotion; and the imitation of its natural use in this way is to the poet the most powerful instrument for painting passion to the life. The works of all the greater poets, and especially the Hebrew poetry of the Old Testament, abounds with familiar instances of this use of the ellipsis.

Ellip'soid, in geometry, a solid figure produced by the revolution of an ellipse about its axis, and all plane sections of which are ellipses or circles. The earth, generally said to be an oblate spheroid, has been designated also an oblate ellipsoid.

Ellis, Alexander John (originally **Sharpe**), English scientist and philologist: b. Hoxton 14 June 1814; d. London 28 Oct. 1890. He was educated at Shrewsbury, Eton, and Trinity, Cambridge, and devoted himself to mathematics, the scientific side of music, and more especially to philology and phonetics. His translation of Prof. Helmholtz's 'Sensations of Tone' (1875), has taken a place as a standard work on scientific music. In 1848 he published two small works: 'The Essentials of Phonetics'; and 'A Plea for Phonetic Spelling,' and collaborated with Sir Isaac Pitman (q.v.) in framing a phonetic system. His *magnum opus* on 'Early English Pronunciation,' with special reference to Chaucer and Shakespeare, appeared between 1869 and 1889.

Ellis, Edward Sylvester, American writer of school text-books and juvenile literature: b. in Geneva, Ohio, 11 April 1840. For some years he was superintendent of public schools at Trenton, N. J. Besides 'The People's Standard History of the United States' and several school histories, his works include: 'The Boy Pioneer Series' (1883–4); 'The Camp Fires of Gen. Lee' (1887); 'The Hunters of the Ozark' (1887); 'The Great River Series' (1888); 'Storm Mountain,' and many other juveniles.

Ellis, George, English author: b. London, England, 1745; d. April 1815. He was educated at Westminster School and Trinity College, Cambridge, and was one of the junta of wits concerned in the well-known political satire, 'The Rolliad.' He published: 'Specimens of the Early English Poets, with an Historical Sketch' (1790); 'Specimens of Early English Metrical Romances' (1805); and was an intimate friend of Sir Walter Scott.

Ellis, George Edward, American Unitarian clergyman and historical writer: b. Boston, Mass., 8 Aug. 1814; d. there 20 Dec. 1894. He was pastor of the Harvard (Unitarian) Church, Charlestown, Mass., 1840–69; and held the professorship of systematic theology in the Cambridge Divinity School 1857–63. As president of the Massachusetts Historical Society he made valuable contributions to early colonial history. He published: 'A Half-Century of the Unitarian Controversy' (1857); 'History of the Battle of Bunker's Hill' (1875); 'The Red Man and the White Man' (1882); 'The Puritan Age and Rule in the Colony of Massachusetts Bay, 1629–85'; various memoirs, and several biographies in Sparks' 'American Biography.'

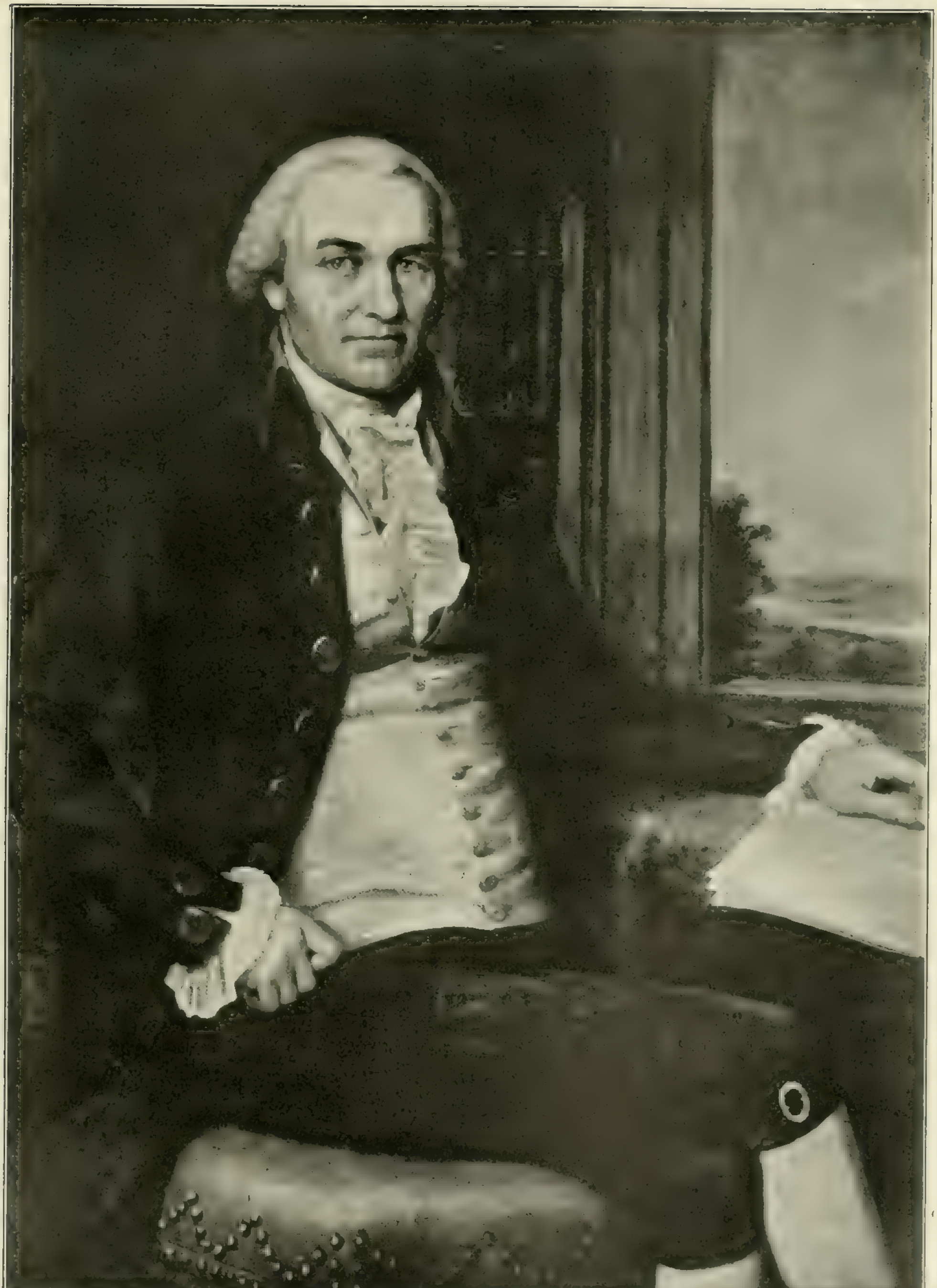
Ellis, Henry Havelock, English scientist and literary scholar: b. Croydon, Surrey, 2 Feb. 1859. He taught school in New South Wales 1875–9, and on his return to England practised medicine for a short time and then devoted himself to literary and scientific work. He is a Fellow of the Medico-legal Society of New York, and honorary Fellow of the Chicago Academy of Medicine, and has been general editor of the 'Contemporary Science Series' from 1889. He edited the 'Mermaid Series of Old Dramatists' (1887–9); and is the author of 'The New Spirit' (1890); 'The Criminal' (1890, enlarged 1901); 'Man and Woman: a Study of Human Secondary Sexual Characters' (1894); 'Sexual Inversion,' being Vol. I. of 'Studies in the Psychology of Sex' (1897); 'Affirmations' (1897); 'The Evolution of Modesty,' being Vol. II. of 'Studies in the Psychology of Sex' (1899); 'The 19th Century: a Dialogue in Utopia' (1900); 'Analysis of the Sexual Impulse,' being Vol. III. of 'Studies in the Psychology of Sex' (1902).

Ellis, Job Bicknell, American botanist: b. Potsdam, N. Y., 1829. With B. M. Everhart he has published: 'North American Pyrenomycetes' (1892); and 'North American Fungi' (1878–93).

Ellis, John, English naturalist: b. London about 1710; d. 1776. He was the first who suggested the idea that the South Sea islands were constructed and raised from the bottom of the ocean by means of zoophytes or the polypi inhabiting different species of coral ('Essay Towards a Natural History of Corallines' 1754). He was for some time agent for the colony of West Florida and the island of Dominica. Among his works is a posthumous one entitled 'The Natural History of Many Curious and Enormous Zoophytes' (1786).

Ellis, Robinson, English classical scholar: b. Barming, Kent, 5 Sept. 1834. He was educated at Rugby and Balliol College, Oxford; and in 1870 became professor of Latin in University College, London. From 1883 till 1893 he was university reader in Latin literature at Oxford, and in the latter year he was elected to the corpus professorship of Latin. His name is chiefly associated with the elucidation of the poems of the Roman poet Catullus. In 1867 he published a critical edition of Catullus ('Catulli Veronensis Liber'), and in 1871 'The Poems and Fragments of Catullus' in the metres of the original, these works being followed by a 'Commentary on Catullus' (1876). Other publications of his include: Ovid's 'Ibis,' with commentary (1881); 'Fables of Avianus' (1887); 'Noctes Manilianæ' (1891); 'The Fables of Phædrus' (1894); and a new recension of 'Velleius Paterculus,' with commentary.

Ellis, Sarah Stickney, English author: b. London, England, 1812; d. Hoddesdon, Herts, 16 June 1872. She was the wife of William Ellis (q.v.). Among her works the best known are: 'Women of England' (1838); and 'Daughters of England' (1842). Still others are: 'Poetry of Life' (1838); 'Summer and Winter in the Pyrenees' (1841); 'The Island Queen' (1846), a poem; 'Fireside Tales' (1848); 'The Brewer's Family' (1863); 'William and Mary' (1865); 'Northern Roses.'



OLIVER ELLSWORTH.

CHIEF JUSTICE OF THE UNITED STATES SUPREME COURT, 1796-1800.

Ellis, T. Mullett, English poet and novelist: b. 29 Dec. 1850. He is the founder and editor of 'The Thrush,' a magazine for original verse, and has published: 'The Earl's Nose,' humorous verse; 'Reveries of World History' (1893); 'The Beauty of Boscastle' (1894); 'Zalma' (1895); 'Tales of the Klondike'; 'God is Love' (1898); 'Kitty, a Story of the Transvaal War'; etc.

Ellis Island, a small island owned by the United States government, and used as an immigrant station. It is situated in New York Bay, one mile southwest of the Battery, where the old immigrant station, Castle Garden, was located. The United States immigrant commissioner has his offices on this island. Immigrants detained for investigation as to compliance with the United States immigration laws, are kept on this island until allowed to land or are deported. See IMMIGRATION LAWS.

Ellora, ĕ-lō'rä, **Elora,** or **Eluru,** ĕ-loo'rä, India, village in the province of Aurungabad; celebrated for some remarkable cave temples, excavated in the solid rock, which in magnitude and perfection surpass all other constructions of the kind in India.

Ellore, ĕ-lōr', India, town, in the Godavari district of the Madras presidency, on the river Jammaler, once the capital of the Northern Circars. It has magisterial and judicial establishments, police station, post-office, etc., a number of Christian missions, and a garrison. There are some manufactures of carpets and saltpetre. Pop. 29,382.

Ells, Robert Wheelock, Canadian geologist: b. Cornwallis, N. S., 26 July 1845. He was graduated at McGill University in 1872, and in May of that year joined the staff of the Canadian Geological Survey, of which he later became senior geologist. He is the author of numerous reports on geology and mineral resources, published in the annual volumes of the Canadian Geographical Survey since 1872.

Ells'worth, Ephraim Elmer, American soldier: b. Mechanicsville, N. Y., 23 April 1837; d. Alexandria, Va., 24 May 1861. He organized about 1859 a zouave corps which became noted for the excellence of its discipline. In March 1861 he accompanied President Lincoln to Washington, and in April he went to New York, where he organized a zouave regiment of firemen, of which he became colonel. Ordered to Alexandria, he lowered a Confederate flag floating over a hotel, for which act the hotelkeeper shot him dead.

Ellsworth, Oliver, American jurist: b. Windsor, Conn., 29 April 1745; d. there 26 Nov. 1807. He was graduated at the College of New Jersey in 1766, and soon after commenced the practice of law. In 1777 he was chosen a delegate to the Continental Congress, and in 1780 was elected a member of the council of Connecticut, in which body he continued till 1784, when he was appointed a judge of the superior court. In 1787 he was elected to the convention which framed the Federal Constitution, and was afterward a member of the State convention, where he earnestly advocated the ratification of that important instrument, which his exertions had essentially aided in producing. In 1789 he was chosen a senator of the United States, which station he filled till 1796, when he was nominated by Washington chief justice of the Supreme Court of the United States. In 1799 he was appointed envoy extraordinary to Paris, and with his associates successfully negotiated a treaty with the French. He resigned his office of chief justice in 1800.

Ellsworth, Timothy Edwards, American soldier and politician: b. East Windsor, Conn., September 1836; d. Buffalo, N. Y., 10 Feb. 1904. He was admitted to the bar in 1858, and at the outbreak of the Civil War recruited a company of cavalry, of which he was made captain, and which became a part of the 7th N. Y. cavalry. He practised law at Lockport, and was elected to the State Senate in 1881, 1883, 1895, 1898, and 1900, being at one time speaker *pro tem.* and Republican leader.

Ellsworth, Maine, city, port of entry and county-seat of Hancock County, on both sides of the Union River, and on the Maine C. R.R.; 29 miles southeast of Bangor. It is the trade centre of the county and has extensive timber, ice, ship-building, and fishing interests, exporting over 50,000,000 feet of lumber annually. It has shoe, woolen, leather, and other manufacturing industries, a public high school, custom house, court-house, public library, two national banks, and two weekly newspapers. Pop. (1900) 4,297.

Ell'wanger, George Herman, American author: b. Rochester, N. Y., 10 July 1848. He was educated in Europe and has devoted himself mainly to literature. His published works are: 'The Gardener's Story, or Pleasures and Trials of an Amateur Gardener' (1889); 'The Story of My House' (1891); 'In Gold and Silver' (1892); 'Idyllists of the Country Side' (1896); 'Meditations on Gout, With a Consideration of Its Cure Through the Use of Wine' (1898); 'Love's Demesne, a Garland of Contemporary Love Poems' (edited 1896).

Ell'wood, Thomas, English Quaker: b. Crowell, near Thame, Oxfordshire, 1639; d. Amersham 1 March 1714. About 1660 he was induced to join the Society of Friends, and subsequently became reader to Milton, with whom he improved himself in the learned languages, but was soon obliged to quit London on account of his health. In the year 1665 he procured a lodging for Milton at Chalfont, Bucks, and was the occasion of his writing 'Paradise Regained' by the following observation made on the return of the 'Paradise Lost,' which the poet had lent him to read in manuscript: "Thou hast said much of paradise lost, but what hast thou to say of paradise found?" In 1705 he published the first part of 'Sacred History, or the Historical Parts of the Old Testament'; and in 1709 'Sacred History, etc., of the New Testament.' His other works are numerous; among them 'Davideis, the Life of David, King of Israel, a poem, which is more distinguished for piety than poetry. His life, written by himself, and published the year after his death, affords many interesting particulars of the history of his sect.

Elm, *Ulmus,* a genus of trees and a few shrubs of the natural order *Ulmaceæ.* The species, of which about 20 are known, are natives of the north temperate zone and the southern portions of the Arctic zone. Their southern limits seem to be the Himalayas in Asia and the mountains of southern Mexico. None are natives of the Pacific slope. They are characterized by short petioled, alternate, rough, usually deciduous, leaves with serrate edges; axillary racemes of perfect, apetalous flowers which appear in early spring before or with the leaves; and compressed, winged, dry fruits (nutlets). Many of the species are of wide economic importance. Their hard, heavy, tough, pliable wood is largely used in the manufacture of barrels, agricultural implements, boats, wagon wheels, buildings, etc., and for fuel. The inner bark of some species furnishes an article of food, and that of others a tough bast fibre used for cordage and cloth making. The outer bark of others is used in dyeing and sugar refining. Various parts of several species were formerly popular remedies employed in medicine, but except in domestic and local practice are rarely prescribed. Most of the species are highly valued as ornamental trees in street and park planting, those specially popular being the straight trunked, tall growing, vase-formed species, which quickly over-arch the streets and cast an abundant shade. Many cultivated varieties of fantastic form, color of foliage or habit of growth are also planted as curiosities.

The best-known American species is probably the white, water, or American elm (*U. alba* or *Americana*), which grows in rich moist woods, especially on the shores of streams from Newfoundland to Florida and westward to the eastern side of the Rocky Mountains. It is a tall tree, often attaining a height of 120 feet when growing in the forest, and a wide-spreading, less lofty top when growing in the open, where it may be seen in several different forms, popularly known as vase, plume, oak-tree, etc., according to the arrangement of the branches. Some specimens of each form develop numerous twiggy growths upon the trunk and main branches, which are thus rendered very attractive because of their feathery appearance. The most common form is the vase, in which the main branches develop at about 20 feet or more, and at their bases gradually, and toward their extremities widely diverge. This is probably the most popular street form and species in America. Another well-known American species is the slippery or red elm (*U. fulva* or *rubra*), which attains a height of 70 feet in rich soils and is found from Quebec to Florida and westward to Texas and Dakota. It is called red because the bud scales are reddish and conspicuous when unfolding in spring; and it is called slippery because of its mucilaginous inner bark. Its wood is less valued than that of the English elm, but more than that of the white elm. The cork or rock elm (*U. racemosa*), which grows on river banks from New England to Nebraska and as far south as Kentucky and Tennessee, attains a height of 100 feet and is noted for the corky developments resembling wings on the smaller branches. Its wood is specially valued for its great durability, strength, pliability, and toughness. Another species with corky, winged branches is the Wahoo or winged elm (*U. alata*), which ranges from Virginia to Florida and westward to Texas and Illinois. It rarely exceeds 70 feet in height, is very attractive in habit, and is planted for ornament in the South, but not in the North, as it is not sufficiently hardy for the rigors of winter.

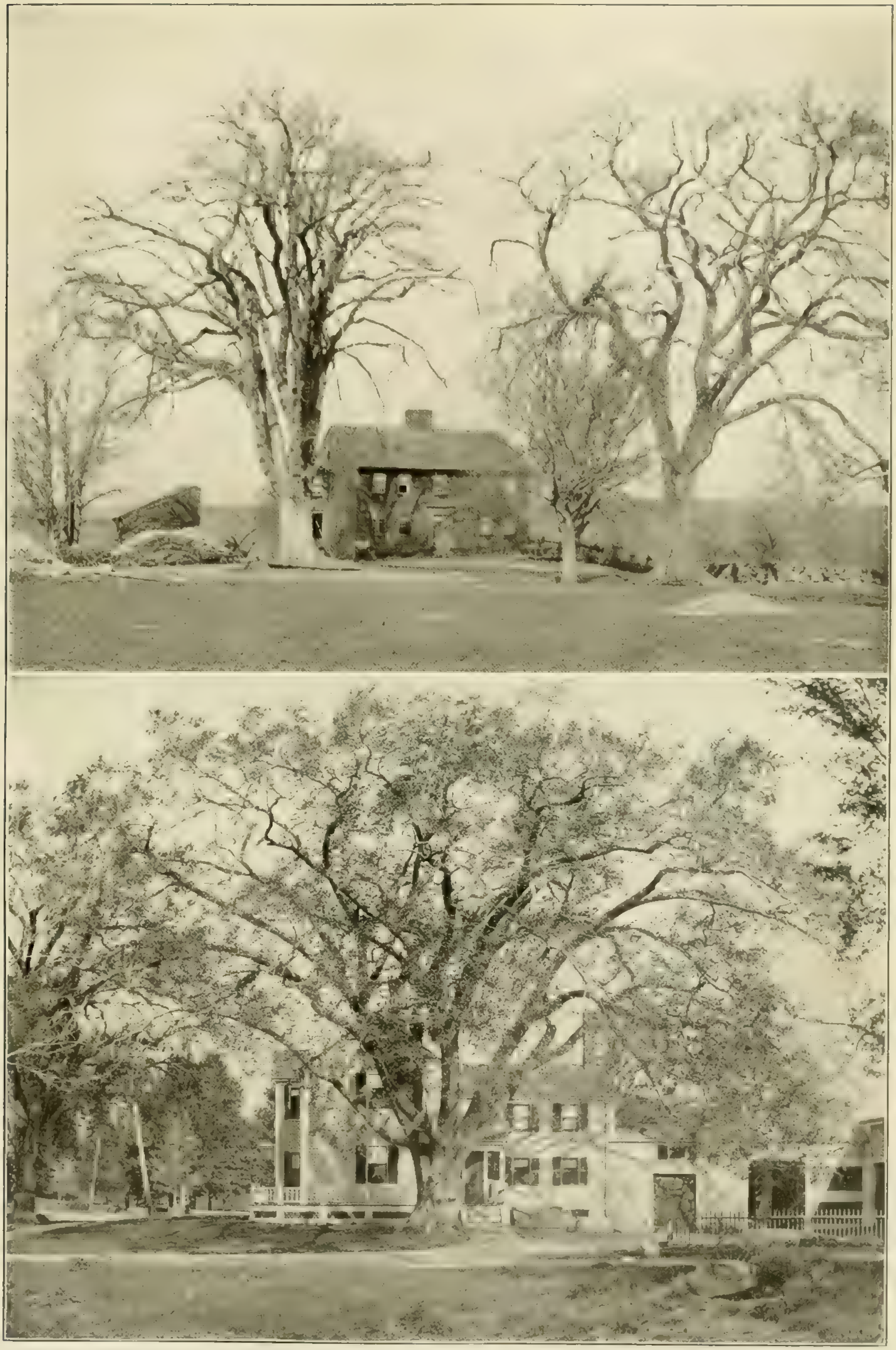
The most noted European species is the English elm (*U. campestris*), which ranges through middle and southern Europe, northern Africa, and eastward to Japan. It reaches 100 feet in height and has a rather round-topped or open head, on account of its spreading branches. It is frequently planted for ornament at home and abroad, and in America is valued because its foliage continues green for several weeks after that of the white elm. It has several distinct varieties, which are sometimes considered as distinct species, and of which there are a large number of horticultural varieties. The next most important European species is probably the Scotch or wych elm (*U. scabra* or *montana*), which has much the same range as the preceding species, like which it attains a height of about 100 feet. It is a variable species with many cultivated varieties, one of the best known of which is the Camperdown elm, which has long, pendulous branches, on account of which the tree is frequently planted as a curiosity in parks and gardens. The Chinese elm (*U. parvifolia*) is a semi-evergreen shrub or small tree, a native of eastern Asia, which has proved hardy in America as far north as Massachusetts.

Elms are readily propagated from seed which ripens in late spring or early summer and should be sown at once. The seedlings are easily managed, both as to cultivation, transplanting and pruning. The trees do best in rich soil, especially if moist. The choice varieties are generally grafted. The trees, especially of the American or white elm, are specially liable to the attacks of certain insects and diseases, which often defoliate them. The latter may be kept in check by the timely and proper application of a standard fungicide (q.v.).

The name elm is also given to various unrelated trees, the best known of which are probably the following: Water elm (*Phanera aquatica*); Spanish elm or Bois-de-Chypre (*Cordia gerascanthus*), and also to *Hamelia ventricosa*, both of which species are natives of the West Indies. Several Australian trees are also known as elms, especially *Duboisia myoporoides* and *Aphananthe Philippinensis*, each of which is valued for its timber.

Elm, Slippery, in medicine, the bark of *Ulmus fulva*, is widely used as a demulcent. It is probable that the ancient Indian inhabitants of the country introduced it into modern medicine. Slippery elm bark is noted for the large amount of mucilage which it contains, thus rendering it a pleasing demulcent for sore throat, diarrhœa, dysentery, and inflammation of the intestinal tract in general.

Elm-insects. Few ornamental trees are more subject to the attacks of insects than are the elms, and especially the American elm. The European species are, however, attractive to the European insects, of which many have been brought over unintentionally, and have spread remarkably because of the absence of their enemies. One of the most notable is the plant-louse known as *Colopha ulmicola*, which produces the cockscomb galls upon the foliage. It is rarely very troublesome, and has usually done its damage before it can be attacked. Kerosene emulsion, if applied in time, will prove



FAMOUS NEW ENGLAND ELMS.

effective. (See INSECTICIDE.) A borer (*Saperda tridentata*) is sometimes troublesome, but there seems to be no satisfactory way to control it. Most of the other insects that attack the elms are beetles, their larvæ, or the caterpillars of various moths. These all bite their food, and hence may be attacked with arsenites or other stomach poisons sprayed upon the foliage. Among these insects are the four-horned sphinx-moth (*Ceratomia amyntor* or *quadricornis*), a green caterpillar with four little horns near the head and the long anal horn characteristic of the sphinx-moth. The bag-worm (*Thyridopteryx ephemeræformis*), the gypsy-moth (*Ocneria dispar*), the tussock-moth (*Notolophus* or *Orgyria leucostigma*), and several other general feeders are frequently troublesome. But the most important leaf-eating enemy of the elm is the elm-leaf beetle (*Galeruca xanthomelæna*), a greenish-yellow, two-striped European insect which appears and eats the leaves in spring. The bottle-shaped yellow eggs are laid in rows on the under sides of the leaves, and the hairy, black-spotted, yellow larvæ eat circular holes between the leaf-veins. Spraying with arsenites is effective, but where more than one brood is produced the sprayings must be repeated frequently throughout the summer. Consult Marlatt, 'Elm Leaf Beetle,' Circular 8, Division of Entomology, United States Department of Agriculture.

Elmer, Horace, American naval officer: b. Bridgeton, N. J., 1847; d. Brooklyn, N. Y., 27 April 1898. He entered the navy as acting midshipman in September 1861, and reached the rank of commander in 1885. During the winter of 1897–8 he superintended the construction of naval vessels at Cramp's shipyard in Philadelphia. When it became evident that war with Spain would break out, he was ordered to organize the naval force afterward known as the "mosquito fleet" for coast patrol duty.

Elmina, ĕl-mē'nä, or **St. George del Mina,** West Africa, a town belonging to Great Britain, formerly the capital of the Dutch settlements on the Gold Coast, five or six miles west of Cape Coast Castle. The Castle of Saint George del Mina was the first European establishment on the coast of Guinea, having been erected by the Portuguese in 1481. Pop. 10,530.

Elmi'ra, N. Y., city, county-seat of Chemung County, on both sides of the Chemung River, and on the Delaware and Lackawanna, the Lehigh Valley, the Northern Central, and the Erie railways; 100 miles southeast of Rochester, 149 miles east-southeast of Buffalo, and 46 miles south-southwest of Ithaca.

Industries, etc.—The government census for 1900 records a total of 362 industrial establishments, with a capital of $7,365,534, the average number of wage-earners being 4,914, with total wages of $1,965,056. Among the more important establishments are railway car and general construction and repair shops, steel-plate works, boot and shoe manufactories, glass works rolling-mills, fire-engine construction works, boiler and engine shops, lumber and planing mills, sash, door and blind factories, breweries, tobacco warehouses and factories of tobacco products, iron and steel bridge works, dye-works, silk-mills, knitting-mills, and hardwood-finishing works. The district is fertile, and there are also stone-quarries in the vicinity.

Public Institutions, Buildings, etc.— Here are located Elmira College (q.v.), a State armory, the State reformatory (see ELMIRA REFORMATORY), the Arnot-Ogden Memorial Hospital, the Steele Memorial Free Library, a Federal government building housing the Federal courts, the post-office, etc., and various charitable institutions. The park system includes Wisner, Riverside, Eldridge, and Hoffman parks. Elmira is finely laid out, and has an excellent water supply, and gas and electric lighting.

History, Government etc.— Elmira was permanently settled in 1788, was incorporated as the village of Newtown in 1815, and in 1828 was re-incorporated as the village of Elmira. In 1836 it became the county-seat of Chemung County, and in 1864 obtained its city charter. During the Civil War it was the State recruiting and military rendezvous, and in 1864–5 one of the Federal prisons for Confederate prisoners of war was here situated. Near the present site of Elmira the battle of Newtown was fought, 29 Aug. 1779. General Sullivan, with an American force numbering 5,000, defeating a combined band of Tories and Indians commanded respectively by Sir John Johnson and Joseph Brant (Thayendanegea) and numbering approximately 1,500. The battle-ground is now marked by a memorial to Sullivan. Elmira is governed, under a charter of 1894, by a mayor, who is biennially elected, and a common council, which is unicameral. In addition to the aldermen, who are chosen by wards for terms of two years, the recorder, municipal judge, and 12 supervisors, to act as a county board, are also chosen by popular vote. Pop. (1890) 30,893; (1900) 35,672; (1903 est.) 37,106.

Elmira, Battle of, 29 Aug. 1779, in the Revolution. See CHEMUNG, BATTLE OF.

Elmira College, an institution for women, located in Elmira, N. Y. It was founded in 1855 under the auspices of the Presbyterian Church, and its course of study from the first demanded as high a grade of work as is usual in first-class colleges. The degrees conferred are bachelor of arts, bachelor of science, bachelor of music, and master of arts.

Elmira Reformatory, a State institution, located in Elmira, N. Y. It is a reformatory to which may be sent only men between the ages of 16 and 30 who have not served a period in a State prison. The court of the State of New York, in sentencing a prisoner to this institution, has no authority to limit the time; that is determined by the managers of the institution, and is almost wholly dependent upon the conduct of the prisoner. However, the term of imprisonment shall not, according to the law of the State, "exceed the maximum term provided by law for the crime for which the prisoner was convicted and sentenced." This reformatory, which takes the place of a State prison for male offenders who have not become hardened in crime, has effected a radical change in methods of dealing with the class of law-breakers intended to benefit. (See BROCKWAY, Z. R.) Consult: Winter, 'The Elmira Reformatory'; New York State Laws of 1877, sec. 2, ch. 173.

Elmo, Ermo, or Erasmus, Saint, a martyr who suffered death at Formiæ, a town of ancient Italy, during the persecution under Diocletian, in 303. He is considered the patron saint of sailors, and is usually invoked by Italian sailors during a storm. His feast is kept on June 3.

Elmo's Fire, Saint, is the popular name of an electric appearance sometimes seen, especially in southern climates during thunderstorms, of a brush or star of light at the tops of masts, spires, or other pointed objects. It is also observed at the tops of trees, on the manes of horses, and occasionally about human heads. It is similar in kind to the luminous glow seen at the point when a lightning-rod is working imperfectly, or when there is any very rapid production of electricity. The phenomenon, as seen at sea, was woven by the Greeks into the myth of Castor and Pollux, and was regarded as of friendly omen. The name Elmo is by many thought to be a corruption of that of Helena, the sister of Castor and Pollux. Others take it to be a corruption of Saint Erasmus (Italianized, *Ermo, Elmo*), a Syrian bishop and martyr of the 3rd century, who is invoked by Mediterranean sailors during storms. The phenomenon has also been called the fire of Saint Elias, of Saint Clara, of Saint Nicholas, and of Helena, as well as composite, composant or corposant (that is, *corpus sanctum*).

El'more, Alfred, Irish artist: b. Clonakilty, Ireland, 18 June 1815; d. London 24 Jan. 1881. He studied at Royal Academy, London, traveled through Europe to Rome, where he lived two years, returned to England 1844, becoming an associate of the Royal Academy 1845, and Royal Academician 1856. Among his works are: 'Martyrdom of Thomas à Becket' (1840), St. Andrew's Church, Dublin; 'The Novice' (1843); 'Rienzi' (1844); 'Death of Robert, King of Naples' (1848); 'Griselda' (1850); 'Charles V. at Yuste' (1856); 'Marie Antoinette in the Temple' (1861); 'Louis XIII. and Louis XIV.' (1870); 'Ophelia' (1875); 'Mary Queen of Scots and Darnley' (1877); 'Pompeii,' 'John Alden and Priscilla' (1878); 'After the Ruin,' and 'Lenore.'

Elms, City of, a popular name given to New Haven, Conn.

Elmshorn, ĕlmz'hôrn, Germany, town in Sleswick-Holstein, 20 miles northwest of Hamburg, on the railway to Kiel, and on the Krückau, a navigable tributary of the Elbe. It carries on a considerable amount of traffic by land and water, and has manufacturing industries of various kinds, such as leather, boots and shoes, machinery, dyeing, linen- and cotton-weaving, distilling and brewing, etc. Pop. 13,720.

Elobey (a-lō-bā'ē) **Islands,** the name of two small islands off the coast of Guinea, in Africa, both of which belong to Spain. On Elobey Chico, the smaller island, there is a missionary school, and some manufacturing has been begun. Elobey Grande is the larger island. Pop. of both (1901) 350.

Elocution, the art of correct speaking or reading in public, including the appropriate use of gestures. Great attention was paid by the ancients to this art as a branch of oratory. The rhetors in Greece had schools in which young men were trained in the correct use of the voice. Many of the Romans were sent to Greece to study and afterward there were similar teachers of elocution and oratory in Rome. In modern times the stage has fostered the study of elocution and special attention has been given to it in the Paris Conservatoire, where the strictest canons of the art have been maintained. Many colleges have established professorships of elocution, and it is also one of the branches in the curriculum of well-regulated conservatories of music. The tendency of modern teachers is toward greater simplicity and naturalness of gesture and repose of manner than was formerly used. Perhaps the most successful teacher of this century was Delsarte (q.v.), whose theories and practice worked a revolution both in France and other countries. Notable schools of elocution have been established in this country by Charles Wesley Emerson, Franklin H. Sargent, and others. The list of distinguished elocutionists includes the names of Munroe, Riddle, Riley, Powers, and Mackaye. See ORATORY.

Eloge, ā-lōzh (French), is a discourse pronounced in public in honor of the memory of an illustrious person recently deceased. In modern times the éloge is peculiarly a French institution, and has given rise to a quite distinct species of literature, which, though its style is not the most agreeable, is not altogether without utility, as the best éloges frequently contain rapid and summary views of the state of science, art, literature at a particular time, of the works of some distinguished author, the political events of a period, or whatever other theme may be suggested to the orator by the particular career of the subject of his eulogy. The éloges of Fontenelle (1731), and of Cuvier (1819), are particularly valuable and interesting. Such summaries, of course, considering the object with which they are made, must be received with great caution, but they frequently convey information not easily accessible in other ways. An éloge is pronounced over every member of the French Academy when he dies, as the inaugural discourse of the new member who is chosen to succeed him. The abuses to which this style of composition is liable have given rise to burlesque and satirical éloges.

Elohim, ĕl'ō-hĭm or ē-lō'hĭm (plural of Eloah), one of the Hebrew names for God, of frequent occurrence in the Bible, especially in those parts of the Pentateuch attributed to the earliest writers in the northern domain of the Semitic race. Elohim is used in speaking both of the true God and of false gods, while Jehovah is confined to the true God. The plural form of Elohim (literally signifying "the great Eloah" or God) has caused a good deal of controversy among critics. By some it has been considered as containing an allusion to the doctrine of the Trinity, others regard it as the plural of excellence, while others hold it as establishing the fact of a primitive polytheism. This word, along with Jehovah, has played a great part in modern criticism. Critics have professed to find in the comparative frequency of the two terms an evidence of the date of the manuscripts in which they occur; but on this controversy we cannot enter. See ELOHIST.

Elohist, ĕl'ō-hĭst, also called **Yahwist,** both used in contradistincton to Jehovist (q.v.), one of the Biblical writers, hypothetically assumed to have written part of the Pentateuch, who habitually, if not exclusively, used **the**

Hebrew name Elohim for God. The Elohistic passages in the Old Testament, as determined upon by Biblical scholars, are simple, straightforward, and bear no signs of rhetoric or poetic effort, therein contrasting with the Jehovistic paragraphs. Gen. i. 27 is Elohistic; Gen. ii. 21-4 is Jehovistic. See BIBLE.

Elonga'tion, in astronomy, the angle that measures the apparent distance of two stars as seen from the earth. The term is, however, by usage confined exclusively to the distance of a planet from the sun, and of a satellite from its primary. The greatest elongation of Mercury amounts to about 28° 30′; that of Venus to about 47° 48′, and that of the superior planets may have any value up to 180°. When two fixed stars or planets are spoken of the word «distance» is employed.

Elopement, an act of unlicensed departure, especially when a wife forsakes her husband and flees with a paramour, or when a daughter or ward accepting the protection of a lover leaves her natural or legal guardians. In almost every one of the States, the male principal in an elopement is held guilty of an abduction provided his associate in the act is under age. Marriage, however, checks all consequent criminal proceedings unless the female alleges coercion. All persons guilty of aiding or abetting an elopement of a male with a female are deemed in law accessories, and liable to legal proceedings. Elopers themselves are not safe from arrest, their act coming within the purview of the criminal statutes.

Elothe'rium, an extinct suilline animal of the Oligocene Epoch, remotely related to the hippopotami and pigs. The skull suggests that of the hippopotamus, but it has a narrow elongated muzzle; and the front teeth resemble those of the carnivora rather than the shearing tusks of the hippopotami and pigs. The limbs and feet are tall and stilted, the lateral toes reduced to small rudiments, as in ruminants. Different species ranged in size from that of a sheep to that of a rhinoceros.

El Petén, Guatemala, one of the northern departments of the republic; pop. 6,752. Its chief town is Flores; pop. 1,671, and altitude above sea 482 feet.

El'phinstone, Mountstuart, East Indian administrator: b. Scotland 6 Oct. 1779; d. Limpsfield, Surrey, 20 Nov. 1859. He joined the Bengal civil service in 1795; was ambassador to the Afghan court in 1808; resident at the court of Poonah from 1810 to 1817; and British commissioner to that province from 1817 to 1819, when he became governor of Bombay. During a government of seven years he established a code of laws, lightened taxes, and paid great attention to schools and public institutions. He resigned in 1827. A college established by the natives was called after him Elphinstone College. He was the author of an 'Account of the Kingdom of Cabul and Its Dependencies' (1815); and a 'History of India' (1841).

Elphinstone, William, Scottish prelate: b. Glasgow 1431; d. 25 Oct. 1514. Having gone to France he studied law for three years, and was appointed professor of law, first at Paris and subsequently at Orleans. He was subsequently made commissary of the Lothians, and in 1479 was made archdeacon of Argyle. Soon after he was made bishop of Ross; and in 1483 was transferred to the see of Aberdeen. In 1488 he was made lord high-chancellor of the kingdom, In October of that year he assisted in the coronation of James IV. He was afterward sent on a mission to Germany, and on his return was installed in the office of lord privy-seal, which he held till his death. In 1494 he obtained a papal bull for the erection of a university at Aberdeen, and King's College and University soon came into existence.

El Quicke, Guatemala, one of the northern departments of the republic; pop. 92,753. Its chief town is Santa Cruz; pop. about 12,000 and altitude above sea-level 5,543 feet.

Elsberg, ĕlz'bĕrg, **Louis,** German-American physician: b. Gerlohn, Prussia, 1836; d. in the United States in 1885. He introduced the art of laryngoscopy in the United States, wrote many papers on the throat and its diseases, notably, 'The Throat and the Production of the Voice'; was the first to illustrate the character of undertones and divisions of sound in articulation, and invented many instruments which are used in surgical treatment of the throat and ear.

Elsheimer, ĕlz'hīm-ĕr, **Adam,** German painter: b. Frankfort-on-the-Main 1578; d. probably at Rome 1620, called the «Roman Painter of Germany.» He studied in Rome and settled there while still very young. He painted many biblical and mythological scenes and was a master of landscape, being the chief German artist of the end of the 16th century to acclimatize Roman art in Germany. Among his principal works are: 'Jupiter and Mercury with Philimon and Baucis'; 'Joseph in the Pit'; and 'Judith,' at Dresden; 'Martyrdom of St. Lawrence,' and 'Flight into Egypt,' at Munich; his portrait and 'Triumph of Psyche' at Florence; many landscapes at Naples, Venice, and Madrid; 'Good Samaritan,' and another 'Flight into Egypt' at the Louvre, and a large collection of drawings.

Elsie Venner, a romance by Oliver Wendell Holmes, first published serially, in 1859-60, under the name of 'The Professor's Story.' It is a study in heredity, introducing a peculiar series of phenomena closely allied to such dualism of nature as may best be described by the word «ophianthropy.» Delineations of the characters, social functions, and religious peculiarities of a New England village, form a setting for the story. The victim of some pre-natal casualty, Elsie shows from infancy unmistakable traces of a serpent-nature intermingling with her higher self. This nature dies within her only when she yields to an absorbing love.

Elsinore, ĕl-sĭ-nōr', or **Elsineur** (Danish, Helsingör), Denmark; seaport, on the island of Zealand; 24 miles northeast of Copenhagen. Its inhabitants are engaged chiefly in commerce and seafaring. The castle of Kronborg, built about 1580, is the chief defense of the town. It is a Gothic-Byzantine edifice, built by Frederick II in the boldest style, and is said to be one of the finest structures of its kind in Europe. It is now chiefly used as a prison, and was the place of confinement of the unfortunate Matilda, sister of George III. of England. The manufactures are chiefly fishing-nets and a coarse cloth. Ship-building has been an important industry. Pop. (1901) 13,902.

Elson, Henry William, American author: b. Muskingum County, Ohio, 29 March, 1857. He was educated at Lutheran Theological Seminary, Philadelphia, and the University of Pennsylvania. After occupying two or three Lutheran pastorates he left the ministry and took up the work of writer and lecturer of the University Extension Society of Philadelphia. He has published 'Side Lights on American History' (1899); 'Four Historical Biographies for Children: Andrew Jackson, U. S. Grant, Daniel Boone, and Frances Willard' (1899); 'How to Teach History' (1901), and 'Elson's History of the United States.'

Elson, Louis Charles, American writer on music: b. Boston, Mass., 17 April 1848. After studying music at Leipsic he returned to Boston and has been a teacher and lecturer on music there from 1876. He has been musical editor of the Boston *Advertiser* since 1888. He has published 'Curiosities of Music' (1883); 'German Songs and Song Writers' (1886); 'Our National Music and Its Sources' (1886); 'Theory of Music' (1890); 'Realm of Music' (1892); 'European Reminiscences' (1893); 'Great Composers' (1897); 'Shakespeare in Music' (1900); 'Famous Composers and Their Works,' new series (1901).

Elssler, ĕlz'lėr, **Fanny,** Austrian dancer: b. Vienna 23 June 1810; d. there 27 Nov. 1884. She was the daughter of Johann Elssler, Haydn's factotum, and was educated at Naples for the ballet, with her elder sister Theresa, who in 1851 became the morganatic wife of Prince Adalbert of Prussia and was ennobled. Fanny Elssler during her visit to the United States gave an entertainment in order to raise money for the Bunker Hill Monument.

Elster, ĕl'stĕr, two German rivers. (1) The White, or Great Elster, rising in the west of Bohemia, flows north into Saxony, receives the Pleisse and Parde at Leipsic, and joins the Saale between Halle and Merseburg, after a course of about 115 miles. (2) The Black Elster, rising in Saxony, flows north into Prussia, then northwest, receives the Pulsnitz and Röder, and joins the Elbe between Wittenberg and Torgau, after a course of about 130 miles.

Els'tracke, Reginald or **Ronald,** English engraver: b. probably in London and lived there early in the 17th century. His plates were made with the graver solely, their chief value being historical. He executed portraits of Mary Queen of Scots, Darnley, and Queen Elizabeth. Among his works was a volume of 32 plates called 'Basiliologia: a Book of Kings, being the true and lively effigies of all our English Kings from the Conquest until this present' (1618).

Elswick, ĕlz'wĭk, England, suburb of Newcastle, containing the great ordnance works of Sir William Armstrong, Mitchell & Company. These works are probably the largest of their kind in Europe, and employ about 14,000 persons. Pop. 51,000.

El'ton, Charles Isaac, English jurist and archæologist: b. Somerset 1839; d. Chard, Somerset, 23 April 1900. He was educated at Oxford and was called to the bar in 1865. He represented West Somerset in Parliament as a Conservative 1884–5 and 1886–92. On legal subjects he published: 'Tenures of Kent' (1867); 'Commons and Waste Lands' (1868); 'Copyholds and Customary Tenures' (1874–93); 'Improvement of Commons Bill' (1876); 'Custom and Tenant-Right' (1882); and 'Robinson on Gavelkind' (1897). Other works of his are: 'Norway, The Road and Fell' (1864); 'The Career of Columbus' (1892); 'The Great Book-Collectors' (1893); and 'Shelley's Visits to France' (1894). His greatest work, however, is his 'Origins of English History' (1882). It is chiefly characterized by its thorough investigation of the evidence furnished by Greek and Roman writers regarding the condition and circumstances of early Britain, by its discussion of the ethnology and prehistoric archæology of the country, and by the importance assigned to the Celtic and even pre-Celtic element in forming the English nation.

Elton, James Frederick, English explorer: b. 3 Aug. 1840; d. 13 Dec. 1877. He entered the Indian Army in 1857. In 1871 he found himself in the Transvaal and Natal; in 1873 he was vice-consul at Zanzibar, two years afterward as consul in Mozambique he explored the coast of East Africa for the sake of repressing the slave trade. With Cotterill he reached Lake Nyassa in 1877 and scaled the Konde range of mountains at the north end of the lake, to the height of 10,000 feet. After his death Cotterill published his journal under the title: 'Travels and Researches among the Lakes and Mountains of Eastern and Central Africa.'

Elton, a shallow lake in the government of Astrakhan, in Russia; area, 60 square miles. Eight salt-water streams flow into this lake, and it has no visible outlet; thus a large salt deposit rests on the bed of the lake. From about the middle of the 17th century for 100 years, the salt from this lake was in demand; but since the opening of the salt fields in the southern part of Russia (1860) the Elton salt has not been on the market.

Elvas, āl'väs (Rom., Alpesa; Moorish, Balesh), the strongest fortified city of Portugal, in the province of Alemtejo, near the Spanish frontier; 10 miles west of Badajoz. Standing on a hill, it is defended by seven large bastions and two isolated forts. Pop. (1900) 14,018.

Elves (O. Eng., œlf; Germ. Alp; phantom, spirit); imaginary creatures of the northern mythology, forming, according to some classifications, with the undines, salamanders, and gnomes, groups of elementary sprites identified respectively with the water, fire, earth, and air. The elves are of the air, and have been more widely received in the faith and poetry of Europe under this name than under that of sylphs, invented by Paracelsus. They are capricious spirits, of diminutive size but preternatural power. Their stature is less than the size of a young girl's thumb, yet their limbs are most delicately formed, and when they will they can hurl granite blocks, bind the strongest man, or shake a house. They are divided in the sagas into good and bad, or light and dark elves, the former having eyes like the stars, countenances brighter than the sun, and golden yellow hair, the latter being blacker than pitch, and fearfully dangerous. The elves ordinarily wear glass shoes, and a cap with a little bell hanging from it. Whoever finds one of these slippers or bells may obtain from the elf who has lost it any thing which he asks for. In the winter they retire to the depths of mountains, where they live in much the same way as men, and in the first days of spring issue from their grottoes, run along the sides of hills, and swing upon the branches of the trees. In the morning they sleep in blossoms or watch the people who pass by, but at the evening twilight they meet together in the fields, join hands, and sing and dance by the light of the moon. They are generally invisible, but children born on Sunday can see them, and the elves may extend the privilege to whomsoever they please. In England and Scotland they became fairies in the former, and brownies in the latter country, and were subject to a king and queen. The islands of Stern and Rugen, in the Baltic, are especially subject to the king of the elves, who rides in a chariot drawn by four black horses, and whose passage from island to island is recognized by the neighing of the steeds, the blackness of the water, and the bustle of the great aërial company who follow in his train. The elves sometimes become domestic servants, and would be valuable as such if they were less easily offended and less dangerous after taking offense. As long as their caprices are gratified, their food and drink regularly left at an appointed place, and no attempt made to interfere with their freedom, the furniture is sure to be dusted, the floor to be swept, and every chamber to be perfectly in order. But the brothers Grimm, in their 'Deutsche Sagen,' have chronicled the misfortunes of many a young girl, who, having called an elf to her aid, repented too late of having offended it.

El'well, Frank Edwin, American sculptor: b. Concord, Mass., 15 June 1858. He studied at the Ecole des Beaux Arts, Paris, and also under Jean Alexandre Falguiere, and is a member of the Institute of France. Among his works are a monument at Edam, Holland, 'Death of Strength'; statue in Paris of 'Awakening of Egypt'; equestrian statue of Gen. Hancock at Gettysburg; monument to Edwin Booth, Mount Auburn, Cambridge; the two fountains of 'Kronos' and 'Ceres' at the Pan-American Exposition, Buffalo; 'Dickens and Little Nell,' Fairmount Park, Philadelphia; and a bust of Levi P. Morton, Senate chamber, Washington.

Elwell, James William, American philanthropist: b. Bath, Me., 27 Aug. 1820; d. Brooklyn, N. Y., 2 Sept. 1899. He became a partner in his father's commission-house in New York in 1838; and after the death of his father founded the firm of James W. Elwell & Company in 1852. The firm owned three lines of vessels to the principal European, southern, West Indian and South American ports. His philanthropic gifts aggregated $3,000,000, and he bequeathed $25,000 to his favorite charities. He originated the Helping Hand Society and was one of the founders of the Brooklyn Orphan Asylum. He was also identified as trustee or director with many other charitable institutions.

El'wood, Ind., city in Madison County; on the Pittsburg, C., C. & St. L., and the Lake Erie & W. R.R.'s; about 50 miles northeast of Indianapolis. It is surrounded by an agricultural region, and is in a natural-gas belt. Its industries are chiefly lumber, flour, tin-plate-mills; window, plate glass and lamp chimney and other factories. Its shipping trade consists in the agricultural products of the surrounding country, and the articles manufactured in the city. Pop. 12,950.

Ely, Richard Theodore, American political economist: b. Ripley, N. Y., 13 April 1854. He was graduated from Columbia University in 1876, and studied also at Heidelberg, Germany. He became professor of political economy at Johns Hopkins University in 1881, and professor of political economy and director of the school of economics and political science at the University of Wisconsin in 1892. On account of his advocacy of trade unions, he was accused in 1894 of "aiding and abetting" a strike, and of being a Socialist, and an attempt was made to force him out of his professorship at the university. A committee of the regents appointed to investigate the matter acquitted him. While he is not a Socialist, he advocates public ownership of "natural monopolies" and has carefully investigated and stated the aims of the Socialist movement. His works include: 'French and German Socialism in Modern Times' (1883); 'Socialism and Social Reform' (1894); 'Recent American Socialism' (Johns Hopkins University Studies, Vol. III., 1885); 'Problems of To-Day' (1886); 'The Labor Movement in America' (1886); 'Political Economy' (1889); 'Social Aspects of Christianity' (1889); 'Social Law of Service' (1900); 'Monopolies and Trusts' (1900). This last is a small part of a large work, 'The Distribution of Wealth,' which is not completed.

Ely, England, an episcopal city, in the county of Cambridge; about 15 miles northeast of Cambridge; on the Ouse. The place is noted for its cathedral, one of the most remarkable edifices of the kind in England. It occupies the site of a monastery founded about the year 673 by Saint Etheldreda (or Audry), daughter of Anna, king of East Anglia. Its ancient history is most interesting. In 1071, Hereward, the noted English outlaw, defended Ely against the Normans. See HEREWARD. Pop. 7,812. Consult: Van Rensselaer, 'English Cathedrals'; F. Bond, 'English Cathedrals'; Stewart, 'Architectural History of Ely Cathedral.'

Ely, Isle of, a district in England, in the county of Cambridge, separated on the south by the Ouse from the remaining portion of the county, and forming itself a sort of county; area 227,326 acres. It rises about 100 feet above the general level of the fen country, and was formerly surrounded by marshes, which at times became sheets of water. The whole has by drainage been converted into fertile fields. Pop. (1901) 64,494.

Elymais, ĕl-ĭ-mā'ĭs. See ELAM.

Elyot, ĕl'ĭ-ŏt, SIR **Thomas,** English author: b. Wiltshire not later than 1490; d. Carlton, Cambridgeshire, 20 March 1546. In 1511 he became clerk of assize, in 1523 clerk of the king's council. In 1531–2, as ambassador to Charles V., he visited the Low Countries and Germany, having orders to procure, if possible, the arrest of Tyndale. 'The Boke named the Gouernour, deuised by Sir Thomas Elyot, Knight,' was published in 1531. It may be described as the earliest treatise on moral philosophy in the English language, the author's principal object being "to instruct men in such vertues as shall be expedient for them which shall have authoritie in a weale publike." An elaborate 10th edition appeared in 1880, with life notes and glossary by H. H. S. Croft. Elyot's 12 other works include: 'Of the Knowledge which maketh a Wise Man' (1533); 'Pasquil the Playne' (1533); Isocrates' 'Doctrinal of Princes' (1534); Picus de Mirandola's 'Rules of a Christian Lyfe' (1534); 'The Castel of Helth' (1534); 'The Bankette of Sapience' (1534); 'Bibliotheca' (1538), the first Latin-English dictionary; 'The Image of Governance' (1540); 'Defence of Good Women' (1545); and 'Preservative against Deth' (1545). These books went through edition after edition in their author's lifetime, and have now become among the rarest treasures of the bibliomaniac.

Elyr'ia, Ohio, city, county-seat of Lorain County; on the Black River; and on the Cleveland, L. & W., and the Lake Shore & M. S. R.R.'s; 25 miles southwest of Cleveland. Agriculture is the chief industry of the surrounding country; the sandstone quarries furnish employment to a number of people. The chief manufactures in the city are supplies for automobiles and bicycles, saddles, and iron and steel products. Pop. 8,112.

Elysée, Palais de l', pă-lā dė lā-lē-zā, the official residence of the president of France, in Paris, on the Rue du Fauburg St. Honore, with its garden extending to the Champs Elysees. It was built in 1718 for the Count d'Evreux; in the reign of Louis XV. it became state property, and was the residence of Madame de Pompadour. It was also used as a residence by Napoleon I., and by Louis Napoleon, and became the presidential residence in 1871.

Elys'ian Fields, or **Elysium,** in classical mythology, the residence of the blessed after death. Elysium was supposed by Homer to have been at the western end of the earth; other poets placed it in the Fortunate Isles; later it was supposed to be in the under world. It was represented as a region of perfect happiness, where the sky was always cloudless, and a celestial light shed a magic brilliancy over every object; where each one was free to follow his favorite pursuit, and cares and infirmities were unknown.

Elze, ĕl'tsĕ, **Karl,** German historian of literature: b. Dessau 22 May 1821; d. Halle 22 Jan. 1889. His specialty was English literature, and he was professor of English philology in the University of Halle 1875–89. One of his first works was a compilation entitled a 'Treasury of English Song.' He produced critical editions of Shakespeare and other English dramatists, and wrote biographies of Byron and other English authors. Specially noteworthy is his 'Outline of English Philology.' 'Westward' (1860) contains translations of English and American poems.

Elzevir, ĕl'zĕ vĭr, name of a notable family of printers descended from Ludovic Elsevier or Elzevier, Latinized Elzeverius, a native of Louvain: b. 1540. Having learned the bookbinders' trade, he practised it for some years in his native town, but 1580 he removed to Leyden in the United Provinces, and there set up a printing press. His five sons, Matthew, Ludovic, Egidy, Joost, and Bonaventura, were also printers and booksellers; but it was the youngest of the five, Bonaventura, born 1583 at Leyden, that gave the name Elzevir its great celebrity. The first work published by the house of Elzevir appeared in 1583, the 'Ebraicæ Quæstiones et Responsiones' of Drusius, not the whole three books, but only the second and third. In 1608, nine years before his father's death, Bonaventura Elzevir founded a separate printing and publishing establishment in the same city, and then commenced the issue of works in Greek, Latin, and other languages which have ever since been regarded as models of correct and elegant typography. He conducted the business of his house more than 42 years, till his death in 1652, having had as partner from 1626 Abraham Elzevir, his nephew, whom he survived one month. He was succeeded by his son Daniel and Abraham's son John: this partnership was soon dissolved, John carrying on the business in Leyden, Daniel migrating to Amsterdam in 1655 and entering into partnership there with another of his cousins: both of these were dead 1680. The last of the Elzevirs to figure in the history of typography was Abraham, son of Abraham, one of the five sons of Ludovicus: from 1681 to 1712 he was printer to the University of Leyden. The Elzevir editions of the ancient classics, especially Latin, while admirable in point of typography, are mostly reproductions of the texts adopted by previous printers and hence are inferior from the critical point of view. The number of works published by the different Elzevir houses number 1,213, namely, Latin 968; Greek 44; French 126; Flemish 32; Oriental 22; German 11; Italian 10.

Emancipation, the act by which freedom of various kinds is granted to individuals, races, or nations. In Roman law the dissolution of paternal authority (*patria potestas*) in the lifetime of the father. It took place in the form of a sale by the father of the son to a third party, who manumitted him. The Twelve Tables, the foundation of Roman law, required that this ceremony should be gone through three times. In general, the son was at last resold to the father, who manumitted him, and thus acquired the rights of a patron which would otherwise have belonged to the alien purchaser who finally manumitted him. In the case of daughters and grandchildren one sale was sufficient. The Catholic Emancipation Act was the act signed 13 April 1829, which removed the most galling of the Roman Catholic disabilities in England. See CATHOLIC EMANCIPATION; EMANCIPATION PROCLAMATION; SLAVERY.

Emancipation, Catholic, the customary designation of a measure of relief from penalties and civil disabilities granted to professors of the Catholic religion in England and Ireland by acts of the British Parliament 1829: the act did not extend to Scotland. The necessity of granting relief to the Catholics of Ireland became apparent soon after the outbreak of the war against the American colonies, and the first relaxation of the penal laws against the professors of the Catholic religion was made in 1780. At that time it was high treason for a priest, native of the kingdom, to perform any of the duties of his office. Catholics could not own land in fee. Roman Catholics whose titles to land antedated the penal laws were ousted if the legal heir professed Protestantism. A Catholic could not practise law, nor conduct a school. In 1780 a bill for removal of some of the disabilities was passed for England and Ireland. When the act of union of the kingdom of Ireland with that of Great Britain was passed in the Irish Parliament 1800, solemn pledges were given by the British Cabinet that the disqualifying statutes should be repealed; but after the union the promise was ignored. In 1824 in Ireland was formed the Catholic Association to agitate for civil rights, such as the right to vote for members of the Parliament, to be elected members of the same, and to occupy various offices in the government, national and local. In 1829 it was seen by English statesmen that to withhold these rights and franchises any longer would provoke a rebellion in Ireland; and a bill of relief was introduced in the Parliament 5 March, and passed in both houses and approved by King George IV. 13 April, permitting Catholics to elect and be elected to the Parliament, and to hold offices under the Crown; but they remained still expressly excluded from certain high offices — that of lieutenant-governor of Ireland, that of regent of the universal kingdom, of lord chancellor of the United Kingdom, or of Ireland, etc. In 1867 the last named disability was removed, as was, many years after, the disability of a Catholic to be lord chancellor of the United Kingdom. But the Act of Grace of 1829 contained a clause forbidding Catholic ecclesiastics, monks, friars, and nuns from wearing the attire or habit of their respective station or order in public under a penalty of $250 for each offense. This proviso was ostentatiously violated in Ireland, and with impunity, for, like the $500 forfeiture for violation of the Ecclesiastical Titles Acts (q.v.), no penalty was ever exacted. Another clause of the Catholic Emancipation Act, which was also ignored and condemned, required that Jesuits and members of religious orders of the Roman Catholic Church living within the kingdom should register in the office of the clerk of the peace of the county under a penalty of $250. See O'CONNELL, DANIEL. Consult: Butler, 'Historical Memoirs'; Milner, 'Supplementary Memoirs'; Lingard, 'History of the Church in England'; Green, 'History of England.'

Emancipation in Latin-America: the Manumission of Slaves in Relation to the several Declarations of Independence. In Haiti, where African slavery was first introduced into America, the negroes received as a gift "the full liberty, equality, and fraternity" of the French republic in 1794, and by fighting established their independence in 1804. In Central America (when Guatemala, Salvador, Honduras, Nicaragua, and Costa Rica were united in the Central American republic), the laws of 31 Dec. 1823 and 17 and 24 April 1824 emancipated all slaves, and made free slaves of other countries coming to Central America. The slave trade was prohibited, under penalty of forfeiture of the rights of citizenship. H. H. Bancroft, in his 'History of the Pacific States,' says: "Of all the nations of North America, to the Central American republic belongs the honor of having first practically abolished slavery." We shall presently show, however, that this distinction fairly belongs to Mexico. Ecuador, which made its first effort to gain independence at Quito, 10 Aug. 1809, and actually threw off the yoke of Spain on 9 Oct. 1820, abolished slavery during the presidential term of Gen. Urvina, 1852–6. The Argentine nation began its struggle for independence 25 May 1810, and at the congress of Tucuman, 9 July 1816, the formal separation from Spain was declared. Article XV. of the Constitution of 25 Sept. 1860 provides that "there shall be no slaves in the Argentine nation. Those few who now exist in it shall become free at the very moment this constitution goes into effect. The indemnifications which this declaration may involve shall be provided for by special law. Any contract involving the purchase or sale of a person shall be held to be a criminal offense. . . . Slaves introduced in any way whatever into the country shall become free by virtue of the fact that they have trodden the soil of the republic." In Colombia (New Granada) the number of negroes was never very great; it was estimated at 80,000 in the middle of the 19th century. The struggle for independence, beginning 20 July 1810, or as a vigorous insurrection in 1811, was continued after the union with Venezuela (December 1819), and the republic of New Granada was formed in 1831. In 1821 a law was pased by the republic of Colombia for the gradual manumission of slaves, and all born after that date were declared free at the age of 18,— that gradual process applying, of course, to all the territory of the Greater Colombia at the time of the law's enactment. (See COLOMBIA, *History*.) A law of 1851 abolished slavery entirely in New Granada, by giving liberty to all who remained slaves on 1 Jan. 1852, provision being made for the payment of indemnity to the owners. The beginning of the war for independence in Mexico dates from 16 Sept. 1810 (see DOLORES, EL GRITO DE); on 6 Nov. 1813 the first Mexican congress, installed in the town of Chilpancingo, issued the declaration of independence and decreed the emancipation of slaves. This, therefore, was the starting point of emancipation on the mainland of America. Venezuela's declaration of independence (5 July 1811) was followed after 10 years by the law for the gradual manumission of slaves which we have mentioned above, that is, the law of the Greater Colombia of 1821. Paraguayan independence should be dated from 11 June 1811, when an assembly of deputies began its sessions; for the resolution passed by this assembly, renouncing allegiance to Spain, was ratified as a declaration of independence by the Paraguayan congress of 1 Oct. 1813. The question of African slavery was comparatively unimportant in Paraguay. "In 1865 there were negroes and mulattoes at Emboscada, Tabapy, and Aregui; but the negroes have now almost completely disappeared" ('Handbook of Paraguay,' September 1902, issued by International Bureau of the American Republics). Chile entered upon a contest with Spain on 18 Sept. 1810, and the independence of the country was proclaimed 12 Feb. 1818. The negro problem did not weigh upon that country, the population being recruited from Europe quite largely. The independence of Peru was declared at Lima 28 July 1821; that of the Dominican republic 1 Dec. 1821; that of Brazil 7 Sept. 1822; and Bolivia became an independent republic 6 Aug. 1825. In Brazil the conservative statesman, Silva Paranhos, obtained from the parliament the passage of a bill (28 Sept. 1871) for the gradual extinction of slavery, which provided that thereafter every child born of a slave mother should be free, and created a special fund for emancipation by redemption. Private philanthropy, largely directed by the Masonic lodges, effected more than the fund created for this purpose; and the number of slaves began to decrease. A bill for the immediate and unconditional abolition of slavery in Brazil was signed by Princess Regent Isabel 13 May 1888; the monarchy was overthrown 15 Nov. 1889; the new Constitution approved 24 Feb. 1891. In Cuba the slaves were emancipated on the conclusion of the Ten Years' War, that is, in 1878, and Cuba became a republic 20 May 1902. The experiences of the French, Danish, and British possessions may be referred to briefly in conclusion. Napoleon restored slavery in French Guiana, Martinique, and Guadeloupe, although his efforts to accomplish the same result in Haiti were, as mentioned above, frustrated by the resistance of the blacks themselves. The freedom of all who were held in bondage throughout the French dominions was declared in 1848. Slavery in the Danish West Indies (St. Thomas, etc.) was abolished also in 1848. The act to abolish slavery throughout the British colonies, providing £20,000,000 for compensation of the owners, was dated 28 Aug. 1833, and its effect was to free 770,280 slaves on 1 Aug. 1834, the number thus emancipated in Jamaica being 309,000.

MARRION WILCOX.

Emancipation Proclamation, 1 Jan. 1863. The Republican administration at the outbreak of the Civil War was awkwardly placed for dealing with slavery. To assail it in its own territory was not only to belie the past professions of the party, but to alienate so much Northern support as to assure failure; nor indeed had the great bulk of the party any thought beyond fettering the slave power for future aggression. On the other hand, to leave slavery untouched was not only to chill the energies of the most reliable upholders of the War, but to give foreign countries a pretext for asserting that the North was fighting merely for dominion, and that the Southern cause was that of liberty and morally entitled to help. The former horn of the dilemma was much the sharpest; and the government moved very cautiously, restraining its subordinates like Fremont (30 Aug. 1861) and Hunter (9 May 1862) from forcing its hand by emancipation orders. On 9 Aug. 1861 an act had declared masters employing slaves against the government barred from further claim to them; but that was a mere warning and rule of court. The first embarrassing problem was how to deal with slaves in conquered districts, or who had come within its lines: was the government to act as slaveholders' trustee and return them to servitude? The growing resentment against slavery as a convertible term for the rebellion, and disgust at being slave-catchers to the behoof of their enemies, supplied the answer, and on 13 March 1862 all army officers were forbidden to return fugitive slaves; their surrender from any quarter was made harder (though the fugitive-slave law was not formally abolished till 28 June 1864); on 17 June 1862 all captured, deserted, or fugitive slaves of owners in rebellion were freed. As to the main body, who plainly could not be left in unchanged status as the core of a fresh abscess, Lincoln's wish was for compensated emancipation; he sent a special message to Congress 6 March, and that body passed a joint resolution 10 April, declaring that the United States ought to co-operate with any State which would adopt gradual abolition, by paying for the slaves, and on 16 April those in the District of Columbia were thus emancipated; but despite his repeated urgencies, the border States would take no measures of the kind. On 19 June the slaves in the Territories were freed.

The final blow came, as John Quincy Adams 20 years before had forecast that it would, by using the President's war power to suppress insurrection. As the second year of the conflict wore on, the majority demanded the crippling of its enemy by the most efficient means, and very many believed that a threat of general emancipation would bring about a general surrender. Lincoln wished for a great victory first, that it might not appear the selfish resource of an overmatched power; but the discouraging Peninsular campaign obliged him to satisfy his supporters by holding this bludgeon over the enemy. On 22 Sept. 1862 he issued a proclamation announcing that 100 days after, on 1 Jan. 1863, the Executive would issue another proclamation designating the States or parts of States then deemed in rebellion, evidence to the contrary being the presence of *bona fide* representatives in Congress, that all slaves in the designated sections should be permanently free, and that the civil and military authorities of the United States would maintain their freedom, and would not repress any effort of theirs to make it good. The only result was a retaliatory proclamation by Jefferson Davis 23 December, ordering that captured negro Federal soldiers and their officers should be turned over to the States, and that Gen. B. F. Butler should be hanged if captured. On the 1st of January the threatened proclamation was issued, as "by virtue of the power in me vested as commander-in-chief of the army and navy of the United States, and as a fit and necessary war measure for repressing said rebellion." It designated Arkansas, Texas, Louisiana except 13 "parishes" or counties, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, and Virginia except West Virginia and seven other counties, as in rebellion, emancipated all the slaves in them; enjoined these freedmen to abstain from all violence except in self-defense, and to work faithfully for reasonable wages; announced that suitable members of them would be received into United States military and naval service, and for this act invoked "the considerate judgment of mankind and the gracious favor of Almighty God."

The curious feature of this proclamation is that it abolished slavery only in the sections not under the military power of the United States, and left it untouched in those which were, namely, the ones specially excepted by it, "which are, for the present, left precisely as if this proclamation were not issued." Hence it was argued by the Democrats that it had no legal force whatever, and emancipated no one; a question the Supreme Court never passed on. It was always accepted by the majority party, however, as a continuing act, applying as fast as any of that territory fell into the Union power, and not necessary to repeat. Politically, the results were enormous. Recognition of the Confederacy thenceforward meaning a flat maintenance of slavery instead of freedom, the entire anti-slavery sentiment of France and Great Britain was thrown against those countries' interference, which at once be-

FROM THE PAINTING BY CARPENTER.

SIGNING THE EMANCIPATION PROCLAMATION.

came unthinkable. It drove away many lukewarm northern Republicans, and brought many local and State defeats to the administration; but it took the party "off the fence," and made it a coherent organization with one firm, open principle, for many years unassailable. In the South, as defeat meant emancipation by their enemies and it would be no worse if done by themselves, some of the leaders (as Lee) seriously thought of offering freedom to slaves to fight in their armies in the latter part of the War, hoping to save independence and the control of their own destinies at least.

Emants, ĕm'änts, **Marcellus,** Dutch poet and descriptive writer: b. Voorburg, near The Hague, 12 Aug. 1848. His volumes of travels display his keen observation and his poetical imagination. Among his best are: 'A Journey Through Sweden' (1877); 'Monaco' (1878); 'Along the Nile' (1884); 'From Spain' (1886). He holds a permanent place in the literature of the Low Countries through his charming narrative poems, 'Lilith' (1879); 'The Shimmer of the Gods' (1883).

Eman'uel the Great, king of Portugal: b. 31 May 1469; d. Lisbon 13 Dec. 1521. He ascended the throne in 1495. During his reign were performed the voyages of discovery of Vasco da Gama, of Cabral, of Americus Vespucius, and the heroic exploits of Albuqerque, by whose exertions a passage was found to the East Indies (for which the way was prepared by the discovery of the Cape of Good Hope in 1486 by Bartolomeo Dias), the Portuguese dominion in Goa was established, the Brazils, the Moluccas, etc., were discovered. The commerce of Portugal, under Emanuel, was more prosperous than at any former period. The treasures of America flowed into Lisbon, and the reign of Emanuel was justly called "the golden age of Portugal." He died deeply lamented by his subjects, but hated by the Moors and the Jews, whom he had expelled. As a monument of his discoveries, Emanuel built the monastery at Belem, where he was buried. He was a friend to the sciences, and to learned men. He left 'Memoirs on the Indies.'

Emba, ĕm'bä, a river in the district of Orenburg, Asiatic Russia; the Russians call it Jemba, the Kirghiz, Dchem. It rises at three sources in the western slope of the Mugodchar foothills; flows sluggishly through an area of steppes, is about 200 feet wide and 500 miles long, and forms a delta at its embouchure in the Caspian. It is not navigable, but abounds in fish. The fortress Embinsk is built on its upper waters.

Embalming, the act of preserving the body after death. It was probably invented by the Egyptians, whose bodies thus prepared for preservation are known as mummies, but it also prevailed among the Assyrians, Scythians and Persians. It is at least as old as 4000 B.C. The Egyptian mummies were placed in costly coffins ready for sepulture; but were frequently kept some time before being buried — often at home — and even produced at entertainments, to recall to the guests the transient lot of humanity. The usual method of embalming among the ancients was as follows: The intestines and brains were taken out, and the cavities filled up with a mixture of balsamic herbs, myrrh, etc.; the arteries and other vessels were injected with balsams The ancient Egyptians filled the cavities of the trunk with aromatic, saline, and bituminous stuff. The cloths in which the mummies were swathed were saturated with similar substances. So effectual were some of the processes that, after 2,000 or 3,000 years, the soles of the feet are still elastic and soft to the touch. By 700 A.D., when embalming practically ceased in Egypt, probably 730,000,000 bodies had been thus treated; many millions of them are still concealed. In 1881 upward of 30 mummies of potentates, including that of Rameses II., were discovered together at Deir-el-Bahari. (See MUMMY.) The Persians employed wax for embalming; the Assyrians, honey; the Jews aloes and spices. Alexander the Great was preserved in wax and honey. Desiccated bodies, preserved by atmospheric or other influence for centuries, have been found in France, Sicily, England, and America, especially in Central America and Peru. The art of embalming was probably never wholly lost in Europe. The body of Edward I., buried in Westminster Abbey in 1307, was found entire in 1770. The body of Canute, who died in 1036, was found very fresh in Winchester Cathedral in 1776. The bodies of William the Conqueror and of Matilda, his wife, were found entire at Caen in the 16th century.

Chaussier's discovery, in 1800, of the preservative power of corrosive sublimate, by which animal matter becomes rigid, hard and grayish, introduced new means of embalming; but, owing to the desiccation, the features do not retain their shape. The discovery of the preservative power of a mixture of equal parts of acetate and chloride of alumina, or of sulphate of alumina, by Gannal, in 1834, and of arsenic by Tranchini, pyroxilic spirits by Babington and Rees in 1839, and of the antiseptic nature of chloride of zinc, have led to the application of these salts to the embalming of bodies required to be preserved for a limited time. The latest method common in the United States is an injection of a fluid into the femoral artery and the cavity of the abdomen. The most efficient agents are mercuric chloride, arsenic and zinc chloride.

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Embankment, a mound of earth, thrown up either for the purpose of forming a roadway at a level different from that of the natural surface of the ground, or for keeping a large body of water within certain limits. The slopes should be adapted to the material, so as to secure permanence. To prevent subsidence on marshy or peaty soils, either the weight of the heart of the embankment is diminished, as in Holland, by introducing layers of reeds, or fascines, or artificial foundations are prepared. The embankment may be prevented from slipping laterally by forming steps in the earth of the subsoil, or by cutting deep trenches at the feet of the slopes. In cases where embankments are raised for the storage of water, a "puddle-dike," that is, a water-tight wall, must be inserted through the whole depth of the bank down to the impermeable strata beneath. To resist the action of wind and rain, or of the waters of a slow-flowing stream, the banks should in all possible cases be covered with turf. When embankments are raised at right angles to the current of a river they are called dams.

When they run parallel to the current, and prevent its lateral overflow they are styled levees. Among the largest embankments hitherto executed are those on the banks of the Po, the Meuse, the Scheldt, the Mississippi, United States, on the shores of the Netherlands, and the Croton dam at the head of the reservoir for the supply of water to New York, the Oberhäuser embankment on the Augsburg & Lindau Railway, the Gadelbach cutting on the Ulm & Augsburg Line, and the Tring cutting on the Northwestern Railway (England). See LEVEES; RESERVOIRS.

Embargo in the United States. Prohibition of foreign commerce, to distress foreign countries and obtain the revocation of hostile measures; «peaceful war,» intended to be cheaper than actual warfare and equally efficient, but in fact injuring ourselves deeply and the others little, and ending in real war at last. Our embargos belong exclusively to the French-English wars of 1794–1814. Their ultimate cause was that the agricultural classes, who controlled the administration, did not believe in commerce, and preferred abolishing it to spending anything for its protection; moreover, they were mainly southern and democratic, the commercial interests mainly New England and Federalist, and the former were not loth to spare themselves the cost of war by impoverishing the latter. The first embargo was for 60 days, due to mutual orders of France and England for seizure of neutrals which placed the United States between hammer and anvil. Jay's Treaty (q.v.) of 19 Nov. 1794, for 12 years measurably protected our commerce, but near its end conditions became infinitely worse. In 1806–7 the thronging mutual blows of England and Napoleon, ending in the former's Orders in Council of 11 November, and the latter's Milan Decree of 7 Dec. 1807, made practically every neutral vessel good prize to one or the other. Even more intolerable were the rights of search and impressment claimed by Great Britain, which swept several hundred American sailors every year into the British fleets, and in one massacre (see CHESAPEAKE AND LEOPARD) outraged and humiliated this country beyond forgiveness. But aside from the reasons above given, few landsmen believed till the victory of Old Ironsides (see CONSTITUTION, THE) that American ships could fight English on equal terms, and it was the general conviction that in case of war our entire fleet would at once be «Copenhagenized» (that is, captured bodily and added to the British fleet, as was the Danish). At Jefferson's recommendation, therefore, «The Embargo» was passed 22 Dec. 1807, forbidding all foreign commerce till the obnoxious decrees were repealed. The havoc not only in trade but in the interior life of the people was terrific; the exports fell from $110,084,207 in 1807 to $22,430,960 in 1808. The farming sections were dismayed to find that commerce meant part of their daily bread as well as the carriers' profits, and that they raised and sold much of that $87,000,000; but they clung all the more stubbornly to their anti-war recipe, though England and France approved it highly. Napoleon was glad to see his enemy drifting into war with a western power: England was glad to regain her carrying trade, and see Canada and Nova Scotia receive American capital. Meantime New England fought it with the fierceness of a struggle for life; evaded it largely by sea, and sent armies of smugglers overland to Canada. Congress then extended the act to rivers, lakes, and bays, and allowed collectors to seize on suspicion; and the next Congress, 9 Jan. 1809, passed a savage enforcing act with all the fury of baffled doctrinaires, imposing enormous fines, forfeitures, and bonds, and making the collectors supreme despots of their districts. New England was nearly in insurrection; the collectors were in danger of the fate of those under the Stamp Act, some resigned, others were sued in the State courts; the judges would give no findings against smugglers; finally the States threatened nullification, and John Quincy Adams (a victim to its support) declared that they had resolved to withdraw from the Union, at least temporarily, if force were used, and had opened negotiations with Great Britain. A Federalist declared in the Senate that blood would flow. The Democrats were frightened, and hastily fixed (3 Feb. 1809) 4 March for its discontinuance. But the next month they had regained courage, and passed a «non-intercourse act» to take its place; still prohibiting intercourse with France or Great Britain, but restoring it with other countries and allowing free coasting trade. This policy was continued till the War of 1812 opened. The hostility of New England to the war, only less destructive than the embargo and against her political feelings, induced the British government ostentatiously to relieve that section from the blockade, to sow discord and make a base of naval supplies; and on 17 Dec. 1813 a new embargo was laid to 1 Jan. 1815, which, however, was repealed 14 April 1814. Jefferson always asserted that the policy was the best, and the embargo would have accomplished its object if New England would only have helped. (Histories of the United States through this period, as Schouler, McMaster, etc.; especially Henry Adams' 'History,' covering 1801–15, devoted to the causes and consequences of these measures.

Em'bassy (*ambassy*, from O. Fr. *ambassée*, from low Lat. *ambachus*, a servant, vassal) in its strict sense, signifies a mission presided over by an ambassador, that is, a diplomatic agent of the first rank, as distinguished from a legation or mission entrusted to an envoy or agent. The difference between the powers and privileges of an ambassador and an envoy is, that the former, as the representative of the person of his sovereign, can demand a private audience of the sovereign to whom he is accredited, while the latter must communicate with the minister for foreign affairs. See DIPLOMACY.

Ember-days, called in the Roman Missal and Breviary *Quattuor Tempora* (the four seasons) and in the Anglican 'Book of Common Prayer' «Ember-days at the four seasons,» are in the Roman and in the Anglican calendar the Wednesdays, Fridays, and Saturdays which come next after 13 December, the first Sunday of Lent, the Feast of Pentecost (Whitsunday), and 14 September, respectively. In both the Latin Church and the Anglican these days are days of fasting. The *Quattuor Tempora* were observed at Rome in the time of St. Augustine (the bishop of Hippo, early in the 5th century), and doubtless the observance was already of ancient date. The custom was brought into Britain by that other St. Augustine who was the herald of the gospel to the Anglo-Saxons. It was anciently the custom for bishops to hold ordinations only on the Saturdays of the *Quattuor Tempora*. The origin of the phrase Ember-days cannot be definitely ascertained: but it is probably a corruption of *Quattuor Tempora,* as in German *Die Quatember* signifies the Ember-weeks.

Ember, or **Immer Goose,** the name in northern Scotland of the loon. See DIVER.

Embezzlement (O. Fr. *besiler,* to rifle, lay waste) is the appropriation, by a clerk or servant, of money or property put into his hands for trust. Embezzlement is both a theft and a breach of trust; yet, by the general law, it is only a ground for an action for the value of the property. It must not be confounded with larceny, which is "the felonious taking and carrying away the personal property of another." This "taking" implies a trespass, not to be chargeable in embezzlement, which is an offense or form of crime invented by the English statute, which the United States copied and which changed what was not larcenous into a punishable crime, being the act of fraudulently appropriating to personal use money or property held under a fiduciary relation. This crime in the United States is very severely punished as a felony.

Em'blements (O. Fr. *emblaement,* from *emblaer,* to sow with grain), a term applied to the growing crops of land when the lease of a tenant for life has expired by the death of the tenant, or when an estate at will has been determined by the lessor. In either case the emblements belong to the tenant or his executors. But when the tenant puts an end to his occupation by his own voluntary act, he will not be entitled to the crops.

Embolism, ĕm'bō-lĭzm (Gr. εμβολισμος, intercalation, 'εν, in, and βάλλειν, to cast). In the calendar, an intercalation of a day, as in the second month of our year in leap-year, or of a lunar month, 28 days, in the Greek calendar. In medicine, the blocking up of a blood-vessel by a clot of blood that comes from some distance till it reaches a vessel too small to permit its onward progress. This is often the cause of sudden paralysis and death, or of gangrene and pyæmia.

Embos'sing (Fr. *bosse,* a protuberance), the art of producing raised figures upon plane surfaces, such as on leather for bookbinding, etc.; on paper, wood, or bronze. In architecture or sculpture, in proportion as the figures are more or less prominent, they are said to be in *alto, mezzo,* or *basso relievo* (high, half, or low relief). Leather, paper, and textile fabrics are embossed by powerful presses furnished with dies of the desired pattern.

Embra'cery (O. Fr. *embraser,* to set on fire), an attempt to corrupt or influence a jury by money, promises, letters, threats, or persuasions. This offense in the United States is punished by fine and imprisonment.

Embrasure, ĕm-brā'zūr, in fortification, an opening made in the breastwork or parapet of a battery or fortress, to admit of a gun being fired through it. See FORTIFICATION.

Embree, Charles Fleming, American author: b. Princeton, Ind., 1 Oct. 1874. He is the author of ‹For Love of Tonita› (1897); and ‹A Dream of a Throne› (1900); ‹Heart of Flame.›

Embro, a corrupted form of the name Edinburgh. See EDINBURGH.

Embroidery, the art of producing ornamental patterns by means of needlework on textile fabrics, leather, and other materials. It is closely allied to tapestry, from which, however, it must be distinguished. The essential distinction is that in tapestry work the basis is a series of parallel strings, forming a warp, and the patterns are produced by the manipulation of the threads which form the weft, while embroidery is always worked on an already complete fabric.

The art of embroidery is practised, with characteristic variations, by the rudest tribes, and was well known in very early times. Remains of Egyptian embroidery as ancient as the days of Jacob exist still; and the costumes painted on the monuments of the 18th dynasty show that the most varied patterns were used by the Egyptions 3,000 years ago. The Jews probably acquired the art in Egypt; the description of the curtains of the tabernacle and the garments of Aaron (Exodus xxvi., 1-31, and xxxix.) and other allusions in the Scriptures indicate that their skill in the art was considerable. The knowledge of artistic embroidery came to Europe from the East, where it had its early home, and where it is still most largely practised. To the Greeks and Romans it came from Phrygia, whence at Rome the embroiderer was known as *phrygio,* and embroidered work was called *phrygium.* Frequent references to embroidery are found in Homer, and all later classical writers. It was in mediæval times that the embroiderer's art attained its greatest perfection in Europe, and embroidery was a favorite occupation of women of all ranks. Not only was figure and portrait embroidery highly developed, but, in France especially, much attention was paid to the use of floral and arabesque ornament. Much of the most beautiful mediæval work is found on the vestments and ornaments for the monasteries and churches. Among other famous specimens are two of English origin, the Syon cope of the 13th century, richly charged with scriptural subjects, and the Bayeux Tapestry (q.v.), an example of embroidery with worsteds.

At the present day the Orient stands foremost in art embroidery. The Chinese work is perhaps the most elaborate, done mostly on silk, with brilliant colors; the Japanese embroidery is scarcely less beautiful and elaborate. In Europe and America, there has been in the 19th century a revival of the art of embroidery connected with the increased desire for all forms of decorative art. Practically, embroidery is divided into two distinct classes of work: (1) that which embraces all kinds of artistic needlework done by the hand; and (2) the manufacturing industry which includes all embroidery done by machinery, and hand needlework done on the large scale by following patterns mechanically impressed on the fabric. In art embroidery the materials employed are fine colored worsted yarns called crewels, tapestry wools, embroidery silks, gold and silver threads, spangles, and plates or disks of metal. The textile basis may be any cloth, but the fabrics principally used are stout makes of linen, silks, satins, velvets, and flannels. Small work is done without any special mounting, but for elaborate designs the fabric is fitted and tightly stretched on a frame. The number of embroidery stitches is considerable, and they vary with the nature of the design and the materials used. The principal stitches are the cross stitch, the cushion stitch, the crewel stitch, the outline stitch, the herring-bone stitch, the button-hole stitch, the feather stitch, the satin stitch (the best for fine work on silk and satin), and the rope and knot stitches. In frame-work, "couching" is largely employed, which consists in laying lengths of thread on the surface, and securing them by stitches through the cloth brought up at various points. A distinct class of embroidery consists of appliqué or cut work, in which designs of different materials and colors are cut out and sewed down on the surface of the fabric to be ornamented. In its purely mechanical side, the embroidery trade embraces several distinct sections, of which may be enumerated: (1) white embroidery, known also as Swiss or Scotch sewed work; (2) embroidery in gold, silver, and colored silks, for official costumes, civil and military, badges, etc.; and (3) embroidery in crewels, or other colored wools, colored silks, etc., mostly done for furniture decoration, such as borders of table covers. To a great extent these various kinds of embroidery can be worked by one or other of the machines which have been devised for embroidering. The first successful embroidery machine was that invented by M. Josué Heilmann, of Mülhausen, patented in England in 1829. With Heilmann's machine, or the modifications of it which have since been introduced, one person can guide from 80 to 140 needles working simultaneously, and producing so many repeats of the same design. Embroidery patterns, in a variety of knotted, tambour, and other stitches, and ornamental braiding, are now very largely done by means of the Bonnaz machine, the invention of M. Antoine Bonnaz, first patented in England in 1868.

Bibliography.— Day and Buckle, 'Art in Needlework' (1900); Higgin, 'Handbook of Embroidery'; Lefébre, 'Embroidery and Lace' (Eng. trans. 1888); Morris, 'Decorative Needlework'; Palliser (Mrs. Bury), 'Lace and Embroidery.'

Embrun, ŏṅ-brŭṅ (ancient *Eburodunum Caturigum*), France; town in the department of Hautes-Alpes, on a rocky eminence in the centre of a large plain watered by the Durance, 20 miles east from Gap. It is an ancient place, surrounded by walls and ditches, and of very picturesque appearance. It was pillaged successively by Vandals, Huns, and Saxons, and its inhabitants almost exterminated by the Moors in 966. It is still a bishop's, and was once an archbishop's, see. Pop. 3,812.

Em'bryo. See EMBRYOLOGY.

Embryology (ἔμβρυον, a young animal + λόγος, discourse), strictly speaking, is that division of biological science which deals with the structure and growth of the embryo, that is, the young before it is capable of leaving the egg membranes and leading an independent existence. But such limits are inconvenient and the term as usually employed treats of the larval history as well, including all phases of growth until practically the adult form, if not size, is reached.

The account of embryology begins with the egg or *ovum*. This is a specialized cell (see CELL) formed in the reproductive glands (ovaries) of the mother and differs from all other cells of the body in its capacity, under the proper conditions, of reproducing an animal like the parent. The eggs of different animals vary greatly in size and appearance. In the simplest condition, as in the starfish and sea-urchin, the egg is a spherical mass of protoplasm (q.v.), with a central specialized portion, the nucleus, all being transparent and having a diameter of about one two hundredths of an inch. From this all variations in size and structure can be traced to the complicated and comparatively enormous eggs of birds. These variations are due to secondary features which are added for the protection and nourishment of the growing embryo.

Thus in the familiar hen's egg there is an external calcareous shell, then the double shell membrane enclosing the albumen or "white." Supported in the white is the yolk, which alone arises in the ovary, the other parts being added by the ducts through which the egg passes on its way to the exterior. Hence the yolk alone is the true egg. This owes its large size (compared with the egg of the starfish) to the fact that it contains not only the protoplasm and nucleus of the latter, but also a large amount of food material (food yolk or deutoplasm). On one side of the yolk is a lighter yellow spot (the "tread"), and in this spot are the nucleus and protoplasm, and in it the processes of development begin. All other parts are secondary or adventitious, and it is to the number, character and amount of these that the differences between the eggs of various animals are due.

In the limits of this article only the simplest and most essential features of development can be described; for details the reader must go to special works, but with greater or less modifications the following account will apply to all eggs.

The egg, as it leaves the ovary, is not ready for development. It must become mature. This process of *maturation* is very complex. In a few words it consists of the formation of two small bodies (*polar globules*), which are thrust out of the egg and play no part in its further history. These polar globules carry with them a small amount of protoplasm and three quarters of the essential material (*chromatin*) of the nucleus. This division of the chromatin is peculiar in that with the formation of the first polar globules half of each kind of chromatin is cast off; with the formation of the second half of the kinds of chromatin are lost. In the formation of the male reproductive element, the *spermatozoon*, there is an essentially similar division of the chromatin. Upon these divisions of the chromatin and the subsequent fertilization of the egg next to be described, all modern theories of heredity are based. After the polar globules are formed the remainder of the original nucleus sink back into the egg and form a *female pronucleus*.

After maturation comes fertilization, which consists in the union of a spermatozoon with the egg. The head of the male element penetrates the protoplasm, increases in size, and forms a *male pronucleus*. The two pronuclei unite and thus there is restored to the egg those chromatin elements which were lost in the formation of the second polar globule. It is to be noticed that in eggs which develop parthenogenetically (that is, without fertilization — see PARTHENOGENESIS) the second polar globule is not formed and hence no lost chromatin has to be restored.

Excepting parthenogenetic eggs it is only after fertilization that the egg is normally ready to develop and to begin the formation of the embryo. The first step is the division of the single-celled egg into numerous cells, the so-called *segmentation of the egg.* In the simplest eggs these divisions are regular and total, that is, at each division the resulting cells are equal in size and the planes which separate them cut entirely through the egg. With increase in amount of deutoplasm, as in the egg of the frog, there is a difference in the size of the cells, those at one pole being large, those at the other small (*unequal segmentation*). With still further increase in the amount of food yolk, only a part of the egg divides, and we have *partial* or *meroblastic segmentation,* as in the case of sharks, reptiles, and birds. These variations exercise a great influence upon the subsequent history of development, modifying the various processes in ways which are described in embryological text-books. The peculiar *centrolecithal* eggs of crustacea and insects need not be considered here.

In eggs with equal and total segmentation the first division plane cuts the egg into equal halves. The second plane, at right angles to the first, results in quarters. These two planes, from their relation to the meridians of the globe, are termed meridional planes. The third, which is at right angles to the first two, corresponds to the equator and divides the four cells into eight. After this meridional planes and planes parallel to the equator alternate, increasing the cells in geometrical ratio so that we have 2, 4, 8, 16, 32, 64, 128, 256, etc., cells as a result. In unequal segmentation this regularity is soon lost, while in meroblastic eggs the divisions result in a small patch of cells, the *blastoderm,* on one side of the yolk, as in the hen's egg at the time of laying.

At first the cells resulting from this segmentation form a solid mass known as the *morula* (mulberry) stage. Later this becomes a hollow sphere of cells, one layer thick, the so-called *blastula* (Fig. 1 left), its cavity, in contradistinction to other cavities which may appear later in the embryo, being known as the *segmentation cavity* or *blastocœle* (archicœle). In eggs with regular segmentation the wall of the segmentation cavity is composed of equal-sized cells,

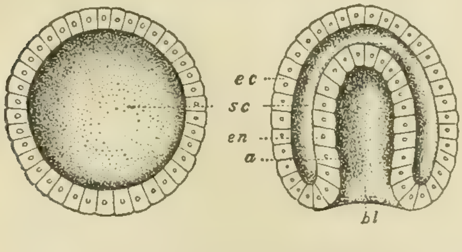

FIG. 1.— Diagrammatic sections of blastula (left) and gastrula (right); *a,* archenteron; *bl,* blastopore; *ec,* ectoderm; *en,* entoderm; *sc,* segmentation cavity.

but in unequally segmenting eggs the cells on one side are thicker than those on the other and the segmentation cavity is more or less excentric in position.

Next in sequence is the differentiation of the single layer of cells of the blastula into the two primary *germ layers.* The process may be compared to forcing in one side of a hollow rubber ball. One side of the blastula becomes turned into the other, partially or completely obliterating the segmentation cavity. In this way two layers are formed, an outer *ectoderm* (*epiblast* of English embryologists) and an inner *entoderm* (*hypoblast*). The opening into the cavity of the entoderm is known as the *blastopore,* while the cavity itself, from the fact that it forms the digestive tract of the adult, is called the *archenteron,* while for similar reasons the embryo at this stage is termed the *gastrula* (Fig. 1 right). In eggs with unequal segmentation it is the larger cells which form the entoderm, and in this way the food yolk, to which they owe their size, is brought into the walls of the digestive tract. In eggs with meroblastic segmentation the phenomena of formation of the gastrula are greatly modified and are impossible of description in a few words. They can, however, be harmonized with the foregoing account.

The mouth of the gastrula (blastopore) may remain permanently open and form the mouth of the adult, or it may close in the middle, the ends remaining open as mouth and anus. Again only one end may remain open, this forming in some the mouth, in others the anus. Lastly the blastopore may close completely and either mouth or anus may be formed outside its line of closure. From this it is evident that it is important to recognize the limits of the blastopore in tracing resemblances between different groups of animals, and this necessity is increased when we recollect that the central nervous system arises around the blastopore.

In some Cœlenterates and scattered members of other groups of animals the two layers, ectoderm and entoderm, may arise in a different way. On arrival at the stage of the blastula the inner ends of the cells which compose its walls become cut off from the outer ends, thus forming the two layers. While in this case the segmentation cavity becomes converted into the archenteron. This process is called *delamination* and is difficult to reconcile with the process described above.

In many Cœlenterates and a few other imperfectly known forms, the adult animal does not progress beyond the two-layered stage and hence these are sometimes grouped as the *Diploblastica,* in contrast to the *Triploblastica,* in which a third layer is added. This additional germ layer is the *mesoderm* (mesoblast of the English). It arises either from the entoderm or from the line of junction between ectoderm and entoderm and extends into the space (remains of the segmentation cavity) between these two layers, making up, in most animals, by far the largest part of the adult body. It shows considerable differences in its method of origin even in one and the same animal, and is frequently subdivided by writers into *mesothelium* and *mesenchyme* by characters which need not be detailed here.

From these three (or four) germ layers all the structures of higher animals (metazoa) arise. The derivation of the various structures in man may be enumerated here.

Ectoderm.— External layer (epidermis) of skin, hair, nails, sweat and milk glands, brain, spinal cord, nerves, the sensory portions of ears, eyes, nose, etc., lining of mouth, enamel of teeth.

Entoderm.— Lining of digestive tract (including its glands — liver, pancreas, etc.) of Eustachian tube, windpipe, lungs and lining of lungs not of notochord.

Mesothelium.— Lining of body cavity (peritoneum), pleura, and pericardium; all voluntary muscles of the body and muscles of the heart; internal reproductive and excretory organs.

Mesenchyme.— Deeper layers (derma) of skin, and of alimentary tract; tendons, fat, cartilage, bone, dentine of teeth; involuntary muscles with the exception of those of the heart; blood-vessels, blood, and lymph.

Space will not permit tracing the development of the various organs of all animals from

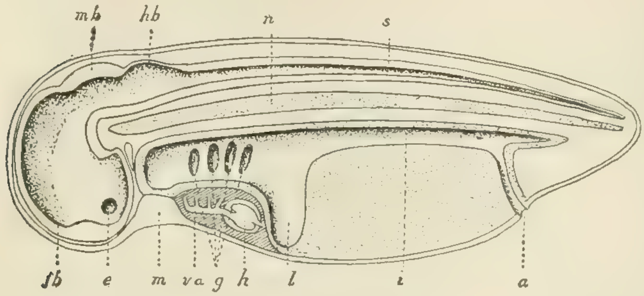

FIG. 2.— Diagrammatic long section of a salamander embryo. *a*, anus; *e*, place of outgrowth of eye; *fb*, fore-brain; *g*, gill slits extending outward from pharynx; *h*, heart in pericardium; *hb*, hind-brain; *i*, intestine; *l*, beginning of liver; *m*, thickening of ectoderm where mouth will form; *mb*, mid-brain; *n*, notochord; *s*, spinal cord; *va*, ventral aorta. Cut surface of entoderm dotted.

these germ layers, but later in this article a slight sketch of the processes as they occur in the vertebrates will be given.

From the stage in which the germ layers are formed some animals develop directly into the adult, while in others larval stages, differing markedly from the adults in appearance, are introduced. In some instances these larvæ are clearly adaptations to enable the young to begin its free life and its self-support as early as possible; in others they are indicative of the ancestry, representing, in the history of the individual, stages passed through in the development of the race. Larvæ are more abundant among marine than among fresh-water or terrestrial forms. See LARVA.

Development of Organs.— Space will permit the outlining of the development of organs from the germ layers in but one animal. For reasons of simplicity and of general interest the salamander has been selected as a type of the group of which man is a member.

The eggs of the salamander are laid in the spring, enclosed in a transparent jelly. They are fertilized after being laid, form polar globules, and undergo a total but unequal segmentation, a result of the large amount of food yolk present. The small segmentation cavity is consequently excentric in position. Since the segmentation cavity is small the gastrula cannot be formed in the typical way described above, but rather by a modified type of infolding, not easily described in a few words. The blastopore closes along what will eventually make the middle line of the back, the egg changing during this process from a spherical to a more elongate form.

On the dorsal surface, around the line of closure of the blastopore, the ectoderm becomes thickened, forming a *medullary plate*, broader in front. The edges of this plate gradually rise, roll inward toward each other and gradually convert the plate into a tube, from which later will develop the central nervous system. The broader anterior portion gives rise to the brain (Fig. 2), the rest to the spinal cord, while the lumen of the tube forms the canal of the cord as well as the cavities (ventricles) of the brain. Starting from this central system the nerves attain their outward growth later.

The eyes arise in large part from the brain, extending outward from it as hollow vesicles which grow laterally toward the ectoderm of the side of the head. Then the vesicle becomes folded into itself like a double cup, the inner wall of which gradually develops into the retina, while the optic nerve grows backward along the line of the stalk of the cup into the brain. The lens of the eye has its origin in the ectoderm of the side of the head opposite the outgrowing optic vesicle. This thickening increases, becomes folded into a ball and becomes cut off from the rest to sink to its permanent position at the mouth of the optic cup. The essential or sensory part of the ear begins as a pit on the side of head behind the eye. This deepens and sinks inward to join the outgrowing auditory nerve. It later becomes closed and completely cut off from the skin and by a complicated process of folding becomes developed into the two chambers and the three semicircular canals of the adult, these corresponding in position and origin to those of man. (There are no middle and outer ears in the salamander.)

The entoderm, arising by the modified process of gastrulation, becomes more and more elongate with the lengthening of the embryo. Behind, the canal (archenteron) remains small (Fig. 2, *i*), the ventral wall being enormously thickened by the large amount of yolk present. In front the cavity enlarges to form the liver (*l*), while in front of this is a short portion which has to develop into pharynx, gullet, and stomach. As yet there is no mouth. This arises first as an inpushing of the ectoderm in front (*m*) which later breaks through into the pharynx. In the pharyngeal region paired pockets grow out right and left until they meet the ectoderm with which they fuse (*g*). Then at the bottom of each pocket an opening appears so that this region is in connection with the exterior. These openings are the gill slits. Similar gill pouches are formed in the embryos of all vertebrates, but in the higher groups (reptiles, birds, and mammals) they are transitory with the exception of the anterior which forms the middle ear (tympanum) and Eustachian tube of the adult. Œsophagus and stomach develop later by elongation and differentiation of the region between the liver and pharynx, while the intestine arises from the part behind the liver outgrowth.

The mesoderm grows in as two double sheets between the ectoderm and entoderm (Fig. 3, *m*), the space between the two layers being called the cœlom (*c*). These mesodermal sheets extend on either side of the body from near the tip of the head to the end of the tail. At first they are dorsal in position, but with increase in size the lower margins approach the mid-ventral line, where they finally fuse.

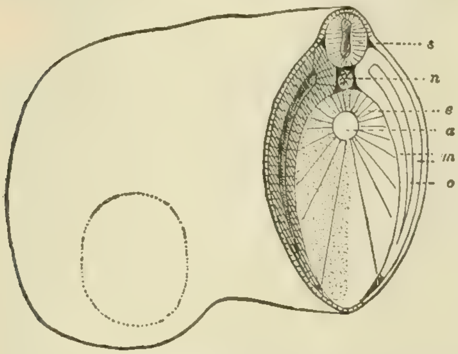

Fig. 3.—Diagram of anterior part of amphibian embryo; *a*, alimentary canal; *c*, cœlom or body cavity; *e*, entoderm; *m*, two layers of mesoderm; *n*, notochord; *s*, spinal cord.

The dorsal portion of each mesoderm plate soon becomes cut up into a series of cubical blocks, the *myotomes*, each myotome containing a portion of the cœlom. These myotomes are to furnish the voluntary muscles of the body. They finally separate completely from the rest of the mesoderm and begin to grow downward between the ectoderm and the lower part of the mesoderm until they extend to near the middle ventral line. During this process the inner wall of each myotome becomes transformed into muscle fibres and in this way plates of muscle (familiar to all in the flesh of a fish) arise. The muscles of the limbs arise as buds from a few myotomes in the regions where the limbs are to appear. With the outgrowth of the limb the buds extend into it and gradually become differentiated into the various muscles. The outer layer of the myotome is not transformed into muscle but gives rise to a connective tissue, the *cutis* or *derma*, which, together with the ectoderm (*epidermis*), forms the skin.

From the region just below the myotomes a second series of segments are formed which have for their most marked functions the formation of the excretory organs, and hence are called nephrotomes (ἐφρόδυ, kidney). The history of these organs is too complex to be followed here. Suffice it to say that in the salamander as in all fish-like vertebrates (Ichthyopsida), there are two kidneys formed in succession, an anterior head-kidney (*pronephros*) and a posterior Wolffian body (*mesonephros*), the latter forming the functional kidney of the adult. In the higher vertebrates (reptiles, birds, and mammals) both pro- and mesonephros are formed in the embryo and these are replaced later by a third kidney (*metanephros*) which alone serves an excretory organ in the adult. The nephrotomes also give rise, directly or indirectly, to the ducts of the reproductive and excretory organs, while from the inner surfaces are budded off cells (mesenchyme) which, among other functions, have to form the skeleton, mentioned below.

The lower portion of the mesoderm does not become divided as do the two upper regions. Its outer wall becomes applied to the muscles, while its inner covers the various viscera, thus forming the lining or *peritoneum* of the lower part of the cœlom which is usually called the body cavity. The only division of this cavity in the lower vertebrates is by means of a transverse partition, the *septum transversum*, which separates an anterior *pericardium* containing the heart from the peritoneal cavity containing the other viscera. In the mammals a second partition, the *diaphragm*, occurs behind the first, marking off the pleural cavities, containing the lungs, from the rest of the peritoneal cavity.

The first skeletal structure to appear is the notochord, a rod of gelatinous tissue which arises in the middle dorsal line from the entoderm, becomes cut off from it and comes to lie between the digestive tract and the central nervous system (Figs. 2, 3 *n*). Behind, it extends to the tip of the tail, but in front it does not reach the tip of the head, but is terminated at a down-growth from the brain, the infundibulum. This rod is not jointed, but serves as a centre around which the vertebræ and the base of the posterior part of the skull arise.

The tissue for the vertebræ and the floor of the skull is furnished by the mesenchyme from the nephrotomes, the origin of which was alluded to above. This tissue gathers around the notochord and forms rings around it, the bodies of the vertebræ; while connected with each body is a plate on either side, the two plates meeting above the spinal cord and forming the *neural arch*. Extending outward between the muscle plates are the rudiments of the ribs. At first vertebræ and ribs are cartilaginous, but later the cartilage becomes replaced by bone. In the head region a cartilaginous skull arises in a somewhat similar way. This is very complex, but may be divided into a cranial and a visceral portion, the latter consisting of cartilage bars for the jaws and between the gill slits. In the cranium only that part which arises around the anterior extremity of the notochord can be compared to the vertebræ. This cartilaginous skull becomes converted into the bony skull of the adult, in part by direct conversion of the cartilages into bone, in part by the formation of additional bones (dermal bones) in the skin which unite with those of cartilaginous origin. The skeletons of the girdles and limbs are almost entirely of cartilage origin, only the coracoid arising as a dermal bone.

The circulatory system is very complicated and only a small part of its development can be outlined here. In the pharyngeal region the descending plates of mesoderm meet below the entoderm, enclosing between them a tube lined by cells of uncertain, though probably of entodermal origin. These cells form the lining of the heart (*endothelium*), while the walls of mesoderm later furnish the muscles of this organ. The cœlom of this region becomes converted into the pericardial cavity.

At first this heart tube is straight, but since it grows faster than the pericardium it becomes twisted somewhat like the letter S and the auricle and ventricle develop out of the folds of the twist (Fig. 2, *h*), valves soon appearing between these chambers. Behind the heart the edges of the mesoderm are prevented from joining by the presence of the liver and hence there arise here two vessels which bring the blood from behind to the heart. In front of the heart is formed in a similar way a tube, the ventral aorta (Fig. 2 *va*), from which vessels (*aortic arches*) gradually grow upward around the pharynx in the tissue between the gill slits. These finally enter vessels above the pharynx which by their union form the dorsal aorta which runs backward above the alimentary tract to the tail. From this dorsal aorta vessels are given off at regular intervals which extend out laterally between the myotomes and serve to carry blood to these last.

From this comparatively simple arrangement the more complicated blood system of the adult is developed by the appearance of other vessels and the disappearance of some which are formed at first; the details of which must be sought in special works. One or two points have more interest and may be mentioned here. For various reasons it seems certain that in the early vertebrates there were formed six pairs of these aortic arches connecting the ventral and dorsal aortæ. In the salamander only the posterior four of these come to development, the anterior two on either side remaining rudimentary. In the development of the higher animals, as in man, there is the same formation of paired arches in the early embryo. Later in the history the fifth arch on either side is entirely lost, the sixth loses its connection with the dorsal aorta and sends its blood to the lungs, thus giving rise to the pulmonary arteries. Of the third pair that on the right side largely disappears, while that on the right persists as the "arch of the aorta" of human anatomy and alone carries blood to the dorsal aorta and the trunk. The anterior arches also lose their connection with the posterior dorsal trunks and give rise to the carotid arteries which carry blood to the head.

With this outline of the comparatively simple development of the salamander the more complicated features of the history of a higher vertebrate can better be understood. In many of their features these closely parallel the account just given. In the reptiles, birds, and mammals other features are added. Thus at an early stage there is formed an embryonic envelope which encloses the whole germ. In some mammals as in man this arises by a splitting of the ectoderm so that the embryo comes to lie in a cavity roofed in above by a delicate membrane, the *amnion*. In many other mammals, as in reptiles and birds, this amnion arises by an up-growth of ectoderm all around the embryo, these growths finally meeting and fusing above the embryo, thus finally enclosing an amniotic cavity similar to that in man.

In the salamander egg, the amount of food yolk is comparatively small. In the birds and reptiles it is enormous in amount. As a result the young reptile or bird appears as a small outgrowth on the surface of a large sphere of yolk. The presence of this causes the blood vessels described above as entering the heart from behind to extend down over the yolk, while other vessels extend to the same region from the dorsal aorta. By means of these a yolk circulation is set up and thus the yolk itself is gradually torn down and carried by the vessels into the circulation and thus used in building up the body. Later this yolk circulation, lying beneath the egg shell, serves as a means of respiration, absorbing oxygen from the air and giving off the carbon dioxide produced by growth.

In most mammals the whole embryonic period (including the fœtal stages) is passed inside the mother, a fact which has resulted in considerable modifications of the processes. Thus the egg has lost its food yolk and has a total, although irregular, segmentation. Larval organs have been lost, but the most remarkable changes are the provisions for furnishing nourishment to the growing embryo and the later fœtus. These may be briefly summarized by saying that an outgrowth occurs at the hinder end of the alimentary canal, the *allantois*, which carries with it arteries and a vein. This allantois increases in size, extending outward into the amniotic cavity, and finally uniting with its outer wall, the chorion. From this union is developed that structure so characteristic of mammals, the *placenta*. This portion comes in contact with the walls of the maternal uterus, while from its outer surface are developed numerous small, thread-like outgrowths, the chorionic villi. These penetrate into the uterine walls, which in the meantime have become spongy through the great development of blood vessels, and from this union the placenta is formed. Blood (or rather its serum) passes by osmosis from the vessels of the uterus into the villi and thence by the allantoic vein to the embryo, while blood which has done its work in the embryo is carried back by the same course to the mother. It is to be noted that at no time is there a direct connection of the blood vessels of parent and off-spring, all transfer being osmotic.

With growth the placenta increases in size, while the stalk of the allantois and accessory structures remain small, and these smaller portions form the umbilical cord. The placenta varies in different animals, three chief types being recognized. In the cotyledonary, as in domestic cattle, the villi are gathered in numerous small patches or cotyledons; in the zonary type, as in dogs, the villi form a girdle or zone around the fœtal envelopes; while in the discoidal condition (man), the villi occupy a disk-like area on the envelopes. At birth the young mammal is in position to breathe for itself and to take food into the alimentary canal and hence the placentar structures are no longer of value. They are, therefore, cast out as the "afterbirth," carrying with them a part of the uterine lining.

The literature of embryology is very large and reference can be made to but a few manuals, which, however, have good bibliographies. A classic work is Balfour's 'Treatise on Embryology' (2 vols., London 1880–1), which includes all groups of animals. Most recent for invertebrates is the Embryology of Korschelt and Heider (translated in 4 volumes, 1900). For vertebrates the best text-books are Minot, 'Human Embryology' (1892), and Mark's translation of Hertwig's 'Embryology' (1892). A smaller, more recent and very clear work is McMurrich, 'Development of the Human Body' (1902). All of these, while emphasizing man in the titles, deal with other vertebrates.

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Professor of Zoology, Tuft's College.

Embury, Emma Catharine Manley, American writer: b. New York 1806; d. Brooklyn, N. Y., 10 Feb. 1863. She was married to Daniel Embury in 1828. Much of her work for periodicals was over the pen-name "Ianthe." Among her published works are: 'Guido and Other Poems' (1828); 'Female Education'; 'The Blind Girl, and Tales'; 'Love's Token Flowers' (1846); 'Poems' (1869).

Embury, Philip, Methodist clergyman: b. Ballygaran, Ireland, 21 Sept. 1729; d. Camden, N. Y., August 1775. He joined John Wesley's society and became a local preacher at Court-Mattress in 1758. Emigrating to New York in 1760, he began to preach in his own house in 1766, and two years later erected a chapel on the site of the present "Old John Street Church." Being a carpenter by trade, he worked on the building with his own hands and completed the pulpit, in which he preached the sermon of dedication 30 Oct. 1768. This was the first Methodist chapel of the New World, and he has been called "the founder of American Methodism." It was, however, at Camden, Washington County, N. Y., that he did his greatest work, forming there a congregation which grew into the flourishing and influential Troy Conference.

Em'den, Germany, town, in the province of Hanover, on the Ems, near where it discharges itself into the Dollart estuary. Emden has an excellent roadstead, and its harbor is connected with this by a canal admitting large vessels. The Dortmund-Ems and other canals connect it with the interior. Its export trade includes grain, dairy produce, cattle, tallow, wool, hides, etc.; and it imports coal, timber, wine, and colonial produce. A considerable number of vessels are built here annually; and the manufactures include leather, paper, wire ropes, bricks, soap, and tobacco. There are also oil-mills, breweries, and distilleries. Pop. (1900) 16,453.

Emelé, ā-mā-lā, **Wilhelm,** German painter: b. Buchen, Odenwald, 1830. He first adopted a military career but studied art with Dietz at Munich, and later at Antwerp and Paris. His canvases are noted for exactness of details, his subjects being military. He has lived in Vienna since 1861. Among his works are: 'Battle of Stockach'; 'Capture of Heidelberg Bridge in 1799' (1857); 'The Fight Near Aldenhoven' (1859); 'The Square of the Battle of Aspern' (1860); 'Capture of Camp Near Farmars'; 'Attack on the English by French Cuirassiers at Waterloo'; 'Battle of Wurzbourg' (1867), his best work; 'The Archduke Charles at Battle of Neerwinden' (1872); 'Attack of the Bournernain Division Near Elsasshausen'; 'Battle of Dijon'; 'Meeting of Patrols of Seventh and Fourteenth Corps, Prussian Army, Near Vesoul'; 'Headquarters of 14th Army Corps in Battle of Belfast'; 'Episode of Battle of Worth'; 'Victory of George II. over the French at Dettingen' (1879).

Emerald (O. Fr. *emeraude*, Gr. σμάραγδος), a gem of pure green color, often very rich and beautiful. It is a variety of the mineral beryl and is, therefore, a silicate of aluminum and glucinum (q.v.), its green color being due to the presence of a little chromium. It is usually found in nodules or in distinct six-sided prisms of the hexagonal system. It is a little harder than quartz, and has a specific gravity of about 2.69. It is not acted on by acids. Many of the most intensely colored and valuable emeralds that we are acquainted with were brought from Peru, the largest from Takowaja, in the Urals, a specimen of which is seen in the 6¾-pound stone at St. Petersburg. Most modern emeralds come from the Republic of Colombia, which quite supplies the current market. In the United States emerald crystals up to nine inches in length and of rich color have been found in Alexander County, N. C., while extensive mining in Mitchell County, N. C., has yielded beautiful gems and much so-called "emerald matrix." The rarity, rich color, brilliancy and hardness of emerald have made it one of the most highly prized of gems. "Oriental emerald" is green sapphire, "lithia emerald" is hiddenite (q.v.), "Uralian emerald" is demantoid, "Brazilian emerald" is tourmaline (q.v.). See also BERYL and GEMS.

Emerald Green, known also as **Schweinfurth** or **Paris Green,** and by a great number of other names, is one of the most beautiful green pigments. It appears to contain copper, arsenic, and acetic acid, and is usually regarded as an aceto-arsenite of copper. It is a crystalline powder, which becomes paler by grinding, is not affected by light and air, and is insoluble in water, but is decomposed by alkalies. It is used both as a water and as an oil color, and is used for tinting wall-papers, though with much less frequency since the danger of that practice has been discovered.

Emerald Isle, an epithet applied to Ireland, from the freshness and bright color of the verdure, produced by the abundant heat and moisture continually reaching it from the Atlantic. This epithet was first used by Dr. W. Drennan (1754–1820), in his poem entitled 'Erin.'

Emerson, Charles Wesley, American educator: b. Pittsfield, Vt., 30 Nov. 1837. Studying law, medicine and theology, he was a clergyman for many years. He founded the Emerson College of Oratory, Boston (1880), and has since been its president, teaching oratory, physical culture and voice development.

Emerson, Edward Waldo, American physician and author: b. Massachusetts 1844. He is a son of Ralph Waldo Emerson (q.v.). He was graduated at Harvard College and Harvard Medical School, and is an instructor in anatomy at the Boston Museum of Fine Arts. He has published: 'Emerson in Concord' (1888); and an edition of the 'Correspondence of John Stering and Ralph Waldo Emerson, with sketch of Sterling's Life.'

Emerson, MRS. **Ellen** (RUSSELL), American author: b. New Sharon, Maine, 16 Jan. 1837. She was married to Edwin Emerson (1862). Her works are: Indian Myths, Legends and Traditions' (1884); 'Masks, Heads, and Faces, with Considerations Respecting the Rise and Development of Art' (1891); 'Nature and Human Nature' (1901); 'The Story of the Vine' (1902).

Emerson, George Barrell, American educator: b. Kennebunk, York County, Maine, 12 Sept. 1797; d. Newton, Mass., 14 March 1881. He was graduated at Harvard College (1817), and was the tutor in mathematics and natural philosophy there (1819–21). In 1823 he opened a private school for girls in Boston, which he conducted until 1855, when he retired from professional life. He wrote the second part of the 'School and Schoolmaster,' of which the first part was written by Bishop Potter of Pennsylvania. He was appointed chairman of the commissioners for the zoological and botanical survey of Massachusetts, in which capacity he published a 'Report of the Trees and Shrubs Growing Naturally in the Forests of Massachusetts' (1846).

Emerson, Luther Orlando, American composer: b. Parsonsfield, Maine, 3 Aug. 1820. He studied music and later taught for eight years in Salem, Mass. He then served as organist and musical director in various churches in Massachusetts, and was the director of about 300 musical festivals and conventions. He has published: 'The Romberg Collection' (1853); 'The Golden Wreath' (1857); 'The Golden Harp' (1858); 'The Sabbath Harmony' (1860); 'The Heart of Judah' (1863); 'Jubilate' (1866); etc.

Emerson, Oliver Farrar, American educator: b. Traer, Iowa, 1860. He studied at Iowa College, taking a post-graduate course at Cornell University. After serving as superintendent and principal of schools in Grinnell and Muscatine, Iowa, he was principal of the Academy of Iowa College (1885–8); instructor in English (1889–91) Cornell University, and assistant professor of rhetoric and English philology in the same institution (1892–6), when he took the same chair in Western Reserve University. He is secretary of the American Dialect Society, and is a regular contributor to philological papers. He has published: 'History of the English Language' (1894); 'A Brief History of the English Language' (1896); an edition of 'Dr. Johnson's Rasselas' (1895); and 'Memoirs of the Life and Writings of Edward Gibbon' (1898).

Emerson, Ralph Waldo, American poet and philosopher: b. Boston 25 May 1803; d. Concord, Mass., 27 April 1882. The celebration two years ago, in 1903, of the 100th birthday of Ralph Waldo Emerson served as a meter to mark how wide and deep was the influence which a single original thinker gifted with literary expression can exert at the end of his first century; for there was public recognition of his ethical and poetic genius in every quarter of the globe. Along with this appreciation went also the perception that a distinct Emersonian school of thought had arisen, modified in some degree by the circle of striking writers and talkers — men and women of thought, fancy, imagination, and eloquence — who gathered around Emerson early or late in his career and now constitute the group known as the "Concord Authors," or the Concord School of Philosophy. Most of these at one time or another lived in the rural village of Concord in Massachusetts, where Emerson spent a half century of his life. Such were Alcott, Hawthorne, Thoreau, Ellery Channing, Louisa Alcott, George William Curtis, Elizabeth Hoar, Elizabeth Peabody, Julian Hawthorne, J. W. Chadwick, W. T. Harris, John Albee, F. B. Sanborn, F. P. Stearns — all of whom lived for longer or shorter times in Concord; and on the outside of the circle, yet not far away, Margaret Fuller, Theodore Parker, Dr. Bartol, David Wasson, Mrs. Ednah Cheney, Christopher Cranch, and John S. Dwight. All these stood in relations more or less direct to Emerson, and were influenced in varying degrees by his fertilizing mind and gentle social attraction. Several of them, as Hawthorne, Thoreau, Channing, Margaret Fuller, and Alcott, were as original as Emerson, though less gifted with the qualities that form a school or coterie; and none of them could properly be styled satellites or Emersonidæ, although that term has been applied to several of them. Emerson was the eldest born of all these, except Alcott. He was the son of a Boston pastor, Rev. William Emerson of the First Church, which had become Unitarian instead of Calvinistic. Most of his male ancestors as far back as the English Reformation were clergymen, and his middle name, Waldo, was said traditionally to come from one of those Waldenses who incurred the censure of the popes as heretics far away in the Middle Ages. His oldest American ancestor founded the Christian Church in Concord in 1635 (Rev. Peter Bulkeley) and by that line Emerson was related to the noble English family of Saint John, of which was Pope's brilliant friend Bolingbroke. From another clerical ancestor, Rev. William Thompson, through the Cogswells, he was related to Wendell Phillips, Phillips Brooks, and other men famous for eloquence; and by another line he descended from a clerical family of Moodys, whose genius verged upon insanity. This last name was perpetuated in Emerson's aunt, Mary Moody Emerson, his father's sister, who had more to do with his intellectual and spiritual training than any other of his early instructors. With this strong clerical bent in his ancestry young Waldo Emerson was destined to the pulpit from his cradle, and was carefully educated in Boston and Harvard College with that view. He entered college early and came under eminent teachers, Edward Everett in Greek, George Ticknor and Edward Channing in literature, and Caleb Cushing in mathematics — but for the last-named study he had no inclination, and did not stand high in general scholarship at his graduation in 1821. He read widely, however, and the discipline of teaching in his elder brother William's school for young ladies at his mother's house in Franklin Street, Boston, gave him exactness in Latin, French, and Greek. He presently (1823) took up the study of divinity with Dr. Channing and Prof. Andrews Norton, and began to preach sermons in 1827. He spent much time in youth at his grandmother's, who owned the Old Manse in Concord, and there he preached for some months in 1828, during the absence of her second husband, Rev. Dr. Ripley. His own grandfather, Rev. William Emerson of Concord, who built the Old Manse, died as a chaplain in the Revolutionary army in 1776.

The clerical life of Emerson was a distinct era, marked by originality and independence in the young divine. His first and only settlement was at the Second Church of Boston, which had been Cotton Mather's, and was Henry Ware's when Emerson was ordained as a colleague in 1829. He became sole pastor in 1830, and in the meantime had married a delicate young Bostonian, Ellen Tucker, who died in 1832. In 1833, upon a point of doctrine con-

RALPH WALDO EMERSON.

cerning the rite of the Lord's Supper, in which he found himself at variance with his deacons, he preached a sermon gently setting forth his scruples and resigned his place, much against the wish of his people. But he was ill and despondent since the death of his wife and the illness of his brother Edward; and a foreign tour was prescribed for him, which broke the continuity of his preaching, although he continued to officiate in pulpits here and there for some six years after his first visit to Europe. Miss Elizabeth Peabody, who had often heard Emerson preach, said at the Concord School of Philosophy in 1883:

> From 1834 I never omitted an opportunity of hearing Emerson preach. I sought and obtained leave to read the sermons he had in manuscript. They were all as truly "transcendental" as any of his later writings in prose or verse. If a volume of them could be printed to-day in their own form it would interpret his later revelations, of which they are but a varied expression. From first to last he never shut in his vision of the living God to the limitations of his own or any other individual conception. I once repeated to him the reply of an unconsciously wise and pious woman of the Lexington congregation, when asked why they did not settle an eminent preacher (Dr. Hedge). "Oh, we are a very simple people in East Lexington; we can hardly understand anybody but Mr. Emerson." He did not laugh; on the contrary, with an accent almost pathetic, he replied, "If I had not been cut off untimely in the pulpit, perhaps I might have made something of the weekly sermon."

No doubt he would have made much of it. But what he did was better; he turned the lecture desk into a pulpit, and for more than 30 years preached righteousness there. From 1835, the date of his second marriage, to Miss Lidian Jackson of Plymouth, lecturing was his chief occupation during half the year. His essays were first lectures and were generally given to many audiences before he thought them good enough to print.

His first book, 'Nature,' published in a small edition in 1835, was not a course of lectures, but rather genuine essays, thought out for years, and mostly written out in their final form at the Old Manse, or finished in his own study at the home he made for himself in 1835 at the east end of Concord village, and where he died, 27 April 1882. The book attracted little notice in America or England at first, and a second edition was not issued until 1849, a dozen years having been required to sell 500 copies. But Carlyle, whom he had visited at Craigenputtock in 1833, and with whom he formed then a strict friendship and corresponded until Carlyle's death, saw its value, and so did Alcott, Hawthorne, Parker, Thoreau, and a circle of high-minded women, who became his constant hearers. It now takes rank as the nearest approach to a system of philosophy which he put forth in successive chapters during his whole active life. He planned another and more elaborate work, which he called 'The Natural History of Intellect,' and of which he wrote several chapters, intended to set forth the function and operation of the qualities of the human mind — memory, imagination, reason, volition, etc.— but he never brought it to such completion that it could be published as a whole, either by himself or his successive editors, Mr. Cabot, Dr. Emerson, etc. When invited to lecture on Philosophy at Harvard, as he was in 1870, he threw these chapters and copious notes and readings into 18 lectures, two in a week, but the effort was too great for him at his age and in his failing strength, and he could never afterward bring the papers into form for printing. Several of the chapters appear separately; and perhaps some future scholar may combine them with 'Nature' into a single work.

Emerson was actually introduced to noisy public notice by two of his early addresses, which are now printed in the same volume with 'Nature' — his Phi Beta Kappa oration of 1837, and his Divinity School Address of 1838. The first attracted attention and praise, mingled with surprise; the second, from its bold appeal to preachers to revise their theology and meet their hearers with original truths, not with traditional forms of religion, aroused the native intolerance of New England to shrill protest and uncharitable malediction. His own college, of which he was the most illustrious graduate, drew back in timid aversion from thoughts alleged to be revolutionary, and it was not until 1867, 30 years after his first Phi Beta oration, that he was again invited to address the student-body, or to receive any collegiate honor. About the same time (1837–8) he identified himself with the unpopular cause of negro emancipation, with the advanced ideas of Alcott in education, and with several schemes of social reform, which the commercialism of the period viewed with dislike or scornful indifference; and so he alienated another class in the New England and New York communities, who might otherwise have been charmed with his literary skill and his peculiar eloquence. Thus his audiences continued small, and his writings had little general circulation, until the gradual education of people in his ideas and his phraseology, gave him the hearing that his genius deserved.

Meanwhile Emerson was drawing about him in Concord and Boston, in Plymouth, Salem, and other New England towns, a circle of friends and a school of thought. The number of these persons was small at first, but their enthusiasm was fervent, and their intellectual and social force was considerable. Prominent among them was Margaret Fuller, a woman of genius who drew other women by her talent and her sympathies, and who had formed a circle of her own in Cambridge and Boston. Among men, the most prominent for a time was Bronson Alcott, an educational reformer, who had shown insight and eloquence in dealing with the young, but whose talent for conversation was not accompanied by any corresponding gift of expressing himself in writing. Others of the circle were F. H. Hedge, an accomplished student of German literature, afterward distinguished in theology; Dr. Convers Francis, a learned pastor and professor at Cambridge; Theodore Parker, equally learned and more radical in opinion; with younger men like William Henry Channing, James Freeman Clarke, Henry Thoreau, Wentworth Higginson, Ellery Channing, S. G. Ward, Marston Watson of Plymouth, J. Elliot Cabot; and in his own immediate acquaintance, Mrs. Sarah Ripley, the most learned woman of New England, who had married Emerson's uncle, Rev. Samuel Ripley; her brother, George Bradford; Miss Elizabeth Hoar, an accomplished woman, betrothed to Emerson's brother Charles (who had died in

1836), and Emerson's own aunt, Mary Emerson, who at times favored and at times opposed the movement in which her nephew was engaged. This movement presently was called, rather than called itself, "Transcendental"— the term borrowed from the phraseology of German philosophy, but hardly corresponding in New England to the meaning it had in Germany, and indeed used loosely in America with no fixed meaning. Its followers were in fact idealists of various shades and divisions of thought and speculative philosophy, whose organ, the quarterly review called 'The Dial,' existing four years (1840-4), became the receptacle of much youthful literature and many earnest essays toward the reformation of society in education, morals, and politics. Its first editors were Margaret Fuller and Rev. George Ripley, the founder of the famous community at Brook Farm; but from the first Emerson had great influence in its councils, and ultimately became its proprietor and editor, associating Thoreau with himself in editing it. Hence much of the earlier writing of Thoreau first came out in 'The Dial,' as did that of Emerson and Margaret Fuller and Theodore Parker. For this review Emerson wrote the introductory essay, as he did in December 1847 for a kindred venture, the 'Massachusetts Quarterly Review,' in which Parker and Elliot Cabot were frequent writers. In these two brief essays must we still look for a characterization of the so-called transcendental movement, so unimportant in its first appearance, yet so momentous afterward in determining some of the chief results of the Civil War of 1861-5. In 'The Dial' Emerson spoke of it as "the progress of a revolution," and such it proved indeed to be. He added:

> Those who share in it have no external organization, no badge, no creed, no name. They do not vote or print, or even meet together. They do not know each other's faces or names. They are united only in a common love of truth and love of its work. . . . Without concert or proclamation of any kind, they have silently given in their several adhesion to a new hope; and in all companies do signify a greater trust in the nature and resources of man than the laws or the popular opinions will well allow.

Seven years later, approaching the same topic from another point of view, and with more experience of his countrymen, Emerson said in the first number of the 'Massachusetts Quarterly':

> The aspect this country presents is a certain maniacal activity, an immense apparatus of cunning machinery, which turns out at last some Nuremberg toys. Has it generated, as great interests do, any intellectual power? One would say there is nothing colossal in the country but its geography and its material activities; that the moral and the intellectual effects are not on the same scale with the trade and production. . . . It is a poor consideration that the country wit is precocious, and, as we say, practical; that political interests on so broad a scale as ours are administered by little men with some saucy village talent; by deft partisans, good cipherers, strict economists, quite empty of any superstition. . . . The state, like the individual, should rest on an ideal basis. As soon as men have tasted the enjoyments of learning, friendship, and virtue — for which the state exists — the prizes of office appear polluted, and their followers outcasts.

The profound discontent so manifested, yet lightened by an ideal hope of better things, was working in the mass of the Northern people, as well as in this small nucleus of Platonists and agitators of New England, New York, and Ohio. While 'The Dial' had to perish for want of subscribers, the *Tribune* of New York rose up to more than fill its place; and Margaret Fuller, Thoreau, George Ripley, and George William Curtis found Greeley ready to give them a hearing in his daily and weekly newspaper, which had readers everywhere. It reported Emerson's lectures, the sermons of Parker, and printed the higher criticism of Ripley, Dana, and Margaret Fuller. Political parties began to be formed on ideal issues, and courageous minorities began to grow into triumphant majorities here and there.

In this escape out of the ideal into the practical Emerson rather unwillingly found himself involved. He began to be popular, and his books, which up to 1850 had scarcely paid for the cost of publishing them, became a source of moderate income. He had followed up the publication of essays in 'The Dial' by the issue in 1841 of a volume selected from his earlier lectures and essays, a second series in 1843, a collection of his orations annexed to a reprint of 'Nature' in 1849, and in 1850 his most effective book for European recognition of his high quality, the 'Representative Men.' All these books had been lectures mainly, though much changed in publication, as may be seen by reading the omitted passages cited in the 'Notes' to Dr. Emerson's 'Centenary Edition' of his father's books, issued in 1904. And by 1850 Emerson had become a widely-sought lecturer, and went as far west as Galena and Saint Louis, though practically shut out of the slave-holding States by his pronounced anti-slavery opinions, which began to be made public by him in 1844. This wider hearing as lecturer was needful to him now pecuniarily; for his small fortune, which had made him independent since 1832, had become involved in railroad speculations by the ambition of a classmate at college, and yielded him little revenue for years. The way had been prepared for his extended reputation in England and on the continent by his visit there in 1847-8, when he lectured extensively in England and Scotland under arrangements made for him by Alexander Ireland of the Manchester 'Guardian,' and by his friend Carlyle and others in London. He had even aroused the envy of Mrs. Carlyle by his welcome in England among the aristocratic circle to which he had access through his friends George Bancroft and Charles Sumner, as well as by the simple dignity of his own manners, which admitted him everywhere in the exclusive society of great cities. On this visit he saw something of the French revolution of 1848, and made acquaintance in England with Arthur Hugh Clough, Matthew Arnold, Froude, and others of the rising young men in literature, as well as the older men of letters whom he met at the breakfasts of Rogers, and in the circle to which Carlyle, long resident at Chelsea, belonged.

Emerson had ever been more forward to publish his friends' books than to hasten to the press with his own. The first edition of 'Sartor Resartus' in America was introduced by him in a preface, and he took charge later of American editions of the 'French Revolution,' and the earlier essays of Carlyle; by all which the author received, from sales in America before 1842, about $1,000, which he assured Emerson was more than he had then got from his books (not his review articles) in Great Britain.

1. Home of Emerson at Concord, Mass. 2. Library in the Emerson Home.

Emerson also edited the first edition of Jones Very in 1839, and promoted the earlier volumes of Ellery Channing and Thoreau from 1840 to 1854, when Thoreau issued the second of the only two volumes published in his lifetime. Altogether, for Carlyle, Margaret Fuller and his other friends, he had caused to be printed three times as many volumes as appeared of his own writing during the 20 years after his second marriage in 1835. In 1852, while in the midst of his lecturing popularity, he paused at Buffalo, N. Y., from one of his extended tours, to urge on his friends at Plymouth to gratify the ambition of Ellery Channing, who would figure as a lecturer as well as a poet. Emerson wrote then to Marston Watson, the «Plymouth Evelyn,» as Alcott styled him, thus (4 Jan. 1852):

Mr. Scherb is a very proper person to take a part in your series of Sunday lectures, and will gladly do so. One other person I should like well to have engaged, my friend Ellery Channing. But I dare not quite say he has any lecture for your purpose, until I hear his lecture on the 'Future.' Both the others of his three I have heard; and though they are full of wit and criticism or sarcasm all round the compass, he needs practice and pruning. I am sorry on his very account to leave home just now; for I wish more that he should lecture than that I should.

As a poet Emerson had been slightly known to his youthful associates in college and elsewhere, and in 1834 he had been invited to write the customary poem for the Phi Beta Kappa anniversary at Harvard, and did so. But he was dissatisfied with it, and for some years after did not publish verses. In 1837 he sent to his friend J. F. Clarke at Louisville, Ky., for printing in the 'Western Messenger' of Louisville and Cincinnati, three poems of his earlier composition, and he continued to print others in 'The Dial.' In 1846 he collected these and others in a small volume, printed in Boston and London in 1847, and he issued another volume, largely made up from contributions to the 'Atlantic Monthly,' in 1867. His son has added many poems and fragments in the final edition, so that it is now possible to judge of Emerson as poet by a perusal of all that he wrote in metre. At first his verse attracted little attention, except by parodists who viewed it as something comical, and to be satirized; this he had expected, for it had happened with his prose also. But even those who admired and quoted his poetical prose were rebuffed by his irregular and difficult verse; and only some 20 years after the volume of 1847 did it begin to be recognized that here was a philosopher putting his thought into oracular verse, some of which was becoming proverbial, as oracles are wont to be. Since 1884, when at the summer session of the Concord School of Philosophy, this feature of his poetry was set forth, it has become a fashion to interpret it in readings; and the essence of his deeper philosophy is best given in his verse; a key to the whole Emersonian theory of the universe being found in the oracular 'Sphinx' of the first 'Poems,' where it stands at the beginning, as befits a key. Besides this philosophic quality, there is also much of a high literary character in single poems devoted to love, friendship, patriotism, and the cause of liberty.

Had it been predicted in 1847, when Harvard professors were scoffing at Emerson's verse, and declaring his philosophy unintelligible, that 60 years later Harvard would be teaching philosophy in a spacious hall named for Emerson and built in part by the contributions of his followers and friends, the prophecy would have been classed with almanac presages of the weather. Yet that very thing has happened, and happened partly in consequence of the 10 years' continuance, from 1879 to 1888, of the summer school of philosophy and literature just mentioned. This school carried out an early dream of Emerson and Alcott, who both took part in it till Emerson's death in April 1882, and Alcott's stroke of paralysis in the following October. It brought together speculative men of different schools, all in their way idealists, and it raised into prominence Emerson's share in quickening and deepening philosophic ideas in America.

Emerson had published his 'English Traits,' a masterly summary of English history and character, in 1856; in 1857 he became a leading writer for the new 'Atlantic'; in 1860 published the 'Conduct of Life'; in 1864 'Society and Solitude'; in 1874 a selection of poems (omitting his own) called 'Parnassus'; and in 1876 'Letters and Social Aims,' edited by his subsequent biographer, Elliot Cabot. During the Civil War he was a frequent orator for the Union and emancipation, and his political speeches have been posthumously collected in a volume of 'Miscellanies,' published in 1883, and enlarged in the Centenary edition. A volume of 'Lectures and Biographical Sketches' (1883 and 1904) gives his posthumous lectures and personal tributes, and a final volume (1893 and 1904), 'Natural History of Intellect,' gives others, and a general index, long needed.

The classification of topics in these later books does not well agree with the titles; and there are still other volumes promised from Emerson's journals and letters, although these have been much drawn upon in notes to the 12 volumes already issued. It remains for some future editor to arrange the writings with a better regard to their chronological sequence; since the estimate of Emerson as a writer depends somewhat on the observed growth and decline of his powers, as in the analogous cases of Plato and Goethe.

It is in the class with these two world-renowned authors that Emerson will stand hereafter. Less copious and less imaginative than either Plato or Goethe, he is not less original than they; and his expression of profound thought and ethical truth was guided by a taste often better than theirs. Much mannerism and many repetitions are found in his books as in theirs; many apparent inconsistencies also, as with them. But these last grew out of the development of his thought, and his increasing perception of the complexity of the two worlds, Nature and Man. Of his many biographers and critics few have fully comprehended him; they furnish material for final judgment rather than a statement to satisfy future readers. The best, in this view, are Elliot Cabot and Dr. Emerson, to whom the world is indebted for much material drawn from the manuscripts, and not found in type elsewhere.

Emerson's health and vigor failed after the partial burning of his house in 1872, and his last tour abroad, in 1872–3, did not restore him. He continued active for years, though withdrawing more and more from publicity, by reason of his failing memory. His virtuous and serene nature remained unshaken by these accidents of mortality, and his final illness, though pathetic from his anxiety to avoid burdening others, was short and hardly afflictive. His wife and three of his four children survived him — Mrs. Emerson, the mother of all, dying in 1892, at the age of 90. His descendants are numerous by various names; his friends are numberless, for he never had a personal enemy, and he inspired affection almost as much as admiration.

Bibliography.—Memoirs of Emerson in various forms began to appear even before his death in 1882, the first good one being by G. W. Cooke (Boston 1881), 'Ralph Waldo Emerson, His Life, Writings and Philosophy'; followed in 1882 by Alcott's last book, 'An Estimate of Emerson's Character and Genius in Prose and Verse.' In 1883, supplemented in 1885, appeared 'The Correspondence of Carlyle and Emerson,' edited by Prof. C. E. Norton, containing much not found in any biography of either. 'The Genius and Character of Emerson, Lectures at the Concord School of Philosophy' (Boston 1884), contains estimates by 12 or 15 literary and philosophic friends. The authentic biography is 'A Memoir of Ralph Waldo Emerson' by J. Elliot Cabot (Boston 1887); the best brief biography is Dr. Richard Garnett's 'Life of Ralph Waldo Emerson' (London 1888). Dr. E. W. Emerson's 'Emerson in Concord, a Memoir' (Boston 1889), is a supplement to Cabot's memoir, dealing chiefly with Concord incidents. The largest recent addition to our knowledge of Emerson's life and writing is found, however, in Dr. Emerson's 12 volumes of the Centenary edition of 1904, containing at least 1,000 pages of new matter, with many dates and incidents not elsewhere recorded (Boston 1903–4). An extensive literature concerning Emerson exists in French, German, and Italian, and he is studied to some extent in Scandinavia, Russia, Greece, Persia, and India. The autobiographies of M. D. Conway and A. D. White (1904 and 1905) contain something on these points.

F. B. Sanborn,
Author of a 'Life of Emerson.'

Emerton, Ephraim, American historian: b. Salem, Mass., 18 Feb. 1851. He was graduated at Harvard 1871 and studied in Leipsic, becoming instructor in Harvard 1876, and professor of ecclesiastical history there 1882. His works include: 'Synopsis of History of Continental Europe'; 'The Study of Church History'; 'The Practical Method in Higher Historical Education' (1885); 'An Introduction to the Study of the Middle Ages' (1888); 'Mediæval Europe' (1894); 'Desedirius Erasmus'; 'Heroes of the Reformation'; 'Sir William Temple und die Tripleallianz vom Jahre, 1668.'

Em'ery, an impure variety of the mineral corundum (q.v.), reddish brown, black, blue black or gray in color, and next to the diamond the hardest mineral known. It consists of nearly pure alumina (65 to 75 per cent) and oxide of iron, and a small amount of silica and water. Emery occurs in large boulder-like masses, closely resembles a fine-grained magnetite ore in texture, and is often mistaken for it. In its native form its value as an abrasive has been known from the earliest times, and many references are made to it in books by Greek authors. Then as now it was used in cutting and polishing jewels and intagli, in the sculpture of statuary from the harder rocks, and in polishing marble. It was undoubtedly used by the Egyptians, and there are many evidences of the use of it or as hard a substance in the manufacture of prehistoric stone implements.

As now used, in its pulverized form, it is one of the most useful substances known to the arts. The rock is broken in powerful crushers and stamping-mills and separated into powders of varying degrees of fineness by screens or by elutriation. These powders, varying from particles one tenth of an inch in diameter to the finest flour, are sprinkled with water or oil upon the lead wheel of the lapidary, or spread upon wood, paper, or cloth to which a thin layer of glue has been previously applied; or as has been found to be its most effective application, mixed with various adhesive substances and molded into solid wheels. Emery-stones of various shapes and sizes are also made in the same manner.

Emery wheels are now made up to 36 inches in diameter and from 4 to 6 inches in thickness, and in every variety of coarseness from rough shapers to fine polishers for brass and steel. The cementing material is usually a secret with the manufacturer, and upon this and upon the quality of emery used depends the cost and the subsequent life and usefulness of the wheel. Properly mounted and turned at a proper speed it is our most effective cutting tool, tearing its way rapidly into chilled castings that the best file will not cut, or taking the teeth instantly off the hardest file. Special points to be observed are uniformity of texture, that the wheel may wear away evenly under use; carefully fitted bearings, that there may be no vibration under the high speed at which it is run; the wheel must not be fitted closely to either mandrel or flanges, lest expansion by heat burst the wheel; and the cementing material of the wheel must be able to resist the tendencies to centrifugal disruption and to melting under the heat generated by its friction with the object being cut. Its effective speed must have been determined and tested and the degree of pressure with which the work is to be applied must likewise be ascertained. Emery wheels that have become misshapen through use are turned true by various special contrivances, all of which must have a cutting edge of rough diamond. Wheels are often shaped for special work in the same manner.

The present supply of emery is chiefly from the island of Naxos and from near Smyrna, Turkey. A small amount is mined near Chester, Mass., and it is found in insignificant quantities elsewhere in the United States. Corundum and precious sapphire have been found in Georgia and North Carolina.

Emesa, an ancient town, now called Hems. See Hems.

Emetic, any agent used to induce vomiting. In medicine the emetics that are used are now few in number. The main object to be attained by their use is to empty the stomach of irritating or poisonous contents. As most emetics act strongly on the sympathetic nervous system, they also cause muscular relaxation, dilated arteries, and a sense of weakness, amounting at times to collapse. Emetics are usually classified as local or as systemic — those acting directly on the stomach-walls, such as lukewarm water, mustard, alum, and the more violent corrosive metallic salts, or those, as copper sulphate, whose influence is exerted on the central nervous system, after first being absorbed into the blood. Of these tartar emetic, ipecacuanha, and apomorphine are examples. Emetics should be given with caution. In children particularly the stronger emetics often cause great prostration, and if a child be suffering from a disease that causes heart weakness, such as diphtheria, emetics are not advisable. In cases of poisoning emetics should be promptly given, but washing out the stomach by means of a flexible rubber tube is preferable. It is sometimes justifiable to give emetics when there seems to be danger of asphyxiation from retained mucus in the bronchial tubes. The relaxation following emesis is sometimes remarkable. See POISONING; VOMITING.

Em'etine, an alkaloid occurring in ipecacuanha, and constituting its chief active principle. Its chemical formula has not been established with certainty, but is considered to be $C_{30}H_{40}N_2O_5$. Emetine is sparingly soluble in water and in ether, though it dissolves readily in alcohol, chloroform, carbon disulphide, and various essential oils. It is white in color, but is turned to a yellow by the action of sunlight. When taken internally in considerable doses it acts as a powerful emetic, to which circumstance it owes its name.

Emeu. See EMU.

Emigration. See IMMIGRATION.

Emigrés, ā-mē-grā, a French term for those who have been compelled to leave their country on account of religious persecutions, as did the Huguenots, for instance, in the 17th century, or for some other causes. The term, however, is now most commonly applied to those Frenchmen, many of them of noble family, who left France at the commencement of the first French Revolution. Most of these emigrés hoped to see the restoration of the old order, by which they might be enabled to return to their country, and therefore remained at first on the frontiers. It would be harsh, perhaps, to call all those who left their country to its fate in the time of its greatest peril, weak and timid, but the emigration deprived France of the conservative element at the time the country stood most in need of it. The emigration of the royal princes can hardly be justified. Their presence was of great importance to the state, and their example contributed not a little to the extensive emigration which followed, and the injurious consequences which attended it. At the head of the emigrants stood the royal princes of Condé, Provence, and Artois, the first of whom collected a part of the fugitives to co-operate with the allied armies in Germany for the restoration of the monarchy. At Coblentz a particular court of justice was established to settle causes relating to the French *emigrés.* But the invasion of the Netherlands by Dumouriez drove them from these provinces in mid-winter in a deplorable condition, while their number was daily increased by the system of violence and terror carried on in France. The corps of Condé was finally taken into the Russian service, and was disbanded in the Russian-Austrian campaign in 1799. When Napoleon became emperor it was one of his first acts of grace to grant permission to all but a few of the emigrants to return to their country, but by the terms of the charter of 1814 they were precluded from regaining either their status or their ancient privileges. During the Restoration period they persistently petitioned Louis XVIII. and subsequently Charles X. for reinstatement and indemnification, but though a government grant was made for their compensation, the measure was rendered abortive by the July revolution.

Emile, ā-mēl, a famous pedagogic romance by Jean Jacques Rousseau, published 1762, and named from its principal character. Its immediate effect was to call down on his head the denunciations of the Archbishop of Paris, who found him animated "by a spirit of insubordination and revolt," and to exile him for some years from France. Its lasting effect was to lay the foundation of modern pedagogy. Due to the suggestion of a mother who asked advice as to the training of a child, it was the expansion of his opinions and counsels; the framework of a story sustaining an elaborate system of elementary education. Emile is reared apart from other children under a tutor, by a long series of experiments conducted by the child himself, often with painful consequences. Little by little, his childish understanding comes to comprehend at first-hand the principles of physics, mechanics, gardening, property, and morals. From the hints contained in 'Emile,' Basedow, Pestalozzi, and Fröbel drew their inspiration and laid the broad foundations of modern elementary education.

Emilia, ā-mēl'ē-ä, a compartimento of Central Italy, comprising the provinces of Bologna, Ferrara, Forli, Modena, Parma, Piacenza, Ravenna, and Reggio Emilia. The name is derived from the ancient Via Æmilia, a continuation of the Via Flaminia, which passed through these territories. Area 7,920 square miles; pop. 2,451,803.

Emin Pasha, ā'mēn păsh-â', or păsh'a (EDUARD SCHNITZER), African army surgeon, governor and explorer: b. Oppeln, Prussia, 28 March 1840; d. 1892. He was educated at Breslau, Berlin, and Konigsberg, going to Turkey in 1864, and being appointed surgeon in the Turkish army 1865. In 1875 he went to Egypt, becoming surgeon-general of the Egyptian army under Gen. Gordon, who made him governor of the equatorial provinces in Sudan. He made several exploring expeditions, giving to the world much information in reference to the fauna and flora of that region, together with much geographical knowledge. He was cut off from relations with the rest of the world by the insurrection of the dervishes under the Mahdi in 1883, although maintaining his position. The Egyptian government made him a pasha 1887. Rescued by Stanley in 1888 he entered the service of the German East Africa Company in 1890. He went with Dr. Stuhlman to East Africa upon an exploration expedition and was assassinated by Arabs.

Emine, Nikita Ossipovich, nē-kē'tä ŏs-sē-pō'vēch ĕm'ē-nē, Armenian historian: b. near Ispahan, Persia, about 1815; d. Moscow, Russia, 7 Jan. 1891. He was educated at the Lazareff Institute for Oriental Tongues, and at the University, Moscow. Russian learning is indebted to him for his translation into Russian of all the Armenian historians. His monumental work, a 'History of Armenia,' was translated into French.

Eminence, as a designation of cardinalitial dignity, is of comparatively recent introduction; it dates from the 17th century. Down to that time the cardinals were addressed by the titles Most Illustrious (*Illustrissimus*), and Most Illustrious Lordship (*Illustrissima Dominatio*); but in 1630 Pope Urban VIII. promulgated a decree, drawn up in accordance with a report of the Congregation of Rites, substituting for the previous formulas Most Eminent (*Eminentissimus*), and Eminence (*Eminentia*), respectively. No dignitary but a cardinal (or by exception the Grand Master of the Knights Hospitallers of the Order of St. John of Jerusalem) was to be addressed in this form. Further, a cardinal was to ignore any communication addressed to him in any other form; and any prelate who assumed the title Eminence, or Most Eminent, was made liable to penalties.

Eminent Domain, the power of the state to appropriate private property for public use on payment of just compensation to the owner. A superior right of property subsists in a sovereignty, by which private property may, in certain cases, be taken, or its use controlled, for the public benefit, without regard to the wishes of the owner. This highest and most exact right of property is immanent in the government, or in the aggregate body of the people in their sovereign capacity, giving the power to resume the possession of the property, in the manner pointed out by the constitution and the laws of the various states, when the public good requires it. There seems to be no objection to considering this right, theoretically at least, as so much of the original proprietorship retained by the sovereign power in granting lands or franchises to individuals or corporations, wherever the common law theory of original proprietorship prevails. Extraordinary and unforeseen occasions arise in cases of extreme necessity in time of war, or of immediate and impending danger, in which private property may be impressed into the public service, or may be seized and appropriated to the public use, or may even be destroyed, without the consent of the owner. The power exists only in cases where public exigency demands its exercise. It makes no difference whether corporeal property, as land, or incorporeal, as a franchise, is to be affected by the exercise of the right.

Eminescu, ā-mēn-ĕs'koo, **Michael,** Rumanian lyric poet: b. Botuschani 1849; d. Bucharest 27 June 1889. He was for a time editor of 'The Times,' a strong Conservative journal, and the fierceness of political strife would seem to have spoilt his fine poetical genius. He died in a madhouse. His fame rests on his first volume of 'Poems'; they are mostly elegio-satiric, and touch questions political, social, religious, and moral.

Emir, ē'mėr, or **Emeer,** ē-mēr' (that is, noble, princely), a title of honor given in the East and in North Africa to those who claim descent from Mohammed and his daughter Fatima. These emirs are found in Arabia, where they are the chieftains of the Bedouins. Their origin, however, is doubtful. In Turkey they form a kind of hereditary nobility, and wear as a badge a green turban, as Mohammed is said to have done. They have certain privileges, but otherwise no higher claims to civil offices than other Mussulmans. The word emir is also applied to certain offices and employments, for example, *emir hadji,* conductor of the pilgrims to Mecca; *emir-akhor,* commander of the Turkish horse; *emir-bazar,* overseer of the markets; *emir-alem,* the Turkish standard-bearer; *emir-al Umara,* prince of princes. The title *emir-al-mumenin,* commander of the faithful, was borne by the caliphs. In earlier times the title emir was much more generally assumed by nobles and princes of high rank. It was borne, for instance, by the Thaherids and Samanids in Persia, by the Tulunids in Egypt and by the first seven Ommiads of Cordova, Spain. There were also Christian emirs in the Lebanon region of Palestine, who represented Mohammedan clans converted to Christianity.

Emma, Adelheid Wilhelmine Therese, queen dowager of Holland: b. Arolsen, Germany, 2 Aug. 1858. She was the second daughter of Prince George Victor of Waldeck and Pyrmont, and was married 7 Jan. 1879 to King William III. of Holland. She is the mother of Queen Wilhelmina of Holland, and was Queen Regent of the Netherlands after the death of William III. 23 Nov. 1890 until 6 Sept. 1898, when her daughter ascended the throne.

Emmanuel College, founded in connection with Cambridge University in 1584, by Sir Walter Milday as a Puritan institution. The chapel was designed by Wren. John Harvard, who gave so liberally to education in America, was from this college.

Emmaus, ĕ-mā'us or ĕm'mā-ŭs, Palestine, (1) A village, about eight miles from Jerusalem, the place mentioned in Luke xxiv. 13. The exact location of this village is not known, the modern El Kubebe and also Koloniyeh are mentioned as being the places alluded to in Luke. (2) Modern Amwas, the place mentioned in Macc. iii., iv., and ix. In ancient times and down to the conquest of the Mohammedans, this Emmaus was a place of importance. Its position, about 18 miles northwest of Jerusalem, and near the Roman Road from Jerusalem to Jaffa, on the seacoast, made it prominent.

Emmenagogues, ĕ-mĕn'a-gŏgz, are agents that stimulate the pelvic organs, and are used to bring about a restoration or regulation of the menstrual function if it should be absent or abnormal. Occasionally absence of menstruation is due to anæmia or lack of iron in the blood, in which case taking iron internally, by overcoming the anæmia, restores menstruation and may be thus termed an emmenagogue. More properly speaking, however, the term is applied to such drugs as ergot, quinine, and hydrastis. These bring about direct stimulation of the unstriped muscles of the body, and hence act most forcibly on the uterus, it being the largest mass of unstriped muscular tissue in the body. Aloes, myrrh and the active cathartics act as emmenagogues by increasing the amount of blood in the large intestine and other pelvic organs, thereby increasing the nutrition of the uterus. Occasionally massage and electrical applications are used to bring about the restoration of the menstrual flow, and hence may be included in this group.

Em'meran, or **Emmeram, Saint,** martyr, bishop of Poitiers: b. the last of the 6th century; d. 653. His feast is kept on 22 September, but the exact date and place of his death is not known. In his own day he was renowned for his piety and learning. His biographer says of him: «For his great learning and sanctity he was chosen bishop of Poitiers, in the 7th century; he preached the pure maxims of the gospel with indefatigable zeal, without respect of persons.» After a time his zeal led him to ask permission to go to Bavaria to preach to the «infidels and idolators.» After three years' work in Bavaria, he began a journey to Rome. On the way he was assassinated by men who believed false accusations which a wicked woman had made. He is the patron saint of Ratisbon.

Emmerich, ĕm'mĕr-ĭн, Germany, town in Rhenish Prussia, on the Rhine, five miles northeast of Cleves. It is enclosed by walls and ditches, contains several ancient and modern churches, a gymnasium, ecclesiastical seminary, and orphanage; and has manufactures of woolen and linen cloth, hosiery, leather, etc.; some shipping, and a free port, at which an active trade is carried on, chiefly with Holland. Its history dates from the 7th century. Pop. 11,000.

Emmerson, Henry Robert, Canadian lawyer and politician: b. Maugerville, N. B., 25 Sept. 1853. He was graduated from the Boston University Law School in 1877, was admitted an attorney the same year, and has since been engaged in all the leading cases at Dorchester, N. B. He entered public life in 1888 when he was elected to the Provincial Assembly. He was elected to the Canadian House of Commons in 1891, and is a well-known Free Trader.

Emmet, Robert, Irish patriot: b. Dublin 1778; d. 20 Sept. 1803. He intended to practise law, and with that view studied at Trinity College, Dublin, from which, however, in 1798, he was expelled, on the ground of exciting rebellion. Subsequently he became an object of suspicion to the government, and accordingly quitted Ireland and traveled on the Continent, but returned on the repeal of the suspension of the Habeas Corpus Act. He now became a member of the Society of United Irishmen, whose object was the establishing the independence of Ireland. In July 1803 he was the ringleader in the rebellion in which Lord Kilwarden and several other persons were killed, but which was almost immediately suppressed. Emmet was arrested a few days afterward, tried, and executed by a sentence of the royal commission. His fate excited considerable interest, from the circumstance of his attachment to Miss Sarah Curran, daughter of the celebrated barrister. Moore has immortalized his memory and that of Miss Curran in the poem beginning, «She is far from the land where her young hero sleeps.» Consult: Madden, 'Lives of the United Irishmen.'

Emmet, Rosina. See SHERWOOD, ROSINA.

Emmet, Thomas Addis, American lawyer: b. Cork, Ireland, 24 April 1764; d. New York 14 Nov. 1827. He was a brother of Robert Emmet (q.v.), and being tried for the crime of treason, was sentenced to exile. He came to the United States and became a noted lawyer in New York. In 1812 he was elected attorney-general of the State.

Emmet, Thomas Addis, American gynecologist: b. Charlottesville, Va., 29 May 1828. He was graduated at Jefferson Medical College 1850, and is author of 'Principles and Practice of Gynecology.' He is a celebrated surgeon, and inventor of several special surgical instruments and operations.

Em'metsburg, Iowa, city, county-seat of Palo Alto County; on the Des Moines River, the Burlington & M.; the Chicago, M. & St. P., and the Cedar Rapids R.R.'s.; about 123 miles northeast of Sioux City. It is in an agricultural section of the State, and it has several grain elevators. Some of the industries are the manufacturing of butter, cheese, and flour. Pop. 2,468.

Emmett, Daniel Decatur, American song writer and negro minstrel: b. Mount Vernon, Ohio, 1815. He served in the army, joined a circus company 1835, and formed the first negro minstrel company 1842 with Frank Brown, William Whiltock, and Richard Pelham, appearing at the old Chatham Theatre, New York, and later in Boston, and in England, where Emmett remained till 1844. He was with Dan Bryant 1854–65, writing the famous song 'Dixie' in 1859. He became a manager 1865, returning to his native town 1878. He was a most prolific song writer, and among his productions were: 'Old Dan Tucker'; 'The Road to Richmond;' and 'The Boatman's Dance.'

Em'mitsburg, Md., town in Frederick County; on a branch of the Western Maryland R.R.; about 45 miles northwest of Baltimore. The town is known chiefly for its two large educational institutions, Mount St. Mary's Theological Seminary (q.v.), just outside the town's limits, and St. Joseph's Academy, within the town. It contains also the Mother-house and Seminary of the Sisters of Charity of St. Vincent de Paul, from Paris. Emmitsburg was the scene of the labors of Mother Eliza Seton (q.v.) when establishing the Sisters of Charity in the United States. There are about 1,800 sisters working in different parts of the country, who belong to this Mother-house. Pop., including sisters whose homes are here, 2,074.

Emmons, Ebenezer, American geologist: b. Middlefield, Mass., 1799; d. 1863. He was educated and afterward taught at Williams College, later becoming geologist-in-chief, second district, New York State Geological Survey. He introduced the new Taconic stratigraphic system, not now in vogue. He was made professor of chemistry in the medical college at Albany 1838, and had charge of the geological survey of North Carolina 1858. His works include: 'Manual of Mineralogy and Geology' (1826); and 'American Geology' (1856).

Emmons, George Foster, American naval officer: b. Clarendon, Vt., 23 Aug. 1811; d. Princeton, N. J., 2 July 1884. He entered the navy as midshipman in 1828; was promoted lieutenant in 1841; rear-admiral 1872; and was retired the next year. He was a member of the South Sea exploring expedition under Capt. Wilkes in 1838–42; took part in the Mexican war; and during the Civil War captured Cedar Keys, Fla., and Pass Christian, Miss., with 20 prizes in 1862. He served as captain of the fleet under Dahlgren, off Charleston, in 1863; and raised the American flag over Alaska in 1868.

Emmons, Nathaniel, American Congregational clergyman: b. East Haddam, Conn., 20 April 1745; d. Franklin, Mass., 23 Sept. 1840. After graduating from Yale College 1867 he was ordained pastor of the Congregational Church in Franklin, Mass., which pastorate he held for 54 years, being one of the originators of the Massachusetts Missionary Society and an editor of the magazine from which afterward sprang the 'Missionary Herald.' He was a strong pamphleteer, a Federalist, and an opponent of slavery. His 'Collected Works' were printed, with a memoir, by his son-in-law, Jacob Ide (1842).

Emmons, Samuel Franklin, American geologist: b. Boston, Mass., 29 March 1841. He was graduated at Harvard, taking post-graduate courses at the Ecole Imperiale des Mines, Paris, and Freiberg, Saxony, Mining School, and is a member of several scientific societies, including the National Academy of Sciences, and the Geological Society of America, of which he became president 1896. He has been in the employ of the government almost uninterruptedly since 1867 and geologist upon the United States Geological Survey, Colorado division, since 1879. Among his writings are: 'Descriptive Geology of the Fortieth Parallel Region' (1877); 'Statistics and Technology of the Precious Metals' (1885); 'Geology and Mining Industry of Leadville, Colorado' (1886); 'Geology of Lower California' (1890); 'Geological Distribution of the Useful Metals in the United States' (1893); 'Progress of the Precious Metal Industry of the United States' (1893); 'Geology of the Denver Basin in Colorado' (1896).

Em'odin, one of the active constituents in *Cascara sagrada* and in other species of the genus *Rhamnus*. Emodin acts as a cathartic.

Emory, John, American Methodist bishop: b. Spaniard's Neck, Queen Anne County, Md., 11 April 1789; d. Reisterstown, Md., 16 Dec. 1835. He was graduated at Washington College 1804, practised law, and in 1810 entered the Methodist ministry, becoming a bishop in 1832. He published: 'The Divinity of Christ Vindicated'; 'Defense of Our Fathers,' etc.

Emory, Robert, American educator: b. Philadelphia, Pa., 29 July 1814; d. Baltimore, Md., May 1848. He was a son of John Emory (q.v.). He was appointed professor of ancient languages in Dickinson College in 1834; resigned in 1839; and entered the Baltimore Annual Conference of the Methodist Episcopal Church. He was recalled to the college and made president pro tem. in 1842, and president from the retirement of Dr. Durbin till his death. His publications include: 'Life of Bishop Emory' (1841); 'History of the Discipline of the Methodist Episcopal Church' (1843); and 'Analysis of Butler's Analogy.'

Emory, William Hemsley, American military officer: b. Queen Anne County, Md., 9 Sept. 1811; d. Washington, D. C., 1 Dec. 1887. He was graduated at the United States Military Academy 1831; served in the Mexican war and was chief astronomer for the survey of the boundary between the United States and Mexico in 1848–53. He was appointed lieutenant-colonel of cavalry in 1861; served in the Federal army during the Civil War, and after the War was in command of the Department of Washington till 1876, when he was retired with the rank of brigadier-general United States army. Gen. Emory was author of several important works, including: 'Notes of a Military Reconnoissance in Missouri and California'; and 'Report of the United States Boundary Commission.'

Emory College, an educational institution in Oxford, Ga., founded in 1836 under the auspices of the Methodist Episcopal Church; reported at the close of 1900: Professors and instructors 14; students 289; volumes in the library 20,000.

Emotion, a term applied to a complex series of reactions that have distinct representations in consciousness; or, as defined by Baldwin, emotion "is a total state of consciousness considered as involving a distinctive feeling-tone and a characteristic trend aroused by a certain situation which is either perceived or ideally represented." The conception of the word emotion is of comparatively modern date, but there is no doubt that the nature of emotions is one of the oldest of old psychological problems. Emotions imply peculiar vividness of feeling which is not associated with known and palpable external sources of stimuli. As to their exact character, it is very readily understood that we can know nothing whatever of them, but they may be thought of from at least two different standpoints. By many of the older psychologists and metaphysicians emotions have been considered as arising from the inner consciousness, whereas at the present time there is a large school of psychologists who have accepted what is known as the James-Lange theory of emotions. By this theory is meant, in general terms, that the feeling-tone has its origin in organic or visceral sensations, and that the representations in consciousness of these sensations, in general, constitutes the emotion. Thus the theory would posit as a corollary a certain quantity and quality of external stimuli. As a concrete example, if one in a general way attempts to analyze one's emotions following the hearing of a highly emotional opera, such as one of Wagner's compositions, the origin of the emotional state induced would be construed as due to the mental representations of the motor activities, as seen and as heard. Thus unconsciously the spectator sings and acts cerebrally and a tenseness of the vocal cords and of the whole muscular apparatus of the body results from the imitative effort to make the necessary sounds and to reproduce the necessary movements. This largely constitutes the feeling-tone, which is interpreted as emotion. So with the emotion of fear: the protoplasmic contractions of the various organs of the body acted upon by visual or auditory stimuli give the feeling-tone of fear. The sound of the cracking of a stick in the deep forest when one is alone causes an involuntary contracting process of the blood-vessels throughout the entire body; perhaps also of other organs; and it thus induces the feeling-tone of fear. This theory may be applied to a large number of emotional states, all of which may be analyzed along similar lines from the strictly biological point of view of emotion. It will probably take much more searching and definite knowledge of the action of the sympathetic nervous system before all of the various phenomena connected with the feeling-tone can be satisfactorily explained along the lines of the James-Lange theory. There seems, however, to be little doubt, in the minds of many, that the complete interpretation of emotion lies along some such line of research. Consult: James, 'Principles of Psychology'; Lange, 'Ueber Gemüthsbewegungen' (1887); Baldwin, 'Dictionary of Philosophy and Psychology,' Vol. I. (1901); Spiller, 'The Mind of Man' (1903); Stout, 'Principles of Psychology' (1900).

Empalement, a mode of executing criminals, mentioned by Juvenal, often inflicted in Rome, and still used in Turkey and Arabia. In England the dead bodies of murderers were sometimes staked in this manner, previous to being buried; but the custom was abolished in 1823.

Empáran, Diego de, dē-ā'gō dā ĕm-pä'rän, Mexican writer: b. Puebla, 5 April 1718; d. Ravenna, Italy, about 1807. His book, 'The Jesuits and the Pope' (1746), published soon after entering the priesthood, gained him five years' imprisonment. The year after his release he issued a bitter criticism of Church dignitaries, for which he was deposed from the priesthood and imprisoned in the Castle of Sant' Angelo, but released later. His work was burned by the executioner. His other works include: 'The Tombs of Mohammed and Christ'; 'Voltaire and His School'; 'Science and Superstition'; and 'Religion and Hygiene.'

Empecinado, Don Juan Martin Diazel, dōn hoo-än' mär'tēn dē'äth äl ĕm-pā-thē-nä'dō, Spanish patriot: b. Cestrillo de Duoso, Valladolid, 1775; d. 1825. He joined the army at 17, and for his activity in the war against the French in the peninsula was appointed colonel and later made a field marshal. Losing favor with King Ferdinand VII. on account of his action in petitioning him to restore the Cortes, he was thrown into prison, his imprisonment being followed by banishment to Valladolid. Taking part in the insurrection 1820 he saw much fighting, but was captured 1823, cruelly treated while a prisoner and after two years he was stabbed while resisting the executioners by whom he was about to be hanged.

Emped'ocles, Greek philosopher: b. Agrigentum, Sicily, about 460 B.C. His fellow-citizens esteemed him so highly that they wished to make him king; but being an enemy to all political forms which elevate a few above their fellows, he refused their offer, and prevailed on them to abolish aristocracy, and introduce a democratical form of government. Aristotle states that he died in obscurity at the age of 60 years, in the Peloponnesus, but there are various legends respecting the manner and place of his death. Empedocles presented his philosophy in a poetical form. His general point of view is determined by the influence of the Eleatic school upon the physical theories of the Ionic philosophers. He assumed four primitive independent substances — air, water, fire, and earth, which he designates often by the mythical names Zeus, Hera, etc. These four elements, as they were called, kept their place till modern chemistry dislodged them. Along with material elements he affirmed the existence of two moving and operating powers, love and hate, or affinity and antipathy, the first as the uniting principle, the second as the separating. The contrast between matter and power, or force, is thus brought out more strongly by Empedocles than by previous philosophers. His theory of the universe seems to assume a gradual development of the perfect out of the imperfect, and a periodical return of things to the elemental state, in order to be again separated, and a new world of phenomena formed. Of his opinions on special phenomena may be mentioned his doctrine of emanations, by which, in connection with the maxim that like is known only by like, he thought to explain the nature of perception by the senses. He attempted to give a moral application to the old doctrine of the transmigration of souls, his views of which resembled those of Pythagoras. The fragments of Empedocles have been edited by Sturz (1805); Karsten (1838); and Stein (1852). Consult monographs by Lommatsch (1830); Raynaud (1848); and Gladisch (1858).

Emperor, the title of the highest rank of sovereigns. The word *imperator*, from *imperare*, to command, had very different meanings among the Romans at different periods. It signified one who exercised *imperium*, authority, whether in a civil or military capacity. In the time of the republic consuls were called *imperatores* before they entered on their office. The soldiers afterward conferred the title on their general, after a victory, by hailing him *imperator;* the senate also called a victorious general *imperator* until he had celebrated his triumph. After the overthrow of the republic *imperator* became the title of the rulers or emperors who assumed to themselves personally every department and privilege of civil and military *imperium*. Victorious generals were still, however, sometimes saluted with the title *imperator*, in its original sense. With the fall of Rome the title was lost in the West, but was kept up in the Eastern or Byzantine empire for nearly 10 centuries. In 800 it was renewed in the West when Charlemagne was crowned, by Leo III., as "Carolus Augustus, the God-sent and pious emperor of Rome," which title was borne by his successors until the dissolution of the Holy Roman empire in 1806.

The Eastern empire having been finally overthrown by the conquest of Constantinople in 1453, the imperial dignity in the East became extinct. The sultans, who succeeded the emperors, have never received, in official language, the title of emperor. This title was adopted in Russia by Peter I. in 1721, but the right of the Russian sovereign to its possession was not acknowledged by the German empire until 1747, by France in 1745, and by Spain 1759. Napoleon adopted the old idea of an empire, as a general union of states under the protection, or at least political preponderance, of one powerful state. Napoleon crowned himself as emperor in 1804; the title fell into disuse at his deposition in 1815, but was revived by his nephew in 1852, with whom it again ended on 5 Sept. 1870. In 1806 the first German empire, 1,000 years old, became extinct, and the German emperor, Francis II., adopted the title of Francis I., emperor of Austria. In December 1870 the second German empire was formed, King William of Prussia having accepted the imperial office and title offered him at Versailles while engaged in the siege of Paris.

Great Britain is considered as an empire, the crown as imperial, and the Parliament is styled the Imperial Parliament of Great Britain and Ireland; but the sovereign has not the imperial title in reference to the home dominions, though the king bears the title of emperor of India. The sovereigns of China, Japan, and Morocco are often, though with little propriety, called emperors.

Emperor, or **Purple Emperor,** name of a butterfly of the genus *Apatura*. The antennæ are rather long, the ground color of the wings is rusty black, decorated in the male with a purple lustre wanting in the female; seven white spots in the male; as many faint yellow ones in the female; on the four wings above a transverse white band; an oscellated spot and a darker marginal bar on the hinder ones.

Emphysema, ĕm-fĭ-sē'ma, a disease of the lungs, in which there is a dilatation of the air vesicles with lack of elastic recoil. It is most frequently the result of persistent high intra-alveolar tension, acting upon weak lung tissue. The most important symptoms are bronchitis, loss of breath with harsh and wheezy respirations, and a certain amount of cyanosis or blueness of the face, due to insufficient oxidation in the lungs.

Emphyteusis, em-fĭ-tū'sis (Gr. "implanting"), in Roman law, a perpetual right in a piece of land, for which a yearly sum was paid to the proprietor. It was secured by contract on condition of improvement, as well as payment of rent, and much resembled a feudal holding in the features of perpetuity, etc. See FEUDAL SYSTEM.

Empire City, a name given to the city of New York. See EMPIRE STATE.

Empire State, a name given to New York State because of its predominant wealth and commerce.

Empirical School. See EMPIRICISM.

Empiricism (from Greek ἐμπειρία, experience, trial), the philosophical doctrine which regards immediate sense experience as the only source of knowledge and as furnishing the only practical rules of conduct. It is thus fundamentally opposed to the doctrine of innate ideas, and to all *a priori* theories of the *origin* of knowledge. And, on the other hand, as a *method* of knowledge it is opposed to Rationalism (q.v.), which proceeds to reason out deductively the necessary consequences of certain conceptions and principles that are taken as self-evident. As a theory of the *origin* of knowledge, empiricism teaches that all truth is based on sensation. The mind is originally a *tabula rasa*, an empty chamber, which gets its filling from the impressions coming to it through sensation, inner and outer. It thus minimizes, or altogether denies, all original activity on the part of the mind, and tends to explain all mental complexes and constructions as the resultants of the mechanical play of the elements themselves. The doctrine thus logically leads to sensationalism, and this, through its subjective and relativistic character, to scepticism. This development has more than once been illustrated in the history of philosophy. We may trace it in the ancient world among the sophists, though here the principle is not so consciously maintained, or so systematically worked out as in modern thought. Locke is usually regarded as the father of modern Empiricism. His most important successors who have further developed the doctrine are Berkeley, Hume, Hartley, James Mill, and John Stuart Mill, in England, and Condillac, Bonnet, and Helvétius in France. Kant, by his method of criticism, and Herbert Spencer, through the conception of evolution, have sought in different ways to reconcile Empiricism with the *a priori* standpoint of Rationalism.

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Empiricism, in medicine, refers to at least two different things. In the age of renovation, or the reform period in medicine, a special group of men, Phalinus and Serapis at their head, founded what was called the Empirical School. They were disciples of Herophilus and Erasistratus, and from 200 to 300 A.D., they formed one of the most important Alexandrian schools. Their followers were mostly opposed to the teachings of the Dogmatic School. Their chief point of view was that of practical observation, as opposed to the theoretical speculations of the Dogmatic School. Their chief alliances were with the skeptics. Anatomy, insomuch as it could teach nothing of physiology, they believed was of secondary importance.

At the present day what is meant by empiricism is the following of accumulated experience independent of rational explanation. A physician uses a drug empirically because he, or others, believe it to be of service, although no reason can be given by him, nor by others, why it should be of service. Little by little, the real causes of the action of drugs that physicians have used from time immemorial has been revealed by students of medicine, and the reproach that medicine is an empirical science has little weight at the present time.

Employer's Liability, the relation of the hirer to the hired, as party in a contract. The hire of services is a contract, by which the work or service of a person is given for a compensation or reward. Out of the contract arises the relation of master and servant, or that of employer and employee. The rule of law is well established, that an implied contract cannot arise, where there is a subsisting express contract, covering the entire subject matter. A contract of hiring, unless for more than one year, need not be in writing. And as between strangers the general rule is, where nothing appears to the contrary, that whenever services are rendered and received, a contract of hiring, or an obligation to pay, will be implied. A contract to do an act that is immoral is void at common law and will not be enforced. Contracts which involve the doing of acts contrary to public policy, are also void and cannot be enforced. One who offers himself for employment in a professional capacity represents himself by implication as possessing: (1) That reasonable degree of learning and skill, which is usually possessed by the professors of the same art or science, and which is ordinarily regarded by the community, and by those conversant with the employment, as necessary to qualify him to engage in such business. (2) That he will use reasonable and ordinary care and diligence in the exercise of his skill and the application of his knowledge, to accomplish the purpose for which he is employed. (3) That he will use his best judgment in the exertion of his skill and the application of his diligence. The skill required is not that of the highest or of the lowest member of his profession, but such as averages with the knowledge and skill usually possessed by a majority of the profession. The fact, however, that a professional man has requested and received no pay for his services, does not exempt him from liability for injuries or damages resulting from his failure to exercise the ordinary care and skill of his profession, but the patient or client must obey the instructions of the surgeon, physician, lawyer, etc. The hiring of artistic and scientific services is governed by the same general principles of law that are applicable to contracts of hire of other services. The law implies a contract on the part of the employee, or person hired, that he will perform the service skilfully, and he will be liable for damages to his employer for a failure to do so. Where mechanical services upon a chattel are the subject of hire, and the chattel is entrusted to the workman, he becomes a bailee of the property to be worked upon, and is liable for ordinary neglect. The relation of the workman to the employer is personal, and grows out of the confidence the employer is presumed to repose in the skill and fidelity of his employee when entrusting his property to him for the service intended to be performed on or toward it. And the law implies a contract on the part of the employee or bailee to perform the service skilfully, and then return the property faithfully on payment for his service. The employee is liable for his negligence or misconduct, whether the damage is done directly to the property of the employer or whether it arises from the reparation which the employer has been compelled to make to third persons to satisfy his liability for the acts of his employee.

The recent disputes between industrial corporations and their employees, frequently leading to strikes which are productive of serious inconvenience and pecuniary loss to the general public, have prompted several States to interfere by legislation in order to control the contract-making power of the employer and the employed. Boycotting unpopular employers or employees, in order to influence the making of contracts, is expressly prohibited by certain States, while, in many more, such a prohibition seems implied by the terms of recent statutes. Fourteen States prohibit the employer from exacting an agreement from any one, as a condition of being employed, that he will not join or become a member of any labor organization. Blacklisting, by which employees are cut off from the opportunity of making a contract and gaining employment is expressly declared unlawful in 21 States, and in eight other States its illegality is implied in recent statutory enactments. The option of the employer to exact by contract more than eight hours' work is taken away by the laws of a majority of the States, and in very many of them eight hours is made to constitute a day's work on public roads, highways and bridges, in State, county and municipal undertakings. This specific legislative interference in the dealings of the employer and the employed has been supplemented by the institution of a permanent board to settle labor disputes, in which the public, organized labor and the employers are represented by delegates.

Employment Bureaus, establishments, whether private or public, at which those seeking employment are put into communication with those who are offering it. Private employment bureaus are found in every large city, but they are often conducted without judgment, sometimes have been accused of dishonesty; they are in any case mercenary, and their usefulness is at least problematical. Public bureaus, opened by the national or city government, are non-mercenary, and the motive that has prompted their establishment is a sound humanitarian and political motive. Such bureaus have two practical objects. They are a means of communication between employer and employee, labor exchange, as they are called in France. In the second place they do something toward settling the wage question, by giving quotations of the amount offered and asked.

The public governmental employment bureau originated in France. In 1848 one such bureau was established in each of the mairies of Paris. The institution languished, but in 1886 was revived and has since become universal in France. The first employment bureau opened in England was at Egham, near London, in 1885, and the movement has since been spreading to the larger towns. Switzerland followed suit with a labor bureau at Berne in 1888, and another at Basle in 1889; Germany established one at Freiburg in 1892, and the movement has been taken up enthusiastically by almost every city of importance. The United States has its government employment bureaus also, and Ohio was the pioneer in the movement. Nine States have authorized their establishment by legislative enactment, and although three States have tried and given up the government employment bureau, they are States of the West, where employment is plentiful, and the need of an intermediary is scarcely felt, certainly not as keenly as in the crowded cities of the East.

Emporia, Kansas, city and county-seat of Lyon County; on the Neosho River near its junction with the Cottonwood, in the central part of the State, and on the Missouri, K. & T., and a division point of the Atchison, T. & S. F. and the Kansas City, M. & O. Railways; 60 miles southwest of Topeka. It is the commercial centre for a large section of country devoted to farming and dairying and to the fattening of western range cattle for the eastern market. Emporia has a thriving jobbing and export trade and some manufactures, including marble and iron works, carriage and canning factories, woolen mills, and flour and grist mills. It has three banks, with a combined capital of $250,000 and doing a large annual business, and daily and weekly newspapers. Gas is served by a private company, and the water-works and electric-lighting plant are owned and operated by the city. Emporia is the seat of the State Normal School (2,000 students), and of the College of Emporia (Presbyterian), and the Western Conservatory of Music, and has a business college, railroad and public libraries, nine school buildings, 11 churches, and many handsome business buildings and private residences. It is the largest town in Kansas that never has permitted a saloon to open within its limits since the passage of the prohibitory law in 1880. The city is governed by a mayor, elected biennially, and by a council, half of which is elected each year. Emporia was founded in 1856 by P. B. Plumb, afterward United States Senator, and a group of pioneers from the Middle States; it was incorporated in 1870. Pop. (1904 est.) 9,000.

WILLIAM ALLEN WHITE,
Editor 'Emporia Gazette.'

Empyema, ĕm-pĭ-ē'ma, a collection of pus consequent on pleurisy. True empyema is pus secreted from the pleura; the false, when an abscess of the lung bursts into the cavity of the chest. When the quantity of fluid is so large as to cause great dyspnœa and endanger life, it must be let out by tapping the chest.

Empyre'an, a word used by the ancient Greek philosophers to designate the highest region of the heavens, where the purest and most rarefied elements of fire and light exist; and by mediæval poets to indicate the ninth heaven, the home of the blessed. In modern poetry the empyrean is merely the over-arching dome of the heavens.

Empyreuma, ĕm-pĭ-roo'ma (Gr. «a live coal covered with ashes to keep the fire in it»), the smell acquired by organic matter when subjected to the action of fire, but not enough to carbonize it entirely. The products of imperfect combustion, as from wood heated in heaps or distilled in close vessels, are frequently distinguished as empyreumatic.

Ems, ĕmz, Germany, a celebrated watering place in the Prussian province of Hesse-Nassau; on the river Lahn. The environs are beautiful. As early as 1583 it was a town of resort as a watering-place. The mineral waters at Ems are warm — from 70° to 133° F.; they are of the saline class, containing large quantities of carbonic acid gas, and are used with much effect in chronic catarrhs, pulmonary complaints, and some other diseases. The history of the town dates back to the 9th century, and the lead and silver mines have been worked a number of years. Since 1865 the fame of the springs has overshadowed its industrial and trade advantages. It was here that the memorable interview between the king of Prussia and the French ambassador, Benedetti, took place which formed the prologue to the Franco-Prussian war of 1870–1. Pop. 6,519.

Ems, a river of Germany, which rises at the southeast extremity of the Teutoburger-Wald, in Lippe-Detmold, flows northwest through Rhenish-Prussia, and Hanover, and into the Dollart, near Emden; length 234 miles. It is navigable as far as Papenburg for light vessels. In 1818 it was connected by a canal with the Lippe, and thus with the Rhine, and its importance has been greatly increased by the opening of the Dortmund-Ems and other canals.

Emser, ĕm'zĕr, **Hieronymus,** German Roman Catholic theologian: b. Ulm 26 March 1472; d. Dresden 8 Nov. 1527. In 1502 he became professor at the University of Erfurt, where Luther is said by him to have been among his pupils. In 1504 he established himself at Leipsic, where he also lectured at the university. With Luther and the theologians of Wittenberg generally he was on good terms until the disputation of Leipsic in 1519, from which time he made, in union with Dr. Eck, incessant endeavors to oppose the increasing influence of Luther and the progress of Protestantism. The German translation of the Bible by Luther was attacked by him as erroneous, whereupon it was forbidden in Saxony by Duke George. Emser then himself published a translation of the New Testament into German, made from the Vulgate (1527). He also wrote: 'Vita S. Bennonis,' as he ascribed to St. Benno his recovery from a severe sickness.

E'mu, the only representative of the family *Dromaiidæ,* and with the cassowaries the Australian representatives of the order *Struthiones.* In size the emu ranks between the African ostrich and the rhea of South America, the African bird being seven feet in height and the emu five. In general appearance and form it is more bird-like than either of the others. Like the cassowary of northern Australia, its head and neck are feathered, and the back is gracefully arched. Its body is covered with a rich brownish plumage. With the rhea and cassowary, it has three toes on the foot, while the African ostrich has but two. The emu is a bird of the plains, where it feeds upon fruits, herbs, and roots. The nest is scooped in the sand, and the number of eggs is six or seven, of an attractive green, each measuring five inches in length. The feathers have no ornamental value, and the flesh is eaten only by the natives. Coursing the emu has been carried to such an extent that the birds of New Holland, once spread throughout the whole continent, are now in many parts exterminated. The emu utters a faint booming noise. In confinement it is found to be tractable, and is readily tamed.

Emul'sin, an active enzyme found in many seeds and especially in the bitter almond, but also in the sweet almond and the cherry: The addition of a small amount of water to this seed develops the characteristic reaction and the formation of the oil of bitter almonds, containing the deadly poison prussic acid in solution.

Emul'sion, the term applied to those preparations in pharmacy in which oleaginous substances are suspended in water by means of gum, sugar, carrageen, yolk of egg, etc. In general it will be found that the bulk of the emulsifier must first be taken, while the oil should only be added little by little, rubbing together in a mortar, and taking care that it is completely absorbed or emulsified before further additions. Should too much be added, the effect is to throw out most of what has already been incorporated; it is then almost impossible to remedy the error. The emulsion of cod-liver oil is familiarly known.

Emys, ĕm'ĭs, a member of the family *Emydidæ,* which includes all the fresh-water turtles, and is the largest group in the order. It varies from the prevailing type of the order in having a convex rather than a depressed shell, which is also rounded like that of the box-tortoise. Its color is dark green, spotted with yellow. The carapax is provided with lids, which are closed down at will when the feet are drawn in. *Emys meleagris,* known as Blanding's box-tortoise, is larger than the common box-tortoise. It is the only representative of the genus in North America, and is found east of the Mississippi River.

Enaliosauria, ĕ-năl'ĭ-ō-sâ'rĭ-a, a name proposed by Conybeare, and no longer in use, for the fossil reptiles, Ichthyosauri and Plesiosauri

EMU (*Hippalectryo Uniappendiculatus*)

(Ichthyopterygia and Sauropterygia, of Owen, respectively), which are now known to differ too widely to be thus combined.

Enambuc, or **Esnambuc, Pierre Vandrosque Diel d',** pē-ār vän-drōsk dē-ĕl dā-nōn-bük, French navigator: b. Dieppe about 1570; d. St. Christopher, W. I., December 1636. Being of an adventurous spirit, he sailed from Dieppe in 1625 in a brigantine of eight guns, for the Antilles. He landed in the island of St. Christopher on the same day with a party of English colonists, with whom he divided the island, and, until his death, held the French half of the colony with extraordinary tenacity. In 1635 he took possession of Martinique, in the name of the king of France, and founded the town of St. Pierre.

Enamel, the name given to vitrified substances of various composition applied to the surface of metals. Enameling is practised (1) for purposes of utility, as in making the dial-plates of watches and clocks, coating the insides of culinary vessels, etc., when it may be considered as belonging to the useful arts; and (2) for producing objects of ornament and beauty — artistic designs, figures, portraits, etc.— when it belongs to the fine arts. The basis of all enamels is an easily fusible colorless silicate or glass, to which the desired color and the desired degree of opaqueness are imparted by mixtures of metallic oxides. The molten mass, after cooling, is reduced to a fine powder, washed, and the moist paste is then usually spread with a spatula on the surface of the metal; the whole is then exposed in a furnace ("fired") till the enamel is melted, when it adheres firmly to the metal. The metal most commonly used as a ground for enamel is copper; but for the finest kinds of enamel work gold and silver are also used.

Artistic or Ornamental Enameling.— This art is of great antiquity. It was extensively practised at Byzantium from the 4th till the 11th century, and afterward in Italy, in the Rhenish provinces, and at Limoges in the south of France. The Byzantine and other early styles of enamel work, down to the 14th century, were generally employed in ornamenting objects connected with the service of the Church. Enamel was also greatly used in ornamenting jewelry, and vessels made for use or display in the mansions of the rich, such as salt-cellars, coffers, ewers, candlesticks, etc.

Manner of Execution.— Enamel-work may be divided into four kinds: (1) *Cloisonné* (q.v.), or inclosed, in which the design is formed in a kind of metal case, generally of gold or copper, and the several colors are separated by very delicate filigree gold bands, to prevent them running into one another. Of this style the grandest example extant is the famous Pala d'oro in Saint Mark's church, Venice. (2) *Champ Levé,* practised by the Rhenish and early Limoges schools. In this process the ornamental design, or the figures which were to be filled in with color, were cut in the metal (generally copper) to some depth; wherever two colors met, a thin partition of the metal was left to prevent the colors running into each other by fusion when fired. (3) *Translucent* enamel, which had its origin in Italy, was composed of transparent enamel of every variety of color, laid in thin coatings over the design, which was incised on the metal, generally silver, the figure or figures being slightly raised in low relief, and marked with the graver, so as to allow the drawing of the contours to be seen through the ground, instead of being formed by the coarse lines of the copper, as in the early Limoges enamels. (4) *Surface-painted* enamels, which may be divided into two stages. The first stage, which is known as the late Limoges style, sprang up about 1475, and flourished till 1630. In this the practice was to cover the metal plate with a coating of dark enamel for shadows, and to paint on this with white, sometimes having the hands and other parts of the figures naturally colored. In this method the plate is covered with a white opaque enamel, and the colors are laid on this with a hair-pencil, and fixed by firing. The paints are prepared by grinding up colored enamels with oil of spike and, when fused by the heat, they become incorporated with the enamel of the ground.

The greater part of the artistic enamel-work of the present day is Japanese and consists of cloisonné work on a copper basis.

Enameled Iron.— Since the beginning of the 19th century many attempts have been made to cover iron with a vitreous surface; several patents have been taken for such methods of enameling. The chief difficulty in applying enamels to iron arises from the tendency of the metal to oxidize before it reaches the temperature at which the enamel fuses, and to become brittle from the oxide combining with the silica of the enamel. This action being superficial, the mischief is the greater in proportion to the thinness of the iron. Therefore it is much easier to enamel thick cast-iron vessels than thin vessels made of sheet-iron. A glass may be made by combining either silicic acid or boracic acid with a base; the latter fuses at a lower temperature than the former, but the glass is much dearer and not so durable as the silica glass. The enamels used for coating iron consist of a mixture of silica and borax, with various basic substances, such as soda, oxide of tin, alumina, oxide of lead, etc. Lead is not, or ought not to be, used in the enamel for coating culinary vessels. A great variety of articles, many of them beautifully decorated in colors, such as grate-fronts, clock-dials, panels of different kinds, sign boards, tablets, and name plates, are now executed in enameled iron at a moderate cost. It is also applied to corrugated roofing. The effect of heat on enameled iron, especially, is to expand the metal more than the enamel and cause the latter to peel off. Acids find their way through minute invisible pores which exist in the best enamel; when once they reach the iron, they rapidly spread between it and the enamel, and undermine and strip it off.

The enamel of teeth is the very hard translucent white layer covering the working surfaces of the dentine, or ivory of the teeth.

Luis Palma di Cesnola,
Late Director Metropolitan Museum of Art.

Enargite, en-är'jīt, a native sulpharsenate of copper, of which it contains 48.3 per cent. It constitutes an important ore of copper at Butte, Mont., occurring there and elsewhere in cleavable-granular masses, also in orthorhombic prisms. It has eminent prismatic cleavage, a brilliant metallic lustre, and grayish-black color and streak. Its hardness is 3 and specific gravity 4.44.

Enara, ā-nä'rä, or **Enare**, ā-nä'rä, a lake in Finland; area, about 145 square miles. The outlet is Patsjoki River, which flows into the Arctic Ocean. A town of the same name, at the southwest extremity, is inhabited chiefly by fishermen.

Enarea, ĕ-nä'rā-ä, a country of the Gallas, south from Abyssinia, between lat. 7° and 8° N.; and lon. 35° and 37° E. In the valley of the Gibbi, immediately beyond Sakha, the chief town of the country, are extensive plantations of coffee, which, along with ivory, is largely exported. The inhabitants are the most civilized of the Gallas, and show much skill in manufactures.

Enault, Louis, loo-ē ā-nō, French novelist: b. Isigny, Calvados, 1824; d. Paris 1900. He used the pen-name "Louis Vermond." He wrote many novels and books of travel, including among them: 'Promenade en Belgique et sur les bords du Rhin' (1852); 'La Terre Sainte' (1854); 'Constantinople et la Turquie' (1855); 'Voyage en Paponie et en Norvège' (1857); 'La Méditerranée, ses iles et ses bords' (1862); 'L'Amerique centrale et meridionale' (1866); 'Paris brûlé par la Commune' (1871); 'Valneige' (1887); 'Le Château des Anges' (1891); 'Tragiques Amours' (1891); 'Jours d'Epreuve' (1894); 'La Tresse bleue' (1896); 'Myrto' (1898); and a French translation of 'Uncle Tom's Cabin.'

Encænia, ĕn-sē'nĭ-a, or **Encenia**, a name given to the feast in commemoration of the dedication or consecration of Christian churches. In early times it was applied to the feast in honor of the founding of a city as well as in honor of the founding, or taking possession by dedication or consecration, of churches. The custom of observing the anniversary of the consecration of a church or cathedral dates from the time of Constantine, when Christians were permitted more freedom of worship in the Roman territory; but the Jews before the coming of Christ solemnly dedicated their tabernacles; and in a certain sense, consecrated their houses of worship. The name is applied also to commemorative festivals in honor of the founders and benefactors of Oxford and Cambridge universities. At Oxford University "Commemoration," or "Encænia," usually takes place the third Wednesday after Trinity Sunday. The oration in honor of the founders and benefactors is given in Latin.

Encalada, Manuel Blanco, mä-noo-ĕl blän-kō ān-sä-lä'dä, Chilean soldier and statesman: b. Buenos Ayres, Argentina, 1790; d. Santiago, Chile, 5 Sept. 1876. He studied at Madrid, and in the Naval Academy at Leon, and after deserting from the Spanish ranks, joined the Chilean revolutionary party, and served with distinction both in the artillery and in the navy. He became rear-admiral in 1819, and major-general of infantry in 1820; and in 1825 was appointed head of the army of Chile. He was for two months president of the republic in 1826, governor of Valparaiso 1847–52, and minister to France 1853–8.

Encaustic Painting (Lat. *encaustica*, Gr. ἐγκαυστική, "burning in"), an ancient method of painting, the final process of which consisted in the application of fire to the surface of the picture. The vehicle used was wax stiffened by an admixture of resin, and the colors were softened by heating, and then laid on with a brush. Both the inside and outside walls of a building were thus decorated, and sculptures in marble thus colored, and it is considered by some that neither oil, tempera, nor fresco paintings are so permanent as those executed by this now obsolete process. No important examples of classic Greek encaustic painting have come down to us; such as those of Polygnotus, whose 'Battle of Marathon' in the Stoa Poikile, or Painted Porch, at Athens, retained its colors unimpaired for 900 years. Perhaps the most interesting remains of the kind are the Egyptian paintings discovered at the Oasis of Fayum. They were brought to light in 1887, are on sycamore wood, and are of high artistic as well as historic value. They consist of bust portraits, sometimes sufficiently extended as to display the hands. They have been distributed among the museums of Europe. While evidently belonging to the later Roman empire, in time, they must have been produced under Greek inspiration. Encaustic painting is one of the lost arts, and the details of its production only to be guessed at. Consult, however, Cros et Henry, 'L'encaustique et les autres procédés de peinture chez les anciens' (1884), and Ebers, 'Die hellenischen Bildnisse aus dem Fajjûm, untersucht und gewürdigt' (1893).

Encaustic Tiles, a species of ornamental tiles made of a finer kind of clay than the ordinary tiles, but not so fine as porcelain. These are of two sorts: plain and figured. The plain tiles are sometimes square, but more frequently triangular, and of different colors; the latter shape renders possible a greater number of designs when the tiles are employed in a sort of mosaic work for the paving of churches, halls, etc. They are made by putting the colored clay into strong steel molds and subjecting it to a pressure of several hundred tons, by means of a plunger fitting accurately into the mold. The under surface of the tile is usually ribbed in order to afford a better hold for mortar. The clay for figured tiles is pressed into an iron mold, the bottom of which is formed of a plaster of Paris pattern, bearing the desired design. The pattern being removed, the depressions on the surface of the tile are filled with colored clays, and the surface is then shaved to remove all superfluities and ruggedness, leaving the pattern intact. The tile is then dried for two or three weeks, and finally fired by being exposed to an intense heat for 60 hours. See Tiles.

Enceinte, ŏn-săñt, in military engineering and in fortification, the continuous line of works which forms the main enclosure of a town or fortress. The term is also applied to the area within this line. See Fortification.

Encel'adus, son of Tartarus and Gæa in Greek mythology; one of the hundred-handed Titans who made war against the Gods, Jupiter slew him with a thunderbolt and buried him under Mount Ætna. The name Enceladus was given to the second satellite of Saturn, discovered by Herschel 28 Aug. 1789.

Encephalitis, an inflammation of the brain proper which may be localized or diffused, and results from coexistent intoxications, or following any acute affection such as ulcerative endocarditis, rheumatism, mumps, etc. It is quite probable that many cases of acute encephalitis occur in children, resulting in the well-known picture of infantile hemiplegia. The symptoms are very indefinite. There is headache, vomiting, somnolence. There may be coma or delirium, the symptoms all pointing to acute inflammation of the brain. Acute encephalitis is usually fatal. In many of the insanities, as acute mania, delirium, dementia paralytica, there is a form of encephalitis usually present. Localized encephalitis usually results in abscess. See ABSCESS; BRAIN.

Encephalocele, ĕn-sĕf'a-lō-sēl, a hernia or a protrusion of a portion of the contents of the cavity of the brain through an opening in the skull beneath the skin. At least three different forms are described: Meningocele, when the dura mater alone protrudes from the cavity, forced out by the pressure of the cerebrospinal fluid; hydrocephalocele, in which the tumor consists of an internal hydrocephalus; and encephalocele, which is made up of true brain-tissue with more or less fluid surrounding it. Most of these tumors are of congenital origin, due to insufficient union of the bones of the skull; a few are acquired later in life. Surgical procedure is the only efficient mode of treatment.

Enceph'alon. See BRAIN.

Enchasing, or **Chasing**, a process analogous to that of sculpture, being the art of enriching, beautifying and finishing, ornamental designs in raised work upon metal surfaces, especially gold and silver. When these designs have received their general form by casting or hammering they are ready for the skilled hand of the artisan and his chasing tools. These are of a great variety of shapes and sizes, fitted to correspond with the minute details of the most complex work. Some are grooved or checkered at the ends, and some of the gravers and burins are curved and blunt, while others taper to a needle-point. The worker possesses a set of hammers, big and little, graded in size to suit any kind of tool. To offset his alternating task of punching and carving he employs sand bags upon which to rest his work. In order that the form of hollow articles may not suffer injury during the operations they are filled with a composition of melted pitch and brick dust or rosin. Articles in copper and brass are sometimes filled with lead to give them firm support within. Fine steel blocks are often used to the same end. Excellent specimens of chased work are seen in pieces of ancient armor, and in vases and other ornaments in gold and silver-plate. Among the most beautiful are those executed by Benvenuto Cellini in the 16th century. Bronze, richly wrought, is rapidly taking its place beside gold and silver work.

Enchanter's Nightshade, a name common to plants of the genus *Circœa*, belonging to the order *Onagraceœ*, of which there are two American species, *C. lutetiana* and *C. alpina*. The former is about a foot and a half high, and has delicate ovate leaves, small white flowers tinged with pink, and small roundish seed-vessels covered with hooked bristles. It abounds in woods from Nova Scotia to western Ontario, south to Georgia and west to Nebraska. It is also called the bindweed nightshade. *C. alpina*, which is similar, but smaller and more delicate, is found in cold, moist shady woods throughout the northern hemisphere. Both plants are common in Europe and Asia. Neither has any affinity with the nightshades.

Enchondro'ma, a tumor made up largely of cartilage. See TUMOR.

Encho'rial Alphabet. See DEMOTIC ALPHABET.

Encina, Juan del, hoo-än' dăl ĕn-thē'nä, Spanish dramatist: b. Salamanca 1469; d. there 1534. His first volume of poems, 'The Song-Book,' contained also a dissertation on 'The Art of Castilian Poesy.' His lyrics are full of charm and lively wit. He wrote 14 dramas; eight of which are shepherd-plays or eclogues; the rest are pieces for Church holy seasons. He made the Jerusalem pilgrimage, and described it in the poem: 'Tribagia; or, the Sacred Way of Jerusalem' (1521). He has been styled "The father of the Spanish drama."

Encisco, Diego Ximenez de, dē-ā'gō he mĕn'āth ĕn-thēs'kō dā, Spanish dramatist: b. in Andalusia. He flourished in the 16th century, and his works are quite noted, though little is known of his life. His best-known play is 'The Medicis of Florence.'

Encisco, Martin Ferdandez de, mär-tēn fĕr-nän'dĕth dā ĕn-thē'sō, Spanish geographer: b. Seville about 1470; d. after 1528. He came to America in 1500; practised law in Santo Domingo and supplied funds to Alonso de Ojeda for the colonization of Tierra Firme, the region about the Isthmus 1509. Encisco followed in 1510 and founded the city Santa Maria la Antiqua del Darien. His soldiers revolting, he was arrested by Vasco Nunes de Balboa, and went to Spain, returning to Darien 1514 as alcalde, and opposing Balboa till the latter's unjust execution by Pedrarias Davila at Darien 1517. He was the author of 'Suma de Geographia, que treta de todas las partidas del mundo,' the first Spanish description of America which touched upon the difference in level of the two oceans.

Encke, ĕng'kĕ, **Erdmann**, German sculptor: b. Berlin 20 Jan. 1843; d. 1896. He was a pupil of the Berlin Academy and of Abert Wolff, his first piece being a group entitled: 'A German Struggling With Two Gauls.' He took a prize for the statue of Jahn in 1872, and was made professor at the Berlin Academy in 1883. His art was related to the school of Rauch, his temperament being at the same time realistic and poetical. Among his prominent works are a statue of the Great Elector, Frederick I. of Brandenburg, Town Hall, Berlin; a colossal statue of Queen Louise of Prussia, Thiergarten, Berlin; and the sarcophagi of Emperor William I. and Empress Augusta in the mausoleum at Charlottenburg.

Encke, Johann Franz, yō-hän fränts, German astronomer: b. Hamburg 23 Sept. 1791; d. Spandau 26 Aug. 1865. He studied under the astronomer Gauss, at Göttingen; during the war of liberation (1813–15) served as artillerist in the German army, and on the conclusion of peace was appointed assistant in the observatory of Seeberg, near Gotha. Here he calculated the orbit of the comet observed by Mechain, in 1786, by Miss Herschel in 1795, and by Pons in 1805–18. He predicted its return in 1822–25–28, and with each reappearance more data were afforded for computing its exact orbit, which, it was calculated, required three and a quarter years to complete. By comparison of the times of its earlier and later appearances, Encke was subsequently led to detect a gradual acceleration of its movement, amounting to about two and a half hours on each revolution. This acceleration he ascribed to a resisting medium, which sensibly affects the body of the extreme rarity of this comet, which is transparent to its centre. The fame of his two publications: ‘Die Entfernung der Sonne’ (1822), and ‘Der Venusdurchgang von 1769’ (1824), led to his appointment as director of the observatory of Berlin (1825), a position which he held till his death. Many of his works are contained in the ‘Astronomische Jahrbücher’ (1830–66), a publication during these years issued under his direction.

Enclosure, or conventual seclusion of nuns who have taken solemn lifetime vows, is guarded very strictly by the laws of the Roman Catholic Church. The conventual seclusion of monks is less strict, the prohibition of converse with the outer world being in their case limited to the exclusion of women from the interior of the monasteries and rigid rules on the observance of silence. The Council of Trent forbids nuns to leave their convents, even for a short time, on any account whatever save for a legitimate cause — a cause specified in the law — with the approval of the local bishop. And no person from outside, male or female, young or old, high or low, lay or clerical, is to be admitted within the *clausura* of a nunnery unless with leave in writing from the bishop or superior. By violation of this rule excommunication is incurred *ipso facto*. These rules, however, apply to regularly cloistered nuns, who take solemn life-vows of detachment from the world: they do not apply to the houses or convents of religious women whose work brings them in contact with the outside world, such as sisters of charity, of mercy, little sisters of the poor, and the like. In such religious institutes the spirit of the Tridentine law governs, not the letter.

Encratitæ, ĕn-krā'tĭ-tē (*continentes,* abstainers) a Gnostic sect of the 2nd century, disciples of Tatianus, who was himself a disciple of Justin Martyr, and like him, author of an *Apologia* on behalf of Christian believers. Tatianus held that the material world is essentially evil, proceeding from the evil principle. For him marriage was sinful and animal food an abomination; he employed water instead of wine in the eucharistic rite.

Encrinites, ĕn-krĭ-nī'tēz, fossil crinoids or sea-lilies, known as stone-lilies. See CRINOIDS.

Encyc'lical (*literæ encyclicæ*), a circular letter. The word used in an ecclesiastical sense means a letter addressed by the Pope to all the bishops in the world who are in communion with him, in which he condemns errors prevalent in the world, or explains the line of conduct which Christians ought to take in reference to practical questions pertaining to faith and morals. Leo XIII. issued a large number of encyclicals on such questions as, rights of labor, education, marriage, Bible study, etc. (See LEO XIII.) An encyclical differs from a bull or brief, in that the encyclical is to the bishops of the whole world, treats of matter of universal interest, and is of concern to the entire Church. A bull or brief is determined by circumstances, is of a special nature, and may be of particular value only to some locality. There is a difference in the form of an encyclical from that of a bull or brief,— that is, in the seals used, the signatures and the introductory words.

Encyclopæ'dia, Cyclopædia, or Cyclopedia. This word, formed from the Greek *en,* in, *kuklos,* a circle, and *paideia,* instruction, but not a native Greek compound, originally denoted the whole circle of the various branches of knowledge which were comprehended by the ancients in a liberal education (the *artes liberales* of the Romans). The distinction between the words encyclopædia and cyclopædia is almost too trifling to be comprehended. At a later period the word was applied to every systematic view, either of the whole extent of human knowledge or of particular departments of it. The want of such general surveys was early felt; and as knowledge increased they became still more desirable, partly for the purpose of having a systematic arrangement of the sciences in their mutual relations, partly for the readier finding of particular subjects; and, for these two reasons, such works were sometimes philosophically, sometimes alphabetically, arranged. The spirit of compiling, which prevailed in the Alexandrian School, soon led to attempts remotely allied to this, and Varro and Pliny the elder, among the Romans, composed works of a similar kind.

The honor of undertaking encyclopædias on a regular plan belongs to the Middle Ages, which produced not only a large number of cyclopædias of particular sciences, called *Summæ* or *Specula* (for example, the ‘Summa Theologiæ’ of Thomas Aquinas), but also a Universal Encyclopædia, such as had never been seen before. The indefatigable Dominican, Vincent of Beauvais, about the middle of the 13th century, exhibited the whole sum of the knowledge of the Middle Ages in a work — or rather three works — of considerable size — a real treasure to the inquirer into the literary history of the Middle Ages. An exceedingly popular work was the ‘De Proprietatibus Rerum’ of Bartholomeus de Glanvilla, an English Franciscan friar, which maintained its reputation from the year 1360 to the middle of the 16th century. In the 17th century various encyclopædic works were compiled, such as the Latin one of John Henry Alsted, ‘Encyclopædia vii Tomis distincta’ (Herborn 1620), a work in which the subjects are divided into 7 classes, and treated in 35 books. In 1674 appeared the first edition of Moréri's ‘Le Grand Dictionnaire Historique.’ In 1677 John Jacob Hoffman published at Basel his ‘Lexicon Universale,’ the first work of the kind in which a summary of art and science was presented in dictionary form. In 1697 appeared Bayle's famous ‘Dictionnaire Historique et Critique’ (Rotterdam, 4 vols.), a work which is still of great value. Among the greatest works of earlier date would have been reckoned the ‘Biblioteca Universale’ of Coronelli, had it been completed according to the original plan. It was to have appeared in 45 folio volumes, of which only seven were published (Venice 1701–6). More successful, especially in being brought to a completion, was the 'Grosses vollständiges Universallexicon aller Wissenschaften und Künste' (Grand Universal Lexicon of all the Arts and Sciences), commonly called Zedler's, from the person, a bookseller, who conducted it (Halle and Leipsic 1732–50, 64 vols.; Supplement 1751–4, 4 vols. folio). It has, on the whole, much merit. Lives of living men were included after Volume XVIII.

The first encyclopædia written in English and with the articles alphabetically arranged, was the 'Lexicon Technicum,' or an 'Universal English Dictionary of Arts and Sciences' (London 1704, 1 vol. folio), by John Harris, a London clergyman. This was a useful and popular work, though it omitted from its scope theology, biography, antiquity, and poetry. It was reprinted in 1708, and a second volume was added in 1710. Among other important encyclopædic works in English the following may be mentioned: Ephraim Chamber's 'Cyclopædia'; or an 'Universal Dictionary of Arts and Sciences' — a work published in 1728, in two volumes folio. A second and improved edition came out in 1738. Latterly it was revised and enlarged by Abraham Rees, in which form it was several times reprinted, being finally known as 'Rees' Cyclopædia,' and published in a number of volumes. Then was published the 'Encyclopædia Britannica.' Of this there have been nine editions. The first edition was completed in 1771, in three volumes, and the ninth edition was completed in 1889, in 24 volumes, and an index volume. The 'Edinburgh Encyclopædia' (1810–30, 18 vols.) was devoted particularly to the sciences and technology, and was conducted by Sir David Brewster. The 'Encyclopædia Metropolitana' (London, begun 1815, completed 1845, in 25 vols., was published in four divisions, according to a plan devised by the poet Coleridge). The 'London Encyclopædia,' by Thos. Curtis (22 vols.), and the 'Penny Cyclopædia' (29 vols.), appeared in 1833–46. Chambers' 'Encyclopædia' (in 10 vols.) was published in 1860, and a new edition appeared in 1902.

In the United States an early work was the 'Encyclopædia Americana,' edited by Francis Lieber, and published 1839–47 in 14 volumes. 'The American Cyclopædia,' edited by George Ripley and Charles A. Dana, appeared in 1858–76 in 16 volumes. The publishers of this work have since 1861 published the 'American Annual Cyclopædia,' designed to record the progress of science and the arts, and the world's history from year to year, and to serve as supplements to the 'American Cyclopædia.' It is in the same form as that work, octavo, and comprises about 800 pages per volume. 'Johnson's New Universal Cyclopædia' first appeared in 1874–7, in four imperial octavo volumes. It was especially strong in the departments of natural science — physics, chemistry, mechanics, etc.,— and American gazetteer matter. In its later form, 'Johnson's Universal Cyclopædia' (1893–5, 8 vols.), with a change of publishers, the work was thoroughly revised, by a corps of 36 editors, under the direction of Charles Kendall Adams. Then followed 'The International Cyclopædia' (New York 1884), which was succeeded by 'The New International Encyclopædia' in 17 volumes (1902), and later (1903) by the 'Encyclopedia Americana' in 16 volumes.

Of the French cyclopædias the most famous is the great 'Encyclopédie, ou Dictionnaire Raisonné des Sciences, des Arts, et des Métiers,' by Diderot and D'Alembert.' This was published in 35 volumes 1751–80. Not only information was given in these volumes, but opinions of the most radical character, hostile to the Church, subversive of religion, intensely antagonistic toward everything in the old order of things. The clergy and the court had fought the work, had even broken into it with alterations secretly made at the printers', and left no stone unturned to prevent its circulation. Yet Europe was filled with it, and shaken with the effects of it. It was an immense burst of everything which journalism to-day means; a fierce prophecy of changes which are still hanging; a wild proclamation of the problems of human aspiration and desire. Not only were the sciences pushed to the utmost by Diderot, but he made industry, labor, human toil in the shop, an interest unceasingly cherished. It was an explosion heralding the Revolution a quarter of a century later. Still more comprehensive is the 'Encyclopédie Méthodique, ou par Ordre des Matières' (Paris 1781–1832, in 166½ vols.), an aggregate of dictionaries rather than a single work. The French have also the 'Encyclopédie Moderne,' begun in 1824, finished in 1832, 26 volumes, and subsequently republished; the 'Encyclopédie des Gens du Monde' (1835–44), 22 volumes; 'Larousse's more recent and valuable 'Grand Dictionnaire Universel du XIX. Siècle,' 16 volumes folio (with two supplementary volumes); and 'La Grande Encyclopédie,' an extensive and excellent work which was completed in 1903. Of works published in Germany the most famous is 'Brockhaus' Conversations-Lexikon,' now in its 14th edition. It is equaled, if not surpassed, by the similar work of Meyer. The huge 'Allgemeine Encyklopädie der Wissenschaften und Künste,' originally edited by Profs. J. S. Ersch and J. G. Gruber, begun 1818, is not yet completed. Three sections of the alphabet are carried on simultaneously. Other German encyclopædias deserving mention are those of Pierer and Spamer. Similar works have also been published in Italy, Spain, Holland, Denmark, Norway, Sweden, Russia, etc.

The rapid advancement of the sciences and arts, and the proportionately rapid communication between all civilized nations, have made a general acquaintance with many different branches of knowledge more necessary than ever before. This is one of the chief causes which have produced in our time so many encyclopædias of various kinds, some very learned, and others more adapted for the general reader; some embracing all the sciences and arts, others only single branches.

End-brain, a name given to the front part of the brain, which corresponds to the fore-brain or telencephalon. See Brain.

End-organs, important nerve-structures specially designed for particular purposes. Thus the taste-buds in the mouth and tongue, the touch-bulbs in the fingers, and the muscle-plates in the muscles are special forms of nervous end-organs. There is a vast variety of nervous end-organs found in the special glands, such as the secretory glands of the skin of the mucous membranes, in the liver, the spleen, the kidneys, etc.

Endarteritis, ĕn-där-tē-rī′tĭs. See ARTERITIS; BLOOD VESSELS.

Endeman, Wilhelm, vĭl′hĕlm ĕn′dē män, German jurist: b. Marburg, Hesse, 24 April 1825. He studied at Heidelberg and was professor of law at Jena 1862–7 and at Bonn in 1876. He was a member of the Reichstag 1871–3. His writings on German commercial law are highly esteemed. Among his works are: 'Die Beweislehre des Zivilprozesses' (1860); 'Der deutsche Zivilprozess' (1878-9); 'Die Entwicklung des Beweisverfahrens im deutschen Zivilprozess' (1895).

Endem′ic (Gr. «prevailing among the people»), a name often applied to diseases which attack the inhabitants of a particular district or country, and have their origin in some local cause, as the physical character of the place where they prevail, or in the employments, habits, and mode of living of the people. Every part of the world, every climate, and every country, has its peculiar endemics. Thus the tropical and warm climates are subject to peculiar cutaneous disorders, eruptions of various kinds, because the constant heat keeps up a strong action of the skin. In northern climates eruptions of the skin occur, but they are of a different kind. Thus in all the north polar countries, especially in Norway, a kind of leprosy, the *radesyge,* is prevalent, arising from the coldness and humidity of the climate, which dispose the skin to such disorders. Hot and moist countries generate the most violent typhoid and putrid fevers; the West Indies and some of the South American coasts, for instance, produce the yellow fever. In different parts of the United States intermittent fevers, arising from local malarial conditions, are common, as they are in countries generally in places that are damp and not warm, on marshes and large rivers, etc. Places in a more dry and elevated situation, northern countries particularly, are peculiarly subject to inflammatory disorders. In countries and districts very much exposed to currents of wind, especially in mountainous places, we find at all seasons of the year rheumatisms, catarrhs, and the whole train of complaints which have their origin in a sudden stoppage of the functions of the skin. In large and populous towns we meet with the most numerous instances of pulmonary consumption. In cold and damp countries like England, Sweden, and Holland the most frequent cases of croup occur.

Diseases which are endemic in one country may also appear in others, and become epidemic if the weather and other physical influences resemble those which are the causes of the endemic in the former place; the climate being for a time transferred, as it were, from one to the other. Endemic disorders in some circumstances become contagious, and thereby spread to other persons, and may be transplanted to other places, the situation and circumstances of which predispose them to receive these disorders. This is known by the migrations of diseases, the spreading of leprosy from Oriental countries to Europe, and the like.

It is favorable to the cure of obstinate disorders for the invalid to remove to a climate where his particular complaint is rare. Thus it is customary for people attacked with pulmonary complaints to remove to localities where the air is pure and dry, and sunshine abundant. So it is of advantage to the consumptive to exchange unwholesome city air for pure air in the country. Modern sanitation is learning to deal with conditions which, alike in populous and sparsely peopled places, have hitherto bred diseases; so that immunity from fatal disorders may be said to show the good results of sanitary science, as do also the improved statistics of longevity.

Ender, ĕn′dėr, **Eduard,** Austrian artist: b. Vienna 1824. A son and pupil of Johann Ender, (q.v.), he studied at the Vienna Academy, becoming a historical and genre painter. Among his works are: 'Wallenstein and Seni' (1844); 'Corbeille de Mariage' (1850); 'Tasso at Court of Ferrara' (1852); 'Francis I. in Cellini's Studio' (1854); 'Emperor Rudolph II. and Tycho Brahe' (1855); 'Shakespeare Reading Macbeth at Court of Elizabeth'; 'Emperor Joseph II. Meeting Mozart'; 'Schiller at Court of Weimar'; 'Rembrandt at his Studio'; 'Elizabeth and Van Dyck'; 'Game of Chess' (1857); 'Marie Antoinette's Farewell of Maria Theresa.'

Ender, Johann, Austrian artist: b. Vienna 4 Nov. 1793; d. 16 March 1854. As a portrait painter he was successful at an early age. In 1818–19 he made a tour of Italy, Turkey and Greece, remaining in Rome 1820–6. Upon his return to Venice he devoted his attention to miniature and historical paintings, being professor at the Academy from 1829 to 1850. Among his works are: 'Madonna with Slumbering Christ-Child,' Vienna Museum; 'Marcus Aurelius on his Death Bed' (1814), Esterhazy Gallery; his masterpiece, 'The Crucifixion,' a fresco in the Vienna Cathedral; 'Orestes Pursued by the Furies' (1815); 'Minerva Showing Ithaca to Ulysses' (1816); 'Assumption'; 'Sleeping at Christ's Sepulchre' (1817); 'Judith'; 'Bacchus finding Ariadne'; and many portraits.

Ender, Thomas, Austrian artist: b. Vienna 4 Nov. 1793; d. there 28 Sept. 1875. He was twin brother of Johann Ender (q.v.). He also studied at the Vienna Academy, becoming a noted landscape painter. He won the grand prize at the Vienna Academy 1816. Going to Brazil in 1817, he brought back nearly a thousand drawings and water colors. In 1836 he became corrector and later professor at the Vienna Academy, filling that chair until 1849. Among his works are: 'View of Grossglockner'; 'Castle Tyrol'; 'Coast of Sorento'; 'View of Rio Janeiro,' Vienna Academy; 'Chapel in the Woods,' National Gallery, Berlin.

En′derby Land, a region in lat. 65° 57′ S., lon. 47° 20′ E., named by John Briscoe in 1831, when on a whaling voyage, in honor of his employer, Samuel Enderby. Briscoe could not approach within 20 or 30 miles, and was unable to say whether it was an island or a strip of continental coast. It was first discovered by Dirk Gherritoz, in 1599, and named for him.

Ender′mic, a term designating a form of medication once much in vogue, but now almost abandoned, consisting in raising a blister upon the affected part and applying to the raw surface the remedy to be absorbed. See HYPODERMIC.

En′dicott, Charles Moses, («JUNIUS AMERICANUS»), American historical writer: b. Danvers, Mass., 1793; d. Northampton, Mass., 1863. He contributed to the 'New England Historical and Genealogical Register' and to the Boston *Gazette*. He wrote a 'Life of John Endicott'; 'The Persian Poet, a Tragedy'; 'Essays on the Rights and Duties of Nations'; and 'Three Orations.'

Endicott, John, American colonial governor: b. Dorchester, England, 1589; d. Boston, Mass., 15 March 1665. He was sent out to this country by the "Massachusetts Company" to carry on the plantation at Naumkeag, or Salem, where he arrived 6 Sept. 1628. In April 1629 he was chosen governor of "London's plantation"; but in August it was determined to transfer the charter and government of the colony to New England, and Winthrop was appointed governor. Endicott was deputy-governor of the Massachusetts colony 1641–4, in 1650, and 1654; and was governor in 1644 and 1649, 1651–4, and 1655–65. He was bold and energetic, a sincere and zealous Puritan, rigid in his principles, and severe in the execution of the laws against those who differed from the religion of the colony. So averse was he to everything like popery that he cut out the cross from the military standard. He was opposed to long hair, insisted that the women should wear veils in public assemblies, and did all in his power to establish what he deemed a pure Church. In 1659, during his administration, four Quakers were put to death in Boston.

Endicott, William Crowninshield, American lawyer; b. Salem, Mass., 19 Nov. 1826; d. Boston 6 May 1900; was a descendant of John Endicott (q.v.), the Puritan governor of Massachusetts. He was graduated at Harvard College in 1847; was an unsuccessful candidate for governor of Massachusetts, on the Democratic ticket, in 1884; and was appointed secretary of war in President Cleveland's cabinet in 1885.

Endive, ĕn'dĭv (*Cichorium endivia*), an annual or biennial herb of the natural order *Compositæ*. It is an East-Indian annual or biennial, with a rosette of smooth radical leaves, more or less lobed or cut, blue axillary sessile flowers, and grayish angular seeds. It has long been cultivated as a salad, for which use it probably ranks in Europe next to lettuce, but not quite so high in America. It is as easily cultivated as lettuce, but must be blanched, either by loosely tying the outer leaves up over the inner ones or by covering the plants with large drain-tiles or similar tubes. Of the numerous varieties, those that naturally are most curly-leaved, and that ordinarily develop a white centre without blanching, are the most esteemed. The leaves are also used as a pot-herb and as an ingredient in soups, stews, etc.

Endless or **Perpetual Screw,** a mechanical contrivance, consisting of a screw, the thread of which gears into a toothed wheel at an oblique angle corresponding to the pitch of the screw. It derives its name from the endless recurring effect its thread produces when in motion. It is in general use as a means of producing slow motion in the adjustments of machines rather than as a transmitter of great power.

End'lich, Gustav Adolf, American jurist: b. Alsace Township, Berks County, Pa., 29 Jan. 1856. He was educated in Germany and at Princeton; studying law and being admitted to the bar in 1877. He was elected judge of the 23rd judicial district, Pennsylvania, 1889, and re-elected 1899. He has published: 'The Law of Building Associations' (1882); 'The Law of Affidavits of Defense in Pennsylvania' (1884); 'Woodward's Decisions' (1885); 'Commentaries on the Interpretation of Statutes' (1888); 'Rights and Liabilities of Married Women in Pennsylvania' (1889).

Endlicher, ĕnd'lĭн-ĕr, **Stephen Ladislas,** Hungarian botanist: b. Hungary 24 June 1804; d. Vienna 28 March 1849. He was destined for the priesthood, but in 1827 began botanical and linguistic studies, and in 1840 became professor of botany in Vienna. Much disturbed by the events of 1848, he fell into melancholy, and in 1849 put an end to his own life. His 'Genera Plantarum' (1836–40) has had great influence on succeeding botanists.

Endocardi'tis, inflammation of the endocardium or serous membrane lining the valves and internal surface of the heart. See HEART.

Endog'amy, a custom among some savage peoples of marrying only within their own tribe. Opposed to exogamy.

Endogens, ĕn'dō-jĕnz, a name for monocotyledons, referring to the mode of growth of the stem. See BOTANY; MONOCOTYLEDONS.

Endometri'tis. See WOMB.

Endoneurium, ĕn-dō-nū'rĭ-ŭm, the delicate coat of connective tissue-cells found in and around the nerve-fibre bundle. See NERVE FIBRES.

Endor, ĕn'dėr, a village of Palestine, four miles south of Tabor; now a poor mud hamlet. It was the place which Saul visited (1 Sam. xxviii. 7) to consult the "woman with a familiar spirit" previous to his fatal engagement with the Philistines.

Endoscope, in surgery, a general term for an instrument for the examination of internal parts. It consists of a tube and an apparatus for lighting. The most serviceable is that devised by Nitze and Leiter.

Endosmo'sis. See OSMOSIS.

Endothelioma, ĕn-dō-thē-lĭ-ō'ma. See TUMOR.

Endothe'lium, a modified form of the cells lining certain internal organs. Such are the internal lining membranes of the heart and blood vessels, the joints, and other closed cavities. Endothelium is a modification of epithelium (q.v.).

Endym'ion, in classical mythology, according to some a huntsman, according to others a shepherd, and according to a third account a king of Elis. One tradition is that he asked of Zeus eternal youth and eternal sleep, and that Selene (the moon) saw him sleeping and became enamored of him. Others relate that Selene herself, charmed by his beauty, conveyed him to Mount Letmus in Caria and threw him into a perpetual sleep in order that she might kiss him whenever she pleased. The legend is the subject of Keats' 'Endymion.'

Enemata, fluid substances passed into the rectum and large intestine for cleansing, for medication, or for nutrient purposes. For the treatment of chronic constipation, enemata of cold or hot water, water and soapsuds, water and glycerine, are found to be of great service. Almost any remedial substance capable of solution and absorption may be placed in the rectum or large intestine to affect the parts locally or to exert a general action on the body. Almost all remedies that are taken into the stomach may be taken by means of enemata. The dose has to be somewhat larger in most instances. For the treatment of pinworms, diarrhœa, and dysentery enemata are invaluable. In medicine the lower bowel may be used much oftener than it is. In acute colicky pains from "wind" in the bowels there is nothing better, as a rule, than a hot enema of at least two quarts, at a temperature of from 116° to 118° F. As the lower bowel is not provided with digestive juices, when nutrient enemata are to be given the insoluble food-substances should be so converted as to render them capable of absorption — hence all gruels, eggs, milk, etc., to be used should first be predigested by peptic or pancreatic ferments. A special form of enema, consisting of hot (116° to 118° F.) salt solution (1 teaspoonful of salt to 1 pint of water), allowed to pass in and out of the bowel slowly and made to ascend some distance, is of immense service in cases of surgical shock, in profuse bleeding, and in cases in which the kidneys refuse to secrete urine. This is termed enteroclysis (q.v.). Enemas for cleansing the bowel should be copious; those for nutrient purposes should be small — not over half an ounce. Enemas may be given by the ordinary fountain syringe, by a Davidson syringe, or by a rubber or glass syringe.

Enemy. See War, Laws of.

Energet'ics, that branch of mathematical physics which deals with energy and its transformations. A general theory of energetics, discussing the quantitative relations that hold true in all imaginable transformations, was given by Rankine. Consult: 'Miscellaneous Scientific Papers,' p. 209. See Energy; Perpetual Motion; Thermodynamics.

Energumen, ĕn-ėr-gū'mĕn, a person controlled or "worked up" (ἐνεργούμενος) by evil spirits. The word is in common use in the writings of the Greek and Latin fathers: it is equivalent to the (δαιμονιζόμενος) (possessed by a devil) of the New Testament. In the 3rd century the churches kept registers of their energumens and dealt with them much as though they were lepers: they were supported by the alms of the faithful and lodged in dwellings near the churches; so we learn from the acts of the Council of Orange 529 (*Concilium Arausicanum*). Various modes of exorcizing were employed by the special ministers called Exorcists or by the bishop and his clergy, for the relief of the energumens; these, until cured, were denied the sacraments of the Church. See Exorcism.

E'nergy, in physics and theoretical mechanics, that attribute of a body, or of a material system, by virtue of which the body or system can do work; work being simultaneously defined as the overcoming of resistance through distance. A raised weight can do work by falling to the ground; a coiled spring can do work in unwinding; a mass of compressed air can do work in expanding down to the normal atmospheric pressure; and similar examples might be multiplied indefinitely. All of these bodies, or systems, that can do work by changing their position, or their shape, or their state, are said to possess "energy"; and the energy that a body possesses is measured strictly by the quantity of work that it can do. The unit that is adopted in the measurement of work depends upon the nature of the problem that is under consideration. In modern scientific investigations the unit of work is commonly the erg, which is defined as the work that is done in overcoming a resistance of one dyne, through a distance of one centimetre. In ordinary engineering operations, the unit of work commonly employed (at least in the United States and in England) is the foot-pound, which is defined as the amount of work that is done in overcoming a resistance of one pound, through a distance of one foot. The foot-pound is not as precise and definite a unit as the erg, because the attraction that the earth exerts upon a pound of matter varies with the latitude and with the elevation above the sea, and hence the foot-pound varies in the same manner. The variation is not great enough, however, to destroy the usefulness of the foot-pound as a unit of work in ordinary engineering operations, and hence this familiar unit is not likely to be superseded, for ordinary purposes, unless the metric system is brought into general use in the United States. There is no great difficulty in understanding that a weight can do only a definite amount of work in falling from one level to another, or that a spring can do only a definite amount of work in unwinding; for we all know that clocks have to be wound up regularly, and that a small waterfall will not yield the same power as a big one that has the same difference of level between its top and its bottom. In the case of a body that falls freely through the air, however, the fact that the energy that it had in virtue of its elevated position is not lost is not so evident. It is true that the energy, in this case, is not immediately expended in overcoming frictional resistance, nor in doing work of any obvious and visible kind. Nevertheless it is not lost; for it is expended in giving the moving body its velocity. A moving body possesses energy in virtue of its motion, and work must be done by it before it will stop. Thus a railroad train, moving at high speed, cannot be brought to rest at once, because the energy of motion that it possesses must first be expended in overcoming the resistance of the brakes, or the natural frictional resistance of its axles in their journals and its wheels upon the tracks. The energy that a body possesses in virtue of its motion is called "kinetic energy," that which it possesses on account of its position, or its state of strain, being called "potential energy," by way of distinction. The amount of work that must be done upon a body of mass M, which is moving with a speed V, in order to bring it to rest (that is, its "kinetic energy"), can easily be shown to be given by the formula Kinetic Energy $= \frac{1}{2} MV^2$.

The conversion of kinetic energy into potential energy and back again, is well illustrated in the pendulum. At the lowest point of its swing, the energy of a pendulum is entirely kinetic; while at the highest point of the swing, and just as the motion is about to be reversed, the energy is entirely potential.

Conservation of Energy.— The physical law that is known by this name merely asserts that the total amount of energy in any isolated system is absolutely invariable in amount. Energy may be added from without, or abstracted in a similar manner; but so long as no external influences are permitted to interfere, the total quantity of energy within the system is incapable of either increase or diminution. In the case of the pendulum this is easily admitted; but other systems are easily imagined, in which the truth of the law is by no means obvious. For example, a tightly-wound watch-spring possesses potential energy, in virtue of which it may be caused to drive a train of wheels, and to do work. But suppose the coiled watch-spring is dissolved in an acid, and meanwhile secured in some manner so that it cannot unwind. We cannot assume that the solution that is ultimately obtained is any different, whether the watch-spring was coiled before dissolving, or not. What becomes of the energy in the spring? This question would be best answered by experiment; but in the absence of experimental data the conjecture may be reasonably made that the two sides of the spring, being in different states of strain, act like plates of different metals when immersed in the acid, and give rise to electric currents through the liquid, whose combined chemical and thermal effects correspond precisely to the potential energy that was stored in the spring by winding. The simpler case of a body falling freely through the air is also somewhat confusing at first thought, because although it may be admitted that the potential energy is stored up by accelerating the body while it is falling, it is by no means evident that the energy is not annihilated as soon as the body strikes the ground. As a matter of fact, the energy of the falling body is converted into heat when the visible motion is suddenly arrested, and the body and the ground immediately around it are warmed by an amount that corresponds precisely to the kinetic energy that the body had immediately before the arrest. This explanation is not merely speculative, for it rests upon sound experimental evidence. The arrest of a cannon-ball is accompanied by the generation of enormous quantities of heat, and the woodwork on battle-ships is often set afire in consequence of the mere impact of projectiles. The water at the bottom of a waterfall is measurably warmer than that at the top; and the rise in temperature that is observed when a falling mass of lead is suddenly arrested was used by Hirn with remarkable success for the determination of the mechanical equivalent of heat.

The idea that energy cannot be created appears to have been familiar to Galileo, who inferred the fact from a careful study of the simple machines that were in use in his day. There appeared to be many cases in which energy is destroyed, however, and the indications were, in fact, that all mechanical energy is gradually wasted away by frictional losses and by others of like nature. In cases in which these losses do not exist, or are negligible, the idea of the conservation of the energies of a system, and of the perpetual transformations of kinetic energy into potential energy and the reverse, proved to be of the greatest service in simplifying the theoretical discussion of many problems in mechanics, even before the modern theory of heat was formulated. The motions of the celestial bodies, for example, are much more easily described by the aid of the principle of conservation of energy than they could be without it. The extension of that principle so as to cover all the cases in which it had previously appeared to be violated could not be made until the fact was recognized that heat is not a substance; for, obviously, it was impossible that a substance could be converted into mechanical energy. In the first years of the 19th century Rumford made experiments tending to prove that heat is not a substance, and he appears to have been convinced, in his own mind, of the correctness of his novel views. A quarter of a century later Carnot appears to have reached the same conclusion, if we may judge from the note-book that he left among his papers. It was not until about 1840, however, that the great steps were taken that led to the establishment of our present views. Several eminent names are connected with these beginnings of the modern theory of heat, and it is difficult to apportion the credit among them justly. Prominent among these names are those of Séguin, Mayer, Colding, and Joule; but it is undoubtedly to Mayer and Joule that we are chiefly indebted for the new ideas, and controversy has been mainly confined to the discussion of the priority and the relative importance of the contributions of these two men.

Dr. Julius Robert Mayer, an obscure physician of Heilbronn, Germany, who had had some professional experience in the island of Java, had observed that the venous blood of the Javanese often exhibits the brilliant red color that is commonly observed only in the highly oxygenated blood of the arterial circulation; and after much reflection he came to the conclusion that this is because a lesser amount of oxidation suffices to maintain the temperature of the body in a hot climate than would be required in a cooler one. These observations were made in the summer of 1840. In May, 1842, he published, in Liebig's 'Annalen,' a paper entitled 'Remarks on the Forces of Inorganic Nature,' in which he gave a preliminary account of his discovery. Here he presents the general outline of the new theory very clearly, and the grasp of the subject that he displays at this early date is truly wonderful. The locomotive itself was then a great novelty, but he uses it to illustrate the transformation of heat into mechanical energy and back again in the following sentence, which would be a credit to the most advanced physicist of to-day: "Our locomotives may be compared to distilling apparatus; the heat beneath the boiler passes into the motion of the train, and is again deposited as heat in the axles and wheels." In 1845 he published a second and much more remarkable paper entitled 'Organic Motion in its Connection with Nutrition,' in which he gives a detailed calculation of the mechanical equivalent of heat, from the known specific heats of air.

The contributions of James Prescott Joule, of Manchester, England, to the mechanical theory of heat and the conservation of energy were the natural outcome of investigations that he had been making upon the heating effects of electric currents. His first paper that distinctly enunciated the new conception of heat as a form of energy was read at Cork, in 1843, before the British Association, and was entitled 'On the Calorific Effects of Magneto-Electricity, and on the Mechanical Value of Heat.' As first written it was very involved, and Faraday, who appears to have failed to grasp its exceeding importance, advised Joule not to submit it. He did submit it, however, and in it he gave a number of estimates of the mechanical equivalent of heat. The paper apparently did not greatly impress either the British Association or the outside world; for when Joule brought the subject up again before the same association in 1847 he had an experience that is best described in his own words: "The chairman suggested that, as the business of the section pressed, I should not read my paper, but confine myself to a short verbal description of my experiments. This I endeavored to do, and discussion not being invited, the communication would have passed without comment if a young man had not risen in the section, and by his intelligent observations created a lively interest in the new theory." The young man was Lord Kelvin, then simply William Thomson, two years out of college. In later years Joule obtained far better values for the mechanical equivalent of heat, and spent much of his time devising and executing new methods for its determination.

In England and the United States Joule is commonly credited with the discovery of the true nature of heat; but in Europe the honor is given to Mayer. Tyndall compares the two very fairly. "Withdrawn from mechanical appliances," he says, "Mayer fell back upon reflection, selecting with marvelous sagacity, from existing physical data, the single result on which could be founded a calculation of the mechanical equivalent of heat. In the midst of mechanical appliances, Joule resorted to experiment, and laid the broad and firm foundation which has secured for the mechanical theory the acceptance it now enjoys. A great portion of Joule's time was occupied in actual manipulation; freed from this, Mayer had time to follow the theory into its most abstruse and impressive applications. With their places reversed, however, Joule might have become Mayer, and Mayer might have become Joule."

In 1847 Hermann Helmholtz published his remarkable paper entitled 'On the Conservation of Energy,' in which the subject was presented with great generality and clearness, and which had a profound influence in spreading the new doctrine which taught that no energy is ever created or annihilated, but that we have to do merely with endless transformations of it from one form into another. Attempts have been made to deduce the principle of the conservation of energy from the general laws of mechanics, and in many special cases these attempts have been successful, though they cannot be in all cases, because systems are easily imagined in which the law is not fulfilled. The point is, however, that these imaginary, non-conservative systems apparently do not exist in nature. In allusion to the two-fold nature of the subject (that is, the mathematical and physical aspects), it has been humorously said that everybody now believes firmly in the conservation of energy, because the mathematicians believe it to be a fact of observation, while the physicists believe it to be a theorem in mathematics. It is now generally admitted, however, to be a fact of observation, whose truth or falsity is to be established by experiment. Helmholtz proved that in any system composed of particles moving about in paths or orbits, and subjected only to "central forces" (that is, to forces that act always toward fixed centres or foci, or which act, between every pair of particles, along the line adjoining their centres), the energy must be conserved, if the ordinary laws of theoretical mechanics hold true for the motions of the particles of which the system consists. Hence, if it be admitted that all matter consists of atoms that act upon one another only by forces that are central, a long step has been taken toward proving the law for all material systems. Unfortunately, however, we are not sure that central forces are the only ones that act upon the atom. It is an interesting fact that it was the study of the processes of organic nature that gave Mayer his first inspiration concerning the true nature of heat, and yet it is precisely here that the only doubt as to the entire generality of the law of conservation now exists. The most general test that can be applied to a system to enable us to judge from theoretical considerations whether it is conservative or not, is this: Let the system be protected from external influences, and then, at a given instant, conceive the motion of every one of its particles to be precisely reversed in direction, without being modified in any other way. If, when left to itself, the system would then retrace its previous history so that the events of that history would recur in reverse order, the conservation of energy is rigorously fulfilled in it. If, on the other hand, the system would not so retrace its history, we cannot affirm that it is conservative, but must test the point by a direct appeal to experiment. Now, although this crucial condition of reversibility is frequently (and probably universally) fulfilled in inorganic nature, we certainly cannot assert it to be true in connection with living matter, not even with respect to the meanest fungus. Hence we cannot, from reasoning based on the inorganic world alone, draw any sound conclusion whatever about the conservation of energy in the organic changes that occur in living tissues. To reach such conclusions for the living animal, we must weigh and analyze the food administered and the excreta given off; we must determine the oxygen absorbed and the carbon dioxide and other products exhaled; and we must measure the heat given out, and the external work performed. When these things have been weighed, measured, and analyzed for a sufficient period and with the necessary precision, then, and then only, shall we be competent to affirm or deny the truth of the conservation of energy in the animal machine. Such data are difficult to obtain, but much has been done in this direction, and while we are not yet prepared to establish the fact, beyond controversy, that energy is conserved in the animal body, all the data that we have point to this conclusion, and it is now commonly admitted to be true. Consult: Stewart, 'The Conservation of Energy.' See PERPETUAL MOTION; THERMODYNAMICS.

Energy, Conservation of. See ENERGY.

Eneuresis, a symptom of many diseases of the bladder resulting in incontinence or involuntary passage of urine. It is a prevalent malady of childhood and only becomes of importance after the period of infancy, when the child should have learned to control the bladder. The control of the bladder is in part a matter of conscious effort, and has its representation in the higher brain-centres. Bladder-control is also exercised by that portion of the sympathetic nervous system found in the solar and sacral plexuses, and likewise in a number of cells in the spinal cord, situated in the lumbar region. Interference with the action of any or all of these centres may result in eneuresis. Disease of the spinal cord may cause excessive irritation of the sympathetic nervous system, and may result in nocturnal eneuresis; and the cutting off of the cerebral control may also bring about this condition. During deep sleep the cerebral control is usually cut off, accounting thus for the prevalence of eneuresis in deep sleep in children. Very frequently the immediate cause of eneuresis is some form of local irritation. This is particularly prevalent in young girls, and should always be removed, if possible, in the treatment. Drug medication is extremely unsatisfactory for this condition. The most efficient measures consist in building up the general nervous system of the patient by tonics, cold baths, and exercise in the open air.

Enfantin, ŏṅ-fŏṅ-tăṅ, **Barthélemy Prosper,** French socialist of the Saint Simon school: b. Paris 8 Feb. 1796; d. there 31 Aug. 1864. After the July revolution of 1830 Enfantin associated himself with Bazard for the active propagation of Saint-Simonism. Bazard expounded it in its relations to philosophy and politics; Enfantin mainly in its relations to the social state. Soon, however, a schism broke out between the two on the question of marriage and the relation of the sexes, for his views on which Enfantin was, in 1832, sentenced to two years' imprisonment and to pay a fine of 100 francs. Being released at the expiration of a few months, he went to Egypt. He was subsequently appointed a member of the scientific commission for Algiers, and on his return from Africa wrote 'Colonization of Algeria' (1843). After the revolution of 1848 he edited the journal 'Public Credit.' Other works by him are: 'Economie politique, et politique Saint Simonienne' (1831); 'La Religion Saint Simonienne' (1831); 'Morale' (1832); 'La livre nouveau' (1832).

Enfeoffment, ĕn-fĕf'mĕnt, the act of bestowing or conveying the fee-simple of any estate; or the instrument or deed by which the fee-simple of an estate is conveyed. See FEE-SIMPLE.

Enfield, William, English Nonconformist clergyman: b. Sudbury, England, 29 March 1741; d. Norwich, England, 3 Nov. 1797. In 1763 he became pastor to a congregation at Liverpool, and in 1770 became resident tutor and lecturer on belles-lettres at the academy at Warrington, where he remained for several years, and published several works, including his well-known 'Speaker.' Here he also drew up 'Institutes of Natural Philosophy,' theoretical and experimental. In 1791 he published his 'Abridgment of Bruckers' History of Philosophy.'

Enfield, Conn., town, in Hartford County; on the Connecticut River, and the New York, N. H. & H. R.R.; 20 miles north of Hartford. Its chief manufactures are carpets, shoddy, powder, supplies for undertakers, and bicycles; and it has large brick works. A large amount of the now celebrated Connecticut tobacco is here prepared for use and shipped to different parts of the world. Shaker Station is a part of the town (see SHAKERS). Pop. 6,715.

Enfield, England, a market town in the county of Middlesex; on New River, nine miles northeast of London. Enfield is the seat of the well-known government manufactory of rifles and small-arms, and the "Enfield rifle" used in the British army is made here. Some noted people have lived in Enfield. See D'ISRAELI; LAMB; KEATS. Pop. (1901) 42,738.

Enfield Rifle, a muzzle-loading rifle used in the British army prior to the introduction of the breech-loading system. It was also used in the United States during the Civil War by the Northern army, when Springfields could not be obtained, and by the Confederate army. In England large numbers of these rifles were converted into breech-loaders on the Snider principle, and were known as the Snider-Enfield or simply Snider.

Enfilade, ĕn-fĭ-lād' (from the Fr. *enfiler*), in the military art, is used in speaking of trenches or positions which may be raked by the enemy's shot along the whole length. In conducting the approaches at a siege care must be taken that the trenches be not enfiladed from any part of the place besieged. To avoid this they are generally cut in a zigzag.

Enfleurage, ŏṅ-flė-räzh, in perfume-making, the method of extracting, by contact and absorption, the scents of flowers used for perfumery. For this purpose wooden frames containing glass smeared with pure grease are filled with flowers, which are allowed to remain from one to six days. The grease gradually absorbs the scent, the flowers being renewed from time to time. The scent is afterward separated from the grease by soaking the latter in strong spirits of wine. Sometimes wire frames covered with cotton cloths, saturated with fine olive-oil, are used instead of glass. In this manner the most delicate odors are extracted from flowers, which would be lost in the process of distillation.

Eng and Chang. See SIAMESE TWINS.

Engadine, ĕn-gä-dēn, a beautiful valley in Switzerland, in the Grisons, on the banks of the Inn, bordering on the Tyrol. The language generally spoken is the Ladin, a branch of the Romanic tongue. Several towns and villages are situated in the valley, which is visited by numbers of strangers on account of its picturesque beauty and its mineral springs. Pop. 12,503.

Engano, ĕn-gä'ño, an island of the Malay Archipelago, 60 miles south of Sumatra. It is covered with forests and surrounded by coral reefs; area, including several small adjacent islands, 300 square miles. The natives are Malays. Pop. 6,410.

Engedi, ĕn-gē'dī or ĕn'gē-dī (Heb. "Fountain of the Goat"), on the western shore of the Dead Sea; about 30 miles southeast of Jerusalem. The modern Arabic name is Ain-Jidi. The ancient name was applied also to the eastern part of the Wilderness of Judah. The city, in the time of Abraham, was called Hazazon-tamar, the tamar meaning palm-tree. In 1 Samuel mention is made of David fleeing to the wilderness of En-gedi to escape from Saul.

Engel, Carl, German-English writer on musical topics: b. near Hanover 6 July 1818; d. Kensington, London, 17 Nov. 1882. After a general musical education as pianist, organist and composer he removed to England and settled in London (1850). Here he studied the history of national music and musical instruments. Among his works are: 'The Music of the Most Ancient Nations' (1864); 'Introduction to the Study of National Music' (1866); 'Musical Myths and Facts' (1876); 'Researches into the Early History of the Violin Family' (1883).

Eng'el, Eduard, German literary critic: b. Stolp, Pomerania, 12 Nov. 1851. He made a German translation of 'Italian Love-Songs' (1875); and wrote 'Lord Byron: An Autobiography from Journals and Letters' (1876); 'Psychology of French Literature' (1884); 'Did Bacon Write Shakespeare's Plays?'; 'History of English Literature: With Appendix, American Literature'; 'Wall to Wall' (1890); and 'Exiled and Other Stories.'

Engel, Johann Jakob, yō'hän yä'kōb, German prose writer: b. Parchim 11 Sept. 1741; d. there 28 June 1802. On the accession of King Frederick William III. of Prussia, whose tutor he had been, he was invited by his former pupil to Berlin, where he made himself exceedingly useful in the Academy of Sciences by his writings. Among his philosophical works may be mentioned his 'Philosoph für die Welt,' distinguished for acute observations on men and manners, enlivened by elegant illustrations. Of a similar character is his 'Mirror for Princes' (Fürstenspiegel). His 'Ideen zu einer Mimik,' full of taste, acuteness, and knowledge of human nature, may be regarded as a kind of manual for players. He also wrote several plays — 'Der dankbare Sohn'; 'Edelknaben,' etc. His 'Lorenz Stark,' a novel, is a masterly picture of life and manners. A complete edition of his works appeared at Berlin (1801–6).

Engel, Karl Dietrich Leonard, German musician and writer: b. Grand Duchy of Oldenburg 21 Feb. 1824. He went to Russia as a violin virtuoso at the age of 18, becoming a member of the Imperial Orchestra at St. Petersburg at 22, and later its concert-master. He went to Dresden in 1869 and took up his residence there. Among his works are: 'Deutsche Puppen Komödien' (1874–93); 'Das Volksschauspiel Doktor Johann Faust' (2nd ed 1882); 'Zusammenstellung der Faustschriften vom 16. Jahrhundert bis Mitte' (1884); 'Die Don Juan Sage auf der Bühne' (1887).

Engelbrechtzen, ĕng'ĕl-breʜt-zĕn, **Cornelis,** Dutch painter: b. Leyden 1468; d. there 1533. He was the son of the wood-engraver Engelbert, and the teacher of Lucas, being the earliest known painter in Leyden. Many of his works were destroyed during the Reformation, but among his authentic paintings are: Altarpiece with 'Crucifixion,' and altarpiece with 'Pieta,' Town Hall, Leyden. Doubtfully attributed to him are: 'St. Leonard,' Antwerp Museum; 'Crucifixion,' old Pinakothek, Munich; 'Deposition,' Moritz Chapel, Nuremberg; 'Madonna and Child,' National Gallery, London; 'Crucifixion,' Venice Academy.

Englehard, Friedrich Wilhelm, frēd'rĭʜ vil'hĕlm ĕng'ĕl-härt, German sculptor and painter: b. Grunhagen, Prussia, 1813; d. 1902. He studied at Hanover, at Copenhagen with Thorwaldsen, and at Munich with Schwanthaler. He executed many groups, single figures and genre pieces. Among his creations are: 'Love on a Swan'; 'Dancing Springtime'; 'Slinger with Dog'; 'Bacchus Conquering a Panther'; 'Cupid and Psyche'; the frieze of the 'Edda,' his chief work; 'A Child Fishing'; 'A Child Threading a Needle'; statue of 'St. Michael'; portrait medallion of Bismarck for the monument of Canossa, near Harzberg; 'Christ Blessing Little Children'; and the legendary characters of Germany, 'Odin,' 'Thor,' and the Valkyries.

Engelhardt, Johann Georg Veit, German theologian: b. Neustadt-an-der-Aisch, Bavaria, 1791; d. Erlangen 13 Sept. 1855. In 1822 he became professor of theology at Erlangen; during the years 1845, 1847, and 1848 was the representative of his university in the diet at Munich. His most celebrated works are a translation of the writings ascribed to Dionysius the Areopagite; 'Handbuch der Kirchengeschichte' (1834); 'Richard von St. Victor und Johannes Ruysbroek' (1838); 'Auslegung des speculativen Theils des Evangeliums Johannis durch einen deutschen mystischen Theologen' (1839); 'Dogmengeschichte' (1839).

Eng'elmann, George, American botanist: b. Frankfort-on-the-Main 2 Feb. 1809; d. St. Louis, Mo., 4 Feb. 1884. He studied at Heidelberg, Berlin, and Würzburg, and emigrated to the United States in 1832. In 1835 he began the practice of medicine at St. Louis, Mo. He early devoted his attention to botany, becoming the chief authority on the North American vine and cactus. He was the first president of the St. Louis Academy of Science, and his exhaustive botanical collection is in the Shaw Botanical Garden, St. Louis.

Engelmann, Johannes, yō-hän'nes ĕng'ĕl-män, Russian jurist: b. Mitau, Courland, 7 July 1832. Educated at the University of St. Petersburg, he became professor of Russian law at Dorpat 1860, retaining the chair for 39 years, and delivering his lectures in Russian instead of German after 1887. Among his works are 'Die Verjahrung nach russischem Privatrecht' (1867; in Russian, 1868); 'Die Zwangsvollstreckung auswärtiger richterlicher Urteile in Russland' (1884).

Engels, ĕng'ĕls, **Friedrich,** English Socialist: b. Bannen, Prussia, 28 Nov. 1820; d. London 5 Aug. 1895. He lived mainly at London after 1869. He was an intimate friend of Karl Marx (q.v.), and his most efficient helper in the work of organizing the Socialist movement. In 1870 Engels was corresponding secretary of the International Workingmen's Society for Belgium, Italy and Spain. With Marx he wrote the 'Communist Manifesto' (1847); he also wrote 'The Working Class in England in 1844' (new edition 1892); 'The Origin of the Family'; 'The Development of Socialism from Utopia to Science' (1894, a part of a large work left unfinished); and edited Marx's 'Capital.'

Engerth, ĕng'ert, **Eduard von,** Austrian painter: b. Pless, Silesia, 13 May 1818. He was a pupil of the Vienna Academy, taking the gold medal there in 1845. He became director of the Prague Academy 1854 and in 1855 professor at the Vienna Academy. He was appointed director of the Belvedere Gallery 1871 and director of the Academy 1874. He was made commander of the order of Francis Joseph 1867. Among his works are: 'Haman and Esther'; 'Ladislaus and Akus' (1844); 'Coronation of Rudolph I.'; 'Joseph Explaining the Dream' (1845); 'Seizure of King Manfred's Family' (1853), a masterpiece in the Vienna Museum; 'Victory of Prince Eugene at Zenta' (1865); 'Marriage of Figaro'; 'Fable of Orpheus' (1868); 'Coronation of Francis Joseph as King of Hungary' (1870); 'Death of Eurydice' (1877).

Enghien, Louis Antoine Henri de Bourbon, loo-ē än-twän ōn-rē de boor-bōn än-gàn, Duke of, French prince: b. Chantilly 2 Aug. 1772; d. Vincennes, France, 21 March 1804. He was the son of Louis Henry Joseph Condé, Duke of Bourbon. From 1796 to 1799 he commanded with distinguished merit the vanguard of Condé's army, which was disbanded at the Peace of Lunéville (1801). He then married and took up his residence at Ettenheim, in Baden. He was generally looked upon as the leader of the *émigrés,* and was suspected by the Bonapartists of complicity in the attempt of Cadoudal to assassinate the First Consul. The spies of Napoleon reported that Enghien was often absent for 10 or 12 days together from Ettenheim, and it was believed that on some of these occasions he had secretly visited Paris. Napoleon therefore invaded the duchy of Baden and the Duke of Enghien was seized 15 March 1804, conducted to Starsburg, and thence to the fortress of Vincennes, where he arrived on the evening of the 20th. That same night a court-martial was assembled, and the prisoner was, after a mock trial, in which no witnesses were examined, found guilty on various charges of treason. He requested an interview with Bonaparte, which was refused, and he was immediately led out to execution. He was shot between 4 and 5 o'clock in the morning in the ditch outside the walls, and his body was thrown, dressed as it was, into a grave dug, it is said, the day before. Napoleon and the other chief actors in the tragedy took every pains to justify their conduct, or to throw the chief blame upon others' shoulders, and it is believed by some that the First Consul found himself in the position of a leader whose subordinates are only too ready to rush extreme measures on the least hint from their master.

Enghien, or **Enguien,** Belgium, (1) Town in Hainault, about 19 miles southwest of Brussels. One of the chief occupations is lace making. (2) A watering place a short distance north of Paris.

Engine. A motor or prime mover which is capable of absorbing the inherent forces of material substances such as steam, gas, and water through the medium of heat and pressure, and then converting those forces into mechanical energy in the form of motion, which may be utilized for doing mechanical work, thus distinguishing it from a "machine," which can receive motion only from a motor or engine external to itself.

The various forms of engines may be classified into two general groups — heat engines and hydraulic engines, according to the manner in which they convert the natural forces into mechanical energy, power, or work.

All heat engines act through the medium of a working substance which absorbs heat, converts a portion of that heat into mechanical energy, which is represented by the work performed by the engine, and rejects the remaining portion of the heat, still in the form of heat. The working substance may be a gas, a liquid, or a solid, and incidentally affords a basis upon which the various practically successful forms of heat engines may be conveniently grouped into three general classes — steam engines, gas and oil engines, and steam turbines.

Steam Engines.— In all forms of actual steam engines, the working substance is saturated steam, a fluid consisting of a mixture of water and steam in varying proportions, the expansive energy of which is utilized to drive or impart motion to a piston working within a cylinder.

They may be classified as follows: (1) according to the manner in which the steam is utilized; (2) according to the mechanical arrangement of their parts; and (3) according to the purposes for which they are used.

The first class includes the high-speed and low-speed engines; the single-acting and double-acting engines; the direct-acting and indirect-acting engines; the expansive working and non-expansive working engines; the condensing and noncondensing engines; and the simple engines, compound engines, and multiple-expansion engines, which may be briefly described as follows:

High-Speed Engine.— One in which the piston speed exceeds 900 feet per minute. It possesses the advantages of small dimensions and small weight for a given power, and on account of the frequency of its strokes, is capable of meeting variations in loading more quickly than a low-speed engine. Its disadvantages consist in the greater waste of steam, the greater wear, and the increased danger of the heating of the moving parts. Also, the higher cost of construction and operation.

Low-Speed Engine.— One in which the piston speed is less than 600 feet per minute.

Single-Acting Engine.— One in which the pressure of the steam is exerted only on one side or the under side of the piston, which is pressed down again by the pressure of the atmosphere on the other side against the vacuum produced by the condensation of the spent steam. They were formerly used chiefly for pumping purposes, and in connection with steam hammers, but are now practically out of date.

Double-Acting Engine.— One in which the steam acts alternately on both sides of the piston, either against the pressure of the air, or against the vacuum of the condenser. Originally, all engines were made single-acting, but all modern engines are made double-acting.

Direct-Acting Engine.— One in which the action of the piston is transmitted directly to the crank-shaft. Nearly all engines are direct-acting engines.

Indirect-Acting Engine.— One in which the motion of the piston is communicated to the crank-shaft by means of intermediate levers. In the beam-engine, the connection between the piston and the connecting rods consists of a beam, the oscillating point of which is placed midway between the two rods. They are chiefly employed for pumping purposes, and for driving paddle-wheel steamers. Other than in this limited field, they are becoming practically obsolete.

Expansive Working Engine.— An engine is worked expansively when the steam, instead of being admitted at full pressure into the cylinder until the termination of the stroke, is cut off at some fractional part of the stroke and thus caused to do work simply by its own expansion. The steam may be expanded in one or more cylinders. The amount of steam consumed is low as compared to the amount of work done. It is universally used where circumstances will permit, on account of its greater economy as compared to the engines of the nonexpansive working type.

Nonexpansive Working Engine — An engine in which the steam is allowed to enter the cylinder at boiler pressure, and is maintained at that pressure behind the piston during the whole of the stroke. The amount of steam consumed is disproportionately high as compared to the work done. It is never used except in cases where circumstances will not permit of the use of an expansive working engine.

Condensing Engine.— One in which the spent steam in the cylinder is exhausted into a vacuum and condensed into water, thus obliterating the back pressure of the atmosphere, and consequently effecting a gain of pressure equivalent to 14.7 pounds per square inch, in the effective working pressure of the steam.

Noncondensing Engine — One in which the spent steam in the cylinder is exhausted into the air at atmospheric pressure, thus entailing the work of forcing the piston against a back pressure of 14.7 pounds per square inch, at the expense of the effective working pressure of the steam.

Simple Engine.— One in which the steam after having forced the piston through its stroke is exhausted into the air, or into a vacuum or condenser.

Compound Engine.— An engine with two or more cylinders in which the steam after having expanded and performed its work in one cylinder passes into the next cylinder, of larger size, and continues to expand and perform work. The different types of compound engines are distinguished by the number of cylinders employed for the expansive working of the steam, and are designated as the two-cylinder engine, the three-cylinder or triple-expansion engine, and the four-cylinder or quadruple-expansion engine. The cylinders are usually arranged side by side or parallel with each other. Sometimes, as in the case of the « tandem-compound,» they are placed « in line » one behind the other, and also vertically one above the other as in the case of the « steeple-compound.» In a « cross-compound,» the cylinders are placed side by side and parallel to each other, but sufficiently far apart to allow space for a fly-wheel between them. Up to the present time, the quadruple-expansion engine appears to be the limit beyond which the number of expansions have not been carried with success. The great practical advantage of the multiple expansion engines lies in their high steam economy.

The second class of steam engines includes the various types of reciprocating engines which are more definitely designated as horizontal engines, vertical engines, and inclined engines, according to the position of the axis of the piston, and various forms of direct-acting and indirect-acting engines, such as beam engines, oscillating engines, trunk engines, back-acting engines, and various forms of rotary engines.

The third-class includes the various forms of marine engines, stationary or land engines, locomotive engines, and a great variety of portable engines. The engines included in these two classes may be briefly described as follows:

Reciprocating Engine.— One in which the piston moves backward and forward alternately, in a right line. Almost all heat engines are of this type.

Horizontal Engine.— One in which the axis of the cylinder and piston rod is horizontal.

Vertical Engine.— One in which the axis of the cylinder and piston rod is vertical. Vertical engines are made in a great variety of forms, and are usually arranged with the cylinders uppermost. Very few of them are constructed with the cylinders lowermost, and those are only of the smallest sizes. The principal advantages of the vertical engines consist in the small space required for their foundations, and the uniformity of wear on the cylinders, pistons, and rods. The type includes many forms of steam hammers, launch engines, screw engines, and inverted cylinder engines.

Inverted Cylinder Engine.— A vertical engine in which the cylinder is inverted or placed above the piston rod, connecting rod, and crank-shaft. It is typical of the marine engines employed to drive screw propellers.

Inclined Engine or Inclined Cylinder Engine. — A form of marine engine in which the cylinders are inclined toward each other at an angle of about 120 degrees, and make a triangle with the base. They are connected by cranks to a common crank-shaft.

Beam Engine.— An indirect-acting engine in which the piston rod is connected to the connecting rods by means of a lever in the form of a beam. It is more fully described under the term Indirect-Acting Engine.

Oscillating Engine.— A marine engine of the direct-acting type in which the cylinders are suspended upon hollow trunnions and oscillate thereon, thus allowing the motion of the piston rods to accommodate itself to that of the crank at all parts of the revolution. It occupies but little space, and is peculiarly adapted for paddle-wheel steamers. For screw propulsion, it has been entirely supplanted by the various forms of multiple-expansion engines of the inverted cylinder type.

Trunk Engine.— An interesting though practically obsolete form of marine engine formerly used on war vessels. The aim of its design is compactness of arrangement, so as to place all of its working parts below the waterline, thus protecting them from the enemy's shot. Its distinguishing feature is a hollow, trunk-shaped piston rod which passes through both ends of the cylinder and is encircled in the middle by the piston head. The connecting rod is attached to the interior of the piston rod, thus saving the length of the piston rod in all of the vertical dimensions of the engine. Its chief defect consists in its low steam economy, due to the great loss of heat by radiation from the large conducting surfaces of the hollow piston rod which are exposed to the air.

Bogie Engine.— A locomotive provided with a bogie or swivelling framework which carries the axle of the main driving wheels, and enables the main framing to accommodate itself to curves of short radii. In the single bogie, the main driving wheels are the bogies; in the double bogie, both the main driving wheels and the back driving or trailing wheels are bogies. A bogie truck is a short four-wheeled truck pivoted at its centre to the main frame of the engine, and enables the engine to run around sharp curves.

Corliss Engine.— A very economical type of engine in which the valves are controlled automatically from the governor, and the steam supply proportioned to the requirements of the engine at each moment during its working stroke. The valve forms a segment of a circle and revolves through an arc of a circle, and alternately covers and uncovers the steam port. It is operated by a rod from a wrist plate, but is disconnected at every stroke of the engine, and the supply valve closed instantaneously by means of a dash-piston and spring.

Cornish Engine.—A standard type of pumping engine, originally of the single-acting type. At the present time it appears in two forms — the beam engines and the direct-acting engines. The valves of a Cornish engine are operated by a special device called a cataract consisting of a weighted piston which works in a cylinder provided with a large inlet valve and a small discharge valve. The working stroke of the pump lifts the weighted piston and draws the water into the cylinder through the former, and the return stroke discharges it through the latter, and at the same time actuates the valves of the steam cylinder of the pump so as to cause another working stroke.

Marine Engine.— Any form of engine used for propelling a vessel. They are usually of the compound or multiple-expansion type.

Stationary Engine.— An engine on fixed foundations, as distinguished from the locomotive, portable, and marine engines.

Locomotive Engine.— A high pressure steam engine and multitibular complete, mounted on a carriage, and provided with suitable wheels to enable it to draw loaded cars upon a permanent way or railway track.

Portable Engine.— An engine of the locomotive type, mounted on a carriage which permits of its being moved from place to place for use in connection with work of a temporary character. Portable engines are extensively used for agricultural purposes, and for general traction purposes on ordinary highways.

Gas and Oil Engines.— These classes of heat engines are commonly designated as internal combustion engines for the purpose of distinguishing them from the various more or less impracticable forms of hot air engines in which the working substance consists of air alone, which is heated from an external furnace, the heat being conducted through the walls of the containing vessel.

In the gas engines, the working substance or charge is a mixture of coal gas and air, explosive in character, which is introduced into the working cylinder where it is compressed by the action of the piston, and then ignited and exploded by a special device. The energy developed by the explosion is utilized to actuate the piston or do mechanical work.

This method of heating the working substance is called the gas engine method. It is one feature possessed in common by all gas engines irrespective of variations in form, or of working cycles, and serves to distinguish them from all other forms of heat engines.

The various types of gas engines may be conveniently divided into three general classes, according to their mode of operation as follows: (1) Those in which a specified amount or constant volume of gas is drawn into the cylinder at atmospheric pressure or without compression, and then ignited, as in the case of the Lenoir, Hugon, and the Otto-Langen engines, which were quite successful for powers under one-horse power, but are practically obsolete; (2) those in which the working substance is first compressed in an auxiliary cylinder and then admitted to the working cylinder and ignited, as in the case of the Brayton engine, which although the most successful engine of this class is also practically obsolete; and (3) those in which a specified amount or constant volume of gas is admitted to the working cylinder where it is compressed by the piston and then ignited, as in the case of the Otto engine, and in, by far, the greater number of other gas engines in successful use at the present time.

Gas engines are also designated as two-cycle, four-cycle, and six-cycle engines, according to the number of distinct operations in their working cycles. The six-cycle engines were of the scavenging type, but were not successful, and are obsolete. The four-cycle engines represent the application of the Beau de Rochas or Otto cycle, and constitute the most successful type developed up to the present time. The two-cycle engines are as yet in a comparatively experimental state, but possess great possibilities of successful development, and may eventually supplant all the other forms.

Up to within the last few years, the gas engines were rarely made in sizes capable of developing an amount of power equivalent to 50, 75, or 100 horse-power, and rivalled steam engines of equal capacity only in special and limited fields of application; but now, since the introduction of the various gas producer systems, gas engines developing 4,000 horse-power are in successful use, and others capable of developing as high as 6,000 horse-power are in the process of construction.

The oil engine differs from the gas engine principally in the character of the charge, which consists of a mixture of vaporized petroleum, gasoline, or paraffin oil and air. They may be conveniently classified, (1) according to the method employed to vaporize the oil; or (2) according to the method employed to ignite the charge.

The first class includes those in which the oil is subjected to a spraying operation before being vaporized; those in which the oil is injected into and vaporized within the cylinder; and those in which the oil is vaporized by a special apparatus outside the cylinder and then admitted into the cylinder in the form of a vapor.

The second class includes those in which the charge is ignited by means of an electric spark; those in which the charge is ignited by an incandescent tube; and those in which the charge is ignited by the heat of the internal surfaces of the combustion chamber.

Steam Turbines comprise a class of heat engines in which the kinetic energy of expanding steam is utilized to drive a wheel and thus convert the natural heat energy of steam directly into mechanical energy in the form of rotary motion. The principal forms are the Parsons, De Laval, Seger, and Dow turbines, and their chief field of application and development appears to be in the marine service. Noteworthy examples of their latest applications are those of the Cunard Line Passenger Steamship «Carmania,» and the battleship «Dreadnaught,» of the British Royal Navy, the largest warship in the world built up to date.

Hydraulic Engines.—Mechanical power is obtained from flowing water by its weight, pressure, or impact, utilized in various forms of water wheels, turbines, hydraulic rams, and water pressure engines. In the water pressure engine the pressure of the water only is utilized to drive a piston in a cylinder. In some forms the action of the piston is reciprocating, and in others rotary. In all of them the actual amount of pressure expended is only that which is needed to impart motion to the fluid to follow the piston and escape from the cylinder, and, therefore, the greatest efficiency is obtained by making the piston as small as practicable and using a large pressure. The majority of them are of the reciprocating, low-speed type, and are particularly useful as secondary motors for operating the opening machinery of various forms of swing, draw, and lifting or rolling bridges, and in connection with cranes and various forms of hydraulic lifts.

For further detailed information relative to the construction, operation, and application of the various forms of engines, consult the articles under the titles: GAS ENGINES; LOCOMOTIVE; LOCOMOTIVE, DESIGN AND CONSTRUCTION OF THE MODERN; LOCOMOTIVE ENGINE; PUMPS AND PUMPING MACHINERY; ROTARY STEAM ENGINE; TRACTION ENGINES; TURBINES; WATER MOTOR; AND WATER WHEELS, in this Encyclopedia.

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Engine, Testing of. Engines are tested in order to determine the economy with which they produce a given amount of power. The economy of steam engines, as usually determined, relates to the weight of steam consumed, or to the quantity of coal used in making the steam, or to the number of heat units supplied; while in the case of an internal combustion engine, it relates to the amount of gas, gasoline, oil, alcohol, or other fuel burned. Also, if the latter operate on producer gas, the determination of economy involves the amount of coal burned in the gas producer.

Factory tests are generally limited to the performance of individual engines, to determine the set of the governor relative to the proper speed, and to ascertain if the valves are set and operate properly. In the case of gas engines, the factory test is extended to cover the correct timing of the igniter, and to determine the correct compression.

In its broadest sense, however, testing is a form of scientific investigation conducted for the purpose of securing practical results which are very important not only to the manufacturer, but also to the owner of the engine who has to pay the expense of its operation, and to those who require information showing the capabilities of the machines for the purpose of advertising and trade.

As an engine test involves the determination of two elementary quantities,—(1) the amount of fuel consumed, and (2) the amount of power developed,—it is necessary that these two factors should be represented by units of measurement which are susceptible of universal application.

Standard Unit of Fuel.—The most satisfactory unit for expressions of economy based on the amount of fuel consumed, is the British Thermal Unit (B.T.U.), which is the quantity of heat required to raise one pound of water one degree Fahrenheit at or about 39.1° Fahr. According to Joule, it is equivalent to 778 foot-pounds of mechanical energy.

A convenient and useful subsidiary standard is that based on a «standard coal» unit, the term «standard coal» defining a coal which imparts to steam 10,000 B.T.U.'s for each pound of dry coal consumed. It is a coal which has a calorific value of 12,500 B.T.U.'s, equivalent to an efficiency of 80 per cent. when used in a «standard boiler.»

Standard Unit of Power.—The unit of mechanical power which most satisfactorily expresses the power developed by an engine, is the «horsepower,» which represents an energy of 33,000 foot-pounds per minute, equivalent to 2,545 B.T.U.'s per hour.

Standard of Engine Economy.—Employing the given standard units of fuel and power, the expressions of engine economy which are best adapted to meet all conditions of service, and for all classes of heat engine, are those represented by the «indicated» horsepower based on the number of B.T.U.'s consumed per hour.

Such an expression is commonly called a horsepower-hour, and represents a heat energy of 1,980,000 foot-pounds converted into mechanical power or work by the consumption of 2,545 B.T.U.'s per hour.

Rules for Conducting a Test.—All tests should be conducted systematically under a set of standard rules, clearly defining the character of the data to be obtained and the methods which should be employed for their determination. A set of such rules may be briefly defined as follows:

1. *Object of the Test.*—At the beginning, the specific object of the test should be ascertained. It may relate to the determination of highest economy obtainable; the economy under ordinary working conditions and the existing defects; the performance under special conditions; the effect of changes in existing conditions; or the fulfillment of a contract guarantee; and the preparations for the test should be made accordingly. These preparations will necessarily depend largely upon the good sense, judgment, and ingenuity of the engineer making the test.

2. *Condition of the Engine.*—The engine should be carefully examined and its general condition noted, especially any points of design, construction, or operation which bear upon the object of the test. Special examination should be made of all valves, by inspecting their seats and bearing surfaces, and great care taken to ascertain, in the case of a gas engine, that the piston rings work freely in their grooves and are perfectly gas-tight.

3. *Dimensions.* — The cylinder dimensions should be taken whether they are already known or not, the measurements being made when they are hot and in working order. When practicable, the clearance volume or compression space of the cylinder should be measured by filling it with water previously measured, the proper correction being made for temperature.

4. *Fuel.*—When the test involves the complete plant—in the case of a steam engine including the boilers, and in the case of a gas engine including the gas producer plant,—the class, name of mine, size, moisture, should be stated in the report,—and the quality of the coal used should be of some recognized standard. This is desirable for purposes of comparison. In the case of an internal combustion engine, if the test is made to determine the maximum efficiency, the gas, oil, or other fuel used, should be the best obtainable, or one that possesses the highest calorific value.

5. *Measurement of Fuel.*—The methods of determining the amount of fuel consumed depend upon the character of the fuel used. If it be coal furnished to the furnace of a boiler, or to a gas producer, the amount consumed during a period not less than 24 hours should be carefully measured by weight. If it be oil, gasoline, distillate, alcohol, etc., it can be drawn from a tank, which can be refilled to the original level at the end of the test, and the amount required for this purpose weighed; or in the case of a small engine, it can be drawn from a properly calibrated vertical pipe. When gas is used, it should be measured by a suitable gas meter, and gas bags should be placed between the meter and the engine to keep the pressure as constant as possible. The pressure and temperature of the gas, and the barometric pressure and temperature of the air, should be measured, and in determining the quantity of the gas supplied, as given by the reading of the meter, the temperature and pressure of the gas should be taken into account.

6. *Measurement of Heat Units Consumed.*—The number of heat units consumed by the engine can be found by multiplying the number of pounds of coal or oil, or the cubic feet of gas supplied, by the total heat of combustion of the fuel as determined by a calorimeter, or from the results of a chemical analysis. In determining the total heat of combustion, usually, no deduction is made for the latent heat of the vapor of water in the products of combustion, therefore, for purposes of comparison care should be taken to state whether the higher or the lower value has been used in the determination.

The Mahler calorimeter is the most suitable for determining the heat of combustion of solid fuels and oils, and the Junker calorimeter for gases.

7. *Instruments and Their Calibration.*—All instruments and apparatus used in the tests should be calibrated, and their accuracy verified by comparison with recognized standards. All such as are liable to undergo changes, or become broken during the progress of a test, especially gauges, indicator springs, and thermometers, should be calibrated both before and after the test.

Gauges.—For measuring pressures above that of the atmosphere, the most convenient and reliable standard is the dead-weight testing apparatus consisting of a cylinder having a close-fitting vertical piston working in oil or glycerine, by the medium of which the pressure is transmitted to the gauge. The piston is surmounted by a circular stand on which weights may be placed so as to secure any desired pressure. The total weight, in pounds, on the piston, divided by the area of the piston, in square inches, gives the pressure in pounds per square inch.

The mercury column is another reliable standard of comparison for pressures, but when it is used care should be taken to see that it is properly graduated with reference to the ever varying zero point; that the mercury is pure, and that the proper correction is made for any difference of temperature that may exist at the time of using, and the temperature at which the instrument was graduated.

For pressures below that of the atmosphere, the use of an air pump or some other means of producing a vacuum is required. The apparatus must be referred to a mercury gauge, which may consist of an U-shaped tube about 30 inches in length, with both arms properly filled with mercury.

Thermometers.—Standard thermometers are those which read 212° Fahr. in steam escaping from boiling water at the normal barometric pressure of the atmosphere (29.92 inches) when the whole stem up to the 212° point is surrounded by the steam; and which read 32° Fahr. in melting ice, when the stem is completely immersed to the 32° point; and which are calibrated for points between and beyond these two points of reference.

For temperatures between 212° and 400° Fahr., the thermometers should be compared with the temperatures given in Regnault's Steam Tables, by placing it in a mercury well surrounded by saturated steam under sufficient pressure to give the desired temperature.

For higher temperatures, such as those occurring in gas-engine practice, which often exceed 2,000° Fahr., some form of pyrometer or calorimeter should be used. That of Le Chatelier, which makes use of the thermocouple, has been successfully used for accurately measuring temperatures over 2,500° Fahr.

Indicator Springs.—For gas engine indicating, the indicator springs used should be much stiffer and stronger than those used for steam-engine work, so as to enable them to withstand the higher and more suddenly developed pressure. When indicator springs are calibrated, the temperature of the indicator should be as nearly as possible the same as that which exists during the test. An indicator may be conveniently heated by subjecting it to steam pressure immediately before calibration, and the actual work of calibration then performed by the use of compressed air or compressed carbonic acid gas. The calibration may be made under a constant pressure, or more satisfactorily by covering the whole range of pressures through which the indicator acts, by gradually increasing the pressure from the lowest to the highest point, and then by gradually reducing it from the highest to the lowest point, and a mean of the results taken for at least five points—two for the pressures corresponding to the maximum and minimum pressures, and three for equally distant intermediate points. These values should be compared with a dead-weight-testing apparatus, a mercury column, or a steam gauge, compared with either of the two first-named standards, and the correct scale of the spring used for calculating the mean effective pressure from the indicator diagrams taken during the test should be the average based on this calibration.

Gas Meters.—A meter used for measuring the gas supplied to a gas engine, should be calibrated by comparing its readings with the displacement of a gasometer of known volume; with a standard gas meter of known error; or by passing air through the meter from a tank containing air under pressure. In the latter case, the pressure and temperature of the air in the tank, both at the tank and the meter, should be observed at uniform intervals of time during the work of calibration; and the amount of air passing through the meter calculated from the volume of the tank and the observed temperatures and pressures.

The volume of the gas thus ascertained should be reduced to the equivalent volume at a given temperature and atmospheric pressure, corrected for the effect of moisture in the gas, which is usually at or near the point of saturation. For gas-engine work, a convenient standard is the equivalent volume of the gas when saturated with moisture at normal atmospheric pressure at a temperature of 60° Fahr. A volume of moist gas at any other temperature may be reduced to this standard by being multiplied by the factor

$$\frac{459.4+60}{459.4+t} \times \frac{b-(29.92-s)}{29.4},$$

in which b represents the reading of the barometer in inches at 32° Fahr.; t, the temperature of the gas at the meter in degrees Fahr.; and s, the vacuum in inches of mercury corresponding to the temperature of t given in the steam tables.

8. *Duration of a Test.*—The length of time devoted to a test will depend largely upon its character and the purpose for which it is made. For determining the working economy, the time allowed should be equal to the number of hours per day during which the engine is really operated. In the case of a gas engine using producer gas, the time should be sufficient to determine the amount of coal used in the gas producer. It should never be less than 24 hours, and usually, it should extend over several days.

9. *Commencement of a Test.*—If the test is to determine the performance of an engine under working conditions, it should begin at the time the engine is started, and the observations continued until it shuts down for the day. If the test is for determining the maximum economy of the engine; at first, it should be run a sufficient length of time to make all conditions normal and constant, then the observations may be commenced and continued for the allotted time.

10. *Measurement of Water.*—In the case of a steam engine this relates to the feed water or steam consumption. The usual method is to measure all the feed water supplied to the boilers, and deduct therefrom all the water discharged by separators and drips, and the water and steam lost by leakage from the boiler and its main and branch pipe connections with the engine. Where the engine exhausts into a surface condenser, the steam consumption can be measured by measuring the quantity of water discharged by the air pump, and adding thereto the steam used by jackets, reheaters, and auxiliaries as determined independently. In measuring the water, it should be carried through a tank resting on the platform of a suitably arranged weighing scales, and the water subsequently emptied into a reservoir beneath, from which the pump is supplied.

For measuring small quantities of water, about 6,000 pounds per hour, the most convenient apparatus consists of a small hogshead connected to the suction pipe of the pump or injector, and an ordinary oil barrel placed on a platform scale. The barrel is filled by means of a cold-water pipe leading from the source of supply. For pressure not less than 25 pounds per square inch, this pipe should have an internal diameter of 1½ inches. The outlet valve of the barrel is attached to the side, near the bottom, and should be at least 2½ inches in diameter, so as to permit of quick emptying.

Where larger quantities of water have to be measured, the barrel can be replaced by a hogshead and two hogsheads can be joined together for the lower reservoir. With this arrangement, when the weighing hogshead is supplied through a 2½-inch valve under 25 pounds of pressure, and emptied through a five-inch valve, the capacity attained is 15,000 pounds of water per hour.

For the measurement of very large quantities, or in some cases, very small quantities, the orifice method gives the most satisfactory results, and when applied, the average head of water on the orifice must be ascertained, and the discharge of the orifice should be calibrated under the conditions of use.

In the case of an internal combustion engine, the measurements of water relate to that supplied to the water-jacket provided for cooling the temperature of the cylinder. The measurements may be made by the methods already described, but care should be taken, in cases where the temperature exceeds 212° Fahr., to first cool the water by discharging it into a tank of cold water previously weighed, or by passing it through a coil of pipe immersed in running cold water, so as to prevent the loss of evaporation which takes place when hot water is discharged into the open air.

11. *Determination of Speed.*—The speed of the engine or the number of revolutions of the crank shaft per minute can be determined by counting the number of revolutions in one minute with the eye fixed on the second hand of a timepiece, or by the use of some form of mechanical counter such as a tachometer, or continuous recording engine register. The use of such instruments is imperative when the speed exceeds 250 revolutions per minute.

In the case of internal combustion engines governed by the hit-or-miss method, the number of explosions per minute should be ascertained, when the engine is running under nearly maximum load, by counting the number of times the action of the governor causes a miss in the explosions.

The determination of variation of speed during a single revolution on the effect of fluctuations due to sudden changes of load, should be made especially in the case of engines employed to drive electric generators used for lighting purposes.

12. *Indicator Diagrams.*—From the indicator diagrams taken during the test for the computation of the mean effective pressure, etc., sample diagrams nearest to the mean should be appended to the report.

The mean effective pressure (M.E.P.) is obtained as follows: Measure the diagram with a planimeter and divide the area, in square inches, thus obtained by the length of the diagram in inches to obtain the mean height or mean ordinate of the diagram. Multiply the mean ordinate by the scale of the indicator spring and the product will be the mean effective pressure desired. In the absence of a planimeter, the diagram can be divided by ten ordinates and their mean length taken for that of the mean ordinate. If the indicator is specially designed for indicating internal combustion engines, the mean ordinate should be multiplied by twice the scale of the spring, unless the scale has been expressly marked for the reduced piston.

In the case of internal combustion engines, when indicator diagrams are not obtainable and the compression pressure is known, the mean effective pressure may be determined approximately as follows: For example, in gas engines the compression pressure ranges from 70 to 90 pounds per square inch, and the maximum pressure developed by the explosions is about 3.5 times the compression pressure. Therefore, if p represents the compression pressure, then for compressions of 100 pounds per square inch or less, $\text{M.E.P.} = 2p - 0.01p^2$; thus, if $p = 70$ pounds per square inch, $\text{M.E.P.} = 140 - 49 = 91$ pounds per square inch.

In the case of a steam engine, the steam accounted for by the indicator diagram may be calculated by means of the formula

$$M = \frac{13750}{\text{M.E.P.}} \left((C+E) \times Wc - (H+E) \times Wh \right),$$

which will give the weight in pounds per indicated horsepower per hour. M.E.P. represents the mean effective pressure, which in the case of a multiple-expansion engine is the combined mean effective pressure referred to the cylinder in question. For example: In the case of a compound engine, the combined mean effective pressure for the high pressure cylinder consists of two items: (1) the mean effective pressure of the high pressure cylinder, and (2) the mean effective pressure of the low pressure cylinder multiplied by the ratio of the piston displacement of the low pressure cylinder to that of the high pressure cylinder. The sum of these two items is the combined mean effective pressure for the high pressure cylinder.

Similarly the combined mean effective pressure for the low pressure cylinder consists of (1) the mean effective pressure of the low pressure cylinder, and (2) the mean effective pressure of the high pressure cylinder divided by the ratio already stated. The sum of the two items is the combined mean effective pressure of the low pressure cylinder.

In the given formula, C represents the proportion of the piston stroke completed at points on the expansion line of the diagram near the actual cut-off or release; H the proportion of compression; and E the proportion of clearance; all of which are determinable from the indicator diagram. Wc represents the weight of one cubic foot of steam at the cut-off or release pressure; and Wh the weight of one cubic foot of steam at the compression pressure.

13. *Standards of Economy and Efficiency.*—The standard expression for engine economy, as already stated, is the hourly consumption of heat units divided by the indicated horsepower or the brake horsepower. The standard expression for efficiency is the thermal efficiency ratio, or the proportion which the heat equivalent of the power developed bears to the total amount of heat actually consumed, as determined by test. One horsepower-hour represents the consumption of 2,545, B.T.U.'s per hour, therefore,

$$\frac{2{,}545}{\text{B.T.U.'s per horsepower per hour}},$$

expresses the thermal efficiency ratio.

In comparing the standard for internal combustion engines with that for steam engines, it must be noted that the former usually covers the losses due to combustion, but the latter does not, and therefore, in order to make a direct comparison between the two classes of engines as complete horsepower plants, the losses in generating the working agent must be considered in both cases not only on the basis of the fuel used, but on the basis of equivalent fuel used in each case. In comparing a gas engine plant using producer gas, with a steam plant, the producer should be included in the former, and then the fuel consumption, represented by the weight of coal in both cases, may be directly compared.

14. *Heat Analysis.*—For scientific purposes, a heat analysis of the indicator diagram, in the case of a steam engine, and a heat balance in the case of an internal combustion engine, should be made, showing the manner in which the total heat of combustion is expended in working the engine.

In the case of a steam engine, the analysis shows the interchange of heat from steam to cylinder walls, etc. For example: the amount of heat supplied to the engine in a given time is represented by the number of pounds of steam supplied multiplied by the total heat of one pound of steam. A portion of this heat is used in the jacket, if one be employed, and the remainder passes through the cylinder. The heat entering the jacket is lost partly by radiation from the outside surface, and the remainder enters the walls of the cylinder and is absorbed by the steam within it. The cycle of operations within the cylinder consists of the following phases: (1) A portion of the entering heat is transferred into a small portion of the thickness of the cylinder walls, and heats them to the temperature of the entering steam. This transference of heat is more active during the period of admission and up to the point of cut-off than during any other part of the cycle. (2) Beyond the point of cut-off, the transference of heat continues until the lower pressure due to expansion causes the temperature of the steam to fall below that of the interior surfaces of the cylinder last uncovered. At this point the interchange of heat is reversed, the metal giving up heat to the steam, and causing the re-evaporation of the particles of water condensed on the surface of the cylinder walls and piston. The radiation of heat from the small thicknesses of the interior walls which were heated during admission to the temperature of the entering steam, commences after cut-off or after the pressure begins to lower by expansion, and continues to the end of the stroke.

A portion of the heat is also expended in the performance of work, and a loss of heat is sustained by radiation from those portions of the cylinder not protected by the jacket. The amount of heat remaining after the steam has passed through these operations is that which is rejected by it through the exhaust valve to the atmosphere or to the condenser.

In the case of an internal combustion engine, the total heat of combustion expended in the working of the engine may be divided into three parts: (1) Heat converted into work and represented by indicated or brake horsepower. (2) Heat carried away by the cooling water circulated through the water jacket. (3) The heat lost in the exhaust gases, and through incomplete combustion and radiation.

15. *Heat Converted into Indicated or Brake Horsepower.*—The number of foot-pounds of work done by one pound or one cubic foot of fuel divided by 778, the mechanical equivalent of one British Thermal Unit, will give the number of heat units desired.

16. *Heat Carried Away by the Jacket Water.*—This is determined by measuring the quantity of cooling water passed through the water jacket equivalent to one pound or one cubic foot of fuel consumed, and calculating the amount of heat rejected by multiplying that quantity by the difference of the temperature of the water entering and leaving the jacket.

17. *Heat Rejected in the Exhaust Gases, or Total Heat Unused.*—The sum of the heat converted into brake horsepower and the heat carried away by the jacket water, subtracted from the total heat supplied, will give the total heat rejected or unused.

In order to determine the cost of each horsepower hour in thermal units, the gas consumed and the air supplied should be reduced to the conditions of temperature and pressure corresponding to some adopted standard. This may be done as stated under gas meters in rule 7, or more conveniently by the formula

$$v = \frac{t}{p} \times \frac{v^1 p^1}{t^1},$$

in which v = volume of gas reduced to standard; $t = 461 + 60 = 521°$ Fahr., absolute standard temperature; $p = 29.92$ inches of mercury; v^1 = volume of gas registered by meter; p^1 = pressure of gas at meter measured by manometer in inches of water; t^1 absolute temperature of gas.

Since t and p are constants

$$v = 18.00\,\frac{v^1 p^1}{t^1},$$

and as p^1 and t^1 are practically constant during a given test, $v = E\,v^1$, in which

$$E = 18.00\,\frac{p^1}{t^1}$$

and p^1 = height of barometer + (0.073 × reading of manometer); and t^1 = temperature of gas at meter + 461.

For example: Assume the height of the barometer as 29.40 inches; the reading of the manometer as 6 inches; the temperature of the gas 80° Fahr.; and the volume of the gas registered by the meter 350 cubic feet; then for determining (v) the equivalent volume of gas for standard conditions =

$$p^1 = 29.40 + (0.073 \times 6) = 29.84;$$
$$t^1 = 80 + 461 = 541;$$
$$E = \frac{18.00 \times 29.84}{541} = 0.976;$$

then $v = 0.976 \times 350 = 341.6$ cubic feet.

The air supplied should be metered and reduced to standard conditions in the same manner.

If the rate method is employed to ascertain the amount of gas consumed, the number of cubic feet for a ten-minute interval may be found by dividing the number of cubic feet registered by one revolution of the small dial by the time in seconds elapsed at the completion of that revolution and multiplying the result by 6,000.

18. *Indicated Horsepower* (I.H.P.).—This factor, is expressed by the formula—

$$\text{I.H.P.} = \frac{P \times L \times A \times N}{33{,}000},$$

in which P is the mean effective pressure in pounds per square inch; L the length of the piston stroke in feet; A the area of the piston in square inches; and N the number of revolutions of the engine crank shaft per minute.

$$\frac{A \times L}{33{,}000},$$

is constant for a given engine, and in the case of an internal combustion engine, N is the number of explosions per minute.

19. *Brake Horsepower* (B.H.P.).—When this factor is determined by the use of some form of dynamometer, such as the Prony brake, it may be readily computed from the formula—

$$\text{B.H.P.} = \frac{W \times N \times L \times C}{33{,}000},$$

in which W is the net weight in pounds on the scales; N the number of revolutions per minute; L the length of the lever arm, from the center of the braked wheel to the knife-edge of the brake, or the radius of the braked wheel if a rope brake is used; and C the circumference of the braked wheel.

$$\frac{C \times L}{33{,}000},$$

is constant for a given Prony brake, therefore, if L be made 5¼ feet, this constant becomes 0.001, and gives the simple and very convenient expression—

$$\text{B.H.P.} = \frac{N \times W}{1000}.$$

20. *Total B.T.U.'s Per Hour.*—The total amount of gas consumed, in cubic feet, multiplied by its calorific value.

B.T.U.'s Per Brake Horsepower-Hour.—The total B.T.U.'s per hour divided by the brake horsepower.

B.T.U.'s Per Indicated Horsepower-Hour.—The total B.T.U.'s per hour divided by the indicated horsepower.

Friction Horsepower.—The difference between the indicated horsepower and the brake horsepower.

Thermal Efficiency.—The ratio of 2,545 B.T.U.'s to the B.T.U.'s per horsepower hour.

Mechanical Efficiency.—The ratio of the brake horsepower to the indicated horsepower.

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Engineer Corps, a branch of the service of the United States Navy; and of those of other countries. The first step toward the organization of an engineer corps in the United States Navy was taken on 2 July 1836, when C. H. Haswell (q.v.) was appointed chief engineer of the *Fulton;* it was not, however, until 31 Aug. 1842 that Congress passed an act providing for a regular corps, under which act chief engineers were "commissioned" and assistants "warranted." On 3 March 1845 Congress passed an act whereby the power of appointing engineer officers was transferred from the Secretary of the Navy to the President "by and with the advice and consent of the Senate." With the growth of the navy the corps gradually increased till at the time of the Civil War there were 474 regulars and 1803 volunteers.

A course of instruction for cadet engineers was established at the Naval Academy by act of Congress 4 July 1864. The original two-year course was changed to four years in 1874 and continued in vogue till 1882, when on 5 August Congress amalgamated the cadet engineers and midshipmen and they are now known as naval cadets. The cadets then took the usual six years' course at the Academy and upon completion of the third year of the course were divided into an Engineer Division and a Line Division in proportion to the vacancies that have occurred in the several corps during the preceeding year. At the end of the six years' course appointments to fill vacancies in the line and in the Marine Corps were made from the Line Division, and to fill vacancies in the Engineer Corps from the Engineer Division. If, after making assignments as above, there should still be vacancies in one branch and surplus graduates in the other, the vacancies in the former were filled by assignment to it of surplus graduates from the latter. This arrangement was in vogue until the Line and Engineer Corps were amalgamated under the act of 3 March 1899, at which time the Engineer Corps ceased to be a separate organization, the older officers now being required to perform engineering duties only, whereas the younger officers must pass examinations in navigation, gunnery, seamanship, etc. A grade of warrant machinists to perform watch duties was also established because of the lack of commissioned officers for this work. See NAVAL ACADEMY, UNITED STATES; NAVY; NAVY OF THE UNITED STATES.

Engineering is, in its strict sense, the art of designing, constructing, or using engines, but the word is now applied in a more extended sense, not only to that art, but to that of executing such works as are the objects of civil and military architecture, in which engines or other mechanical appliances are extensively employed. Engineering is divided into many branches, the more important being civil, mechanical, electrical, mining, military, marine, and sanitary engineering.

Among the most notable of the engineering works belonging to very remote antiquity are the pyramids of Egypt. The rude stone monuments of the north, as at Stonehenge and Carnac, also testify to some engineering skill. The harbors and temples of ancient Greece are very memorable. The buildings of ancient Rome — its theatres, temples, baths, and aqueducts, its roads, bridges, and drainage-works, vie in extent and magnificence with the most celebrated works of modern times. From that period down to the commencement of the 18th century the most extensive works executed were the canals, embankments, and other hydraulic constructions used by the Dutch for the purposes of inland navigation, and to protect their low lands from the sea; the canals of North Italy; and the cathedrals and fortifications of mediæval Europe.

If the question were asked as to the characteristic feature of the modern applied science of engineering, the reply would undoubtedly be: "The wholesale manner in which work is carried on." It is not so very long ago that everything except the smallest articles and those required in great quantity were made singly, or at least in small lots; and even when standardizing and interchangeability were introduced these methods were by no means used in a way which showed a realization of their possibilities. The present tendency, on the contrary, is toward the elimination altogether of things which cannot be made wholesale; and methods which formerly applied to fire-arms, sewing-machines, typewriters, and the like are now in general use in the manufacture of steam-engines, machine tools, electrical machinery, and nearly all mechanical products.

This has been brought about by a combination of two processes: (1) the standardization of methods of manufacture; and (2) the discouragement of the demand for special articles. Formerly the customer told the manufacturer what was wanted, and the latter hastened to produce it. Or the plans and specifications for a certain structure were prepared by a consulting engineer, and all bidders were required to conform to these documents in the minutest details; no two such specifications being alike. At the present time the customer, knowing what he wishes to accomplish, seeks to do so as best he may by means of the standard articles in the market; or if it be a great engineering structure, the engineer specifies only the general requirements to be met, leaving each manufacturer to meet these with his own standardized product. The influence of these modifications in engineering practice extends to the manufacture and supply of materials.

The result of this concentration and standardization has been to reduce costs very materially and render possible undertakings which would otherwise be prohibitory in price. While to a certain extent it has obliterated individuality in design, it has also removed much useless repetition, and has prevented needless expense in the production of rival machines, differing but slightly in design, yet requiring duplications of drawings, patterns, and tools. There is little doubt that it is to this wholesale development of various departments of engineering work that the rapid extension of the share of the United States in the work of the world is largely due. See MECHANICS.

Engineering, Civil. In order to understand clearly what constitutes civil engineering it will be desirable to consider briefly the steps by which the different engineering professions have been developed and differentiated from one another. The profession of engineering is as old as the most elementary civilization. Up to about the middle of the 18th century there were but two recognized branches of the profession, the civil and the military. The former included all those branches not directly connected with military operations and the construction of fortifications. But the remarkable series of mechanical inventions which distinguished the last third of the 18th century — such as the spinning jenny by Hargreaves, the spinning frame by Arkwright, the mule by Crompton, the power loom by Cartwright, the steam engine by Watt, the puddling process by Cort, and others — followed in the first third of the century just ended by the development of the steam locomotive by Stephenson, the steamboat by Fulton, and by further great improvements in the manufacture of iron and steel, led at length to the differentiation of several branches from the parent stem of civil engineering. Up to that time civil engineering corresponded to what is now the general profession of engineering, and which has probably never been better defined than it was 75 years ago by Thomas Tredgold, as "the art of directing the great sources of power in nature for the use and convenience of man." The first branch to leave the parent stem was mechanical engineering, followed by metallurgical and mining engineering as the developments in the mining and reduction of metals progressed. Thus it stood till about the middle of the 19th century, since which time the tremendous advance in all branches of applied science has speedily differentiated engineers into the classes named, and into others. For instance, within the last quarter of a century the perfecting of the electric motor and the other great discoveries in electrical science have led to the development of electrical engineering as a distinct profession, the increasing importance of the application of chemistry in manufacturing has produced the chemical engineer, while the advances in sanitary science and the discoveries with reference to the nature, causes, and prevention of disease have resulted in the development of sanitary engineering as a branch quite extensive enough to constitute a profession by itself.

But nothwithstanding the divergence of all these branches, even what is left properly included under the title of civil engineering remains undoubtedly the widest in scope of all the engineering professions, and in practising it a man must become a specialist in some one branch. To enumerate its various fields, it comprises: (a) the construction of railroads, of roads, of street and interurban railways; (b) the improvement of rivers and harbors, the construction of canals, of lighthouses, and other works necessary for carrying on maritime trade and commerce; (c) structural engineering, or the construction of bridges, aqueducts, foundations, steel frames for buildings, etc.; (d) hydraulic engineering, including the development of water powers and the construction of dams and power plants up to the point at which the mechanical engineer is called upon to supply the motors; (e) surveying, which is necessary in the laying out of works of all kinds, but constitutes a branch by itself known as land surveying when applied to the object of measuring and subdividing land, and which is known as topographic surveying when the object is to represent upon a map the surface configuration of the land, and which, further, when extended to the survey of very large areas in which the curvature of the earth must be taken into account, leads to the intricate and interesting problems of geodesy, or the measurement of the earth, and touches upon the field of terrestrial physics; (f) it further includes a great variety of problems due to the congregating of persons in cities, such as works of water supply and sewerage, the drainage of lands and buildings, the disposal of wastes, and the construction and maintenance of city streets and pavements. This last group of problems (f), involving the preservation of the health of communities, is rapidly becoming, if it has not already become, the special field of the new profession of sanitary engineering.

The field of the civil engineer, it is evident, touches at many points the other engineering professions. In the construction and operation of steam railroads and electric railways his work comes in many ways into contact with that of the mechanical and that of the electrical engineer, and the same is true in the development of water powers, the construction of pumping stations, and other work of the hydraulic engineer; while in the problems involved in the construction of the foundations and steel frames for high buildings the civil engineer comes into intimate relations with the architect, with whom he must collaborate. The work of the sanitary engineer also comes in many ways into relation with economic, sociological, and legal problems of importance and difficulty.

We may next inquire as to the qualities which fit a man for success in this profession. In the first place, it is evident that the ideal civil engineer must be a scientific man and at the same time a business man. He must have a thorough knowledge of the laws of nature, the fundamental principles of mathematics and mechanics, and the materials of construction, for his work consists in applying those laws, principles, and materials so as to make them of use in the world's business. He must be essentially a man of action. The engineer takes the discoveries of the scientist in his laboratory or the book-worm in his study, and makes them available for the use and convenience of man. His dominant quality must be practical common sense, combined with habits of care and accuracy, and with the courage and training which will enable him to solve new problems and to meet emergencies with success. His mistakes may be very costly, and his opportunities for effecting economies by skilful design and construction very great.

It is often assumed that in order to be a successful engineer a man must be a fine mathematician. As a matter of fact, while the engineer should be thoroughly familiar with the fundamental principles of mathematics up to and including the calculus, he seldom uses any but the simplest applications. In geometry, and especially in trigonometry, he must be thoroughly at home. I should rather be inclined to say, however, after these explanations, that in order to be a good engineer a man must not be what would usually be called a fine mathematician, or at least that he must in addition possess other mental qualifications which are of far greater consequence; for mathematics is in its essential conceptions and methods an abstract science, and the great mathematician is apt to lack the qualities of action, the quick decision, the accurate judgment, the ingenuity in meeting and overcoming obstacles and the natural grasp and insight leading him to see the physical possibilities of a situation which must distinguish the successful engineer. On the other hand, the engineer should have a liking for mathematics, and a quick and instinctive grasp of its principles and methods, together with the insight which will enable him to see how they are to be made of use, and to use them properly when the time comes.

The training of the engineer must be mainly a training in science, and such a training tends to develop the quality of honesty. The only aim of the true scientific investigator is to arrive at the truth concerning the phenomena he is studying. Such a training, if combined with business ability, makes the very best administrators, and whether for this reason or not, engineers are being more and more sought after to fill administrative positions, especially in connection with corporations in which engineering is concerned. On the other hand, the early practice and associations of the engineer are often of a character which fails to produce polished manners or a good address and appearance, the lack of which is sometimes a great handicap.

There have been, and are, two ways of preparing for the practice of this profession. The first is to begin by getting a thorough technical training, in a good engineering school, in the principles underlying the profession. The second is to begin as an apprentice or student in an engineer's office, gaining experience, and studying at the same time. At the present time it may be stated unhesitatingly that the only proper and safe way to become an engineer is to pursue the first method and secure a preparatory training in one of our engineering schools. In this way the student will learn many things that most men will never learn in practice; he will gain habits of study, breadth of view, and the adaptability which will enable him to meet new problems. Moreover, the young man who aims to become an engineer should secure a broad training, not devoted entirely to technical subjects, but covering also those subjects of a general nature which are necessary for every thoroughly educated man. The engineer of the past has too generally been considered a mere builder, and he has not as a rule been given the position to which his responsibilities and his achievements legitimately entitle him; but the engineer of the future should aim to take a position in society and business as a cultivated and highly trained man, on a level with men in any of the other professions.

The broad and thorough education advised can now be obtained at many schools in this country. Many educators would advise a young man to take first a college course, and to supplement it by a course in a professional school. Another plan, which has its advantages, is to lay out a course longer that the usual college course, in one institution, directed from the beginning toward the end in view, some general subjects and some professional subjects being studied in each year, with an increasing proportion of the latter toward the end of the course. The latter plan has the advantage that the student is working always toward a definite end, provided he is able to decide at the beginning what general line of work he desires to pursue. Some of the technical schools of the United States have provided courses of five years or more, in which the student may gain a technical training and a liberal training at the same time. If a young man is unable to decide upon a profession at the beginning of his course, whether he goes to college first or not, he should at least decide within broad limits, in order that he may arrange his studies so as to avoid unnecessary waste of time when he finds himself able to make a definite choice. It is not at present necessary to go abroad to obtain a technical training in civil engineering. Our American schools now offer better preparation for the practice of the profession in America than can be obtained elsewhere, being well equipped, and teaching American methods. Twenty years ago this could not be said, but at present our technical schools are as good as any in the world. Fortunately, also, many of them offer scholarships or other aids to needy but capable young men, so that the lack of money need not prevent a persevering man from gaining a technical education.

The opportunities presented to a young man graduating from one of our engineering schools will be many and varied. All professions are over-crowded in the sense that there are men in them who cannot find employment, and this is true in civil engineering. Yet there are few professions which offer so many opportunities to properly qualified men, so that, properly speaking, it is very far from over-crowded. The young civil engineer will, moreover, find open to him many purely business positions for which his training will have fitted him. The range of the engineering professions is continually widening, one direction in which they are rapidly extending being that of administration. Within the past 60 years nearly the entire railway system of this country has been built, most of our factories started, and our works of sewerage and water supply constructed. These works have required the services of most of our engineers, while the opportunities of profitable employment here have attracted many members of the profession from foreign shores.

The civil engineer of the past has been mainly a constructor; the civil engineer of the future will be more and more an administrator as well. And while the construction of railroads will not proceed as rapidly in the future as it has in the past, there are certain directions in which construction will proceed with great activity. For instance, although the great era of railroad construction may be said to be substantially ended, there is still much work to be done in building branch lines, in double tracking existing lines, in reducing grades and curves and making other local improvements, often on a large scale. Moreover, the construction of urban and interurban electric lines, for the attainment of rapid transit in cities, and the improvements in steam railroad terminals, is proceeding and will proceed, at a rapid rate, and will require the expenditure of many millions of dollars, while the rapid growth of urban population and the advances in sanitary science have recently given a great impetus to the construction of works for supplying pure water and for disposing of the sewage and other wastes without injury to the public health. Further, it is becoming recognized that the man with common sense and a good technical training, if he have also a talent for organization and executive ability, is the best type of man to direct the work of our great industrial corporations. Some of our large railroad corporations have within comparatively few years instituted the practice of choosing their higher officers from their engineering corps, instead of from other branches of the service. Not a few railroad presidents began their careers as civil engineers, and the number of such men will increase in the future.

The field of the civil engineer, therefore, and the same is true of other branches of the profession, is all the time widening, and widening largely at the top, where there is always room, as well as in the lower ranks. A young man should aim to begin his practical experience at the bottom of the ladder, in whatever line of work he may engage, learning thoroughly every detail of the business.

With respect to financial remuneration, the civil engineer stands at an advantage compared with members of some professions in the fact that his services are in demand at the outset, at a fair salary, while the young doctor or lawyer may not be able to meet his expenses for some years. The ultimate financial possibilities presented to the engineer may not be as great as in the professions referred to, but the rewards are still sufficient to tempt even the most ambitious men, while there are few impecunious engineers. The engineer will be appreciated more and more as time goes on. The profession is a growing one, with great possibilities, and few careers offer greater inducements or a surer or truer success to the energetic and capable young man, for we live in a mechanical age, and the work of the man who can "direct the great sources of power in nature to the use and convenience of man" must continually increase in importance.

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Engineering Education. See Education, Engineering

Engineering, Electrical. See Electrical Engineering.

Engineering, Hydraulic. See Hydraulic Engineering.

Engineering, Marine, is partly military and partly civil, embracing naval architecture, building and operating of ships and naval accessories. In the military sense, it comprises the construction of war vessels and the construction and placing of torpedoes, submarine mines, etc. See Navy; Naval Construction; Submarine; etc.

Engineering, Mechanical, is that branch of the science and art of engineering which relates specially to machinery. It is closely allied to all other classes of engineering, inasmuch as there is hardly an occupation or industry in which machines of some sort are not directly or indirectly concerned, and it is often, for this reason, difficult to draw the line clearly between one class and the other. The civil engineer who plans and supervises the building of a railroad, calls to his aid the machinery used in excavating, blasting, building masonry, and numberless other mechanical processes required in the work, all of which are the result of mechanical engineering. Electrical engineering would accomplish comparatively little in the production of light and transmission of power were it not for the dynamo and other machinery on which dependence is placed for the manufacture and use of electric current. Mining engineering would be of little use in devising means for extracting the coal and mineral treasures buried in the earth if suitable machinery planned by mechanical engineers could not be employed to assist the labor of men. In marine engineering it is the mechanical engineer who designs the steam plant which produces the motive power for the propulsion of the steamship, and without his assistance there would be no such a thing as a steamship. In dealing with problems relating to waterworks, the hydraulic engineer would be powerless if he could not make use of the pumps and hydraulic machinery which the mechanical engineer has devised. In every kind of industry where power is required, whether it be connected with engineering, architecture, chemistry, agriculture, or any other subject, the mechanical operations involved are based on the continuous operation of the machine constituting the motive power, whether it be a steam engine or water wheel or other motor, and these are the products of mechanical engineering. When we come to fully analyze the subject, therefore, it appears that mechanical engineering so far underlies engineering of every class, and all kinds of industrial operations, that it can almost be said to sustain the whole fabric of modern civilization.

Mechanical engineering, in its strictest sense, relates simply to the design of machines. In its broad sense it covers not only their design but all matters relating to their proper construction and operation. In its common application it has for its scope both the design and construction of machines required for performing certain desired operations, and in addition the design and operation of the complete industrial plant, of which the individual machines form a part, and the construction of the plant in such a manner as to secure a successfully working whole for whatever purposes the plant is built. A large part of the mechanical engineering required at the present day consists in the assembling of machinery to produce certain desired ends, rather than in the design of the machinery itself. In many cases, the machinery has already been designed and constructed by engineers of the past and the perfected machines can be had by purchase in the market. This class of mechanical engineering covers a wide field. Perhaps its scope in this field can best be shown by referring in some detail to a familiar example. Take the case of the engineering required in a large modern hotel. The mechanical plant of such an establishment embraces a great variety of machinery, among the most important of which are the machines and appliances required for power, heating, ventilation, lighting, elevator service, distribution of hot and cold water, fire protection, refrigeration, ice-making, laundry work, and cooking. The work of the engineer, although confined mainly to the mechanical plant, must, at the very outset, be directed to the building itself. The building, no doubt, accords with the modern ideas of construction which call for a framework made of iron, in the design and construction of which the architect must have the assistance of the mechanical engineer. Not only this, but there must be, at the outset, a careful consideration of the required location of the various mechanical appliances, so that in working out the details of design relating to the building the architect may provide the necessary amount of room. He must leave a place for the boilers, engines, dynamos, pumps, etc., which make up the steam plant, and room also for the storage of coal. Provision must be made for the reception of flues, ducts, pipes, and wiring, which pass up through the building and which are distributed here and there to the different rooms. The character of the structures which may be needed for supporting the machinery, and the location of such structures, must also be planned at the outset so that the building may be prepared for them before it is too late. In the design of the mechanical apparatus, one of the first questions for the engineer to consider is the size and character of the steam plant. In dealing with this matter, he ascertains all the uses to which steam is applied, embracing the generation of power, the pumping of water, the supply of steam for all kinds of heating and cooking, and that required for ventilation. With the data thus obtained he determines the total amount of steam required for all purposes, and then calculates the boiler capacity needed to furnish the steam. For the next step, he decides upon the type of boiler best suited for the purpose, whether fire-tube or water-tube, horizontal or vertical, or whether internally or externally fired, and fixes upon the number and size of the units as well as their location. He then makes a plan showing the location of the boilers in the building; the style of the brick setting, if externally fired; the arrangement and location of the smoke flues, and of the stack or chimney to which they connect. Having done this and settled all matters relating to the accessories which form a part of the boiler plant, he takes up, in due course of time, the remaining portion of the work relating to the boiler plant, which may be described at this point because it is representative of much of the work which requires to be done in relation to the other departments of the plant. He draws up specifications describing in full detail the character of the boiler plant desired and what is expected of it as regards capacity and economy. These specifications are submitted to boiler manufacturers who are asked to furnish proposals for the construction of the plant in the manner described. When the proposals of the different bidders have all been received, the engineer examines them, and after consulting with the owner of the property, selects one of the parties with whom to contract for doing the work. Next follows the inspection of the boilers in process of construction in the shop and erection in the building, the object in view being to determine if all the terms of the specifications are complied with. Finally, when the plant is completed and the contractor sets it to work, the engineer submits it to whatever tests may be required, and thereby determines whether the guarantees which have been made regarding the capacity and economy are fulfilled, and whether the plant performs its work with that degree of success and satisfaction that is called for by the specifications. Referring now to the construction of the remaining departments of the mechanical plant, the next thing considered is the motive power. The greater part of the power in such a plant is likely to be transmitted by electricity, and consequently, the motive power is that required for generating electricity. (See ENGINEERING, ELECTRICAL.) After deciding on the number, size, and type of the engines and generators, he must then locate them, and make a plan showing their respective locations with reference to the boiler plant and other parts of the building. At the same time, there must be laid out on the plan a system of steam-piping connecting the boiler to the engines, and this must be arranged with a view to supplying steam to all other points of use, including the heating of the building. Next in order, the pumping machinery requires attention. This embraces the boiler feed pump, the various pumps used for the different classes of hotel work, the elevator pump, if the hydraulic system is employed, and the fire pump. The engineer must determine the proper size of each one according to the amount of water to be pumped, and he must select the type of pump, fix its location, show it on the plan, and extend the system of steam-piping to furnish each with the proper supply. He must also plan the exhaust piping required for each engine and pump, the necessary vent pipe for carrying the waste steam to the atmosphere, and, if exhaust steam is used for heating, the required connection of the exhaust pipe to the main supply of the building. There must be a heater provided in the exhaust pipe system for heating the feed water before it is pumped to the boilers, and another heater for the supply of hot water to the building, and both of these, in their selection, location, and connection, require the careful attention of the engineer. They must be properly laid out and shown on the plan. A complete system of water piping is required, connecting boilers, pumps, hydrants, and elevators, to say nothing of the hot and cold water supply pipes which extend to the various rooms of the hotel, and the location of these must likewise be shown by means of a suitable plan. Not the least important part of the mechanical engineering for the building is the design and construction of the heating and ventilating apparatus. Calculations of the amount of heat and radiating surface needed, the quantity of air required to be changed in a given time, and the sizes of the mains and returns, are involved in this work. Here, also, the kind of the system to be employed, the location and type of the heating and ventilating apparatus, including all the necessary details, are questions which the engineer must consider and decide, and the results must be indicated by proper plans. These various parts of the work are made the subject of detailed specifications, in the manner already referred to, and, likewise, proposals for the installation of the work are obtained, contracts awarded, inspection carried on during construction, and the work tested for acceptance when it is completed, all of which is done under the jurisdiction of the mechanical engineer. In much the same manner, the selection, location, construction, and installation of the remaining parts of the mechanical plant, embracing elevator machinery, laundry machinery, refrigerating machinery, ice-making machines, and the many other appliances concerned in the work of the hotel, are carried out under his supervision.

The same class of mechanical engineering as that referred to in the above example is that involved in the design and construction of industrial plants of various kinds, such as cotton- and woolen-mills, bleacheries, paper-mills, rubber-mills, machinery and other manufactories, this branch of the profession being commonly known as mill engineering. In all of these cases, the elementary parts consist of the power plant, which is sometimes operated by steam, sometimes by water, and often by both, the machines in the mill or manufactory, and the pulleys, shafting, and belting required to transmit the power from the one to the other. The work of the mechanical engineer in these plants consists in properly assembling the various machines so as to perform their functions, the selection of an appropriate power plant, and the proper design and arrangement of the transmitting apparatus required for operating them.

The work of the mechanical engineer is of paramount importance in the construction of steamships. Not only does the design of the boilers and engines on which the whole operation of the ship depends originate with him, but he is also concerned in the design, location, and connection of the multitude of auxiliary steam appliances which abound throughout the vessel and which contribute so much to the comfort of the passengers. The modern steamship is required to contain all the appointments of a first-class hotel. The services of a mechanical engineer are many times more needed in its design and construction than in that of a hotel, for the reason of the contracted space in which the machinery is necessarily enclosed.

One of the most important industries in which the mechanical engineer is a leading figure is that of the steel-rail-mill. Here the plant, which is distributed over many acres of land, embraces immense blast furnaces where the pig iron is made, elevators by which the raw material is lifted to the top of the furnaces, blowing engines which produce the air-blast required at the base of the furnace, converters in which the iron is changed to steel, hydraulic lifts by which the converters are manipulated and the steel blooms moved to cars, trains of rolls with their powerful direct-connected driving engines where the rails are rolled from the masses of white-hot metal, together with their re-heating furnaces, and, in addition to all these, the extensive boiler plants, and the system of piping and other apparatus required for conveying and supplying the boilers with waste furnace gases, on which they largely depend for fuel. The mechanical engineer who lays out and assembles the parts of which such a plant is composed has a task the magnitude of which is commensurate only with the importance of the interests involved.

Since mechanical engineering includes in its scope not only the proper design and construction of machinery but also its satisfactory performance, one branch of the profession relates to the determination, by means of suitable tests, whether the desired performance has been realized. This has especially to do with boilers, engines, and apparatus using steam, which the engineer requires to be installed under specific guarantees of performance. The performance of boilers in the matter of economy is specified in terms of a certain number of pounds of water evaporated per pound of coal, and, in that of capacity, in terms of the number of horse-power developed, while that of the engine is specified as the number of pounds of feed water or dry steam consumed per indicated horse-power per hour. The performance tests require the determination of the quantities stipulated, by actual measurement of the coal, water, and power consumed under working conditions. Another branch of mechanical engineering, in a similar line, relates to the testing of materials used in construction, the object being to determine whether they have the requisite strength and physical characteristics. A sample or specimen of the material is placed in a testing machine and submitted to an actual breaking force and the amount of strain ascertained by measurement.

Having now given some explanation regarding the character of the profession of mechanical engineering, the question naturally arises as to the qualifications needed to make a success of such a profession. It hardly needs to be said of this profession more than of another that the one who adopts it should do so not merely as a means of livelihood, but because his tastes lie in the direction of mechanical pursuits, if, indeed, he does not love the profession for its own sake. No one should enter the profession who is not fond of machinery, who is not a "born mechanic" as the saying is, or who is not deeply interested, to say the least, in every kind of machine. But apart from natural inclinations, there are qualifications that especially fit one for the work of a mechanical engineer. He should have a technical education so as to be thoroughly grounded in the principles of mechanics. He should not only understand these principles but he should know them by heart. He may or he may not remember the formula derived from the principle, but the principle itself should ever be at his finger's end. He should be familiar with mathematics, geometry, and trigonometry. He should know the strength of materials and be able to calculate the strains occurring in structures and in machines, both at rest and in motion, so that he may design them with the proper amount of strength, or, if already designed, that he may be able to prove that they are of sufficient strength for any purpose he may desire to use them. He should know their behavior under varying conditions, and should be able to detect their points of weakness and know the best methods of strengthening them when they fail. He should be a draughtsman and, what is the draughtsman's next neighbor, an inventor. He should know the processes involved in the work of the patternmaker, founder, blacksmith, and machinist. He should know how to erect machinery, and how to operate it after erection. He should know the practices of the trade, and he should know the various articles concerned in mechanical operations which can be bought in the market, and, in a general way, their cost. He should be familiar with the different kinds of engines and boilers, pumps, water wheels, etc., in the market, and their relative advantages. Not the least in importance should he be grounded in the principles of steam engineering and the laws which pertain to the generation and use of steam, not only for the operation of engines of various kinds, but for the various kinds of steam heating. He should be familiar with the steam engine indicator and be able to test a boiler or engine for capacity and economy. He should be well versed in hydraulic, pneumatic, and electrical machinery. He should know about the construction and operation of the various machines of the plant he has assembled, so as to be able to judge of the correctness of their design and construction, and whether they perform their functions in a proper manner, and according to the specified requirements. He should be able to prepare detailed specifications of the work he plans, and he should possess sufficient literary ability to draw up a suitable report upon any question that may arise regarding the work he is called upon to perform, and pass judgment upon the comparative merits of different makes of machines required for a given purpose or of the different modes of carrying on given processes. In a word, the mechanical engineer must be skilled by observation, by study, and by experience in the science and art of the profession from beginning to end.

One of the leading problems confronting the mechanical engineer, whatever the special line in which he is engaged, is the reduction in the cost of production, and, what is allied to it, the attainment of the maximum result from machinery with the least expenditure of money, time, and labor. As machines and processes are in a continual state of improvement, and almost all lines of business are in a continual state of growth, it does not require many years to elapse after a piece of engineering work has been completed before it must be remodeled or enlarged to meet the demands of the times. This problem of reducing the cost of production is, therefore, one which is continually before him. In the design of an individual machine, the highest aim is to reduce the number of parts and quantity of material used to the smallest amount consistent with proper operation, and to run it at the highest speed which can be safely and successfully maintained. In arranging a plant for carrying on some industrial process, the aim must be to employ machinery wherever it is possible to save the labor of men, and assemble the machines so that the least number of hands and the least expense is required to change the raw material into the finished product. Following in the same direction is the aim to save all unnecessary waste of fuel or energy required in operating the machinery, whatever the class of work and in whatever department of the work such waste may occur.

There are many notable problems of a more specific nature than the one just named which absorb the attention of mechanical engineers and await their solution. One of these is the reduction in cost of steam power. Owing to the great amount of heat which passes to waste through the escaping of exhaust steam to the atmosphere or to the condenser, amounting in the most economical engines to no less than three fourths of that required in the original generation of the steam, there is a wide field for improvement in steam engine economy. Efforts are being made to reduce this waste by employing a part of the heat thus lost for evaporating some other liquid having a sufficiently low temperature of evaporation, and using the vapor thus formed to generate power in an auxiliary cylinder, thereby adding to the total power developed by the engine, and reducing in a corresponding degree the cost of the power per horse-power. Another problem of the same kind is the substitution of some other motive power for the steam plant with the object of reducing its cost. Gas, oil, and other forms of internal combustion engines are being widely developed for this purpose. In the conversion of coal into gas by the employment of a gas producer, and the subsequent use of the gas in the cylinder for developing power, the cost has already been reduced below that of steam power, and even better results may be expected.

The development of the steam turbine and its substitution for reciprocating engines is one of the problems on which mechanical engineers are most diligently working. The advantages to be obtained from this form of engine are the reduced space, increased speed of revolution, and greater uniformity of rotation which the turbine principle secures. There is a special field for its use in the operation of electric generators and in the propulsion of steamships, in both of which there is promise of most efficient results. The belief prevails that in the proper application of the turbine engine to marine work will be found the solution of the problem of rapid transportation by water.

Another great problem of mechanical engineering which is of importance to all business interests, is that of rapid transportation by railroad. The excellent results that have already been accomplished in this direction on short lines of suburban travel are due to the application of electricity, and the wide introduction of the electric railroad makes this a familiar subject to everyone. On steam railroads the efforts for increasing speed on long lines of travel do not lie in the direction of any radical departure from existing practices, but rather in the perfection of details whereby locomotives of greater power and cars of better construction are employed, the road-bed improved, and all the various details of railroad travel arranged so as to secure the most expeditious handling of trains. How best to provide a marked increase of speed on railroads, whether by the application of electricity, or by some new and untried method, is one of the problems still unsolved.

The great problem of aërial navigation is one which naturally lies in the domain of mechanical engineering. Although much has been done experimentally in this field, and there are instances of air-ships being constructed and successfully propelled for short distances at low speed, the practical solution of the problem has thus far baffled all efforts. One of the most encouraging experiments has been made by using a suitably shaped balloon and employing a gasoline engine connected to screw propellers for motive power; the engine being of high power in proportion to its weight, and the steering being effected by a rudder. Experiments have also been conducted with aëroplanes, in the hope of obtaining through these devices the necessary supporting power for the weight to be carried, and thereby dispensing with the use of balloons. With the same end in view, the motion of the wings of large birds has been studied for the purpose of determining the natural laws which govern aërial travel, and, if possible, copying them. In neither of these lines has much success been attained.

There are other great problems of mechanical engineering, yet unsolved, which relate to the production of power by the employment of the forces of nature not heretofore utilized. One of these has for its object the utilization of the sun's heat. It has been worked out in a small way in California. A concave mirror having 1,000 square feet of surface has been employed for converging the rays of the sun upon a steam boiler which lies at its focus, and suitable mechanism is arranged for keeping the mirror always turned in the proper direction toward the sun. It is said that in full sunshine this apparatus has developed 10 horse-power. Wind power is widely and successfully employed on a small scale, but there remains the problem of overcoming its variable nature by providing means for storing it, and of applying the power thus obtained without limitations. The development of tidal power, like that of wind power, is largely a problem of the storage of energy, and no success in this field has been realized.

What the future offers to a young man choosing the profession of mechanical engineering depends very much upon the ability of the man himself. The broad scope of the profession, already referred to, furnishes ample indication that there is a wide field of work for him. That there are positions awaiting the young engineer may be seen by examining the catalogues of prominent technical colleges, which record the names of graduates and their occupations. Referring to one of these catalogues, and taking as a sample the last graduating class given, that for the year 1902, there are recorded a total of 44 mechanical engineers. Of this number only 3 are put down without employment, and 1 of the 3 is in reality employed, being a graduate student. Of the 41 holding positions, 18 are engaged in various engineering occupations connected with the manufacture of machinery, 3 are employed in textile mills, 8 are engaged in steel works, 3 are connected with railroads, and the remaining 9 are variously occupied in engineering pursuits. If the young engineer becomes connected with an industrial business of sufficient size and importance to warrant the steady employment of a mechanical engineer, and he shows the necessary ability, the prospect is that he will in time push forward to a position of responsibility which will command a good salary and satisfy any ordinary ambition. If his desire is to establish an engineering business of his own, he can make the emoluments greater than in a salaried position, provided he is able to secure the necessary clientage, and conduct such a business to advantage. If this is his choice, the most promising course for him to pursue is to first enter the office of a successful engineer, and spend a few years in learning the business. Then, if he has the acquaintance and aptitude necessary for attracting business for himself, he can set up his own establishment, and by careful attention to the execution of his work strive for the success he seeks. In mechanical engineering, as in other professions, large emoluments await the men who rise to the top, for these are the engineers who are called upon by individuals and corporations for consultation.

The profession of mechanical engineering offers as many attractions to those entering it as any other profession, for in this, as in others, there is always room for those who excel, and no professional man meets with success unless his work commands it.

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Engineering, Military. The duties of the military engineer consist in the construction of fortifications, including the trenches and batteries required in besieging places; also of barracks, magazines, of roads and bridges to facilitate the passage of an army. He should have a practical and theoretical knowledge of gunnery. In this country he is often called upon to undertake works which more properly belong to the business of a civil engineer, such as the survey of the country, the inspection of public works, in fact, all the duties of a government engineer. See Gunnery; Ordnance; War; etc.

Engineering, Mining. See Mining Engineering.

Engineering, Sanitary. See Sanitary Engineering.

Engineering Education. Interesting statistics have been prepared showing the work of students in technical schools in the United States, as compared with the work of students in other countries. The following comparative table gives the percentage number of hours' instruction at Massachusetts Institute of Technology, Cornell, the Berlin Technical High School and the Zürich Polytechnicum that are devoted to each group of studies:

Study	M. I. T.	Cornell	Berlin	Zürich
Mathematics	8	5	14.5	19.2
Physics	5	8	6.8	6.0
Chemistry	7	7	1.7	3.0
Applied mechanics	7	10	22.5	19.5
Mechanism	4	......	8.0	......
Steam Engine; Thermo-dynamics	6	6	4.1	8.0
Mechanical, etc., Drawing	26	20	31.0	39.3
Electrical Engineering	2	2	3.4	5.0
Commercial subjects	2	......	8.0	......
Workshop practice	14	30	......	......
French	6	......	......	......
German	3	3	......	......
English	5	......	......	......
Engineering Laboratory	5	9	?	?
	100	100	100	100
Approximate hours	3000	3000	4000	4000
Course in years	4	4	3	3

Marked differences in theories of training is evidenced in these curricula. The American courses are more practical in character and require more laboratory training than is even recommended in the German plan, and they devote a large proportion of the time to teaching skill in handicraft. They give much less time to mathematics, and perhaps there may be a loss of power in mature life on this account, though it is certain that immediate and practical ends are gained by the American programme. See EDUCATION, ENGINEERING.

Engineering Instruments are principally the rod, compass, level and transit. See INSTRUMENTS, ENGINEERING; SURVEYING.

Engineering Schools. The education and training of the engineer in modern times have called for the establishment of technical schools and courses in engineering in the large colleges and universities. These schools provide the student with the theories of mathematics, mechanics, and engineering, and by means of extensive laboratory and outside work provide him with practice in the design, construction, and use of modern engineering appliances. Among the most noted technical schools are the University of Glasgow; Ecole Polytechnique, in Paris; Stevens Institute of Technology, in Hoboken, N. J.; the Massachusetts Institute of Technology, in Boston; and Cornell and Columbia universities. See EDUCATION, SCIENTIFIC AND TECHNICAL.

Engineering and Structural Terms. The following list includes some of the principal terms applied to designate the various mechanical units employed in engineering and structural operation. See also ENGINE; LOCOMOTIVE, DESIGN AND CONSTRUCTION OF THE MODERN; and WORKSHOP TERMS.

ABUTMENTS.— In structural work — the surfaces which support arches, beams, and bridges, and sustain the reactions due to the application of the load. In machinery — any relatively immovable part or surface designed to resist pressure, or to resist reaction. In carpentry — a joint of two pieces, the fibres of one being at right angles with those of the other.

ACTION.— The manner in which a machine or engine works. In mechanics it is axiomatic, that action and reaction are equal and opposite.

ACTUAL OR AVAILABLE HORSE-POWER — A.H.P.— See BRAKE HORSE-POWER.

ANNULAR.— Ring-shaped — as the annular seating or circular seating on which a pump valve rests; or the cylinder and piston of an annular engine.

APEX.— The point or summit of a cone, pyramid, or any triangular-shaped structure or figure. In engineering — the points of the triangles in truss girders, or those portions of the braces which intersect the flanges at the top and bottom.

AXIS.— The line which passes through the centre of a body. The axis of a cylinder, or of a sphere, is the right line which passes through the centres of all the corresponding parallel sections thereof. The axis of an ellipse, a parabola, or a hyperbola is the right line which divides the curves symmetrically. The "axis of symmetry" is an imaginary central line around which a symmetrical body is developed, and which passes through the centre of gravity of the body. The "neutral axis" of a beam is a longitudinal central line along which a beam is neither in tension nor compression. In a beam of uniform section it corresponds with the central line of the cross-section. In beams of varying section it corresponds to the mean of the bending sections.

BALANCE.— The equilibrium or equality of the moments, or the equality of the sum of the forces which tend to move or turn a body in one direction, to the sum of the forces which tend to move or turn it in the opposite direction.

BELT OR BELTING.—A band or strap of leather, india-rubber, or cotton, employed to transmit power over smooth pulleys. Belts act by friction only, and are extensively employed where an exact velocity ratio is not essential, and where the distance between the shafts prevents the employment of a positive means of transmission. The transmitting capacity of a belt depends upon its pull, or upon the lineal velocity at which it travels. The amount of pull depends upon the strength of the belt and the friction on the pulleys. The lineal velocity depends upon the diameter of the pulleys and upon the speed of revolution. Belts are also extensively used as conveyors of material such as coal, ores, grain, and finished products, in mining, milling, and manufacturing plants. They are made in a great variety of sizes both for power transmission and conveying purposes and range from 5 to 60 inches in width, and from 5 to 300 feet in length.

BELT TENSION.— The ultimate strength of belts ranges from 2,000 to 5,000 pounds per square inch, but these values are greatly reduced at the joints. At the laced joints, it ranges from 1,000 to 1,500 pounds, and at the riveted joints, from 1,500 to 2,500 pounds per square inch. The working tension usually maintained ranges from 30 to 60 pounds per inch of width.

BENDING MOMENT.— The sum of the external forces which act upon each side of a given section of a beam bending under a load. It is equal to the "moment of resistance" of that section, or the sum of the internal forces or stresses set up therein by the bending action.

BLOCKING OR BLOCKING-UP.— The elevating and supporting of large pieces of machinery, or entire structures, by means of cranes, jacks, and blocking or short lengths of timber and planks, during erecting and constructing operations. It is also applied to the elevation given to the outer rail of the curve of a railway track, for the purpose of counteracting the effect of the centrifugal force developed by a rapidly moving train.

BOLT.—A metal device employed by engineers for fastening purposes. Bolts are usually made of wrought-iron or of mild steel. In the ordinary forms, the head is forged with the shank, and the opposite end or tail is threaded to receive the screw nut by which it is secured. The heads and nuts are made either rectangular or hexagonal, and the shoulder or neck under the head is often made rectangular so as to fit into a square hole and thus prevent the bolt from turning around on its axis. For general purposes, the dimensions of bolts conform to certain standards. The United States standard is conformed to in America, and the Whitworth standard, in Great Britain and other European countries.

BRAKE HORSE-POWER — B.H.P.— The amount of power delivered by an engine at the driving pulley or power shaft, and actually available for doing work. The power developed by an engine is measured at two points — at the cylinder, as indicated horse-power, and at the driving pulley. Between the cylinder and the pulley a certain amount of power is lost in the friction developed in the running of the engine itself, so that the actual horse-power available for work is the indicated horse-power minus the horse-power lost in friction. It is sometimes expressed — D.H.P., delivered horse-power.

BRITISH THERMAL UNIT — B.T.U.— The amount of heat required to raise the temperature of water one degree Fahrenheit, at or about 39.1° Fahrenheit. Its mechanical equivalent as originally determined by Joule is 772 foot-pounds, but later determinations indicate that it is nearer 778 foot-pounds. To convert values of energy expressed in foot-pounds to their equivalents in British Thermal Units, divide the values by 778.

CAMBER.— The amount of upward curvature given to an arched bar or structure in order to compensate for the downward curvature resulting from the application of the load. In machinery, it is specifically applied to the arching of springs like those of locomotives. In structural work, it is applied to the arching of bridge trusses like the stiffening trusses of suspension bridges.

CANTILEVER.— A beam fixed at one end and loaded at the other, or loaded uniformly. In ordinary structural work it is represented by the brackets employed for supporting balconies or other overhanging platforms like the sidewalks placed on the outside the trusses of a bridge.

CENTRE.— The fixed point about which the radius of a circle or of a circular arc moves. It is extensively applied as a specializing prefix to other terms, as "centre gauge," "centre line," etc. The "centre of compression" is the line in which the resultant of the compressive forces in the lower part of a beam is located. The "centre of gravity" is the point in a body about which the body will remain balanced when placed in any position. The "centre of gyration" is the point in which the momentum of a revolving body is concentrated. The "centre of moments" is the point about which the forces applied to a rigid body act. The "centre of oscillation" is the point in the axis of a vibrating body, such as a pendulum, in which if all the matter of the body were concentrated, the body would vibrate in the same time. The centre of gravity and the centre of oscillation lie in the same axis, but the latter is located farther from the point of suspension. The "centre of percussion" is the point in a revolving body at which if the body struck an immovable obstacle, would result in the destruction of all of its motion. The "centre of tension" is the line where the resultant of the tensile forces in the upper part of a beam is located.

CIRCULAR INCH.— The area of a circle one inch in diameter, as distinguished from a square inch. The number of circular inches in a given diameter is obtained by squaring the diameter.

COEFFICIENTS.— Numerical values deduced from data obtained by experiments and used as constant multipliers in engineering calculations. They have been determined for friction, elasticity, tension, rupture, resistance, the flow of water, etc. For example — the amount of force or weight that will elongate an elastic bar of any material and of uniform section to twice its original length is designated as the "coefficient of elasticity" of that material. Also termed "modulus," as the "modulus of elasticity," the "modulus of resistance," etc.

COHESIVE STRENGTH.— The resistance of a material to rupture under tension. The same as "tensile strength," and equivalent to "tenacity."

COLUMN.—A beam set on end and receiving pressure vertically or in the direction of its longitudinal axis. The latter condition, however, varies with the length of the column. When the length is 25 to 30 times greater than the diameter, it is a "long column," and yields under pressure by bending only, in a manner similar to that of a beam supported at both ends. When the length is 3 to 5 times greater than the diameter, it is a "short column," and ruptures by crushing only. The resistance of a column to flexure is increased by flattening its ends, by extending the area of the ends, and by firmly fixing both ends.

COMPOUND MACHINES.— Those which are designed and adapted for performing several different kinds of work, either simultaneously, or at different periods of time.

COMPLEMENT.—A term employed in angular measurement. The complement of an angle is its difference from 90°.

COMPRESSION.—A term of various applications. A body is in compression when it is subjected to crushing forces which act in the direction of the axis which is continuous with the direction of pressure. The cushioning or resistance of the steam in the end of an engine cylinder to the return stroke of the piston. The pressure exerted on the explosive charge in the cylinder of a gas engine by the piston during its instroke previous to "ignition" of the charge.

CONCENTRATED LOAD.—A load localized or applied at a particular point upon a beam, girder, or structure. A concentrated load will produce twice as much stress as a distributed load.

CONSTANT.—A number deduced from data obtained by actual tests made upon the strength of a particular material, and used in calculations relative to the strength of structures built of that material. For example — having ascertained by actual experiment the weight required to rupture a steel bar measuring 3 x 2 x 1 inches, that weight can be used to estimate the stresses in structures made of the same material but differing in length, breadth, and depth.

COUNTRY CUT.— Timber or lumber which has been sawn into planks and boards in the district where the trees were felled.

COUPLE.— Two equal and opposite forces acting upon a body, which is, therefore, in a state of equilibrium.

CREEPING.— The slight loss of speed due to the slipping of the rope in the case of drums driven by rope gearing, and by the elasticity of the belts in the case of power transmitting belting. In either case the amount is very small per revolution, or for short intervals of time.

DANGEROUS SECTION.— The section of a bar at which the bending moment is greatest.

DATUM OR DATUM LINE.—Any base line from which measurements are made, or dimensions taken, either in actual work, or in graphical calculations.

DEALS.— Sawn timber which usually measures not less than 3 x 9 inches and not more than 3 x 12 inches in cross-section.

DIFFERENTIAL MOTION.— The motion resulting from the combination of the different motions of two parts of a mechanical device. It affords mechanical gain. For example — in the combination of the wheel and axle commonly called the "Chinese Windlass," two axles of unequal diameters rotate together so that the rope which passes through the movable pulley which supports the weight is wound up on the larger axle and unwound on the smaller axle. The upward movement of the weight is consequently very slow, but the mechanical gain is very great. In the case of the "differential screw," two screws of unequal pitch are cut on the same spindle. When the spindle is turned, a nut on one of the screws is moved by an amount equal to the difference in the pitches. A "differential strain" is one that is due to a variable load.

DOUBLE GEAR.— Gearing in which two wheels and two pinions are used. The arrangement affords mechanical gain. The principle is extensively employed in connection with the gear of lifting cranes, drilling machines, lathes, etc.

DRIVEN.—As applied to gearing, it refers to the wheel or wheels actuated by the "driver" or wheel attached to the driving shaft. To calculate the mechanical efficiency of a train of gearing, multiply the radii of all the drivers together, and likewise the radii of all the driven, and divide the latter by the former.

DUTY.— The performance or amount of work done by an engine as determined upon the basis of coal consumption, and stated in foot-pounds. The duty of a steam engine is the number of pounds raised to the height of one foot by the burning of a bushel of coal. In the case of pumping engines, the duty was formerly expressed in millions of pounds of water lifted to the height of one foot by the burning of 100 pounds of coal; but, as the quality of coal varies greatly, the basis now employed is the work done by 1,000 pounds of dry steam, or by 1,000,000 British Thermal Units.

EFFICIENCY.— The efficiency of a machine or of a structure, or any portion thereof, is the ratio of its strength, power, or capacity, to that of some predetermined, understood, or fixed standard of reference. For example — the efficiency of a riveted joint in plate work is its percentage strength calculated relatively to that of the solid plate. The efficiency of a machine is the ratio of its actual value to its theoretical value, or the difference between the amount of work expended on the machine and the amount given out by it or obtained from it.

ENCASTRE.— The immovable fixing of the ends of a cantilever, or the ends of other forms of beams or girders in a wall or support. Beams are much stronger when encastre than when simply supported.

FACTOR OF SAFETY.— When calculating the ultimate strength of a structure it is necessary to provide for contingencies arising from a lack of uniform quality in materials, inferiority of materials, wear and tear of parts, the unexpected application of loads, etc. This provision is made by the use of multipliers such as 4, 6, 8, and in some cases 10, which are applied to certain dimensions. For example — the application of a factor of safety of four will give a structure having four times the strength necessary to carry the load it will be ordinarily required to sustain.

GRAPHIC STATICS.— The graphical methods employed for ascertaining the strains on structures, velocity ratios, etc., by means of lines drawn to an uniform scale and representing the direction and intensity of active forces.

HOLLOW STRUCTURES.— The frames, standards, and parts of large machines and structures, made hollow from motives of economy, or to reduce their weight while retaining their strength. They are represented by the various forms of box girders, base plates, columns, etc.

HORSE-POWER.— A term used for expressing the power developed by a mechanical motor or engine. It was originally selected by James Watt as a basis on which to sell his engines. One horse-power is a quantity of work equivalent to that which is expended in raising a weight of 33,000 pounds to the height of one foot in one minute, or a weight of 550 pounds to the height of one foot in one second. It is expressed in foot-pounds, and is designated as A.H.P.— Actual or Available Horse-Power, or B.H.P.— Brake Horse-Power; N.H.P.— Nominal Horse-Power, a comparatively obsolete term used by some manufacturers to designate the size of an engine; I.H.P.— Indicated Horse-Power, the foot-pounds of work done behind the piston; and F.H.P.— Friction Horse-Power, the number of foot-pounds of power lost by the friction of the engine.

Interchangeable.—Applied to the parts of machines and structures which are made similar and in large quantities, so that a part taken from one may be used in any other of the same size and type.

Mean Effective Pressure.— The power exerted by the expansive energy of a gas in driving the piston of an engine. Being variable for different positions of the piston, the value determined is the average of the pressures at the various positions. It is usually determined by the use of an indicator or pressure gauge diagram.

Thermal Efficiency.— The ratio of the heat converted by an engine into mechanical energy, and the heat absorbed by it from the source of supply. It is limited by the range of temperature through which the working substance within the cylinder acts, and must be always a quantity less than unity.

Traction of Tractive Power.— The pulling power afforded by the frictional adhesion of wheels.

Ultimate Strength.— The strength of a material equivalent to the load which produces actual fracture. The ultimate strength as determined by actual test is usually employed in engineering calculations in preference to the elastic strength, as it affords data of a more definite character.

Units.— Mechanical units are of two classes — those derived from the relations of things having their basis in natural law, and those consisting of conventional standards adopted for convenience in calculations. For example — the Joule, the unit of heat, is based upon a natural and interchangeable fact, while the horse-power is simply a conventional standard accepted by engineers by mutual consent and use.

Velocity Ratio.— The proportional velocity of bodies which are mutually connected, such as levers, gear-wheels, etc.

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Engineers, Corps of, a branch of the military service of the United States, organized in 1802, as "The Corps of Engineers of the United States Army." There are similar organizations in all European countries. See Army; Army of the United States.

Engis, ŏn-zhē, Belgium, an archæological station on the Meuse, southwest of Liége, where a human skull was found imbedded in breccia, with remains of the rhinoceros and reindeer. There has been much discussion among archæologists as to the age of the skull, but it is most commonly referred to the Quaternary Period.

England, including **Wales,** the southern and larger portion of the island of Great Britain, is situated between lat. 50° and 55° 46′ N. and lon. 1° 46′ E. and 5° 42′ W. On the north it is bounded by Scotland; on all other sides it is washed by the sea; on the east by the North Sea or German Ocean; on the south by the English Channel; and on the west by St. George's Channel and the Irish Sea. Its figure is, roughly speaking, triangular, but with many windings and indentations, the coast-line measuring not less than 2,765 miles. The length of the country, measured on a meridian from Berwick nearly to St. Alban's Head, is 365 miles. Its breadth, measured on a parallel of latitude, attains its maximum between St. David's Head, in South Wales, and the Naze, in Essex, where it amounts to 280 miles.

Topography.— The chief indentations are: On the east, the Humber, the Wash, and the Thames estuary; on the west, the Solway Firth, Morecambe Bay, Cardigan Bay, and the Bristol Channel; those on the south are less prominent, though including some useful harbors. The greater part of the coast consists of cliffs, in some places clayey, in others rocky, and sometimes jutting out into bold, lofty, and precipitous headlands, as at Whitby and Flamborough Head on the east, Beachy Head, the Isle of Portland, the Lizard and Land's End on the south and southwest, St. David's Head and St. Bees Head on the west. The most extensive stretches of flat coast are on the east, in the county of Lincoln, and from the south part of Suffolk to the South Foreland in Kent, and in Sussex and Hants on the south coast. The chief islands are: Holy Island, the Farne Islands, Sheppy, and Thanet on the east coast; the Isle of Wight on the south; the Scilly Isles at the southwestern extremity; and Lundy Island, Anglesey, Holyhead, and Walney on the west.

The loftiest heights of England and Wales are situated at no great distance from its west shores, and consist of a succession of mountains and hills, stretching, with some interruptions, from north to south, and throwing out numerous branches on both sides, but particularly to the west, where all the culminating summits are found. The northern portion of this range has received the name of the Pennine Chain. It is properly a continuation of the Cheviot Hills, and, commencing at the Scottish border, proceeds south for about 270 miles, till, in the counties of Derby and Stafford, it assumes the form of an elevated moorland plateau. In Derbyshire The Peak rises to the height of 2,080 feet. By far the most important of its offsets are those of the west, more especially if we include in them the lofty mountain masses in northwestern England sometimes classed separately as the Cumbrian range. Amid these mountains lie the celebrated English lakes, of which the most important are Windermere, Derwent Water, Coniston Lake, and Ullswater. Here also is the highest summit of northern England, Sca Fell (3,210 feet). The Pennine Chain, with its appended Cumbrian range is succeeded by one which surpasses both these in loftiness and extent, but has its great nucleus much farther to the west, where it covers the greater part of Wales, deriving from this its name, the Cambrian range. Its principal ridge stretches through Carnarvonshire from north and west, with Snowdon (3,571 feet) as the culminating point of south Great Britain; across the Bristol Channel from Wales is the Devonian range. It may be considered as commencing in the Mendip Hills of Somerset, and then pursuing a southwest direction through that county and the counties of Devon and Cornwall to the Land's End, the wild and desolate tract of Dartmoor forming one of its most remarkable features (highest summit, Yes Tor, 2,050 feet). Other ranges are the Cotswold Hills, proceeding in a northeast direction from near the Mendip Hills; the Chiltern Hills taking a similar direction farther to the east and the North and South Downs running east, the latter reaching the southern coast near Beachy Head, the former reaching the southeast coast at Folkestone.

A large part of the surface of England consists of wide valleys and plains. Beginning in the north, the first valleys on the east side are those of the Coquet, Tyne, and Tees; on the west the beautiful valley of the Eden, which, at first hemmed in between the Cumbrian range and Pennine Chain, gradually widens out into a plain of about 470 square miles, with the town of Carlisle in its centre. The most important of the northern plains is the Vale of York, which has an area of nearly 1,000 square miles. On the west side of the island, in south Lancashire and Cheshire, is the fertile Cheshire plain. In Wales there are no extensive plains, the valleys generally having a narrow, rugged form favorable to romantic beauty, but not compatible with great fertility. Wales, however, by giving rise to the Severn, can justly claim part in the vale, or series of almost unrivaled vales, along which it pursues its romantic course through the counties of Montgomery, Salop, Worcester, and Gloucester. Southeast of the Cotswold Hills is Salisbury plain, a large elevated plateau, of an oval shape, with a thin, chalky soil only suitable for pasture. In the southwest the only vales deserving of notice are those of Taunton in Somerset and Exeter in Devon. A large portion of the southeast may be regarded as a continuous plain, consisting of the Wealds of Sussex, Surrey, and Kent, between the North and South Downs, and containing an area of about 1,000 square miles. The southeast angle of this district is occupied by the Romney marsh, an extensive level tract composed for the most part of a rich marine deposit. Extensive tracts of a similar nature are situated on the eastern coast in Yorkshire and Lincoln, where they are washed by the Humber; and in the counties which either border the Wash, or, like Northampton, Bedford, Huntingdon, and Cambridge, send their drainage into it by the Nen and the Ouse.

For the climate of England see GREAT BRITAIN, *Climate*.

Rivers.— England is well supplied with rivers, many of them of great importance to industry and commerce. Most of them carry their waters to the North Sea. If we consider the drainage as a whole, four principal river basins may be distinguished, those of the Thames, Wash, and Humber belonging to the German Ocean; and the Severn, belonging to the Atlantic. The basin of the Thames has its greatest length from east to west, 130 miles, and its average breadth about 50 miles, area 6,160 square miles. The river itself, which is the chief of English rivers, has a length of 215 miles. The basin of the Wash consists of the subordinate basins of the Great Ouse, Nen, Welland, and Witham, which all empty themselves into that estuary, and has an area computed at 5,850 square miles. The basin of the Severn consists of two distinct portions, that on the right bank, of an irregularly oval shape, and having for its principal tributaries the Teme and the Wye; and that on the left, of which the Upper Avon is the principal tributary stream. The area of the whole basin is 8,580 square miles. The next basin, that of the Humber, the largest of all, consists of the three basins of the Humber proper, the Ouse, and the Trent, and its area is 9,550 square miles, being about one sixth of the whole area of England and Wales. Other rivers unconnected with these systems are the Tyne, Wear, and Tees, in the northeast; the Eden, Ribble, Mersey, and Dee, in the northwest. The southern coast streams are very unimportant except for their estuaries. See THAMES.

Areas and Population.— The total area of England and Wales amounts to 58,323 square miles and the population (1901) aggregated 32,526,075, divided among administrative counties and county boroughs as follows:

ADMINISTRATIVE COUNTIES	Area in Sq. m.	Pop. 1901
Bedfordshire	473.3	171,700
Berkshire	713.3	180,366
Buckinghamshire	749.0	196,844
Cambridgeshire	492.5	120,634
Isle of Ely	371.9	64,494
Chester	1,009.2	601,070
Cornwall	1,356.6	322,960
Cumberland	1,520.4	266,924
Derbyshire	1,010.8	504,577
Devonshire	2,597.8	437,210
Dorset	977.4	202,092
Durham	1,001.1	833,614
Essex	1,523.2	816,503
Gloucestershire	1,236.8	331,516
Herefordshire	842.0	114,150
Hertfordshire	632.0	258,045
Huntingdonshire	365.6	54,127
Kent	1,520.2	936,003
Lancaster	1,707.7	1,827,390
Leicestershire	819.1	225,896
LINCOLNSHIRE		
Lincolnshire—Holland	410.6	77,583
Kesteven	727.9	103,958
Lindsey	1,501.7	206,497
London	117.0	4,536,063
Middlesex	232.3	792,225
Monmouthshire	539.5	230,800
Norfolk	2,036.7	313,438
Northamptonshire	908.9	207,467
Soke of Peterborough	83.5	41,119
Northumberland	2,009.6	388,059
Nottinghamshire	826.8	274,684
Oxfordshire	743.7	137,118
Rutlandshire	152.0	19,708
Shropshire	1,346.6	239,297
Somerset	1,615.8	385,060
Southampton	1,479.1	377,118
Isle of Wight	146.9	82,388
Staffordshire	1,128.2	879,618
SUFFOLK		
Suffolk—Eastern	859.0	189,152
Western	610.8	117,535
Surrey	707.5	519,521
SUSSEX		
Sussex—Eastern	815.3	261,691
Western	630.6	151,541
Warwickshire	879.8	347,691
Westmoreland	789.6	64,411
Wiltshire	1,350.2	271,372
Worcestershire	739.7	358,356
YORKSHIRE		
Yorkshire—East Riding	1,157.9	145,194
North Riding	2,124.5	285,671
West Riding	2,264.2	1,460,861
Total of England	50,216.0	21,931,311
WALES		
Anglesey	276.0	50,590
Brecknock	733.3	54,211
Cardigan	692.3	61,076
Carmarthen	918.4	135,326
Carnarvon	571.8	125,669
Denbigh	665.7	131,588
Flint	254.7	81,490
Glamorgan	792.6	601,092
Merioneth	659.4	48,774
Montgomery	797.0	54,892
Pembroke	613.6	87,910
Radnor	470.6	23,263
Total of Wales	7,446.0	1,455,881
Total of England and Wales	57,662.0	23,387,192

The county boroughs, that is, self-governing cities with county charters, number 67; these have a total area of 661 square miles, and their combined population in 1901 was 9,138,883.

The returns from the census of 1901 showed an increase in the population of England and


LONDON
and Vicinity
SCALE OF MILES.
Hammersmith
Putney
Wimbledon
Merton
Southwark
Greenwich
Sydenham
Dulwich
Streatham
Fulham
Chelsea
Thames
HYDE PARK
Harlesden Sta.
Kingsbury
Hampstead
Islington
NORTH SEA
IRISH SEA
NORTH CHANNEL
ST. GEORGE'S
SCOTLAND
IRELAND
Belfast
Cantyre
Arran
FIRTH OF CLYDE
ISLE OF MAN
Douglas
Castletown
Ramsey
Mull of Galloway
Burrow Hd.
Wigtown
Stranraer
Ayr
Dumfries
Moffat
Lanark
Selkirk
Hawick
Jedburgh
Berwick upon Tweed
Holy I.
Farn Is.
Bamborough Cas.
Dunstanborough Cas.
Alnmouth
Coquet I.
Warkworth
Newbiggin
Blyth
Tynemouth
N. Shields
S. Shields
Sunderland
Seaham Harb.
Hartlepool
West Hartlepool
Middlesborough
Whitby
Scarborough
Filey
Flamborough Hd.
Bridlington Quay
Hornsea
Withernsea
Patrington
Spurn Hd.
Hull
Grimsby
Skegness
Wainfleet
Boston
Hunstanton
The Wash
Cromer
N. Walsham
Foulness
Caistor
Gt. Yarmouth
NORTHUMBERLAND
Newcastle
Gateshead
Durham
Darlington
Stockton
CUMBERLAND
Carlisle
Workington
Whitehaven
St. Bees Hd.
Maryport
WESTMORLAND
Kendal
Appleby
Penrith
Barrow in Furness
Walney I.
Morecambe Bay
Lancaster
Fleetwood
Blackpool
Preston
Blackburn
Burnley
Southport
Bolton
Wigan
Bury
Oldham
Rochdale
Salford
MANCHESTER
Stockport
LIVERPOOL
Birkenhead
Chester
Crewe
Macclesfield
Leeds
Bradford
Halifax
Huddersfield
Wakefield
Barnsley
Sheffield
Rotherham
Doncaster
York
Harrogate
Ripon
Beverley
Chesterfield
Nottingham
Derby
Burton
Stoke upon Trent
Leicester
Lincoln
Newark
Grantham
Peterborough
RUTLAND
Oakham
Shrewsbury
MONTGOMERY
MERIONETH
CARNARVON
Carnarvon
Bangor
ANGLESEY
Holyhead
Amlwch
DENBIGH
Denbigh
FLINT
Wrexham
Llandudno
Conway
CARDIGAN
Barmouth
Tremadoc Bay
Carnarvon Bay
Bardsey I.
SOLWAY FIRTH
Scafell
Windermere
Cross Fell
CHEVIOT HILLS
Carter Fell


ENGLAND AND WALES.
SCALE OF MILES.
0 5 10 20 30 40 50 60 70
Population of places is indicated by
different lettering, thus:
500,000 and over LONDON
100,000 to 500,000 Cardiff
25,000 to 100,000 Folkestone
10,000 to 25,000 Henley
Smaller Places Cranbrook
Railroads
ENGLISH CHANNEL
BRISTOL CHANNEL
STRAIT OF DOVER
CHANNEL ISLANDS
FRANCE
Longitude 4° West from 3° Greenwich
Meridian of 0° Greenwich
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Wales in 10 years of 3,523,191, or 12.15 per cent. The population of the principal cities and towns in England and Wales was as follows: London, 4,536,541; Liverpool, 684,947; Manchester, 543,-930; Birmingham, 522,182; Leeds, 428,953; Sheffield, 380,717; Bristol, 328,836; Bradford, 279,809; West Ham, 267,308; Nottingham, 239,753; Kingston-upon-Hull, 240,618; Salford, 221,015; Newcastle-upon-Tyne, 214,861; Leicester, 211,574; Portsmouth, 189,160; Bolton, 168,025; Cardiff, 163,844; Sunderland, 146,828; Oldham, 137,238; Croydon, 133,885; Blackburn, 127,527; Brighton, 123,478; Preston, 120,860; Norwich, 111,728; Birkenhead, 110,906; Gateshead, 109,891; Plymouth, 107,509; Derby, 105,785; Halifax, 104,997; Southampton, 104,500—all others 100,000 or less. See LIVERPOOL; LONDON; MANCHESTER, etc. For history, government, parliament, political parties, judiciary, local government, education, religion, literature, art, army, navy, foreign relations, finance, banks and banking, commerce, industries, agriculture, fisheries, mining, transportation, etc., see GREAT BRITAIN.

England, Church of, the official name of that body of Christians who have a formal head in the person of the hereditary ruler of England. This designation is used in two senses; first, a general one signifying the Church regarded as continuous, which, from the first triumph of Christianity till now, has been that of the English people; secondly, in a more specific sense, the Protestant Church now established in England as distinguished from the Roman Catholic Church. (See article ENGLAND, *Early Ecclesiastical History.*) The evangelistic zeal of Whitfield, Wesley, and various other clergymen, in the 18th century, awoke the Church to new life, which did not pass away even when the followers of these two great preachers ceased to belong to the English Church. The evangelical party, still the most numerous in the Establishment, is in large measure, the fruit of 18th century revival effort. In the 19th the movement was in other directions. With 1833, just after the passing of the first Reform Bill, the first of a series of 'Tracts for the Times' came forth, and 90 in all were issued within the next eight years. The ritualistic party, at a later date, carried on the work which the tractarians had begun. In 1860 the 'Essays and Reviews,' and in 1862 a work by Bishop Colenso on the Pentateuch, gave prominence to the opposite pole of thought, being what theologians call strongly rationalistic. Church congresses, bringing the representatives of these three parties face to face, softened their antagonisms, and fear of common danger renders them more united than they otherwise would be. In the English Church, at present, there are 2 archbishops and 29 bishops, both of the former and 24 of the latter having seats in the House of Lords; subordinate to these are 30 deans, 82 archdeacons, 613 rural deans, and about 13,500 beneficed clergy, the whole clerical staff of all grades being about 23,000. Including infants, it is believed to have above 13,000,000 adherents in England and Wales. Previous to 1871, the English Church and the Established Church of Ireland constituted but a single body called the United Church of England and Ireland. It is powerful also in the colonies, and by means of its two great societies, the Propagation and the Church Missionary Societies, acts powerfully on nearly every part of the heathen world.

The 39 articles, as the established confession of the English Church, deserve a short analysis. The first five articles contain a profession of faith in the Trinity; the incarnation of Jesus Christ, his descent to hell, and his resurrection; the divinity of the Holy Ghost. The three following relate to the canon of the Scripture. The 8th article declares a belief in the Apostles', Nicene, and Athanasian creeds. The 9th and following articles contain the doctrine of original sin, of justification by faith alone, of predestination, etc. The 19th, 20th and 21st declare the Church to be the assembly of the faithful; that it can decide nothing except by the Scriptures. The 22d rejects the doctrine of purgatory, indulgences, the adoration of images, and the invocation of saints. The 23d decides that only those lawfully called shall preach or administer the sacraments. The 24th requires the liturgy to be in English. The 25th and 26th declare the sacraments effectual signs of grace (though administered by evil men), by which God excites and confirms our faith. They are two: baptism and the Lord's Supper. Baptism, according to the 27th article, is a sign of regeneration, the seal of our adoption, by which faith is confirmed and grace increased. In the Lord's Supper, according to article 28th, the bread is the communion of the body of Christ, the wine the communion of his blood, but only through faith (article 29th); and the communion must be administered in both kinds (article 30th). The 28th article condemns the doctrine of transubstantiation and the elevation and adoration of the host; the 31st rejects the sacrifice of the mass as blasphemous; the 32d permits the marriage of the clergy; the 33d maintains the efficacy of excommunication. The remaining articles relate to the supremacy of the king, the condemnation of Anabaptists, etc. See CHURCH; RITUAL; TRINITY, THE.

Eng'les, William Morrison, American author: b. Philadelphia 12 Oct. 1797; d. Philadelphia 27 Nov. 1867. He was educated at the University of Pennsylvania and became a missionary among the Indians of Wyoming. Later he was pastor of a Presbyterian church in Philadelphia for several years, and in 1838 he was made editor of the output of the Presbyterian Board of Publication, becoming president of the board in 1863. Among his works are: 'Records of the Presbyterian Church' (1840); 'English Martyrology' (1843); 'Sailor's Companion' (1857), and 'Soldiers' Pocket-Book' (1861).

Eng'lewood, N. J., city, in Bergen County, near the Hudson River, on a branch of the Erie Railway; about 13 miles north of Jersey City. It is a beautiful residential city, contains two summer homes for working girls, a hospital, and a library with nearly 10,000 volumes. The mayor holds office for two years. Pop. 6,541.

Englis, John, American ship-builder: b. 1808; d. 1888. He built his first steamers on Lake Erie in 1837. In 1861 he built the Unadilla, the first gunboat built for the United States government. Afterward he built the steamboats St. John, Dean Richmond, Drew, Grand Republic, etc. Many improvements in ship-building were due to him.

English, Earl, American naval officer: b. Crosswicks, N. J., 18 Feb. 1824; d. Washington, D. C., 16 July 1893. He entered the naval service 1840; served in Mexican war; became lieutenant-commander 1862, and served in the Civil War. He was made commodore 1880, and rear-admiral 1884; and retired 1886.

English, George Bethune, American adventurer: b. Cambridge, Mass., 7 March 1787; d. Washington, D. C., 20 Sept. 1828. He studied law and theology, and in 1813 published 'The Grounds of Christianity Examined,' a work in favor of Judaism. In 1820 he served as an officer of artillery in the army of Ismail Pasha against Sennaar, and was afterward United States agent in the Levant, returning home in 1827. He published a 'Narrative of the Expedition to Dongola and Sennaar.'

English, Thomas Dunn, American author: b. Philadelphia, Pa., 29 June 1819; d. Newark, N. J., 1 April 1902. He was graduated in medicine at the University of Pennsylvania in 1839; admitted to the bar in 1842; engaged in journalism in New York in 1844–59; then resumed medical practice in Newark. He was a member of the State assembly in 1863–4, and of Congress in 1891–5. He was the author of 'Ben Bolt,' an exceedingly popular ballad (1843), which after having long fallen into obscurity was revived by its employment in Du Maurier's novel 'Trilby'; 'Walter Woolfe' (1842); 'Ambrose Fecit, or the Peer and the Painter' (1869); 'American Ballads' (1882); 'Book of Battle Lyrics' (1886); 'Jacob Schuyler's Millions' (1886); 'Old Glory,' song (1898); etc.

English, William Hayden, American capitalist: b. Lexington, Ind., 27 Aug. 1822; d. Indianapolis, Ind., 7 Feb. 1896. He was elected to Congress in 1852 and served there through four consecutive terms. As a member of the Committee on Territories, in opposition to his own party, he worked against the admission of Kansas to the Union. He reported from the Committee of Conference what was known as the "English bill," in which it was urged that the question of admission be referred back to the people of Kansas according to the provision of the Lecompton constitution. This was adopted and the people voted against admission. He strongly opposed secession, and warned Southern Congressmen that the North would never countenance such a policy. In 1880 he was the Democratic nominee for Vice-President on the ticket with Gen. Hancock. He published a historical and biographical work on the Constitution and lawmakers of his State and furnished money to the Indiana Historical Society to complete and issue the 'History of Indiana' which he had begun.

English Art. The history of English art embraces four divisions, that is, Architecture, Engraving, Painting and Sculpture.

Architecture.—Numerous so-called Druidical stones, a few rude towers, and some other mysterious structures, are the only remains of the architecture of the ancient Britons. The only monuments of the Roman occupation of the country are the ruins of military works, such as roads and fortified walls that had been executed on a magnificent scale. Very little can be said with regard to the style that prevailed in England between the invasion of the Anglo-Saxons and the Norman Conquest, from the fact that the remains of buildings erected in England before the Conquest are few and insignificant. There was not a single cathedral built before that date but was rebuilt during the Norman period, or at some later time, and although there are traces in numerous churches of pure Saxon architecture, there is no entire church now standing which was built during the Saxon period. There is thus little known about this style beyond the fact that it was a variety of Gothic, probably rather rude. The Normans introduced a more highly developed kind of Gothic, the style in which most of the English cathedrals are built. The earlier specimens of this style of architecture in England, such as may be seen in parts of the cathedrals of Rochester, Winchester, and Canterbury, naturally exhibit no distinctively English features, but resemble on all points the works executed in the same style on the Continent. It was not till the beginning of the 12th century that the new architecture began to assume a character of its own peculiar to England. Durham Cathedral affords the best illustration of this style. The ogive or pointed arch appears to have been introduced into English architecture in the second half of the 12th century, and the first traces of its use are to be found in the cathedrals of Canterbury, Rochester, and Northampton. This new modification of Gothic architecture soon made way for itself, although it appears to have been adopted with some reluctance in England. In the end it became the prevailing and even the sole style of ecclesiastical architecture in England, the round arch being entirely disused for three centuries. Among the edifices erected in this style between the 12th and 15th centuries may be mentioned the cathedrals of York, Wells, Winchester, Lichfield, Worcester, Chichester, Lincoln, Westminster, etc. The most characteristic peculiarity of Gothic architecture in England, after the introduction of the pointed arch, consists in the form of the windows in which the mullions rise right up to the main arch of the window, and are often crossed by horizontal bars. This peculiarity has caused the name of perpendicular to be given to the style of architecture in which it is found. The Tower of London, Windsor Palace and the great hall of the palace of Edward III. are the finest specimens of military and civil architecture belonging to the same period as the religious edifices above-mentioned. The Renaissance style of architecture made its appearance under the Tudors, and was associated with the Gothic. The palaces of Richmond and Hampton Court, the chapel of Henry VIII., and the tombs of Queen Mary and Queen Elizabeth at Westminster, Bishop West's chapel in the cathedral of Ely, and the six coffins placed by Bishop Fox around the choir of the cathedral of Winchester, are the principal examples of this mixed style, in which are wanting both the elegance in details and the capricious fancy which distinguish the productions of continental art during the same epoch. In the reign of Charles I. Inigo Jones designed, among other buildings, St. Paul's at Covent Garden and Greenwich Hospital in a peculiar style, imitating the Græco-Roman. Architecture, neglected under the Commonwealth, revived after the Restoration, when Sir Christopher Wren designed an immense number of buildings, particularly St. Paul's Cathedral at London, the towers of Westminster, the Sheldonian theatre of Oxford, Chelsea Hospital, etc. Other architects of his time were not less productive. Among them are Gibbs, and Sir John Vanbrugh. In the 18th century the style of Louis XV. prevailed in England. The most celebrated architects of the time were W. Chambers and Robert Taylor. At the present day English architects are in the habit of copying indifferently from all styles, and sometimes even mix up different styles in the most monstrous fashion. The most striking novelty in architecture in the 19th century is the method of building in glass and iron, first resorted to on an extensive scale by Sir Joseph Paxton in the International Exhibition of 1851, and subsequently adopted in the Crystal Palace and various other structures. See ARCHITECTURE.

Engraving.—Until the 18th century engraving was not cultivated at all in Great Britain except by foreign artists. The German engraver, Wenzel Hollar (d. 1677), was the most distinguished engraver in England in the 17th century. Alongside of the national school of painters, created in the 18th century by Hogarth, Gainsborough, and Reynolds, there arose almost simultaneously an English school of engravers. Hogarth himself acquired some distinction in the art of engraving; but those who were more specially devoted to this branch of art were George Vertue (1684–1756, celebrated especially for portraits), Sir Robert Strange — a Scot (1721–92), Valentine Green (1739–1813), and Richard Earlom (1743-1822). The last two were mezzotint engravers, and carried this branch of the art to a high degree of excellence. The most celebrated line-engravers in the period immediately subsequent to that during which those just mentioned lived were William Sharp (1749–1824), James and Charles Heath (the former died 1834, the latter 1848), and James Fittler (1756–1835). At this period many small plates were produced as illustrations for books. Toward the end of the 18th century the stipple style of engraving was introduced by the Italian Bartolozzi, and since that period it has been followed by a good many English engravers. In 1775 Thomas Bewick (1753–1828) revived engraving on wood, a style which has since been very extensively resorted to for the illustration of periodicals and other works. The most distinguished of his followers were his pupil Clennell, Branston, and John Thompson. Among other English engravers on copper or steel we may enumerate George Doo, John Burnet of Scotland, Samuel Cousins, William Holl, Edward Goodall, and John H. Robinson. In steel engraving English artists have manifested a decided superiority over those of other countries. In lithography, too, some of the English artists have displayed genuine talent. Among the best works which have appeared in this department may be mentioned the collections of architectural views of England and Belgium by Haghe and Nash. See ENGRAVING.

Painting.—Very little is known of the state of the art of painting among the Anglo-Saxons. In the 7th century, Biscop, abbot of Wearmouth, brought from Italy a large number of pictures with which he adorned the churches dependent upon his monastery. In the 9th century Alfred the Great, with the view of refining his war-like subjects, caused numerous manuscripts to be made and adorned with miniatures. Toward the end of the 10th century, Dunstan, archbishop of Canterbury, had the reputation of being an expert miniature painter, and some of his illuminations are preserved in the Bodleian Library at Oxford. Under the reign of William the Conqueror, and those of his two sons, the painting of large pictures began to be studied. Lanfranc, archbishop of Canterbury, a native of Lombardy, one of the most renowned men of letters of his time, adorned the vault of his church with paintings of ravishing beauty, to use the expression of a chronicle of the period. Numerous miniatures of the 13th and 14th centuries have come down to us; the execution is rude, but the style does not want originality. From this period down to the 18th century there were few native painters, and scarcely any of importance in England. A succession of foreign painters were attracted to the country by the munificence of some of the English sovereigns, and of the English aristocracy, but no native talent was developed in this direction. Among these foreign painters connected with England may be mentioned Hans Holbein, a German painter, who enjoyed the favor of Henry VIII.; Federigo Zuccaro, an Italian, who came to England in the reign of Queen Elizabeth, and painted at her court; and Sir Anthony VanDyck, the great Flemish portrait-painter, who lived at the court of Charles I. There is one native English painter deserving of mention who appeared before the close of the 17th century, although even his chief works belong to the 18th. This was Sir James Thornhill (1676–1734), the painter of the cupola of St. Paul's in London, and of the Painted Hall in Greenwich Hospital. The period of the decline of the art on the Continent was the time when England attained her highest eminence in it. When there was no longer any art in Italy, Spain, Germany, Flanders, and Holland, and when France alone of continental countries possessed some painters of lively fancy, there suddenly appeared in London a painter of original and consummate genius, who may almost be said to have created a new kind of painting, in which the artist exhibited the qualities of a moralist and satirist combined with those of the painter; and he was closely followed by two portrait-painters, whose portraits rivaled, in point of elegance, those of VanDyck. The first of these was William Hogarth (1697–1764); the two latter, Sir Joshua Reynolds (1723–92), and Thomas Gainsborough (1727–88). Gainsborough was a distinguished landscape- as well as a portrait-painter. Throughout the 18th century portrait-painting was the most brilliant specialty of the English school. At the same time that Reynolds and Gainsborough flourished there lived also George Romney (1734–1802), who almost equaled them in excellence, and a little later Sir Henry Raeburn (1756–1823), a painter endowed with some share of the vigor of Velasquez, and Sir Thomas Lawrence (1769–1830), who attained more nearly than any other painter to the elegance of style of Sir Joshua Reynolds. He succeeded Sir Joshua in 1792 as court-painter. Barry, Opie, and Copley, the last an American, are among those who manifested more talent in the painting of simple portraits than in the historical composition which they attempted. There also flourished during this century Richard Wilson (1713 or 1714–82), a Welsh landscape-painter in the style of Claude and Poussin, and Benjamin West (1738–1820), an historical painter, who, though American by birth, deserves to be mentioned here from the fact of his having come early to England, and having been connected with England during the most of his life. Hogarth had no immediate successor in the painting of familiar scenes of daily life. This kind of painting was revived with great effect at the beginning of the 19th century by Sir David Wilkie (1785-1841), one of the most popular and highly esteemed of British artists, He made his first appearance at the Academy Exhibition of 1806 with his 'Village Politicians.' Among the painters who have followed in the footsteps of Wilkie may be mentioned William Mulready (1786-1863), Charles Robert Leslie (1794-1859); Daniel Maclise (1811-70); John Phillip (1817-67); William Powell Frith (b. 1819); Thomas Faed (1826-1900); William Holman Hunt (b. 1827); and Sir John Everett Millais (1829-96). The last two were among the founders of the pre-Raphaelite school of painters, the distinguishing characteristic of which is extreme fidelity in matters of detail. The chief historical painters of the 19th century include William Etty (1787-1849), and Benjamin Robert Haydon (1786-1846); by far the most celebrated landscape painter is Joseph Mallord William Turner (1775-1851); and Sir Edwin Landseer (1803-73) is the most distinguished animal-painter that Great Britain ever produced. Water-color painters have been very numerous and successful in England; among them are Corbould, Cattermole, Haghe, Wehnert, Prout and Gilbert (also an oil-painter). See ART; HOGARTH; PAINTING; etc.

Sculpture.—Cæsar records that the ancient Britons were fond of cutting out ornaments of various kinds on their chariots of war, but that they were entirely ignorant of the art of casting statues in metal, or cutting them in stone. The ivory drinking-horn of Ulfus, preserved at York, is one of the few specimens of carving that has come down to us from the time of the Anglo-Saxons. After the Norman Conquest the arts of carving and sculpturing were practised almost wholly by foreign artists, Frenchmen and Italians, and it was not till the 13th century that some remarkable works began to be produced by native artists. At this epoch, however, the arts of carving and sculpture were still regarded merely as handmaids to architecture. These arts received a check during the wars of the Roses, and were not again cultivated till the Renaissance period, when Torregiano came from Italy and executed two masterpieces in England, the tomb of the mother of Henry VII., and that of Henry himself, at Westminster. The troubles of the reign of Charles I. and the Commonwealth produced a new stagnation in the art; and what is more to be regretted, were the cause of the destruction of many valuable works of art in this department. After the Restoration two sculptors of some note appeared in England, Grinling Gibbons, a wood-carver, born at Rotterdam, and Caius Gabriel Cibber, who, though ridiculed by Pope, was a man of real talent. During the 18th century there was no English sculptor of eminence till John Flaxman (1755-1826) appeared to resist the false taste of the time. His monument to Lord Mansfield, and his statues to Pitt and Reynolds, are among the finest productions of English sculpture. He had for rival and successor Sir Francis Chantrey (1781-1841), who acquired renown by the statues which he made of most of the eminent men of his time. John Carew, Lawrence Macdonald, Sir Richard Westmacott (1775-1856), Edward Hodges Bailey (1788-1867), and John Gibson (1790-1866), are a few of the sculptors of the earlier half of the 19th century, to whom we should not forget to add J. H. Foley, W. C. Marshall, P. McDowell, Sir John Steell, and H. Weekes, as among the first sculptors of their time. See SCULPTURE.

English Channel, or **The Channel** (Rom. *Oceanus Britannicus*), an arm of the Atlantic Ocean extending into the west coast of Europe to the Strait of Dover, by which it is connected with the North Sea. The land bodies separated by this channel are England and France. Its length from the Strait of Dover to the Atlantic Ocean is 280 miles; its greatest breadth, from Saint Malo, in France, to Sidmouth, in England, is 140 miles; area 30,000 square miles. The length of the north coastal line, from Land's End to Dover, is 390 miles; and of the south coastal line is 570 miles. Some of the largest indentations on the coast of England are the bays of Falmouth, Plymouth, Lyme, Weymouth and The Solent. On the coast of France are Baie de la Seine and Baie de Mont St. Michel. The principal islands in the Channel are: Isle of Wight, Channel Islands, and several other islands near the coast of France; Scilly Isles and Ushant at the entrance.

English Chronicles. The writing of English chronicles begins with the 'Anglo-Saxon Chronicle,' the earliest English history written in the English language, and the earliest vernacular record of national events in modern Europe. The 'Chronicle' opens with the Christian era, combining in its earlier parts records of Roman, Christian, and British events. It rapidly becomes strictly national, carrying the record of English history forward to a considerable period after the Norman Conquest. It treats in general of the affairs of all the English-speaking peoples in Great Britain, and as one of the first attempts at an expression of coherent national life and as a trustworthy source of information concerning the language, history, and social manners and customs of the Anglo-Saxon period, the importance of the 'Chronicle' can hardly be over-estimated. Although the work itself does not mention the name of its author, there is strong evidence to show that in its original form it was undertaken at the suggestion of King Alfred and was in part actually written by him. From this original form, now no longer extant, copies were made and carried to different sections of England, where they served as foundations of what, from that time, became separate and independent chronicles. Seven of these local chronicles, with a fragment of an eighth, have come down to us. The date at which the original parent version was made was about 892, and the place was probably Winchester, the capital of the West-Saxon kingdom. The form in which the 'Chronicle' is written is that of a book of annals, the entry for each year containing usually the record of but a single occurrence. For the early years the records, derived chiefly from literary sources, are brief and colorless, but in the later parts, particularly in the accounts of the Danish wars, when the narrative becomes more nearly contemporary with the time of the compilation of the work, they become more detailed and vigorous. At no time, however, is there an attempt to write a philosophic history, to point out the causes or the trend of events. This is in accord with the main purpose of chronicle writing, which is merely to keep the events of history in their right chronological perspective, the details centering about these events being largely entrusted to oral tradition. This annalistic purpose of the 'Chronicle' determined also its mechanical form. The scribe's method was to rule off a number of pages as though preparing a journal in which the entries were to be made by years instead of days. Each year was thus given a blank space opposite its number sufficient usually for only a few lines. The scribe then inserted whatever annals he had been able to collect, leaving the spaces for which he had no materials to be filled in later when new material should become available. This method of chronicle writing remained long in use in England, being followed by Capgrave as late as the 15th century.

Although no single model or source for the 'Chronicle' is known, there were in existence in Alfred's time a number of Latin works which were of help on its original compilation. Of these the most important were Bede's 'Historia Ecclesiastica Gentis Anglorum,' finished in 731; Bede's 'De temporum ratione,' a chronological essay containing a short epitome of the history of the world from Adam to 729 A.D.; Orosius' 'Universal History' ('Pauli Orosii Historiarum Adversum Paganos Libri VII.'); and doubtless many records of national events preserved in local monastic libraries. But the 'Chronicle' was an original work in that it strove to record the life of a nation. Just as the codes of laws systematized the customs and rules of living of the people, so the 'Chronicle' fixed for them the ever-receding events of this history.

From the period of its original composition to the middle of the 11th century, the 'Anglo-Saxon Chronicle' established the form for all historical writing in England. Although we now know only seven, with the fragmentary eighth, versions of the 'Chronicle,' the number in the Anglo-Saxon period must have been much greater, copies being probably kept at every important monastery and town. Towards the end of the Anglo-Saxon period, however, the 'Chronicle' tends to become less and less national, and more and more ecclesiastical in its character. In harmony with this change, the language of chronicle writing changed also to Latin. The use of Anglo-Saxon as late as 1154, the date of the latest entry in that tongue, appears only in one version, and is plainly due to reasons of respect for the traditional language of the 'Chronicle.' To take the place of the English annals of the 'Chronicle,' new histories began to be written in Latin. The earliest of these was that of Ethelwerd; others from the beginning of the 12th to the 14th century were the histories of Symeon of Durham, Florence of Worcester, William of Malmesbury, Henry of Huntingdon, Roger of Hoveden, Matthew of Paris, Matthew of Westminster, Roger of Wendover, and Ralph Higden, whose 'Polychronicon' was the "standard work of general history in the 14th and 15th centuries" (Babington, ed. of 'Higden' in 'Roll's Series,' p. xliii.). All of these Latin histories derived much of their material either directly or indirectly from the Anglo-Saxon Chronicle. In the Middle English period, several metrical histories were written in English, the 'Brut' of Layamon, the chronicles of Robert of Gloucester, and of Robert Manning of Brunne; but these are better characterized as historical romances than as attempts at veracious history. The writing of prose histories in English begins again with Trevisa's translation of Higden's 'Polychronicon,' made in 1387, and with John Capgrave's original chronicle, written about the middle of the following century. The tone of Capgrave's work, as compared with the Anglo-Saxon Chronicle, is extremely naïve. The writers of the Chronicle had a most rigid sense of historical fact, but the work of Capgrave and his contemporaries is marked by an altogether uncritical and credulous mingling of legend and history. As a result, however, of this infusion of the romantic spirit into historical writing, the older annalistic method gave way to one in which greater attention was paid to a consecutive narrative interest, after the manner of modern historical writing. The national awakening accompanying the reigns of Henry VIII. and Elizabeth resulted in a renewed interest in the writing of these history-chronicles. In 1516 appeared Fabyan's 'New Chronicles of England and France'; in 1562 Grafton's 'Abridgment of the Chronicles of England'; in 1565 Stowe's 'Summarie of Englyshe Chronicles'; and in 1578, the most important of the Elizabethan chronicles because of the use made of it by Shakespeare, 'The Chronicles of England, Scotland, and Ireland,' written by Holinshed with the assistance of several others. The term chronicle continued to be used in the titles of historical works to the end of the 17th century, as in Sir Roger de Coverley's favorite book, Baker's 'Chronicle of the Kings of England,' 1643; by this time, however, the naïve annalistic chronicle had largely given way to the more philosophical treatment of events which is designated by the name of history.

Bibliography.—For general bibliography, consult Gross, 'Sources and Literature of English History from the Earliest Times to about 1485' (1900). Editions of most of the chronicles will be found in the Great Britain Rolls Series; the best edition of the Anglo-Saxon Chronicle is that of Earle and Plummer (Oxford 1892-1899). The literary significance of the chronicles is discussed by Schofield, 'English Literature from the Norman Conquest to Chaucer' (pp. 29-46); and by Schelling, 'English Chronicle Plays' (New York 1902).

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English College at Rome, an ancient institute in the papal city, founded, according to mediæval chroniclers, about 816, for in that year the *angelcynes scolu*, school of the English nation, was destroyed by fire. Built anew, it had a like fate twice in that century. Thomas à Becket, archbishop of Canterbury, was lodged in the hostel when he visited Rome. Shortly after the murder of the archbishop and his canonization the church adjoining the college was called by his name. Later the hostel connected with the college was abandoned, and in 1380 a new hostel was built and liberally endowed, chiefly by rich London merchants, for free entertainment of Englishmen visiting the Holy See. In the time of Henry VIII. refugees from England were harbored in the hostel. In the reign of Elizabeth the institution was transformed into a seminary for the education of aspirants to the priesthood who proposed to serve in the English mission, which they entered with pretty fair assurance of the martyr's crown. Between 1578 and 1647, 40 of the alumni of the institution, serving as missionary priests in England, were executed for the high treason of exercising the Catholic ministry contrary to the laws of the realm; and when St. Philip Neri, founder of the Congregation of the Oratorians, met any of the young English ecclesiastics in the streets of Rome, his invariable salutation was *Avete flores martyrum* — "Hail flower of the martyrs." The college was plundered and wrecked by the French republican army 1798 and its resources dissipated; it was resuscitated 1818; its president from 1831 to 1846 was Nicholas Wiseman, afterward first archbishop of Westminster, and cardinal.

English Constitution. See ENGLISH POLITICAL DEVELOPMENT; PARLIAMENT.

English Harbor, a harbor on the southern coast of Antigua, one of the Leeward Islands. It is the site of a British naval station, which from its location is one of the important British possessions of the West Indies.

English Language. The English language is a direct development of the Anglo-Saxon, a circumstance which makes it questionable whether the latter speech ought to be distinguished by a separate name. But although a direct development of the Anglo-Saxon, it is not a development which has been allowed to take place regularly and gradually, as the result merely of internal causes. One important external influence was brought to bear on the original form of our language, which had the double effect, first, of producing a much more sudden and complete modification of the grammatical structure than could have taken place if the language had grown up independently of foreign influences; and secondly, of giving a composite character to the vocabulary of the language by the introduction of a large number of foreign words. This external influence was the Norman Conquest, in consequence of which a new language, the Norman-French, came to be spoken in England by those who had made themselves the masters of the country, and who formed, therefore, almost the only class that had leisure and opportunity for literary pursuits. The immediate result of the Norman Conquest (1066) was thus that the language of the Normans came to be the chief literary language of England (except where Latin was used), and that the Anglo-Saxon was reduced to a very subordinate place. When the latter language again comes into notice as a written language, a great change is seen to have been wrought in it. Before the Conquest it was a very highly inflected, or what is called a synthetic language, that is, one in which the substantives, adjectives, verbs, and articles are subject to numerous modifications, each of which expresses a modification of the root-meaning of the word, or shows the relation of the word to the other words in the sentence. During the period when Anglo-Saxon ceased to a great extent to be a written language these inflections dropped off; and when it re-emerges as a written language about the end of the 12th century, it is no longer synthetic, but analytic, that is, prepositions and auxiliaries are now used instead of inflectional prefixes and terminations to express the various modifications of the idea contained in any word, and the relations of the words in a sentence to one another. At this period, however, the language still continued to be essentially homogeneous in respect of its vocabulary: the Norman words that occur are so rare that they need not be taken into account. And it was natural that it should be so, for the Saxon language was still confined to the Saxon inhabitants of the country; and those who wrote in it addressed themselves only to that portion of the community, and accordingly had no occasion to use any word of Norman origin. This state of matters lasted till about the middle of the 13th century, which is the period at which English proper is usually regarded as having begun to be spoken and written. By this time the Normans began to experience the inconvenience of not being acquainted with the language of the people among whom they dwelt, and in learning to speak and write it they very naturally used a large number of Norman words, and these words were adopted by all such writers belonging to the subject race as wished to make themselves understood by Norman as well as by Saxon readers. A very rapid mixing of the two languages thus took place, and a second important change was wrought in the English language. It is no longer homogeneous in its vocabulary, but contains a large admixture of foreign words. The whole of what precedes may be shortly summarized thus: — From 450 to 1066 the language spoken in England was the so-called Anglo-Saxon, a dialect of Low German, very highly inflected. From 1066 to 1250 two languages were spoken in England, Anglo-Saxon and Norman-French, by two different sections of the population occupying different political positions. During this period the grammatical structure of the former language began to be broken up, chiefly owing to its being disused for literary purposes; and toward the end of the period we find a few works written in a language resembling the English of our day in grammar, but differing from it by the homogeneousness of its vocabulary. Finally, about 1250 the two languages begin to mingle, and form one intelligible to the whole population, Normans as well as Saxons. This is what is usually called English proper. English is thus seen to be a composite language, deriving part of its stock of words from a German source, and part from a Latin source, Norman-French being in the main merely a modified form of Latin. The changes that have taken place in the English language subsequently to 1250 are by no means as striking as those which took place in the transitional period between 1066 and 1250. Some few inflections which the English of the 13th and 14th centuries still retained have now been dropped, but the chief change which the language has experienced consists in its gradual growth and expansion in obedience to the requirements of advancing science, more complicated social relations, and increased subtlety of thought. This growth has been going on at all times, but there are some periods which may be pointed out as more remarkable than others for the rapidity with which it proceeded. Such a period was the end of the 16th and the beginning of the 17th century, the period of the Reformation and following the revival of learning, when numerous words of Latin origin were introduced by scholars directly from that language, instead of through the French, the channel through which most of the Latin words previously found in the language had come. Another such period is the present, when the rapid growth of the sciences already existing, and the creation of new sciences, have caused whole groups of words to be introduced, chiefly from the Greek.

It would scarcely be in place here to discuss the various excellencies and defects of the English as compared with other languages, but we may mention the following as among the qualities which the English language is generally allowed to possess. 1. Strength and expressiveness, adapting it admirably for poetical composition. 2. Copiousness. In connection with this may be noted the extraordinary receptivity of the language, that is, its capacity for adopting new words from all sources, and of naturalizing them at once, so that they may be treated without any appearance of strangeness entirely as native English words. 3. Simplicity in form and construction. 4. Great flexibility, or adaptability to all kinds of composition, the grave and gay, the impassioned and calm, forcible and tender, sublime and ludicrous.

In connection with the subject of the English language, we may here further observe, that England and the United States offer the first instance in history of two great, independent, and active nations having a common language, but situated at a great distance from each other, and daily developing new and characteristic features. These relations must, sooner or later, exert a powerful influence upon the common language, for no language is so stable as not to undergo continual changes, if spoken by a people in the full vigor of social and political life. This state of things has already produced some effect on the English language. The most material difference, probably, has been in the pronunciation of the language, which, however, important in our daily conversation, is of secondary importance in relation to the literature and written language of the two countries. It has often been observed by English travelers and others that the pronunciation of the United States is far more uniform than that of England; and so nearly alike everywhere, that the people of any one town or district are perfectly understood in every other part of the country, which is not true of the lower ranks of England. When considered more minutely, however, there has for a long time existed a marked distinction between the pronunciation of the New England and Southern States. The orthography of the English language has undergone no material change in America, it being the general inclination to follow that of the best English writers of the age.

The English language may be divided into five periods:

1. First Period 450-1100 A.D.
2. Second Period 1100-1250 A.D.
3. Third Period 1250-1350 A.D.
4. Fourth Period 1350-1460 A.D.
5. Fifth Period 1460 A.D.—the present day.

In the first period (called also Anglo-Saxon or Old English), the language was inflectional; in the second it began to show a tendency to become analytic, the tendency increasing till in the fourth period inflections had virtually disappeared. Before the Norman Conquest there were two dialects in English, a southern and a northern, the former of which was the literary language. After the Conquest dialects became much more marked, so that we can distinguish three great varieties, the northern, the midland, and the southern, distinguished from each other by various grammatical differences. The midland dialect was that most widely spread, and it ultimately became the standard language, a result principally due to the influence of Chaucer, and in a less degree of Wyclif, Gower, and others. See DIALECT; SCIENCE OF LANGUAGE.

English Literature. The Norman conquest made a great change in the development of an English literature, as in all other departments of English life. Conditions were at first most unfavorable: the English language might be used by any who pleased, but the clergy naturally used Latin, and people of any position, French, or Anglo-Norman, as it is commonly called. For three centuries, therefore, we do not find in English any striking original work, anything to compare in interest with the Skaldic poetry and the Sagas in Iceland, with the French romances and fabliaux, with the German epic and courtly poetry. During these centuries, however, we do find in England what is in its way most interesting, namely, a singularly rich representation of the different phases of mediæval thought. We may conveniently begin with the work connected with the older order of things. The Anglo-Saxon Chronicle was still kept up at Worcester and at Peterborough. Of these the former is preserved only as far as 1079; the latter is a much later work; in 1121 the whole chronicle was rewritten and then carried on to 1154, being something more than a mere set of annals, with a distinct character of its own. After this, beginning indeed before, comes a stately series of Latin chronicles, but in English we find only chronicles in verse. Layamon's 'Brut,' (c. 1200, after the Anglo-Norman of Wace, which itself is a paraphrase of Geoffrey of Monmouth) is most interesting as language, literature, and legend, giving, among other things, the introduction of King Arthur to English readers. Much later are the chronicles of Robert of Gloucester (c. 1300) and Robert of Brunne (1330). Layamon is hardly as much history as romance. Of this latter almost everything is from French, Scandinavian or Celtic sources: there is little native English either in form or substance. 'King Horn' (c. 1250) and 'Havelock the Dane' (c. 1275) probably go back to Scandinavian originals, though they are still regarded by some as English legend material: more purely national are the stories of 'Bevis of Hampton' (c. 1275) and of 'Guy of Warwick' (c. 1300), though the versions preserved are probably from Anglo-Norman originals. Renderings of Continental romances are numberless, beginning about 1250 with the Alexander story and going on with the tale of Troy, the stories of King Arthur, the Round Table, and the Holy Grail, where the material is partly Celtic, giving even somewhat of the legends of Charlemagne, and many minor stories, as 'Floris and Blancheflor,' 'Amis and Amilon,' 'Sir Tristram.' Somewhat later (1300), and less fully, come versions of the fabliau, 'Dame Siriz,' 'Reynard the Fox,' the 'Land of Cokayne,' the 'Lay of the Ash.' About this time appear the great mediæval collections of stories, the 'Seven Sages' and the 'Gesta Romanorum,' which latter, though in Latin, was collected in England. Besides all this epic and narrative material there is a smaller lyric element: oftenest anonymous, like 'Sumer is ycumen in,' (c. 1250), 'Winter wakeneth all my care,' and other love songs, as well as many political songs, among which are the patriotic poems of Lawrence Minot (c. 1325). But generally where it is not narrative, the Middle English poetry is didactic: the so-called Proverbs of Alfred, dating from the twelfth century and preserved in several versions, may have old material and certainly keep something of the old alliterative form, though there is also the Norman element of verse. And as the Anglo-Saxon priestly writers used alliteration in their didactic prose, so now much of the religious literature is put into rhyme, a fashion of the Norman. The 'Poema Morale' (1200) is a sermon in verse, though now and then with a personal element, and there are many more shorter homilies. A common form is the dialogue; the 'Debate of the Body and the Soul' is known in various forms (1200 and after), the dialogue between 'Mary and the Cross,' and others including, in lighter mood from a French source, the 'Owl and the Nightingale' (1220), a poem full of popular wisdom in which the gay and the gloomy views of life are championed respectively by the two birds who refer the dispute to Master Nicholas of Guilford, generally taken as the author. Less original in substance are the versions of Scripture of which the 'Ormulum,' a metrical paraphrase of the Gospels by Orm of Lincolnshire (1220) is most important for linguistic reasons, preserved in an autograph copy (probably) with an individual system of phonetic spelling. Versions of Genesis and Exodus (c. 1225) are also to be mentioned, while much later in the north (1320) 'Cursor Mundi' reviews the whole extent of history from the creation to the day of judgment. Lives of the saints there were also, especially of Saints Katherine, Margaret, and Juliana, and much devotional poetry, some lyric, like the 'Wohung of oure Loverde' (c. 1225), and others, some didactic, like 'Hali Meidenheid' (c. 1250). There are also certain larger religious treatises: the 'Ancien Riwle' (1225), a prose work of considerable merit, giving the conditions of convent rule, and in the early part of the fourteenth century, three books on holy living, the 'Prick of Conscience,' by Richard Rolle of Hampole; the 'Ayenbite of Inwit,' by Dan Michael of Northgate, and 'Handlyng Synne,' by Robert of Brunne, the two latter from the French. Also to be noted is the very characteristic 'Bestiary' (1225), a compilation of the mediæval speculation on natural history. Such are the main elements of Middle English literature before 1350, although the number of particular works is far greater. As is common in mediæval literature the language is dialectic: no one dialect gains entire primacy till much later, although by this time the East Midland has become the most important. The second half of the fourteenth century was a period of great literary activity. England had been long separate from Normandy, and the English language, like the English people, had digested its different elements into an organic combination. Literature now becomes more literary. The old forms were now only to some degree preserved: Trevisa translated the 'Polychronicon' of Higden (c. 1387); Barbour in the north wrote a rhymed chronicle of Bruce (c. 1375). There are numbers of romances from the French. But didactic or allegoric poetry appears in forms which, though not new, have yet a certain original character. There are two great poets: one of name unknown, the author of the 'Pearl,' 'Gawain and the Green Knight,' 'Cleanness,' and 'Patience,' the other William Langland (as is most commonly thought), the author of the 'Vision Concerning Piers the Ploughman.' Fine as is their work, it is outshone by the genius of Chaucer, who gathered up and summarized the spirit of the century and whose influence was carried through the century following by companions or followers of whom the most noteworthy were Gower, Hoccleve, and Lydgate. The epoch was also illuminated by Wiclif's great translation of the Bible (c. 1382). Two more popular forms of literature must be mentioned, as beginning lines of literary development still important. The ballads of Robin Hood probably go back to this period, while many of the Scotch ballads are older. The four cycles of mystery plays, those of Coventry, Chester, Wakefield (Towneley plays) and York, belong to the earlier part of the century. One remarkable book comes in no category, the 'Voiage and Travaile of Sir John Mandeville,' widely spread in England, and, though a translation, a monument of noteworthy prose. The 15th century was a period of bloody civil strife, and in literature a period of great dearth. Little can be mentioned in a summary. Sir Thomas Malory closed the period of the romances of chivalry by the 'Mort Darthur' (c. 1475), a collection to which he gave organic form and unity. The book was first printed (1585) at the press of Caxton, himself a writer and compiler. Some prose treatises are noteworthy, in religion Pecocke's 'Repressour of too much overblaming of the Clergy' (c. 1450); in politics, Fortescue's 'Monarchy,' (c. 1425), while of lighter interest is the treatise on 'Hawking' by Dame Juliana Berners (c. 1425), and the every-day Paston Letters which belong to literature because they are so interesting.

With the 16th century new influences become powerful. The revival of classic learning stimulated English scholars under the leadership of Grocyn, Linacre, Colet, Cheke. The ideas of the reformation stirred up clouds of controversy in which appear the great figures of Tyndale, Latimer, Coverdale. The spirit of nationality was aroused and More ('Utopia,' 1515), and Elyot (Governour, 1531), thought deeply on questions of politics. These men wrote not so much for literary reasons as for some particular purpose: later came the impulse of the Renaissance which brought forth in England a wonderful burst of literature, generally included in the age of Elizabeth. Most important was its manifestation in the drama. To the mystery plays had succeeded miracle plays, and then moral interludes, and imitations and translations from Seneca and Terence. By the latter half of the century appeared the first specimens of modern drama, 'Ralph Roister Doister,' by Nicholas Udall (1550) and 'Gorbuduc,' later called 'Ferrex and Porrex,' by Sackville and Norton (1569). The Theatre was built in 1579, the Curtain not long afterward, and in the last decade of the century the Rose, the Globe, the Fortune and others. The theatre of the day demanded a drama rich in poetry, rhetoric, declamation, and action. The first group of dramatists, Lyly, Peele, Kyd, Greene, and greatest of them, Marlowe, were all of necessity experimentalists. They created the romantic drama, with tragedy, comedy, history, into which Shakespeare poured his inexhaustible stores of imagination, observation, and wisdom. His plays are typical of the Elizabethan drama: there is little in the other dramatists that you cannot find in him. Yet there were others of great power. Ben Jonson is usually accorded second place, and Beaumont and Fletcher, Marston, Middleton, Heywood, Chapman, Massinger, Ford and Shirley, beside others, have each special powers, although a decline occurs and in 1642 the theatres were closed by order of Parliament and a great dramatic tradition came to an end. One later form deserves special mention: the masque was originally a form of private theatrical and always remained distinct from the plays presented at the public theatres. It was produced for some special great occasion and employed all the possibilities of the day in scenery and costume, music and dancing. The words were often written by dramatists of great ability, notably by Ben Jonson. The most famous and beautiful masque was written at the end of the period, the 'Comus' of John Milton. In lyric poetry as well as in dramatic was the age pre-eminent. In the reign of Henry VIII., Wyatt and Surrey had led the way, though under the influence of Italy, in 1557 appeared Tottel's 'Miscellany,' an anthology which gathered up the verse of preceding years, and some years afterward came another, the 'Paradise of Dainty Delights.' Later collections are the 'Bower of Delights,' 1591; 'The Phœnix' Nest,' 1593; 'The Passionate Pilgrim,' 1599; 'England's Helicon,' 1600. Another characteristic production was the sonnet-sequence, of which Sidney's 'Astrophel and Stella' (1591, but written before), is one of the best and earliest examples. Here belong the famous sonnets of Shakespeare, as well as Daniel's 'Delia' (1592), Drayton's 'Idea' (1593), Spenser's 'Amoretti' (1595), among a host of others. One great lyric poet is pre-eminent, John Donne, whose poems, written in his earlier years, had immense influence. This form of the lyric is in the imitations fanciful and finespun, but in Donne himself it is alive and wonderful. Last among the lyrics and as important as anything else are the songs. Music had an important place in English life, and where there was so much singing, there needed to be good songs. There appeared great numbers, some in the plays and others in song-books, of which many still exist. A good many are translations and more are very slight, but Shakespeare's and Jonson's among the dramatists, and Campion's among the song-writers, are worthy a high place in any anthology. In the seventeenth century, while the drama lost power, the lyric sustained itself remarkably, though in the hands of fewer artists. They are generally followers in well-known lines, the paths of Spenser, of Jonson, of Donne, but they often produced work quite equal to their masters. The early poems of Milton, the exquisite 'Hesperides' (1647) of Herrick, the courtly and amatory poetry of Carew, Suckling, Lovelace, the religious poetry, passionate and almost sensuous in Crashaw, earnest and devoted in Herbert, these show no failure in power or in genius. One great name in Elizabethan poetry is still to be mentioned, that of Spenser. The 'Amoretti' are as beautiful as any of the sonnet cycles, the 'Shepherd's Calendar' (1579) was an immense influence for a long time, but his great title to fame is the 'Faerie Queene' (1590–96), a work which in literary form stands a little apart from its time. It is a romantic epic, akin to the Italian poetry of the preceding century, but Spenser's own, in its high idealism, its pictorial quality, and its mastery of poetic expression. It had imitations and followers, but none of great merit. It is well-nigh impossible to bring the prose of this period under any series of heads. Poetry always comes first in literary development: in the 16th century prose was commonly written for some practical purpose. It is true there was some growth of style: many men labored at improving the vocabulary and elaborating the sentence-structure and the resources in figure and ornament. Yet there were hardly any well-established prose-forms: the 'Arcadia' (1580–90) of Sidney, the 'Ecclesiastical Polity' (1592–7) of Hooker, the Essays (1597) of Bacon, are of widely differing kind and provoked little following. Even Lyly's 'Euphues' (1578–79) which was immensely imitated for a decade, produced no permanent form. The pamphlet or the tract is the one characteristic Elizabethan production: its master was Tom Nash, who poured forth numbers of these ephemeral pieces, of wonderful vigor and spirit. Of the same sort of prose the succeeding century showed much. The reign of Elizabeth had been a time for Englishmen to get together and establish their position against the world. Having made themselves a place, they turned to put in order their own house: the 17th century is a period of civil strife and contention. Literature could not avoid the effect of politics: the disturbance of opinion dragged with it into political or religious controversy many who might otherwise have found expression in literature. Even Milton for a dozen years wrote chiefly prose. We cannot, therefore, look for a varied and definite literary development. The greatest work of the century was in prose and the greatest and most influential single monument was the King James version of the Bible (1611). The spirit of the Bible is everywhere to be felt in the great prose of the time, transmuted into varying substance in the eloquence of Jeremy Taylor ('Holy Living,' 1650), the quaint richness of Fuller ('The Holy State,' 1642), the stately roll of Sir Thomas Browne ('Religio Medici,' 1643), the powerful vigor of Milton's prose — written during the Civil War, to answer in his own way the call of the country — and the intimate simplicity of Bunyan. A few other writers have little tincture of the struggle of the time, Overbury's 'Characters' (1614), Burton's 'Anatomy of Melancholy' (1621), Cowley's 'Essays' (1868), Walton's 'Compleat Angler' (1653) works of a widely different nature, but showing the quiet, contemplative side of the century that was so distracted by controversy. The Civil War occurred in the very middle of the century, and makes a definite bar at least with the poetry of the time. Before it was the Elizabethan age; after it the Restoration. The drama and the lyric before and after are different: even the external form of poetry shows a marked change. At the beginning of the century the verse was free and fluent: at the end it had become concise and brilliant. To the blank verse of Shakespeare succeeded the rhymed couplets of Dryden, organic power giving place to elegant skill. In point of time belonging to both, John Milton in reality belongs to neither. More fully than anybody else he is the representative of Puritanism in literature: its zealous rages, its fanaticisms, its blemishes, its love of liberty and of God give life to his prose tracts on church government, on divorce, on freedom of speech, on the acts of the people: its higher dreams and ideals and aspirations, its unattained possibilities of beauty in 'Paradise Lost' (1667), and his later poems.

With the Restoration of Charles II. began a new period in literature, often called the classic, most immediately noticeable in the drama. The influence of France in the direction of strictness of classic art and looseness of moral life, was strong: added to it was a change in stage conditions, which allowed the development of scenic effect. A realistic, if not spectacular, character, was given to the theatre and the Elizabethan plays, with all their poetry, fell out of fashion, save in versions of the day. A new set of dramatists sprang up to fulfill the conditions. Dryden was the chief, equally strong in tragedy and comedy and what he called the heroic drama, after French models. Otway had the greatest tragic genius ('Venice Preserved,' 1682), but could not so well adapt himself to the taste of the age. Congreve, Wycherley, Farquar and many others wrote comedies depicting a brilliant social world, but of such gross immorality that Jeremy Collier (1698) launched an attack on the whole theatre. His words had some effect and the drama became more decent, but as it really seems to have been quite representative of the life of the time (not artificial as Charles Lamb loved to think of it), the succeeding drama lacked vitality, and for a hundred years hardly a play was written which is now remembered. Addison's 'Cato' (1713), Rowe's 'Jane Shore' (1714), Gay's 'Beggar's Opera' (1728), Johnson's 'Irene' (1749), Home's 'Douglas' (1756), are noteworthy for various reasons, but not as constituting a powerful drama. It was in other directions that the 18th century was successful. In 1709 Richard Steele published a small paper every other day which he called the 'Tatler.' It was not precisely a newspaper, but consisted rather of a series of essays on all sorts of subjects, sometimes by Steele, sometimes by Addison, Swift, or a number of others, who lent occasional help to the enterprise. The 'Tatler' was very popular, and was brought to a close only to be continued in the 'Spectator,' in which Addison took the chief part. He took up the idea of Steele and found in it a form of expression exactly suited to his especial powers. His essays were popular in the best sense: they were read with delight by all sorts of people, but they dealt with subjects of intelligent interest. Addison was a student of human nature, an observer of life and character, a genial philosopher and all these elements of his nature were exhibited in the little essays which he wrote for the 'Spectator.' The success called forth followers: Addison and Steele followed their joint productions with separate publications, which were sometimes political as well as literary. Among the many 18th century periodicals should be mentioned the 'World' (1752), by Lord Chesterfield and others; the 'Rambler' (1750), and the 'Idler' (1758), by Samuel Johnson; the 'Bee' (1758), by Goldsmith. The influence of this sort of literature abroad was also very great: it continued even to the beginning of the 19th century, when a number of clever young men of New York, Washington Irving among them, joined in the production of 'Salmagundi' (1807). One distinguishing element in these periodical essays was that of personal character. Some imaginary person was the means by which they were put before the public: the 'Tatler' was edited by Isaac Bickerstaft, the 'Spectator' by a club of the Spectator and others, including the famous Sir Roger de Coverley. This personal element was characteristic of the century, which was extremely sociable and very much interested in human nature. These frequent sketches of character and observations of life and manners were not absolutely new even in England: so-called "Characters" had been not uncommon in the 17th century and were well known in France. This interest in character for itself is paralleled by an interest in life in action observable in the stories of Defoe. Defoe was a man who lived by his pen (one of the first who had not been connected with the theatre or the court), whose great gift so far as literature was concerned was his power of representing life. His famous 'Robinson Crusoe' (1719) attained inordinate popularity, not only for its adventurous incident, but for its power of realistic story-telling. A little more and these things would have been novels. Addison's 'Sir Roger de Coverley' papers are sketches of life and character without a story. 'Robinson Crusoe' and the many other stories of Defoe have too much action, without attention to life and character, in spite of their realism. These elements were combined by Richardson and Fielding: 'Pamela' (1741), 'Clarissa Harlowe' (1748), 'Sir Charles Grandison' (1753), by the former, were immensely read and influenced all Europe; 'Joseph Andrews' (1742), 'Tom Jones' (1749), 'Amelia' (1751), by the latter, are quite as excellent and somewhat more modern in form. Smollett followed with 'Roderick Random' (1748), 'Peregrine Pickle' (1751), and some others, which are a slight variation upon the first of Fielding's. Goldsmith's 'Vicar of Wakefield' (1766), and Miss Burney's 'Evelina' (1778), give us, the one the life of the country, and the other of the town, and we have the English novel of domestic life, a form of literature which for a hundred and fifty years has lost and gained but little in essential character. The essay and the novel were new: such things had been in England before, but never the definite literary understanding necessary to constitute a true literary form. Meanwhile the older forms of literature were not neglected. There had been no such histories in England before Clarendon's 'History of the Great Rebellion' and Burney's 'History of My Own Time.'

These men wrote of what they had seen, later writers learned to take a larger view and handle larger material. Robertson ('Charles V.,' 1769), Hume ('History of England,' 1754-61) and Gibbon ('Decline and Fall of the Roman Empire,' 1776-88), gave example of the combination of scholarly research and literary skill. Oratory also flourished in the exciting Parliamentary struggles which now took the place of court faction. Chatham, Burke, Fox, and many others created a standard and form of eloquence, which yet serves as a model for many speakers and a foundation for more. A special form of oratory becomes important in literature; sermons were vastly read. Barrow, South, Stillingfleet, Tillotson, published their discourses in the last half of the 17th century, and had many successors in the first half of the 18th. The interest in religion was a part of the general intellectual curiosity of the century; philosophy also became a part of literature. Locke's 'Essay on the Human Understanding' (1690) was more widely read than any other book of such a kind. Every one discussed a little philosophy, whether Christian or free-thinker. Berkeley was the former: his 'Principles of Human Knowledge' (1710) has been of importance in the development of metaphysical ideas. Hume was the latter, so much of a skeptic that his 'Essays' (1746) incited Kant, in Germany, to that profound examination of the human reason that has been the foundation of modern philosophy. The 18th century was a century of reason and of prose. Prose was first simple, either graceful as in Addison, nervous in Defoe, or everything in turn in the wonderful prose of Dean Swift, an unapproached master of satire. As the century continued, style became more elaborate, of great dignity and stateliness at its highest points (Gibbon and Burke) and even for ordinary purposes admirably effective as in the best of Johnson. The time was intellectual and loved the things of the intellect; hence its poetry was not such as to satisfy the more emotional periods that came after. It was too obviously didactic or satiric, for one thing. Dryden was the first great master on these directions with the 'Hind and the Panther' (1687), and the 'Religio Laici' (1682). In Pope the classic poetry (as it is called) came to perfection, the 'Essay on Criticism' (1711), and the 'Essay on Man' (1732), the 'Dunciad' (1728) and the 'Rape of the Lock' (1712), have never been equaled in English for their telling brilliancy. The followers of Pope caught something of his manner, but produced nothing great, save Goldsmith, who infused a charm into this as into every other kind of literature. Dr. Johnson wrote two strong poems, but his chief power lay elsewhere. The minor exemplars of the characteristic 18th century poetry are of far less value. Addison as a poet, Garth, Prior in 'Solomon' (1718), Young, the author of 'Night Thoughts' (1742), Blair, 'The Grave' (1743), even Akenside, the author of 'Pleasures of the Imagination' (1744), did not all write the characteristic couplet, but they are all of the classic school and all wrote that intellectual poetry that now seems so strangely unpoetic. In lighter forms of verse there were more successful practitioners, Prior and Gay and Swift, but in didactic and satiric poetry, save in the work of the greatest, the 18th century produced nothing permanent. But during the whole classic century there had existed, in its time had been growing, a feeling for other things than those which the reason could put into brilliant and elegant form. It found expression in various ways, chiefly in love for the mediæval past, before the classic conventions had been, and in a feeling for the present wherever those conventions did not exist, namely, in nature and in the heart of man. The first feeling came to expression in various ways, often imperfect, as when Thomas Wharton wrote 'Runic Odes' (1748), when Gray wrote poems inspired by the Norse, 'The Fatal Sisters,' 'The Descent of Odin' (1761), when Sir Horace Walpole imitated Gothic architecture in his house at Strawberry Hill. In 1760 Macpherson published what purported to be translations of Ossian (also 'Fingal,' 1762; 'Temora,' 1763), and whether they were genuine or not, the fact that they were read shows the interest that was felt in the remote past. In 1767 Chatterton found that he could gain a public for his poetry by pretending that it had been written by a monk of the 15th century. In 1765 Percy published the 'Reliques of Ancient Poetry,' a collection of old ballads, a kind of literature full of the spirit of the past, and absolutely different from the classic poetry of the day. There had been plenty of ballads printed before, even collections of old ballads (Ramsay's 'Tea-Table Miscellany,' 'Evergreen' (1724); and they had inspired a few, but now they became an immense influence. In the other direction, love of nature and sympathy with man. Thomson's 'Seasons' (1726-30) show his fresh and charming view of nature, though his use of blank verse and the Spenserian stanza was more in keeping with earlier times. Gray produced very little poetry, but his best, the famous 'Elegy' (1751) has none of the brilliancy and intellectuality which marked the century, and it is noteworthy that in stanza 15, where he originally wrote the classic names of Cato, Tully, Cæsar, he afterward put the national names of Hampden, Milton, Cromwell. Burns was far too much of a man to be bound or curbed by fashions, unless they had been far more congenial than those of the 18th century. He took inspiration from the ballads and songs of his own country and produced poetry which touched the heart at once. Cowper, though by no means like him, nor apparently of the character of a reformer at all, wrote with a sincere directness that belonged to an earlier or a later time. The turn of the century shows the characteristic works of the Romantic movement: 'Tintern Abbey' (1798) and 'Michael' (1800), by Wordsworth, may represent the poetry inspired by love of nature and sympathy with man. Coleridge's 'Rime of the Ancient Mariner' (1798), and Scott's 'Lay of the Last Minstrel' (1805, preceded by 'Minstrelsy of the Scottish Border,' 1802) stands for the delight in ballads and mediævalism. With these fine poems and others only less so, it is plain that a new form of art has appeared different *in toto* from the classic conventions of the 18th century. The first great excitement of romance was for strange adventure and the glowing life of the Middle Ages. Wordsworth was for the time unread, while the poetry of Scott delighted all. Scott, however, was eclipsed in the popular mind by Byron, who really was personally the very thing that Scott and the public admired. They longed to hear of men of lofty spirit and recklessness and devotion. Byron was such a man; in 'Childe Harold' (1812) he took England out of itself. In the 'Gaiour,' 'Bride of Abydos,' 'Corsair,' 'Lara,' 'Parasina' (1813-15), he presented figures full of the romantic spirit. As the century continued, however, that spirit expressed itself in all sorts of different ways. Wordsworth presents the common delight in nature, Shelley, noble ideas for the regeneration of mankind. Keats, the power of beauty. Succeeding poets go in much the same directions. Tennyson is the most representative poet of the century in presenting to us in forms of great poetic beauty, all the phases of the thought of the time, religious, scientific, patriotic, literary. Browning gives us a vigorous optimistic conception of life and work, presented in a wonderful series of dramatic figures. Morris, Rossetti, Swinburne (sometimes called preraphaelites) may be said to follow Keats in their love of beauty, which they seek not only in mediævalism, but throughout all history sacred and profane. Matthew Arnold's poetry has classic qualities of style and great eiegaic charm of thought, but he rightly saw that his true field lay elsewhere. The drama has been weak for the whole century, although all the greater poets essayed the form. Only Browning and Tennyson had even temporary success on the stage, while the work of the professional play-writers have without exception failed of a place in literature. By 1800 the novel had become a definite form of literature. In the early years of the century Miss Austen, Miss Edgeworth, Miss Ferrier produced pictures of life in England, Ireland and Scotland, respectively, the first of surpassing excellence. A great change was effected by Scott in the Waverley novels (1814-31). It has been pointed out that the lasting power of these novels depends on their full and vital knowledge of Scotch life and character. Scott, at the beginning, had some idea of doing for Scottish life what Miss Austen had done for English. But the real immediate effect of the Waverley novels was to give an enormous impulse to the romance of adventure and scenery and costume, a romance which found its best expression in the historical novel. The Waverley novels are great historical novels, though, of course, some have little history in them, and they gave a conception and an inspiration which was not wasted. In 1825 appeared the first works of importance of G. P. R. James and of Harrison Ainsworth, who for a quarter of a century achieved a very considerable popularity, though they added but little to the possibilities of historical fiction. More powerful than either was Bulwer, whose first work appeared in 1827, and who for forty years produced not only historical novels, but novels of every kind, works of great talent, though the judgment of time refuses them genius. At much the same time two other writers somewhat extended the field of the novel: Marryat, by sea-stories, which remind one of Smollett; Charles Lever, by stories of the army as well as of Irish life. Brilliant historical novels have appeared through the century: Thackeray's 'Henry Esmond' (1852), and 'The Virginians' (1857); Kingsley's 'Westward Ho' (1855), Dickens's 'A Tale of Two Cities' (1859), Charles Reade's 'The Cloister and the Hearth' (1861), George Eliot's 'Romola' (1862), Blackmore's 'Lorna Doone' (1869), Shorthouse's 'John Inglesant (1880), Pater's 'Marius the Epicurean' (1885), constitute a series of remarkable value. But the great successes of fiction in the middle of the century were made in the long-familiar forms. Charles Dickens had many minor characteristics, and so had Thackeray, but their novels, as well as those of George Eliot, are novels of every-day life. In the main these three are realists, striving chiefly to depict the life that they knew and saw about them. So chiefly were those who came after them. The Brontés, George Meredith, Charles Reade, Anthony Trollope, William Black, Thomas Hardy, George Gissing, these are realists also, though in only the last two cases of the consistent type developed by their contemporaries in France. Some of them sought in every-day surroundings the romance of character like the Brontés, some could perceive the rich spirit of comedy like Meredith. But none felt the need more than once or twice of straying from the familiar life of England. Toward the end of the century the craving for romance began again: it had never been entirely quieted, but it did not come to full expression till Stevenson and Kipling. Both sought the romance of life and character and of the soul, but both were masters also of adventure and incident and striking circumstance and flowing background. Anthony Hope, Stanley Weyman, Conan Doyle, Maurice Hewlett, have in general followed, and in some cases surpassed them. A third development of the century has been in the path of criticism, which at first found expression chiefly in the periodical. The magazine has been one of the most characteristic elements of 19th century literature. There were magazines in the 18th century — the 'Monthly Review,' the 'Critical Review,' the 'Gentleman's Magazine' — but the chief periodical was the Addisonian essay. The 'Edinburgh Review' (1802) and the 'Quarterly Review' (1809) were the beginning of a new movement. 'Blackwood's Magazine' (1817), the 'London Magazine' (1820) and 'Fraser's Magazine' (1830), together with many weeklies and dailies, were the beginning of a flood of literature that is now the form most familiar to us. The influence was at first chiefly critical. Jeffrey, the first editor of the 'Edinburgh,' with Gifford of the 'Quarterly,' set the style of a criticism, which though often unfairly slashing and ridiculously high and mighty in tone, had merit often in expressing sincere and definite opinions in literature and politics. A sort of gaiety and even charm was given by Wilson, who wrote under the name of Christopher North, by Sidney Smith, and Lockhart. But the most important developments came in the field of the personal essay. The 'Essays of Elia' (1820) by Charles Lamb, go beyond the Addisonian essay in their unfettered expression of a charming personality. 'The English Opium Eater' (1821) of Thomas De Quincey, is still farther away from the 18th century in form and spirit, and so is the 'Table Talk' (1824) of Hazlitt. All these are sincere personal utterance, and in their sincerity and personality lies their strength. In the main we may call the work of these men critical, for they were all absorbed in letters, and their view of life was essentially a criticism of literature. Something more in the way of established form were the famous Essays (beginning 1825) of Macaulay. The most remarkable works of their time in the power of focusing wide reading and immense knowledge into forms of extreme brilliancy. A striking contrast is offered by Carlyle, who began by essays of the accustomed character, though not ordinary in style, but after some years produced 'Sartor Resartus' (1833), expressive of his own vigorous personality and thinking, more extraordinary in form than any of his later work, but not more original or powerful. Carlyle had by no means the immediate fame of Macaulay, but his influence on the thought of his time has been vastly greater. Both were historians as well as critics, and by their interest in life and sympathy with man they brought in a new and fascinatingly interesting kind of historical writing, which the later influence of Darwinism and of science in general, has done much to deaden. Hallam before them should also be mentioned, and Green after them. John Ruskin began his career as critic with what seemed the impossible task of dethroning false masters of painting, and establishing an ethical foundation for art. About 1850, having succeeded in his earlier task, he began a struggle against a much wider range of evil, which was not so fortunate. Matthew Arnold also understood the range of the critic as extending beyond the field of art: his views on politics and religion were an influence in the history of thought, but naturally will not last as long as his conceptions on literature. Walter Pater took even a wider view of art, being at home with painting, architecture, sculpture, as well as with literature. He represents the so-called "æsthetic" position which developed from preraphaelitism. In philosophy and science the century has been pre-eminent, and many great books have been produced. The last field hardly belongs to literature, although Darwin, Huxley, and Tyndall were masters of style and could make the results of scientific work absorbingly interesting. More might be said of philosophy and theology, though here little has been produced that will last as literature, except perhaps John Stuart Mill's 'Logic' (1843), Cardinal Newman's 'Apologia pro Vita Sua' (1864), and parts of Spencer's 'Synthetic Philosophy' (1860-1900), all of which stand as representative of important movements in the history of thought.

There are many histories of English literature. That of Garnett and Gosse is an excellent general account, richly illustrated by extracts and reproductions of manuscripts and prints. The three volumes on different periods by Saintsbury and Gosse cover the last four centuries in a convenient form. The work of Taine (translated by Van Laun) expresses his views of the development of literature from national life. That of Ten Brink (translated by Keneday) is unfinished, but covers the ground where German scholarship is strongest, namely, Anglo-Saxon and Middle English. Brandl, in Paul's 'Grundriss der germ. Philologie,' gives a very full and convenient summary. Morley's 'English Writers' is a very full account in ten volumes, but has not got beyond Shakespeare. The 'English Men of Letters' series provides lives of the greatest authors. Ward's 'English Poets,' and Craik's 'English Prose,' are valuable, giving a summary of facts, a criticism by a writer of note, and a number of extracts in case of all distinguished poets and prose writers.

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English Literature, Middle Period. The term Middle English may conveniently be taken to include the period 1100-1500. For more than a century after the Conquest, however, the majority of works produced and read in England were written either in French or Latin. Literature in the vernacular, which had sunk to a low level by the beginning of the eleventh century, did not revive materially until the reign of John. The Anglo-Saxon Chronicle, continued to the year 1154, and a few religious works, chiefly of linguistic interest, almost exhaust production in English during this era of transition. During the thirteenth century English began to compete with the other tongues for supremacy, and by the time of Chaucer its victory was assured, although French and Latin continued to be widely used. At first, the progress of the vernacular was greatly hindered by dialectical differences in various parts of the country. The West-Saxon and Kentish, the Mercian, and the Northumbrian of the earlier period had developed respectively into the Southern, Midland, and Northern, with some changes of boundary. Of these, East Midland was most important, as the dialect of London and Chaucer, and the parent of Modern English. The language as a whole shows very marked differences from Anglo-Saxon, not only in the addition of many foreign words, chiefly French and Scandinavian, but in changes in the vowels and diphthongs, in the disappearance of inflectional endings, and in a freer use of particles and connectives. The dialectical peculiarities gradually became less marked, until at the end of the period there was practically only one literary dialect, with the exception of Scottish.

The influence of Anglo-French and Anglo-Latin upon Middle English was exceedingly important. The Normans took great interest in historical writing after their settlement in England, as the Latin chronicles of such men as Ordericus Vitalis, Henry of Huntingdon, and William of Newburgh attest. About 1136 Geoffrey of Monmouth produced his fictitious 'Historia Regum Britanniæ,' a book condemned by serious historians, but of great significance for mediæval romance. It was later reworked in French rhymed versions by Gaimar and Wace. The Normans were fond of romantic stories, and even retold the deeds of various native English heroes in their own tongue. More serious historical work was done in French verse by such men as Garnier de Pont St. Maxence or Jordan Fantosme. Churchmen like Lanfranc and John of Salisbury wrote on theological matters, and there was early much activity in the new English Universities. Latin writing of a lighter sort is represented by the 'De Nugis Curialium' of Walter Map, or the 'Speculum Stultorum' of Nigellus Wireker. The Normans were a people of practical mind, and most of their literature consisted of utilitarian or devotional prose. Scientific facts, or supposed facts, interested them greatly. They were clever tellers of tales, both of the fabliau type and those pointing a moral. Especially noteworthy is the work of the poetess Marie de France (1175-

1185), who wrote a charming collection of *Lais*, and a book of fables, the 'Ysopet.' The rise of the drama on English soil was due almost wholly to the influence of the French.

Earlier Middle English literature is better studied by types than by authors. Originality, as a general thing, counted for little in mediæval days, and works in the vernacular during the 13th century were based almost without exception upon French and Latin models. The narrative literature is of far greater interest than the religious and didactic writing. The French metrical romances, artistic poems dealing with love and war, and intended for the higher classes, were rapidly made accessible to the English after the middle of the 13th century. The cycle of King Arthur and his knights was the most important and popular. A smaller and less favored division dealt with "the matter of France."—the deeds of Charlemagne and his warriors. A third group is based on native English and Germanic themes—King Horn, Havelock, Bevis of Hampton, Guy of Warwick, etc. Stories of Troy and Thebes form a fourth class. The Troy-story deserves attention because of versions of the Troilus-Cressida theme by Chaucer, Henryson, Lydgate, and Shakspere. Romances of Eastern origin, with a few others not readily classifiable, complete the list. By the time of Chaucer, the metrical romances were showing signs of degeneration, and in the 15th century they died a lingering death. In strong contrast to these are the fabliaux, short witty rhymed tales, intended for the lower classes, usually of a satiric character, and frankly indecent. They were never as popular in England as in France, although stories of this type form the largest genre-division of the 'Canterbury Tales.' Pious tales, generally representing supernatural occurrences in every-day life, and beast stories, like the 'Fox and the Wolf' (13th century), were popular. Noteworthy, too, are the collections of stories, often, as in the case of the 'Gesta Romanorum,' used by preachers as *exempla* upon which to base homilies. Many romantic narratives reappeared in altered form in the ballads. These "stories in song" differed widely from the romances, being short, stanzaic, allusive pieces of unknown authorship, perpetuated among the people by oral tradition, and dealing with a great variety of material. The popular lyric—quite a different thing—is represented by such pieces as 'Sumer is icumen in,' or 'Blow, Northern Wind,' which strike a more truly English note than the art-lyrics of the period. Secular love-poetry was often applied to religious ends, as in the 'Love-Rune' of the Franciscan monk, Thomas de Hales. In the 14th century French lyrics were extensively imitated, as the work of Chaucer and Gower shows. As for metrical chronicles, three deserve especial mention. Most important is the 'Brut' of Layamon (ca. 1205), so called because it traces British history from Brutus. Although dependent upon earlier French and Latin work, it shows imaginative power and patriotic feeling. The same love of England appears in the chronicle of Robert of Gloucester (1298), which may have been written by more than one man, and in the historical work of Robert Mannyng of Brunne in the 14th century.

The devotional and didactic literature is somewhat difficult to classify, since the various types were not always clearly differentiated, and borrowed much from secular writing. A favorite form of conveying wisdom was the proverb poetry. An early collection of this sort was attributed to King Alfred, and another was put into the mouth of a personage called "Hending." A similar purpose was served by the "debates," the most noteworthy of which is the 'Debate of the Body and Soul' (12th century), in which each speaker accuses the other of being responsible for the death of the dead man. The 'Owl and Nightingale' (ca. 1220) is the most important secular debate in English. There was much work on scientific subjects, and this was often made to point a moral, as in the 'Bestiary' of the early 13th century, which appends a "significatio" to each description. A vast number of homilies and devotional treatises were written. The 'Poema Morale,' "a penitential sermon in verse," dates from 1170. The 'Ancren Riwle,' or Rule for Nuns, is an early prose monument of some importance. More celebrated is the 'Ormulum' (ca. 1200), a set of pedestrian metrical homilies valuable to the philologist on account of a peculiar system of spelling. In the 14th century, Dan Michel of Kent, the author of the 'Ayenbite of Inwit,' William of Shoreham, who wrote stiff didactic poems, Robert Mannyng of Brunne, who versified a French manual and gave it the title 'Handlyng Sinne,' and Richard Rolle of Hampole, are all noteworthy. Richard Rolle, the mystic, hermit, and preacher, was more important as a personality than an author, yet his works, of which the 'Prick of Conscience' is the best known, were esteemed in their day. Chief among Bible-paraphrases are an early version of Genesis and Exodus (ca. 1250), in the Midland dialect, and the 'Cursor Mundi,' written in the north. Legends and lives of the saints were much in demand, and huge legend collections were made for homiletic work. The Tales of the Prioress and Second Nun in Chaucer illustrate this genre.

The most prominent figure in Middle English literature is Geoffrey Chaucer (1340-1400). A Londoner by birth, he was brought up in the atmosphere of the court, took part in the French wars, was often employed upon diplomatic missions, and held various public offices. His literary work falls naturally into three periods. The first, extending to about 1372-3, when he first visited Italy, reflects the influence of French poetry. Besides a number of shorter lyrical pieces, most of which are not extant, the period includes a translation of a part of the 'Romance of the Rose,' and 'The Book of the Duchess,' a lament for the death of the wife of his patron John of Gaunt. The second period, which closes about 1385, reveals him imitating Italian models, particularly the works of Boccaccio. Here belong 'Troilus and Cressida,' 'Anelida and Arcite,' 'The Hous of Fame,' 'The Parliament of Foules,' and some stories later utilized in the 'Canterbury Tales.' This period shows a great advance in versatility and poetic power. The so-called English period, in which he attained the summit of his powers, has been held to include the 'Legend of Good Women,' but recent research puts much of it earlier, and makes plain the strong influence of French. The chief work of this period, and his masterpiece, is the 'Canterbury Tales.' The stories were borrowed from various sources; the plan of the whole resembles that of the 'Decameron,' but there is no evidence that Chaucer was acquainted with it. Besides the two prose Tales, Chaucer translated Boethius, and wrote a treatise on the Astrolabe. The chronology of his writings has not yet been exactly determined.

Four important alliterative poems of the latter half of the 14th century, written in the West Midland dialect, may be referred to one author, whose name has not been preserved: 'Sir Gawain and the Grene Knight,' 'The Pearl,' 'Cleanness,' and 'Patience.' The first of these is generally considered the finest of the metrical romances, because of its elevation of tone, descriptive power, and narrative skill. It is written in a highly artificial style of verse. 'The Pearl' describes the appearance of a beautiful maiden in Heaven, seen in a dream. It is probably to be interpreted allegorically, although the poem has often been held to reflect the grief of a real bereavement. The other two poems, which are of minor value, exalt the virtues indicated in their titles. Alliterative verse, without end-rhyme, was employed by William Langland, whose bitter satire contrasts with the genial irony of Chaucer. 'The Vision of Piers the Plowman' attacks the evils of the day by means of allegorical figures seen in a series of dreams. A continuation of the same material appears in the pieces called 'Do Wel,' 'Do Bet,' and 'Do Best.' The allegory is sometimes realistic and sometimes mystic. The 'Vision' appeared in three different versions in the latter part of the 14th century. It has been doubted that this is all the work of one man, and too much weight has been attached to supposed autobiographical evidence in it. 'Richard the Redeless' is generally assigned to Langland.

The fame of John Gower (died 1408) rests, apart from a series of French *ballades*, and minor pieces, upon three works, the 'Speculum Meditantis,' a moral allegory in French verse, the 'Vox Clamantis' in Latin, dealing with the social unrest of his day, and the 'Confessio Amantis' in English, his best-known poem. The 'Confessio' consists of a series of tales, strung on a thread of story. The priest of Venus is sent to "confess" the lover, and gives him instruction by means of tales illustrating the vices and virtues, with special applications to matters of love. Many of these tales are well and simply told, but the artificial and highly finished octosyllabic couplet soon becomes monotonous. The poem is too long (nearly 34000 lines), and is far inferior to the work of Chaucer. An enormously prolific poet, too, was John Lydgate. His long poems, like 'The Troy-Book,' or 'The Falls of Princes,' are tedious versifying; his minor poems and *Fables* show him at his best. As a disciple of Chaucer he stands with Thomas Occleve or Hoccleve, a more interesting personality, but less productive and accomplished than Lydgate. Occleve's chief work is 'The Gouvernail of Princes.'

The prose work of John Wycklif was primarily utilitarian. He was greater as a personality than as a writer, but his translation of the Bible (ca. 1380) did much to fix the form of the language, and his simple and direct sermons appealed strongly to the lower classes. He was assisted in translating the Old Testament by Nicholas of Hereford, and the whole was later revised by John Purvey. An undue importance has sometimes been attached to the fictitious 'Travels' supposed to have been made by a Sir John Mandeville in the 14th century. The book was originally written in French, but the facts of its authorship are not yet fully known. Though purporting to be authentic, it is full of grotesque descriptions of the East, mostly borrowed from mediæval travel-books.

The 15th century was a singularly barren era. England was almost devoid of poetry of distinction; the example of Chaucer inspired little in the south, and the Wars of the Roses had a most unfavorable effect upon literary production in general. Some advance was made in prose writing, however, through the interest taken in historical, legal, controversial, and religious subjects. Reginald Pecock, the great opponent of the doctrines which had been advocated by Wycklif, is remembered for his 'Repressor of Overmuch Blaming of the Clergy.' Sir John Fortescue, the author of 'The Gouvernance of England,' and the chroniclers Capgrave and Fabyan also deserve mention. Perhaps the most distinguished work of the century was Sir Thomas Malory's 'Morte Darthur.' This collection of romantic tales dealing with King Arthur and his knights, told in melodious prose with great skill and charm, was finished about 1470, and printed fifteen years later by Caxton. Of the life of Malory little is known. Although he invented little, he was no mere compiler, but a great literary artist. The introduction of printing and the publications of Caxton mark a new era in English letters. Much of the material which Caxton printed he translated from other languages himself. His activity exerted a strong influence in the development of English prose.

A compensation for the dearth in English proper in the 15th century appears in the emergence of Scottish literature. The first noteworthy work in this dialect, with the exception of certain legends and romances, is the 'Bruce' of John Barbour, whose life falls within almost the same dates as that of Chaucer. The poem partakes of the nature both of a rhymed chronicle and a romance, and though lacking in finish, is full of vigor, and animated by patriotic spirit. It celebrates the deeds of Robert Bruce, with occasional lapses from historical accuracy. Andrew of Wyntoun's 'Original Chronicle'—so called because he began from the very beginning—is an exceedingly monotonous piece of versifying. The exploits of William Wallace were celebrated by Henry the Minstrel, or Blind Harry, as he is often called, in a poem which takes great liberties with history. Blind Harry died about 1492. A pronounced imitator of Chaucer, and not an unworthy one, was King James I. of Scotland, who celebrated his love for Lady Jane Beaufort in 'The King's Quair' (1423). In structure, language, and general literary treatment it is highly artificial, but full of grace and poetic feeling. It derives additional interest from the romantic career and early death of its author. In variety and excellence of work, Robert Henryson, who flourished in the latter part of the 15th century, holds an important place. He wrote the earliest extant English pastoral, 'Robene and Makyne,' and a notable collection of 'Fables.' The influence of Chaucer is seen in 'The Testament of Cressid,' which describes Cressida's unhappy death with great dramatic power. In minor poems he was often felicitous. An elaborate, though tedious and awkward bird-fable is the 'Howlat' or 'Owlet' of Holland. The greatest poet of the period was William Dunbar (1460?-1520?), who led a wandering life in his youth, was later attached to the court of James IV. of Scotland, and entered holy orders. Most of his poems are short, and a large number of them are satirical. More ambitious are 'The Thistle and the Rose,' which commemorates the marriage of the king, and 'The Golden Targe,' an elaborate allegory. 'The Dance of the Seven Deadly Sins,' 'The Flyting with Kennedy,' a brother-poet, 'The Two Married Women and the Widow,' and 'Tidings from the Session' are all representative pieces. 'The Two Friars of Berwick,' a piece of vigorous Chaucerian narrative, is ascribed to him. 'The Lament for the Makers' strikes the elegiac note, but Dunbar was, on the whole, lacking in pathos and tenderness. He was a poet of great variety and originality, using both the "aureate style" then in vogue, and the rude dialect of the people with equal skill. Gawin Douglas, Bishop of Dunkeld (1475-1522) wrote rather stiff allegorical poems, 'The Palace of Honor,' and 'King Heart.' His most important work is his translation of Vergil. Douglas was the most learned of the Scottish poets, and his work was designed to appeal chiefly to the upper classes. Much of the work of Dunbar and Douglas falls outside the formal boundary of this literary period, 1500, yet in the general character of their poetry, and especially in their imitation of mediæval models they are properly to be considered with the earlier men. The same is hardly true of the work of Sir David Lyndsay of the Mount (1490-1545), who completes this group of Scottish poets. The reformatory tone and national appeal in his writings place them in the era following.

In English literature proper a similar distinction is to be made. Alexander Barclay's translation of the 'Narrenschiff' of Sebastian Brandt, which he called 'The Ship of Fools,' and 'The Pastime of Pleasure' of Stephen Hawes, a "belated Chaucerian," both produced in the first decade of the 16th century, belong far more to the age that had passed than does the poetry of Skelton. Although some of Skelton's early work suggests imitation of the older poetry, his most characteristic pieces do not fall within the bounds of Middle English. Neither Hawes nor Barclay were even second-rate poets; their prominence is chiefly due to the fact that they lived in a time when little poetry was written.

The Miracle Plays flourished in England from the early part of this period until the end of the 16th century. The Morality Play, a less important genre, arose in the second quarter of the 15th century, and, with the Interlude, for a time rivalled the popularity of the Miracles. For a discussion of the rise of the drama in the Middle English Period, see MIRACLE PLAYS.

Bibliography.—The most recent and detailed discussion of the earlier Middle English period is by W. H. Schofield, 'English Literature from the Norman Conquest to Chaucer,' which contains bibliography and chronological tables; for individual authors consult the 'Dictionary of National Biography'; for bibliography, G. Koerting, 'Grundriss der gesch. der engl. Litteratur'; for literary history in general, B. ten Brink, 'Gesch. der engl. Litteratur' (English tr. in 3 vols.); A. Brandl, in Paul's 'Grundriss der germ. Philologie'; Jusserand, 'Literary History of the English People' (2 vols.); H. Morley, 'English Writers' (vols. 3-7); Saintsbury, 'A Short History of English Literature'; R. Wuelker, 'Gesch. der engl. Litteratur.' For the French literature of the period, cf. G. Paris, 'La litt. franç. au moyen âge,' 'Mediæval French Literature,' in Temple Primer Series. For the Scottish poets, T. F. Henderson, 'Scottish Vernacular Literature, A History'; D. Irving, 'History of Scottish Poetry,' ed. J. Carlyle.

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English Modern Political Development. The signing of the Magna Charta in 1215 by King John had sown the seed for future constitutional liberty. This came in the shape of the great Protestation in 1621, in which Parliament delegated unto itself the right to discuss state affairs; the Petition of Rights in 1628, prohibiting taxation without the consent of Parliament; the famous Bill of Rights, passed by the Convention Parliament of 1689; the Toleration Act of 1691, allowing Dissenters the freedom of public worship; and the establishing of triennial parliaments and the freedom of the press. At the close of the 18th century, England was an impoverished, benighted, and backward country. A reduced population of 10,000,000 was oppressed with an enormous debt, which it seemed to be hopeless to attempt to pay. America had been lost through a stupid attempt at subjugation, and Ireland was ripe at any time for revolt. Wealth was so unequally distributed that, while the artificial rise in wheat and land enriched the small class which controlled legislation, the bulk of the population was pauperized. The general level of education was so low that the attempt to introduce machinery into a country destined in large measure to live by means of it, led to riots. The press was shackled, the bench far from free, the civil service the football of patronage, and crime was steadily increasing, through the operation of a criminal code, so barbarously severe as to be worse than useless. Yet out of these unpromising beginnings has emerged the England of our day—the England of a great literary, scientific, commercial, and political people, a dominion on which the sun never sets, the country which divides with us the repute of having the greatest resources and greatest enlightenment of modern times, the home of individual freedom and honest administration.

The most marked trait of the management of their affairs by the English in modern times (and much of the dislike of them abroad has been caused by it) has been its commonplace rationality. The age which dawned upon the world with the American and French Revolutions was to Bentham and to Burke no less than to Paine, the Age of Reason, and reason in English minds has never been the abstraction which flourished under the same name in France and wherever French philosophy gained a footing. Pure democracies, as the pages of Athenian, of French, and of American history show, have a fondness for abstract principles of government, which is apparently connected with another recognized tendency of democracies — to be carried away by phrases. Both in France and America, the rise of democracy 100 years ago was marked by attempts to found the system on some broad theory, such as the rights of man, equality, or the social contract theory. All the great Americans who gave life and form to the movement ending in the complete democratization of our institutions, from Jefferson and Franklin to Lincoln, as well as the French constitution makers from 1789 to 1848, were impelled by the idea that they had discovered a new principle of government, which could solve the perplexities of its problem, bring to an end the oppression of man by man, and change the world from a vale of tears into an abode of happiness. To the more phlegmatic English, the Age of Reason was to be somewhat different and saner. Burke and Bentham and Adam Smith in their different fields were great rationalists; but they did not dream of making the world over. Bentham appealed to the principles of utility, the greatest good to the greatest number, a purely practical standard; the political philosophy of Burke, which first led him to sympathize with the American, and afterward to detest the French Revolution, was based on the simple truth, hitherto almost unrecognized and still only slowly establishing itself in the human mind, that the welfare and decay of states is governed by laws analogous to, and at many points identical with, those which determine the prosperity and failure in life of individuals.

Comte insists that all human knowledge passes through three stages, the religious, the metaphysical, and the positive or rational. There is no field in which the Comtean law seems to work more clearly than that of government. For ages mankind appeals to revelation and divine right; this idea being expelled, we are taught that "equality" or "natural right" is the true substitute. The final stage is reached when it is discovered that the only real appeal is to reason. All the great publicists of the 18th century guessed the secret. Their followers in England and America applied it.

A real Age of Reason can hardly prove an era of violent change. In England, since the Reform Bill of 1832, while institutions have been liberalized, nothing has been destroyed. The terrors of the law have been mitigated; its firmness has not been impaired. The press has been made free without being allowed to become licentious. Liberty of worship has been established, and in Ireland the connection between Church and state has been dissolved, but the Church has not been despoiled. Slavery has been abolished, but the slave owners compensated. The control of the crown and the great landlords over elections has been shaken off, and the House of Commons made strictly representative; but the freedom of the representative to act in accordance with his own convictions has not been tampered with. Trade has been made free, and this with absolute indifference to "reciprocity"; English ports are open to the trade of the whole world, no matter how much any other nation closes its own — the crowning triumph of Liberal ideas as to commerce. The old colonial system in all the large English speaking colonies has been abandoned, and a federal system of nearly independent states established in Canada and Australia. A blow at privilege in the army has been struck by the abolition of the purchase of commissions. The immense national debt left by the wars with France has been greatly reduced; and a nearly consistent policy of peace with foreign nations pursued. The land question in Ireland, the constant seed of trouble for centuries, has been disposed of, and all these things have been accomplished without resorting to violent or extreme measures or destroying any established institutions. These are the reforms dreamed of in the 18th century, some of them first introduced in England.

But the form and theory of the English Constitution are still wonderfully unchanged. It is the fashion to speak of the transformation of English society and government and law and manners which the last 100 years has introduced, as the "democratization" of English institutions; but the word would rather be rationalization. The state, the Church, the aristocracy, and the crown still exist as potent factors in the Constitution; privilege plays a great part in the law, and birth and family count socially for more than they are worth. The House of Commons has been democratized, so far as a wide suffrage can of itself effect this result, and the civil service has been thrown open, and the abuses which Burke said he loved to hear "clamored against," overthrown; but the actual control of the government is still to a great degree in the hands of the wealthy and titled classes.

The most important constitutional change of our day in the democratic direction was, curiously enough, unconsciously accomplished. When Bagehot published his account of the English Constitution in the sixties, few people in England were aware of how supreme the House of Commons had become, or how its supremacy had been obtained. Bagehot showed how the ministry (which actually carries on the government) had ceased to be the agent of the Crown, and grown to be a sort of committee representing the party having for the time being the majority of the Lower House. The Crown could no longer refuse to call Mr. Gladstone or Mr. Disraeli, as the case might be, to form a ministry; and as it was admitted that the House of Lords could no longer refuse to pass a bill persistently demanded by the people's representatives, the first inference seemed to be that the English government had become a parliamentary democracy with but a single chamber; without even the checks and balances of the American Constitution, or its division of powers and judicial control over the legislature. Sir Henry Maine was so much impressed with this idea that he wrote a book to prove that England had become a "pure" democracy. But even here the democratization of institutions was not nearly so complete as it appeared on the surface. Through all the changes of the century, the crown has remained in control of foreign affairs, at the head of the Church and the aristocracy; society and wealth have been its allies and the great equalizing influence of mere numbers which has played such a potent part in British politics, has obtained but a slight control in England.

Of course, it would be absurd to attribute the totality of progress in any country to a single cause. The advances made by science and invention count for much; and every country has had its share in the common progress which made the 19th century mark a turning point in the world's history. But when we reflect that in every country the great advance was preceded by a struggle between the advocates of freedom and the old order, in which the former were triumphant, and through which they obtained control and shaped the policy of government, the inference is inevitable that free institutions have enormously contributed to the advance. Those in any country who deny that its welfare is bound up with the rationalization of human institutions have no evidence to appeal to. The pages of their own past are black with the proof of human happiness, comfort, content, and peace, even in as moderate degree as they have yet been realized not only did not exist, but (as long as the final court of appeal in Church and state was authority and privilege) were regarded generally as a rather silly dream; they have advanced in the last 100 years *pari passu* with those rationalizing changes which in some countries have taken the form of democracy, and in England of deliberate and continuous institutional reform through the growth of popular power.

A generation had grown up which had enjoyed all the benefits of rational, free government, and yet had a comfortable state Church, a satisfactory aristocracy and magistracy, an army and navy officered by gentlemen, an excellent press, a well administered system of justice, a trained and honest civil service, and a full purse. The abuses which the old Liberalism had been called to destroy had been destroyed. Was it worth while to go on, after all this, to introduce democracy for the sake of making things systematic? America and France had both started pure democracies but England had secured the benefits of solid, good government without doing anything of the kind. It was not Imperialism which broke the Liberal party in two under Gladstone, and has kept it divided; it was the aversion for sweeping theoretic changes in the national habits which has always been characteristic of the English people.

The remoter causes which have led to the present reaction against Liberal ideas, the tide of which has been swelling for 25 years, are no doubt numerous and diverse. Following on a régime of reason, it seems in some respects like a reaction against reason itself; as if the new generation had got tired, as an individual might, of being reasonable, and were resolved to try something else. It has its economists, who teach that every country, if not every town, city and village, has its own political economy; its historians, who think that what really improves the human race is violence and war. Its poet sings the praises at once of law, order, discipline, violence, blackguardism, and brutality. The writers who heralded it, like Froude, Carlyle, and Ruskin, deified force or imagination, laughed at reason, and delighted in ridiculing the absurdities of the economists under the guidance of whose teachings English commerce and the English language have spread over the earth. Its publicists assure us that the secret of the permanent grandeur of free nations, is plenty of distant colonies, and a huge army and navy and its priests make a laughing stock of themselves and the religion they profess, by preaching the sword as the true means of spreading the gospel of peace. The reaction teaches that protection and government bounty, that is, taxation, is the true source of wealth, and that privilege is the buttress of common right. It is imperialistic and military — that is, it appeals to the passion for foreign dominion, to greed and pride, while it pretends to be democratic because it appeals to an extended electorate, though its success paralyzes every democratic impulse. But there are many causes tending to prevent even a reaction in England from going to extremes — among others the publicity in the glare of which most public events are now transacted. An instance of this is the publicity being brought to bear in all its phases on one of the most recent developments against the "open door," — Mr. Chamberlain's crusade in 1903 for "protection."

It may be observed that foreign relations — the stronghold of this and every other reaction — have never been rationalized in England, nor completely in any country. The foreign office is the only secret branch of government left; and through it the executive retains, no matter what the nominal constitutional checks, the privilege of plunging any country into war without notice, and of explaining the event in any way it chooses. At the same time, none of the great powers, even of those who have most to gain by it, is ready to diminish the risk of war by agreeing in advance to arbitrate its differences. This makes it almost as easy today as it was 100 years ago for a government to get up a war for one reason and inflame the public into support of it by other and totally different reasons. Experience shows that no government function that is secret can long be honestly and properly administered. This is why the doors not only of courts of justice, but of the legislature and other public bodies, have been thrown open. Perhaps the time will some day come when the same principle will be seen to apply to the transactions of states between themselves. The principle of arbitration would of itself entail publicity as to all international differences.

On the whole, modern political development in England tends to establish, among others, the following conclusions:

(1) That there is no intimate connection between the mere form of a government and national prosperity. In England we find, at the height of its prosperity, monarchy, artistocracy, and democracy existing side by side. In South America we find democratic forms producing very little prosperity.

(2) That the conservative opinion so long maintained that the popularization of institutions necessarily produces disaster, tumult, and anarchy is a mistake, the extraordinary prosperity of England having advanced *pari passu* with the popularization of her institutions.

(3) That one of the secrets of prosperity is the emancipation of trade and industry, so far as possible, from all forms of control. The "open door" of which we now hear so much is only an illustration of this principle.

(4) That public business cannot be managed behind closed doors without becoming the private business of those who carry it on.

(5) That wherever government is popular and representative, success in the management of public affairs is dependent wholly on conscious, determined effort at improvement, ex-

actly as is the case with individual effort at self-improvement in private life.

(6) That the way to secure competency, fitness, and honesty in the public service is to follow the methods pursued in private life.

(7) That the worst way to settle any public question is violence, that is, war. During the period of England's great prosperity, 1850–80, she engaged in no important foreign war except that of the Crimea, which was inconclusive and useless.

The enthusiasts of the 18th century were laughed at for putting these ideas into people's heads. The reactionaries of to-day are trying to disprove them. We have in the contemporary history of England a monumental indication that the task will be impossible. See BOER WAR; CRIMEA; GLADSTONE; PITT.

English Snipe, a name among American sportsmen for the common American snipe (*Gallinago delicata*).

English Sparrow. See HOUSE SPARROW.

Engrafting. See GRAFTING.

Engraving, the execution of works of art on plates intended for printing. Impressions from metal plates are named engravings, prints, or plates; those printed from wood being called indifferently wood engravings and wood-cuts.

Engraving on wood, intended for printing or impressing from, long preceded copperplate engraving. It is to Germany we are indebted for the choicest specimens of early wood engraving; and among these the works of Albert Durer stand pre-eminent for delicate yet spirited execution.

The first English engravers on wood worthy of notice are Edward Kirkall, born in 1695, and John Baptist Jackson, who died in 1754. But the art had no real vitality in England until the brothers Bewick, about the close of the 18th century, founded the English school of wood-engraving, which has since attained a position second to no other.

Copperplate engraving arose in the 15th century. Until then the art of engraving on metal had been confined to decorating sacred vessels, armor, services of plate, etc., with emblematic figures, and other pictorial and ornamental devices.

Although the earliest use of engraved copper plates for printing impressions on paper has been claimed for German artists, it is now generally agreed that the practice was first established by the Florentine goldsmith and engraver, Finiguerra, an impression from one of his works having been recognized as produced in 1440, the date of the earliest German print being 1460. The new art had, however, very soon spread over Italy and Germany, for before the close of the century many eminent engravers had risen in both countries.

A perceptible change in style about the end of the 17th century marks the rise of the modern continental schools of engraving. Since then the artists of France, Italy, and Germany, have rivaled each other in producing many noble specimens of their skill and industry.

Great Britain possesses no early engravers in the simple style worthy to rank with the continental masters; and it was not until the middle of the 17th century that a few English and naturalized foreign artists, by their successful cultivation of the compound process, gave an impulse to the art, which had hitherto languished in complacent mediocrity. The succeeding century produced many native engravers who contributed to raise the British school to high eminence. The most celebrated of these, Sir Robert Strange and William Woolet, may be regarded as the founders in Great Britain of the styles in which they respectively excelled.

In proceeding to describe the methods and the instruments employed in the different styles, we give precedence to line-engraving, not only on account of its demanding greater manipulative skill, and that in it the highest triumphs of the art have been achieved, but also because a description of the tools and many of the processes will include those used in most of the other branches.

Line-engraving.— As implied by the term this is executed entirely in lines. The tools are few and simple. They consist of the graver or «burin,» the point, the scraper, and the burnisher; an oil-stone or hone, dividers, a parallel square, a magnifying lens, and a blind, or shade of tissue paper, to make the light fall equally on the plate. For leveling important erasures there are used callipers, a small steel anvil, a small pointed hammer, and punches.

On commencing a plate, the first procedure of the engraver is to make a careful outline of his subject upon thin paper, with a black-lead pencil. The next step is to lay the «ground» on the plate; and an essential preliminary is to thoroughly cleanse its surface. Copper is effectually cleaned by a mixture of fine whiting and turpentine spread over the heated plate, and when the turpentine evaporates, wiping off the whiting with clean rag. The most efficient means of cleaning a steel plate is a strong lye, or solution of the common black ashes of the shops, and turpentine. With this mixture the plate is repeatedly washed, and each time rinsed with cold water; finally, it is rubbed dry with a scrupulously clean cotton rag. The hand-vise is now attached to one corner of the plate, a small thick fold of paper protecting the face at that part; then the plate is laid face upward on a moderately hot iron; or, better still, a tin box filled with water, kept boiling by a charcoal stove, or spirit-lamp beneath. By this latter contrivance all risk of burning the ground, and thus making it unfit for etching, is avoided. When the plate is hot enough, the ball of etching ground is rubbed over the surface, the heat causing it to melt and ooze through its wrapper of silk. The ground is then spread by light and rapid strokes with the rounded face of the dauber, continued until every part is thoroughly covered with an equal thin coating. The ground must now be smoked while the plate is hot, by holding it face downward, and passing the flame of two or three wax tapers loosely tied together, rapidly to and fro and across its surface, till it becomes a clear shining black: but care must be taken not to burn it, by permitting the flame to rest an instant on one place. The plate being cooled the paper on which the outline is drawn is damped, placed carefully face downward on the plate, and secured in its position by small bits of bordering wax; another piece of paper, also damped, is next laid over it, and the whole passed through the roller-press used for printing plates. When the paper is lifted off, the pencil outline is found transferred in reverse to the shining black surface in clear silvery lines.

Etching.— To protect the outline and ground during this process, supports made of paper, wood, or leather, about one eighth of an inch thick, are fixed on the margin; resting on these the parallel square is laid across the plate for the two-fold purpose of supporting the hand and of guiding the point. In a landscape, outlining and etching in the parts go on simultaneously; but in an historical piece the outline must first be secured by dotting it in carefully with the point, and then all parts of the subject it is desirable to etch are proceeded with.

When the etching is completed the supports are taken off, and the bridge — a thin board, having cross pieces about one inch thick under each end — is laid across the plate to support the hand. The margins are then painted over with varnish of brunswick black thinned with turpentine, the entire surface of the ground carefully examined, and all breaks or scratches penciled over with the varnish which resists acid equally with the ground. When this hardens, a wall of bordering wax about an inch high is placed round the subject, and pressed firmly down on the plate to retain the acid which is now applied. It must be borne in mind that the spaces between the lines, however narrow, and all parts not touched with the point, are protected from the action of the acid by the ground. Nitrous acid mixed with three or four parts water and a little sal ammoniac is used to corrode copper. When poured on, small bubbles of fixed air rise out of and collect upon the lines; these must be continually brushed off with a soft feather, otherwise foul or irregular biting ensues. A quarter of an hour generally suffices to corrode the lightest parts to a sufficient depth and breadth. The acid is then poured off, the surface of the plate washed with clean, cold water, and gently dried with blotting paper, or by the wind of a pair of bellows. The light parts being protected by varnish, acid is again poured on, and the process is repeated till all the successive degrees of dept. are obtained.

The biting-in being accomplished, a proof is taken preparatory to the next step toward completion. Finally, the burnisher is brought into play alternately with the graver and point, to give the last finish to all parts.

An almost incredible amount of laborious and carefully minute graving is required in a highly finished historical plate to bring out the proper effects of form, texture, relief, and to impart to it the unity, breadth, and mellowness of effect essential to a highly finished engraving; but many proofs and retouchings are necessary ere a satisfactory result is obtained.

Painters' or Amateur Etching.— This art is a favorite pursuit with amateurs and little practice in the use of the graver and dry point suffices for finishing this description of work.

Aquatinta.— This method, as first practised and still followed, has been already described. See AQUATINTA.

Mezzotinto.— This process differs fundamentally from all other styles of engraving on copper or steel, inasmuch as in it the lights and gradations are scraped and burnished out of a prepared dark ground, whereas in other methods the shading is corroded or cut into a blank surface.

The Mixed Style.— This is based on mezzotinto, which, still forming the great mass of shading, is in this method combined with line and stipple in such proportions as the taste of the artist suggests. All the tools employed in other styles are required for this; the roulette being largely used in subordinate parts.

Engraving on Wood.— See WOOD-ENGRAVING.

Mechanical and Photographic Process.— Engraving in recent times has suffered much from the rivalry of photographic and mechanical substitutes. The most important of these is known as photogravure or heliogravure. The beauty of the work produced by means of this process in the reproduction of paintings, of drawings in monochrome made for the purpose, and of photographs direct from nature, has raised it to a position of great importance. A photo-mechanical process which is much used in the reproduction of the plates of the older engravers and etchers, and in the production of intaglio etched plate-reproductions from pen drawings has been carried to great perfection, some of the work produced being almost equal to the finest original etchings. A positive photograph is taken of the drawing or engraving to be reproduced (that is, the lines are black, the whites clear glass); this is placed over a copper plate coated with a bituminous varnish, and exposed to the light. Where the lines of the photograph have protected the varnish from the light it remains soluble, but where the light has affected it through the glass it becomes insoluble. The varnish may then be dissolved from the lines and the copper exposed exactly as if the etching point had been used to make the drawing on an etching ground. The plate is then bitten in the usual manner, and finally touched up and improved with the graver. See PHOTO-ENGRAVING.

Engrossing, an act which, on ancient statute books, when the natural laws of trade were little understood, and political economy not even guessed at, was set down as a crime. It consisted in something similar to what nowadays is known as "cornering the market" by buying up the crops or the herds wholesale (Fr. *en gros*) before they were fit for use, in order to retail them at a great profit when they matured and were available for consumption. The offense was not only a statutory offense in England, but a crime in common law, and from the time of Edward VI. to that of Queen Anne laws were repeatedly passed for its repression. Even in the last century a prosecution for engrossing was witnessed in an English law court. In acts 7 and 8 Victoria, ch. 24, the offenses known as forestalling, engrossing, and regrating, or retailing at a profit, were abolished. In recent years there has been a good deal of litigation in the United States, and much discussion all over the civilized world with regard to the legality of corporations formed for the express purpose of monopolizing the trade in certain necessities or luxuries of life. See COMBINATIONS; MONOPOLY, RESTRAINT OF TRADE; TRUSTS.

The term is also used to denote the careful transcription of a deed, statute, or other legal document, in large hand; and is often applied, in the United States, to the final and certified copy of a statute, which is ready to be signed by the President, or the governor of a State.

Enharmon'ic (from Gr. ἐναρμονικός, in accord) in Greek music, a mode little known about, but distinguished by the use of small intervals or quarter tones, such as the tetrachord of which the first two steps were quarter steps and the third a major third. In modern music used as a general term to denote a difference in degree but not in pitch, though specifically there is a slight variation of pitch, which the same note takes according to its adjustment to a fundamental *tonic*. Thus C♯and D♭ are practically the same note on keyed instruments, yet strictly speaking, the former should be produced by 15-16 of the whole string sounded, the latter by 9-10. An enharmonic change of key, that is shifting from one scale to another, as in transposing C♯to D♭, often enables a composer to write more easily by avoiding recurrent accidentals.

Enhuber, ĕn'hoo-bĕr, **Karl von,** German painter: b. Hof, Bavaria, 16 Dec. 1811; d. Munich 6 July 1867. He studied at Munich, at first being known as an animal painter and later applying himself to romantic and humorous themes. He was made an honorary member of the Munich Academy 1858, and wears the order of St. Michael. Among his works are: 'The Dying Gunner'; 'Poachers'; 'Smoking Boy'; 'Interrupted Game of Cards'; 'Grandfather's Delight'; 'Wood Carver in His Shop'; and 'Stage Coach at the Tavern.'

Enkhuizen, ĕnk'hoi-zĕn (Lat. *Enchusa*), Holland, a town on a projection in the Zuyder Zee, 29 miles northeast of Amsterdam. It was once a place of great importance and had an extensive commerce, and a population of 40,000. Pop. 7,050.

Enna, ĕn'a, or **Henna.** See CASTROGIOVANNI.

En'neking, John Joseph, American painter: b. Minister, Ohio, 4 Oct. 1841. He studied at Munich and Paris, and was a pupil of Bonnat and of Daubigny. He paints chiefly landscapes and figure paintings. He received honorable mention at the Paris Exposition of 1900, and among his works are: 'Moonlight on the Giudecca, Venice' (1876); 'Freshly Picked'; 'Drove of Cattle on a November Day' (1878); 'The Obersee'; 'Farmyard Scene in France'; 'November Twilight' (1881); 'Summer Twilight' (1883); 'Indian Summer' (1885); 'The Coming Storm'; and 'Springtime.'

Ennemoser, Joseph, yō'sĕf ĕn'ĕ-mō-zĕr, Austrian medico-philosophic writer: b. Tyrol 15 Nov. 1787: d. Egern 19 Sept. 1854. He fought in the rising of the Tyrolese against the French 1809. After the Peace of Paris he went to Berlin, where he finished his studies and, 1816, took his degree in medicine. In 1819 he became professor of medicine at the new University of Bonn. In 1841 he went to Munich, where he obtained great reputation by the application of magnetism as a curative power, and published several works on that subject.

Ennery, Adolphe Philippe De, ä-dōlf fē-lēp dĕn-nĕ-rē, French dramatist: b. Paris 17 June 1811; d. there 26 Jan. 1899. He began life as a clerk, but later turned to the drama; studied scenic effects, the quick change from the tragic to the comic, and the contrast between the serious and ludicrous characters. He subsequently became the master of modern melodrama, producing alone and in collaboration some 200 plays. During the 50 years of his active life he accumulated a fortune of $1,200,000. His most successful plays include: 'Taking of Peking'; 'Mary Jane' (1845); 'Two Orphans' (1873); 'Martyrdom'; 'The Grace of God'; 'Grandmother.'

Ennes, Antonio, än-tō'nē-ō ĕn'nās, Portuguese dramatist: b. Lisbon 1848. He was for some years prominent in journalism, and afterward held high government offices. His first play, 'The Lazarists,' had extraordinary success in Portugal and Brazil, and long held the stage. It was followed by the comedy 'Eugenia Milton' (1874), and the dramas 'The Troubadours'; 'The Mountebank'; 'The Emigration'; 'A Divorce.' The last was translated into Italian and French.

En'nis, Ireland, town, in county Clare, on the Fergus, 19 miles northwest of Limerick. It contains a Roman Catholic college and Ennis College, founded by Erasmus Smith. O'Connell's monument and the ruins of a 13th century Franciscan abbey are among its attractions. A considerable trade in grain, flour, and agricultural produce is carried on, and large fairs and markets are held. Pop. 5,460.

Enniscorthy, ĕn-is-kôr'thĭ, Ireland, town, in the county of Wexford, situated on the river Slaney, 77 miles south of Dublin. There is an old castle erected by one of the early Norman conquerors, and in the neighborhood is Vinegar Hill, the scene of a skirmish in 1798 when the town was stormed by the rebels. The river Slaney is navigable, and there is a considerable trade in provisions. Pop. 5,648.

Enniskil'len, Ireland, a borough and market town of county Fermanagh; 37 miles northeast of Sligo; on an island in the river Erne, which connects the upper and lower sections of Lough Erne. Suburbs are on the adjoining mainland. In its town hall are kept the flags of the battle of the Boyne. The battle of 1689, between the forces of James II. and William III., in which William's forces were victorious, took place here. The noted regiment called Enniskillen Dragoons, or 6th Dragoons, were first formed from the defenders of the town at this battle. The manufacture of cutlery, straw hats, shirts and collars, and the tanning of leather are carried on here, and the trade is considerable. Pop. 5,570.

En'nius, Quintus, Latin poet: b. Rudiæ, near Brundusium, 239 B.C.; d. 169 B.C. When he was 38, Cato the Censor brought him to Rome, where he soon gained the friendship of the most distinguished men, and instructed the young men of rank in Greek. With an extensive knowledge of the Greek language and literature he united a thorough acquaintance with the Oscan and Latin tongues, and exerted great influence on the last. He wrote an epic poem in hexameters, 'The Annals'; tragedies and comedies; satires, epigrams, precepts, etc., but nothing now remains but fragments given as quotations in other ancient authors, many of them mere citations by grammarians and other insignificant extracts. A few larger fragments have been preserved, which give a favorable impression of his genius. His success in his own day was great. His poems were for a long period read aloud to admiring multitudes, and they were often quoted and referred to by the great writers of antiquity. See Sellar, 'Roman Poets of the Republic.'

Enns, ĕns, river in Austria, has its rise in the Alps of Salzburg, flows north-northeast, and then takes a northwesterly course into the Danube. Length about 160 miles. It divides Austria into Upper Austria and Lower Austria.

E'noch, Hebrew patriarch. He became the father of Methuselah at the age of 65 years; and we are told that he "walked with God," and at the age of 365 years "God took him." The words quoted are generally understood to mean that Enoch did not die a natural death, but was removed as Elijah was. The book of Hebrews (xi. 5) confirms this view. Enoch is the name of three other persons in the Bible, one of them being the eldest son of Cain (Gen. iv. 17).

Enoch, Book of, an ancient apocalyptic work in the Ethiopic language, of an assumedly prophetical character, of considerable importance on various accounts, and particularly because of its quotation by St. Jude in the 14th and 15th verses of his epistle. It is referred to by many of the early fathers, and Tertullian believed it to be canonic. Latterly it became discredited, and finally was lost to the Western Church, being known in Europe only by the references of these and other early writers. Bruce, the celebrated traveler, in 1773, discovered two Ethiopic manuscripts of it in Abyssinia, where it was still extant, and brought them home with him. Other manuscripts were subsequently found, and it has since been repeatedly translated and criticised in Europe, the Ethiopic text having also been published. The best translation (with commentary) is that of Prof. Charles: 'The Book of Enoch' (1893). According to him 'The Book of Enoch' as translated into Ethiopic belongs to the last two centuries B.C. All the writers of the New Testament were familiar with it, and were more or less influenced by it in thought or diction. The Ethiopic version was translated from the Greek, but the original was in Hebrew or Aramaic. It consists of revelations supposed to have been made to Enoch and Noah. These refer to the state of future blessedness, to judgments upon the wicked, and to the coming of the Messiah. They are full of elaborate imagery founded on the Book of Daniel and other portions of the Old Testament, upon which the dogmatical teaching of the Book of Enoch is also founded. Prof. Charles regards it as having been based on five separate treatises, which were fused together and modified in various ways, the final editor having made use of a lost apocalypse, called the Book of Noah. See 'Encyclopædia Biblica,' Vol. I. (1899).

Enoch Arden, a narrative poem by Alfred Tennyson (1865). Its theme is the return of a shipwrecked mariner to his home after a lapse of several years, only to find that his wife has married in his absence, believing him dead.

Enomo'to, Buio, Japanese statesman: b. Tokyo. He was educated in Europe, and returning to Japan in 1867, became the first president of a republic which he established in the island of Yego, but was ousted by the Japanese army 1869. After imprisonment for two years, he was appointed vice-admiral in the Japanese navy 1874. He served as minister plenipotentiary to Russia and became a member of the council of state and minister of education 1888, minister of foreign affairs 1891, and minister of agriculture and commerce 1892, which office he held for four years.

Enos, ā'nōs, Turkey, town on the north coast of the Ægean, 70 miles south by west of Adrianople. Pop. 7,000.

Enriquez Gomez, Antonio, än-tō'nē-ō ĕn-rē'kĕth gō'mĕth (properly ENRIQUEZ DE PAZ), Spanish poet; son of a converted baptized Portuguese Jew: b. Segovia early in the 17th century. He entered the army in his 20th year, and rose to the rank of captain; but in 1636 fled to Amsterdam, and, having there professed the Jewish faith, was in 1660 burned in effigy at a Seville auto-da-fé. The date of his death is not known. For his 22 comedies, of which some passed as Calderon's, and his poems, consult Ticknor, 'History of Spanish Literature.'

Enschede, ĕns'нā-dĕ, Holland, town in the province of Overyssel, 30 miles east-northeast of Zutphen. Rebuilt since its destruction by fire in 1862, it has large yarn- and cotton-mills. Pop. 16,178.

Ensenada, ĕn-sā-nä'dä (Spanish, a creek, cove, or bay), Argentina. (1) Seaport in the province of Buenos Ayres, the port of La Plata. (2) Seaport of Mexico, in the northern part of Lower California, on the Pacific coast, at the head of the Bay of Todos los Santos.

Ensign, the flag or colors of a regiment, in England, consisting of a field of white, blue or red, with the union in the upper corner, near the staff. Of naval ensigns the white flag is confined to the royal navy, the red to the merchant service, the blue to the naval reserves. In the American navy the ensign is the national flag, and it is also flown by the merchant service. In England, up to 1871, the lowest grade of commissioned officers in a regiment of infantry, by the senior of whom the regimental ensigns or colors were carried. The name is now abolished, the title of 2d lieutenant being substituted for it. Also the title of the lowest grade of commissioned officers in the United States navy.

Ensilage, ĕn'sĭ-lāj. See SILAGE.

En'statite, a native silicate, chiefly of magnesium, but also containing more or less iron and aluminum. The mineral commonly occurs in massive or fibrous forms, but distinct crystals, prismatic in habit, and belonging to the orthorhombic system, are also occasionally found. Its color varies from white to green. Its hardness is 5.5, and its specific gravity about 3.2. Enstatite is a common constituent of peridotites, crystalline schists, and meteorites, and is also associated with certain serpentines. It belongs in the pyroxene group, is insoluble in hydrochloric acid, and before the blow-pipe it fuses only along its thin edges. The name (Greek, "adversary") refers to these refractory qualities.

Entab'lature, in architecture, the horizontal, continuous work which rests upon a row of columns, and belongs especially to classical architecture. It consists of three principal divisions, the epistyle or architrave immediately above the abacus of the column, next the frieze, and then the cornice. In large buildings projections similar to and known also as entablatures are often carried round the whole edifice, or along one front of it.

En'tada, a genus of leguminous plants containing about a dozen species of climbing tropical shrubs, remarkable for the great size of their pods. *E. scandens* has pods which measure from six to eight feet in length. The seeds have a hard, woody, and beautifully polished shell, and are often made into snuff-boxes, scent-bottles, etc.

Entail′, the settlement of an estate so that it shall pass according to a certain rule of descent. In England after the Norman Conquest estates were frequently granted to a man and the heirs of his body, but in time the law courts interpreted such grants as conferring a fee simple conditional, so that when the condition, namely the begetting of an heir, was fulfilled, the estate became a fee simple absolute and could be alienated by the grantee. The statute ‹De Donis Conditionalibus,› passed in 1285, declared that this interpretation was contrary to the intention of the grantors, and enacted that in all future grants of this nature the grantee should have no power to alienate the estate, and that on the failure of issue the land should revert to the grantor. The effect of this statute was to prevent the free conveyance of land, but gradually the lawyers created a series of proceedings, known as fines and recoveries, by means of which a tenant in possession could bar the entail and convert his estate-tail into a fee simple, that is, into his absolute property. (See FEE, ESTATE.) These remedies created by the courts were abolished by the Fines and Recoveries Act, passed in 1833, and a direct means of barring entails was introduced. This statute enacts that every actual tenant-in-tail shall have full power to dispose of, for an estate in fee simple absolute, or for any less estate, the lands entailed, but a tenant-in-tail in remainder, expectant on an estate of freehold, cannot bar the entail, though he may bar his own issue, without the consent of the «protector of the settlement,» who is usually the tenant for life.

Entasis, ĕn′tā-sĭs, in architecture, the delicate outward curve of a column, found in perfection in the Doric column, by which an arc is described whose highest point is about midway between capital and base. This swelling of the column is intended to counteract the optical error by which a rigidly straight perpendicular line has a tendency to appear concave. The entasis is also calculated to suggest life and motion in the column under the superimposed weight of the entablature.

Entelechy, ĕn-tĕl′ĕ-kĭ, a Greek word meaning «the bringing to completion»), in the peripatetic philosophy of Aristotle is the transition or connecting action between what he calls **δύναμις**, potentiality, and **ἔργον**, actuality; that which, among the schoolmen, is conceived as intervening between the *posse,* and the *esse,* for example, between the infinite possibilities of omnipotence in the Supreme Being, and their manifestation in creation and active providence.

Entel′lus Monkey, or **Hoonoomaun,** an anthropoid ape or monkey included in the family *Simiadæ.* Its general name is *Semnopithecus, pithecus* standing for ape, and the rest of the word signifying sacred, or holy. This name has reference to the superstitious veneration in which the animal is held by the people in the land of its nativity. The specific name *entellus* contains the idea of command, and may refer to its head-dress, suggesting a reason for the worship it receives. In structure the animal conforms to the features which mainly distinguish the Old World monkeys from those of the New World, among which characters are: (1) the downward direction of the nostrils; (2) the presence of an opposable thumb; and (3) a non-prehensile tail. The body measures 22 inches, the tail 38 inches, and the weight is about 20 pounds. The color of the body is light yellow, the outside surface of the limbs chocolate, the hands and feet black. The hair radiating from a point on the forehead forms a crown for the head and a visor to protect the eyes. The range of this species is restricted to the southwest provinces of the river Ganges in India. Although the hoonoomaun is supposed to embody the spirit of a deceased human ancestor, its habits are mischievous and destructive, and it commits great havoc where it is protected.

Entente Cordiale, ŏṅ-tŏṅt kôr-dĭ-ăl, in politics, a term used in international politics, signifying a certain cordiality, based either upon sentiment or community of interest between nations and rulers. It is a relation closely bordering upon an alliance.

Enteralgia, ĕn-tē-răl′jĭ-ạ. See ENTERITIS.

Enter′ic Fever. See TYPHOID FEVER.

Enteritis, an inflammation of the small intestine, the most important symptom of which is diarrhœa. Different varieties of enteritis are described as catarrhal enteritis, the acute enterocolitis of children, or cholera infantum, croupous enteritis, and enteritis due to tuberculosis, carcinoma, and other malignant diseases. In primary enteritis the symptoms may be acute or chronic, the most important single symptom being diarrhœa. The stools are thin and watery, and particles of undigested food may be found in them. There is usually colicky pain with gas, and occasional vomiting. Loss of appetite, thirst, and dry tongue are usually present, but fever is not common. The general causes of catarrhal enteritis are improper food, particularly in children, unripe fruit, toxic substances, changes in the weather, and nervous influences bringing about changes in the character of the secretions and in the muscular activities of the walls of the intestines. Infectious diseases may also be the cause of acute enteritis. Rest in bed, following a mild laxative such as calomel or castor oil, together with milk diet, will usually be sufficient treatment for the simple cases.

Acute enteritis of infants, known as cholera infantum (q.v.), is a much more serious disease. This is a form of dysentery, in which not only the small intestine but the large intestine also is involved, and the most active cause of this disease is a specific micro-organism called the bacillus of Shiga. Treatment of acute enteritis of infants requires trained medical advice. The most important feature, however, in infants is to cut down the feeding, giving practically nothing but water for at least 24 to 36 hours. See CHOLERA INFANTUM; COLITIS; DYSENTERY; INTESTINES, DISEASES OF.

Enteroclysis, a form of intestinal hydrotherapy of much importance. It consists in lavage of the intestines. The ordinary hot-water enema is the simplest form of enteroclysis, but true enteroclysis consists in continuous irrigation with large quantities of solution, either with a single or a double tube. The effect of the introduction of large amounts of hot salt solution (a dram of common table-salt to a pint of water, at a temperature of from 110° to 118° F.) is very marked. There is much increase in the tension of the pulse, and pronounced stimulation of the heart-action, both of prime importance in the treatment of hemorrhage, shock, asphyxiation from drowning or from coal-gas poisoning, and of many forms of drug and industrial poisoning. Enteroclysis has also a marked effect in augmenting the secretion of the kidney, and proves of immense importance in the treatment of chronic uræmic poisoning, such as is seen in Bright's disease, and also in the treatment of diabetic coma. It is likewise of importance in bladder troubles, in colitis, in peritonitis, septic endocarditis, and in ulcerative conditions of the large intestine, such as are found in dysentery and in cholera. Enteroclysis is also an excellent mode of treating collapse in chronic alcoholism.

En'terprise, The, an American 12-gun schooner with a brilliant naval career; one of the steadily "lucky" vessels. Built 1799 to deal with the French privateers in the West Indies, she had an extraordinary cruise in 1800: in a six-months' run she took 8 privateers, some of them much heavier than herself, and aggregating 47 guns, besides recapturing 4 American merchantmen. Sent to the Mediterranean against the Barbary pirates, she captured a 14-gun Tripolitan after a fierce engagement, and later was at the bombardment of Tripoli. But her finest battle was with the English brig Boxer, Capt. Blythe, on 5 Sept. 1813, off the Maine coast, toward Monhegan Island. She had then 16 guns, and was under Lieut. William Burrows; the Boxer had 14. The crews were about 100 each. The fight began at 3.20 P.M., and was ended at 4 by the Boxer striking, literally cut to pieces in hull, masts, rigging, and spars, several of her guns dismounted, boats and quarters shattered; while the Enterprise was almost uninjured, with but one shot in the hull and one in the mainmast. Both commanders were killed. American loss, 2 killed, 10 wounded; British, 4 killed, 17 wounded.

En'toderm (also called entoblast or hypoblast), the innermost layer of cells in the developing embryo. In man it subsequently develops into the epithelium that lines the digestive canal and its appendages, the pancreas, liver, lungs, etc. See EMBRYOLOGY.

Entomological Societies. Half a century ago a single entomological society was all that had been organized in the United States, but at the present time there are probably upward of a score of organizations devoted to this science. The first entomological society of which we have record was formed in 1842, and was The Entomological Society of Pennsylvania, which has long been out of existence. The American Entomological Society of Philadelphia was founded in 1860 under the name of The Entomological Society of Philadelphia, and published 'Proceedings' until 1868, when the society name was changed and the publications became known as 'Transactions.' This, as well as some of the other societies that will be mentioned, is supported by a permanent endowment fund, owns very extensive and valuable collections and a library, which are deposited with the Academy of Natural Sciences of Philadelphia, of which institution its members are associate members of the entomological section. Under the combined auspices of these organizations there is now published 'Entomological News,' which completed its 13th volume in 1902. The Entomological Society of Ontario publishes the 'Canadian Entomologist' which has reached its 35th volume and annual reports. It began publication in 1868, though the society had a previous existence under the name of The Entomological Society of Canada. It is supported by an annual government grant of $1,000 and the sale of its publications. The Brooklyn Entomological Society was organized in 1872, and in 1888, while retaining a corporate existence, became merged in the Brooklyn Institute, forming the department of entomology of that institution. It published 7 volumes of a 'Bulletin' and 6 volumes of 'Entomologica Americana,' but has temporarily discontinued publication. The Cambridge Entomological Club was founded at Cambridge, Mass., in 1874, and publishes 'Psyche,' a quarterly originally devoted largely to bibliographical and biological entomology. The same year The Entomological Club of the American Association for the Advancement of Science was formed. In 1884 The Entomological Society of Washington was organized, publishing 'Proceedings.' The Association of Economic Entomologists, as has previously been mentioned, was established in 1889. Its 'Proceedings' are published in the general series of bulletins of the Division of Entomology of the United States Department of Agriculture. In the year 1881 The New York Entomological Club began the publication of 'Papilio,' but at the end of its 4th volume its members joined the Brooklyn Entomological Society. In 1892, however, another society was organized in New York as The New York Entomological Society. It was incorporated in 1899, and issues a quarterly 'Journal.'

In addition to these, the principal publishing entomological associations of the United States and Canada, there are several entomological sections of larger scientific societies in Canada and in the United States. There are also local clubs or societies in various sections, for example, in Newark, N. J.; at Williamsburg, N. Y.; at Chicago, Pittsburg, and in San Francisco, the home of the California Entomological Society.

There are many foreign societies, nearly all of the largest cities of Europe supporting one or more, usually holding titles significant of an entire nation, for example, there are entomological societies of Belgium, France, Switzerland, Russia, Italy, and Germany, and others representing the cities of London, Berlin, Vienna, and Stockholm. See also AMERICAN ENTOMOLOGICAL SOCIETY.

Entomology, the science which deals with insects. See INSECTS.

Entomology, Economic. Attacks by insects upon useful plants doubtless began with the first cultivation of plants. But it was not until the end of the 18th century that any means for mitigating their ravages were employed beyond hand methods and other purely mechanical measures. A few crude efforts were made among the ancient farmers and fruit-raisers on the shores of the Mediterranean toward the suppression of insect-pests, and Pliny even advised the use of white hellebore, one of the modern insecticides; but it was at about the middle of the 19th century that insecticides

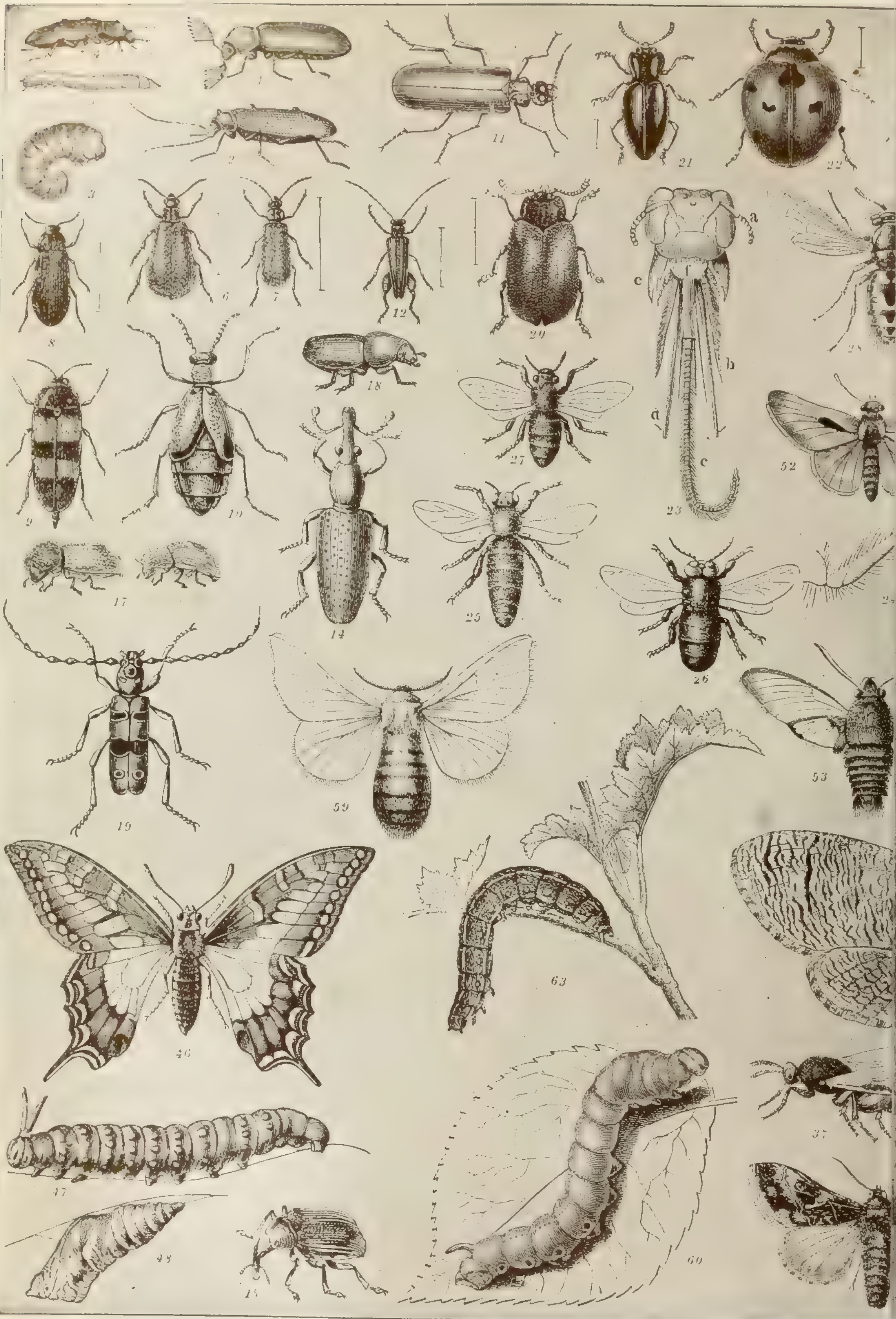
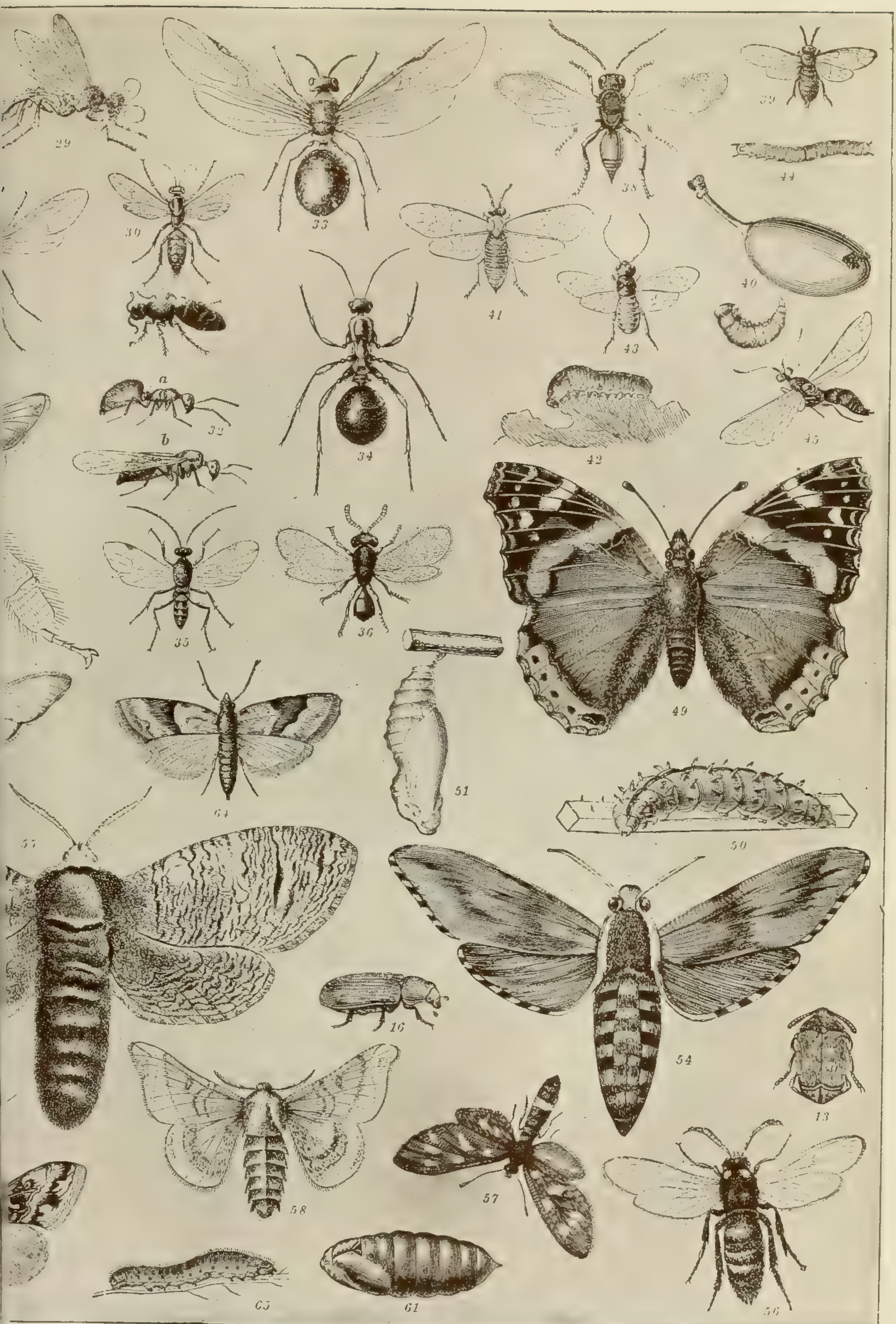
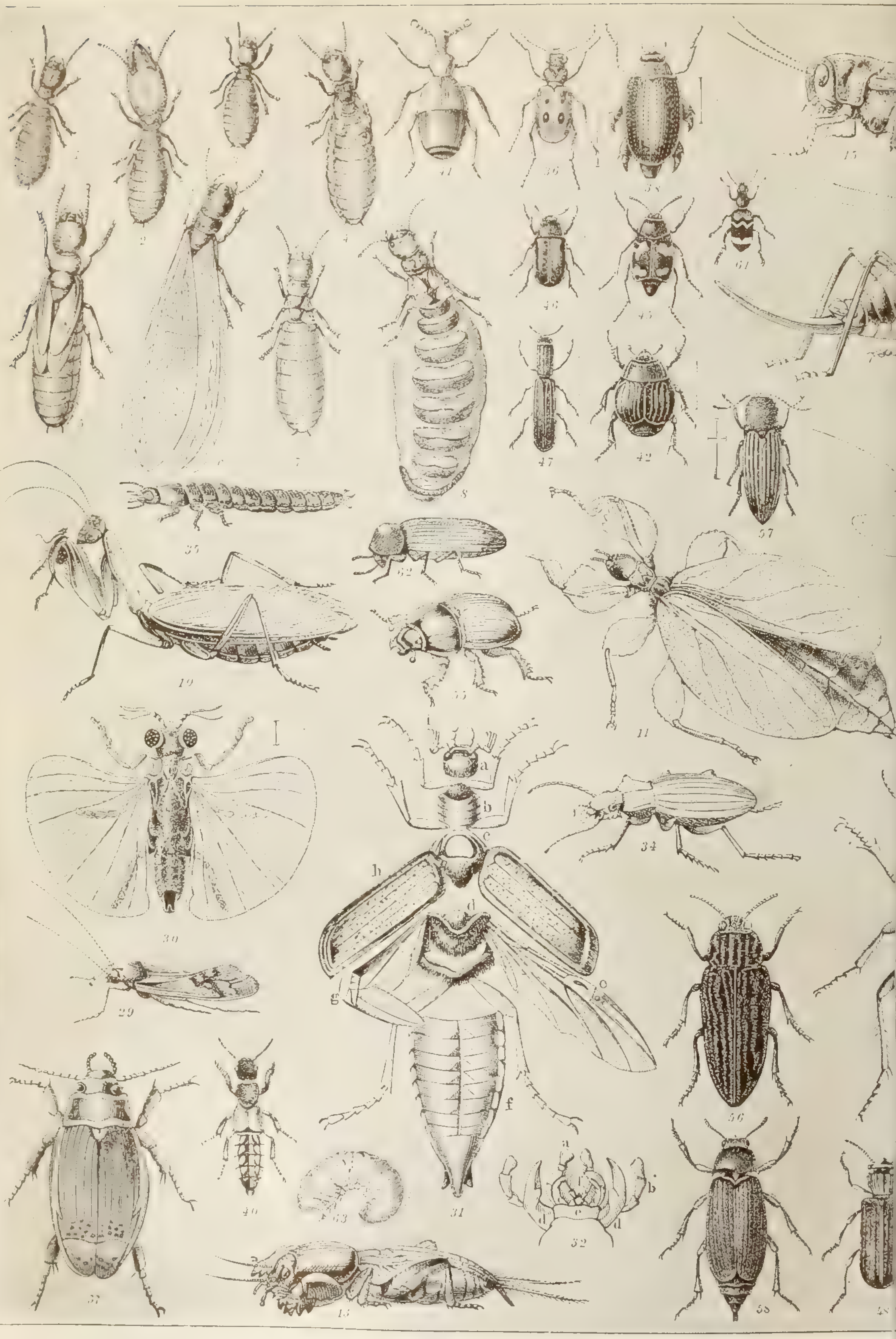


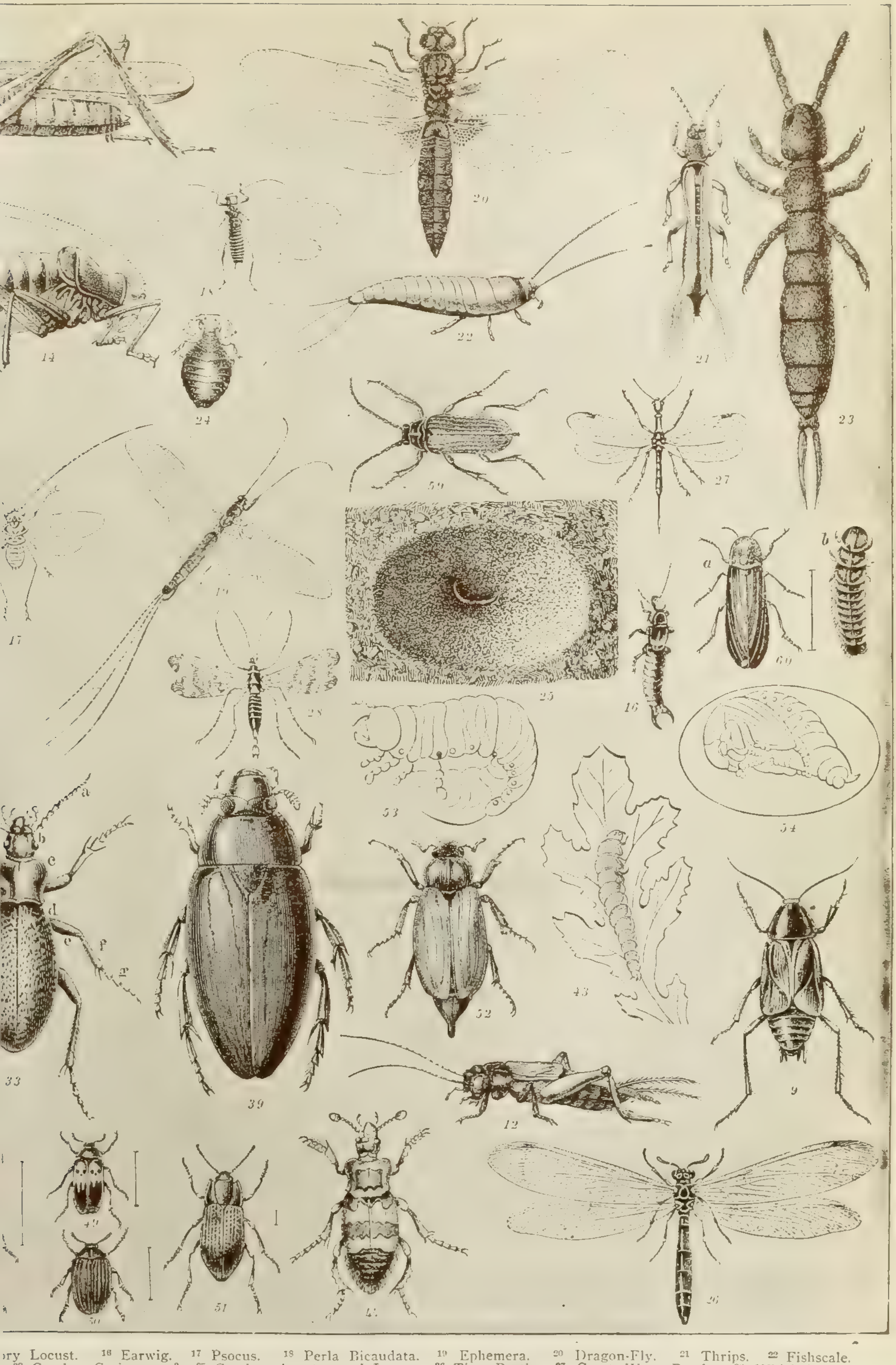
Fig. 1 Boring-Beetle (*Ptilinus*). 2, 3 Boring-Beetle (*Ptinus* and Larva). 4, 5 Tenebrio and Larva (mealworm). 6 L
12 Oedemera. 13 Pea-Beetle. 14 Corn-Weevil. 15 Vine-Weevil. 16 Clover-Weevil. 17 Bostrychus. 18 Plun
24 Hindleg of Worker. 25, 26, 27 Queen, Drone, and Worker. 28 Wasp. 29 Sand-Wasp. 30 Pompilus Vi
of Brown Ant. 35 Microgaster. 36 Teleas. 37 Brilliant Ichneumon. 55 Rhodites Rosæ. 39, 40
45 Corn Saw-fly. 46, 47, 48 Swallow-tail Butterfly, Larva, and Pupa. 49, 50, 51 Admiral Butterfly
56 Bee-Moth. 57 Syntomis. 58, 59, 60, 61 Silkworm Moth—Male, Female, Caterpillar, and Ch



[7] Scarlet-Beetle. [8] Melandry. [9] Mordella Fasciata. [10] Meloe (Oil Beetle). [11] Cantharis (Spanish Fly).
Beetle. [19] Alpine Goat-Beetle. [20] Lina Populi. [21] Fungus-Beetle. [22] Lady-bird. [23] Head of Bee.
[31] European Mutilla. [32] *a*, Female Worker; *b*, Male of Yellow Ant. [33], [34] Female and Worker
ee Saw-fly and Larva. [41], [42] Turnip Saw-fly and Larva. [43], [44] Pear-tree Fly and Larva.
Larva and Pupa. [52] Hesperia. [53] Hawk-Moth. [54] Pine Hawk-Moth. [55] Willow-Moth.
[62] Ypsilon. [63] Caterpillar of Cabbage Butterfly. [64], [65] Vine-Roller and Caterpillar.



Figs. 1—8 Termites. 9 Cockroach. 10 Mantis. 11 Leaf Insect. 12 Cricket. 13 Mole-Cricket. 14 Grasshopper. 15 Mi
23 Glacier-Flea. 24 Bird-Tick. 25, 26 Ant Lion. 27 Inocellia. 28 Scorpion-Fly. 29 May-Fly. 30 Xenos. 31, 32 Coleop
39 Hydrophilus. 40 Rove -Beetle. 41 Claviger. 42 Hister. 43 Larva of Carrion-Beetle. 44 Burying-Beetle
52, 53, 55 Dung-Beetle. 54 Cockchafer, Larva and Pupa. 56 Chalcophora. 57 Agriotes Segetis



ory Locust. [16] Earwig. [17] Psocus. [18] Perla Bicaudata. [19] Ephemera. [20] Dragon-Fly. [21] Thrips. [22] Fishscale.
. [33] Carabus Coriaceus. [34], [35] Carabus Auratus and Larva. [36] Tiger-Beetle. [37] Great Water-Beetle. [38] Whirlwig.
[45] Scaphidium. [46] Nitidula. [47] Colydium. [48] Cucuius. [49] Dermestes. [50] Pill-Beetle. [51] Ground-Beetle.
, [59] Cebrion. [60] Glow-Worm. [61] Clerus Formicarius. [62]—[66] Death-Watch and Larva.

(q.v.) or insect poisons began to be generally adopted, and the migration of the Colorado potato beetle from its native home in the Rocky Mountain region to the potato fields of the East was the indirect means of the employment of arsenical preparations as a means of destroying insects; so that this insect, while an apparent curse, has proved, indirectly, of the greatest value to the agricultural community at large. Prior to the use of Paris green, which appears to have first been applied to this potato pest in Michigan in 1867, knocking the beetles from the infested plants into a pan of water, was the only method of treatment, and was used for many other insects as well. The discovery of the value of this poison as a remedy for the codling moth was made in 1878, by Prof. A. J. Cook, who used Paris green as a remedy for canker-worms, and found that the trees treated with it were free from codling moth. To Prof. Cook also is probably due the first use of kerosene mixed with soap, although the kerosene emulsion, which is now a standard remedy for all sucking insects, was the joint product of Messrs. Barnard, Hubbard, and Riley, and first used in 1877. White arsenic was employed as an insecticide as early as 1871, and London purple was put to practical use in the destruction of the cotton-worm in 1878. London purple has since been displaced by various other insecticides, as it has proved inferior to Paris green, which, in turn, has been replaced by arsenate of lead, because the latter, while poisoning the insects, does not scald or otherwise injure the plants. In the same manner that the discovery of Paris green as a remedy for the Colorado potato beetle was made through the migrations of this insect, the ravages of the cottony cushion scale (*Icerya purchasi*) of the orange orchards of California led to experiments conducted by Mr. D. W. Coquillett, of the United States Department of Agriculture, in 1886, to the finding of hydrocyanic-acid gas as the best medium for extirpation of scale insects (q.v.), and to its general use in fumigation for all insects which can be treated with it. In 1895 Messrs. A. F. Woods and P. H. Dorsett, also of the Department of Agriculture, began experiments which led to the adoption of a perfected system of fumigation with the same gas of plants grown under glass and injured by scale and other insects.

Our best remedies for insects, then, arsenical mixtures and kerosene emulsion and other preparations, and hydrocyanic-acid gas, are the product of American research. The bisulphid of carbon as an insecticide, however, though the discovery of a foreigner, has doubtless received greater attention in our country than elsewhere. It was first employed by M. Doyere, as early as 1856, as a remedy for weevils in stored grain, which is still its principal use; but its cost when first employed was so excessive as to preclude its general employment on a large scale. Subsequently a high grade of this chemical, known as "fuma-bisulphid," was made for sale at 10 cents a pound. It supplements the use of hydrocyanic-acid gas in that the former is used for the fumigation of plants above ground, while the latter destroys insects affecting the root-system. Both gases are used for the treatment of indoor insects in granaries and mills, and in dwellings and ware-houses. Although these are the main insecticides there are others, nearly all of which owe their discovery and perfection to economic workers in America. They include pyrethrum, better known as Buhach, Persian, and Dalmatian insect-powders, the extensive use of which has resulted in the establishment of a considerable industry in the growing of the principal plants which produce these powders (*Pyrethrum cinerariæfolium* and *Pyrethrum roseum*); and whale-oil and fish-oil soaps, originally used against the hop-plant louse in 1886, and later against scale-insects. In more recent years what is now termed the "lime, sulphur, and salt wash" has been found a very valuable remedy against scale-insects.

During the early years of work in spraying for various insects the principal dependence was placed in American insecticide machinery, but after the invention of different forms of nozzles by M. Vermorel, of France, various other nozzles, pumps, and other machinery were invented in America and have gone into general use.

Prevention of Insect Injuries by Farming Methods.— It would be difficult to detail step by step the wonderful progress that has been made in means of subduing insects by simple farming methods which, as a rule, necessitate little or no extra labor or monetary outlay. Some of our principal pests, with which we cannot cope successfully by means of insecticides or by mechanical methods, may be controlled by the judicious use of ordinary methods of tillage. The seed, nursery, or other stock for planting should be selected with a special view to securing immunity from attack by the insect most feared or most prevalent in the region where the crop is to be planted. By planting different immune varieties of wheat the ravages of the Hessian fly are reduced to a minimum. Certain forms of trees may be selected for planting for shade in some regions without danger of injury, because the insects which elsewhere do greatest damage to them are not present. The selection of a suitable location on the farm for a crop should be made with the same end in view. Where injury is feared by an insect which does not travel freely, immunity can be secured by planting in that part of the farm where the insect is known not to exist. The prompt destruction of crop remnants, and the pulling up and burning over of weeds and other rubbish, is a preventive applicable to all crops. Another measure is the use of "trap crops." Thus part of an old crop may be left to attract insects which usually remain in the field after the crop is made; similar or more attractive plants may be grown for the protection of the main crop; or of early varieties of the same plants, as lures for the insects until the main crop can obtain a good start. Trap crops are of considerable value in the treatment of several of the worst enemies of cucumbers, melons, squashes, and similar vines. The stimulation of a plant by means of fertilizers, and the maintenance of healthy, vigorous growth by cultivation, the suppression of diseases, and the prevention of injury by insect pests other than those which it is specially designed to circumvent, are helpful aids. Crop rotation, or the planting of alternate crops which are not injured by those insects which ravage the staples assists in the warfare; as also do fall and spring plowing, which, in proper combination, result in the destruction of nearly all forms of the many insects which pass one or more stages in the earth in hibernation. The use of water by irrigation or submersion, if practised at the right time, will result in the temporary extirpation of nearly all insects in the fields thus treated, particularly in cranberry bogs. The reclamation by drainage of land subject to more or less complete submersion, such as swampy tracts, river bottoms, and the like, and the destruction of the weeds and other plants and the insect life which remain by burning over, are of great value in suppressing many pests. If, to the methods above outlined, we add the strict observance of timely harvesting of crops with a view to the prevention of further attack and the destruction of insects which might reproduce the following year; the utilization of natural enemies, such as parasitic and predaceous insects, poultry, and live stock, to destroy the insects in the field after the crop is off; the systematic inspection of the farm for the first appearance of insect attack, and, finally, the co-operation of neighboring farmers, there is comparatively little use for insecticides save in the case of insects such as grasshoppers and the caterpillars of moths and butterflies, which are strong fliers and cannot be successfully controlled by mechanical methods.

Economic Entomologists.— Dr. T. W. Harris is credited with having been the first economic entomologist of this country, but in reality the honor is due to W. D. Peck, who began writing on injurious insects late in the 18th century (1795–1819). His writings, however, are few, in comparison to those of Harris, whose labors began in 1831 and whose greatest work appeared in 1841, his classic treatise on 'Insects Injurious to Vegetation.' In the year 1853 the New York State legislature appropriated $1,000 for the study of economic entomology, and Dr. Asa Fitch was appointed to perform the work specified. Fitch's work continued until 1871 or 1872, when his 14th and last report was published. Afterward different States, Illinois in 1866–7, and Missouri about a year later, appointed State entomologists, the latter State obtaining the services of Dr. C. V. Riley, who wrote a series of nine reports which, for originality, scientific accuracy, and practical value, have received recognition the world over.

When Dr. Riley assumed the duties of entomologist of the United States Department of Agriculture, economic entomology received a new impetus, his work and that of his assistants marking a new era in practical entomological work. Upon his death in 1894, he was succeeded by Dr. L. O. Howard, under whose direction the Division of Entomology continues to issue reports, bulletins, and circulars of the highest practical and scientific value. See AGRICULTURE, DEPARTMENT OF.

Prior to 1888 Massachusetts, New York, Illinois, and Missouri, were the only States which maintained officially appointed economic entomologists. During that year the State Agricultural Experiment Stations (q.v.) were organized under the Hatch Act, and several official entomologists were appointed in connection with them. In 1889 was formed an Association of Economic Entomologists which held annual meetings in various cities subsequently and had in 1903 a total membership of 167. A list of the addresses of the presidents at each meeting is appended. Together they form a history of the progress of applied entomology in America.

1890. Champaign, Ill., 'The Outlook of Applied Entomology,' C. V. Riley.

1891. Washington, 'Economic Entomology,' James Fletcher.

1892. Rochester, N. Y., 'Work of the Year in Economic Entomology,' S. A. Forbes.

1893. Madison, Wis., 'The Drift and Balance of Our Progress for the Year,' S. A. Forbes.

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Entomos'traca, one of the two great subclasses of crustacea (the other is Malacostraca) including minute forms, the "water-fleas," having a horny shell of many pieces, a well-developed cephalo-thorax, mandibles, and three pairs of maxillæ, five pairs of thoracic feet, but no abdominal feet, and no gills, breathing instead by specialized organs. They have a great variety of shapes and of means of locomotion. The young is a nauplius and develops by numerous molts. The group includes many thousands of species divided into four orders,— *Phyllopoda, Ostracoda, Copepoda,* and *Cirripedia* (barnacles). They abound in stagnant fresh waters, and also in the sea, and furnish an immense quantity of subsistence for fishes that are used for human food. They exist and increase in innumerable

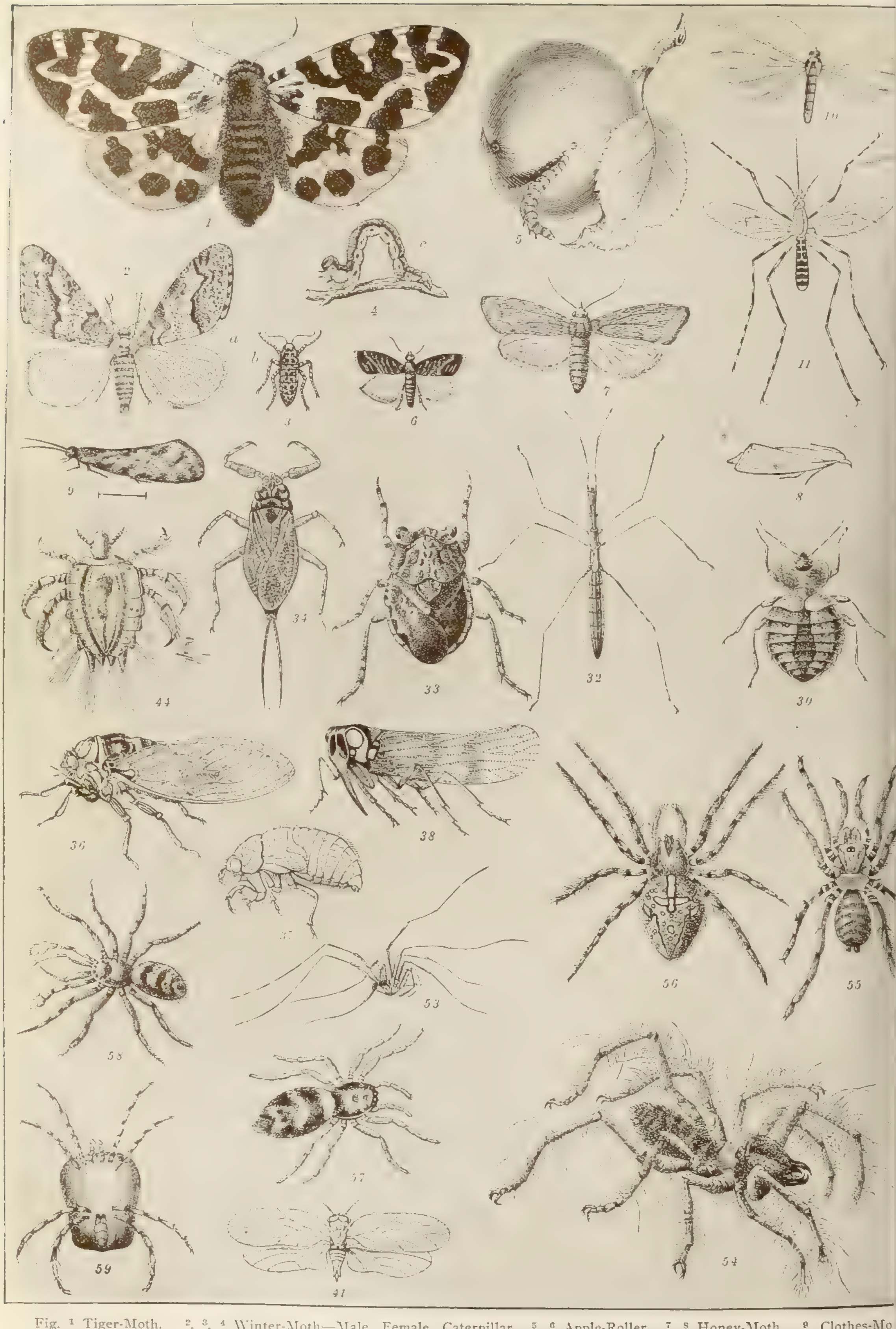
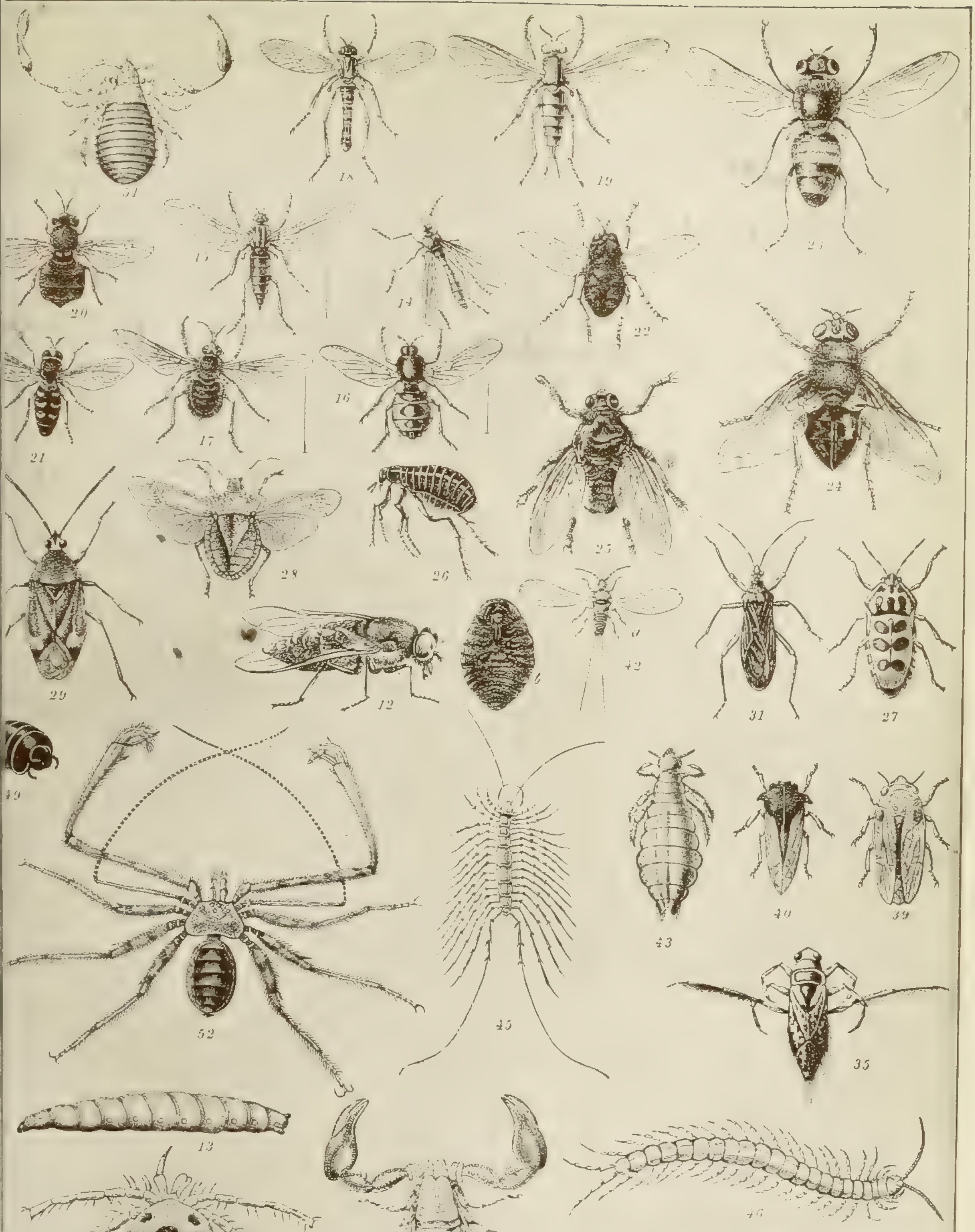


Fig. [1] Tiger-Moth. [2], [3], [4] Winter-Moth—Male, Female, Caterpillar. [5], [6] Apple-Roller. [7], [8] Honey-Moth. [9] Clothes-Mo
[17] Bombylius. [18] Vermileo. [19] Volucella. [20] Stratiomys. [21] Syrphus. [22] Tachina. [23] Bot-Fly. [24] Blue-Bo
[32] Water-Flea. [33] Bank-Scorpion. [34] Water-Scorpion. [35] Water-boatman. [36], [37] Cicada and Larva. [38]
b. Female. [43] Louse. [44] Crab-Louse. [45] Scutigera. [46] Scolopendra. [47] Millepede. [48] Ce
[54] Scorpion-Spider. [55] Mining-Spider. [56] Garden-Spider.



White-plume Moth. [11] Ringed Gnat. [12, 13] Breeze-Fly and Larva. [14] Hawk-Fly. [15] Leptis. [16] Anthrax.
[25] Forest-Fly. [26] Flea. [27] Beetle-Bug. [28] Wood-Bug. [29] Phytocoris. [30] Common Bug [31] Reduvius.
wing Cicada. [39] Frog-hopper. [40] Centrotus Cornutus. [41] Psylla Genistæ. [42] Cochineal, *a*, Male,
. [49] Pill-Worm. [50] Scorpion. [51] Book-Scorpion. [52] Tarantula. [53] Weaving-Spider.
Hunting-Spider. [59] Scarlet-Mite. [60] Water-Mite.

millions. The descendants of a single cyclops may in one year number over 4,000,000,000. At one time they render the surface of the sea-water phosphorescent by their vast luminous congregations. At another time the Atlantic Ocean is colored red over a space of hundreds of square miles by the assemblage of these minute creatures, attracting multitudes of fishes, even of whales, which feed upon them. On the other hand, some forms are equally injurious as parasites. These belong chiefly to the copepod group, *Siphonostomata,* having mouths fitted for suction. Some are commensal, entering the gill-sac or the digestive cavity and feeding upon the food, not upon the tissue of the host. Some attach themselves long enough to suck the blood of their victim and then pass on; while others enter the body as permanent residents and embed themselves in the tissue. Thus they are the pests of starfish, jellyfish, worms, ascidians, fishes, and whales. See BARNACLE; COPEPODA; CRUSTACEA; FISH-LICE; OSTRACODA; PHYLLOPODA.

Entozo'a, formerly employed as the name of a subdivision of radiate animals, has passed out of use as a term of systematic classification, because it fails to indicate or signify any ideas of structure, and only hints at the habitat and occupation of great number of living creatures. Following the strict meaning of the word, entozoa, denoting "animals within" other animals, not only brings together many genera that belong with the different subdivisions of the same general division, but also imports those which are included under classes morphologically distinct. Even this use of the term is liable to confusion, as it excludes many kinds of parasites which attach themselves to other animals, living upon their juices and tissue, without entering the cavities of the body. Of such are the whole troupe of mites which embed themselves within the skins of their hosts. (See EPIZOA.) The common bot-fly, *Gastrophilus equi,* is taken in at hatching time with the food of the horse, and, passing the larval stage of nine months in the stomach of the host, is discharged, to enter upon the adult stage, unless meantime the horse dies as the result of the great number of the guests. The degraded barnacle, *Peltogaster paguri,* attaches itself permanently to the exposed abdomen of the hermit-crab, deriving its sustenance from the host, but feeding upon rather than within the body of its victim.

The present use of the term entozoa is artificial, and tends to restrict its application (following Cuvier in this respect, though for convenience only) to that section of the class *Vermes,* known as platyhelminths or anneloids, a group of lower grade than the true worms, or annelids. All parasitic animals are degraded in structure because the field and manner of their life makes no demand upon higher and more specialized organs. In the class *Platyhelminth,* embracing the following described forms, are the planarians which are not parasitic, and the flukes and tapeworms, which are both parasitic and injurious. The difference between the former and the two latter illustrates one of the most interesting facts in biology. The planarians, leading a free and non-sessile life, are provided with sense-organs and organs of locomotion and defense which equip them for the exigencies of an active, competitive life; the parasites, on the contrary, are destitute of any such outfit or of any effective tools, save hooks or suckers for holding their anchorage, and the simplest instruments for boring into and for eating their hosts. In the free stage of life they abound in fresh water or salt, and in moist conditions. Of the sub-class *Trematoda* are the flukes, very large in numbers, which pass through most interesting changes in development, their habitat and organs varying with each successive stage. The larva, after leaving the egg, swims freely, enters the body of its host, changes form, and becomes the parent of a number of the second generation; these may remain until they mature, or in some species they may, during the progress of their metamorphoses, infest three different hosts. During these transitions the larva enjoys a commensal existence, feeding on the food swallowed by the host; but having reached the adult stage it lives by destroying the tissue in which it is moored. *Distomum hepaticum* or liver-fluke, which is found in fresh water, is a case in point. Its life moves in a circle. As an adult it inhabits the liver of mammals. The eggs there produced are discharged through the intestines into the outer moisture, where they hatch. The larva takes to the water and swims until it attacks a particular snail, *Lymæus trunculatus,* into which it enters; assumes the form of a sac or cyst, which soon produces a tadpole; the snail crawls out among the grass, and leaves this cercaria, which shakes off its tail and becomes encysted on a spear of grass. Finally, a sheep eats the grass, the cyst is dissolved, and the adult worm, three quarters of an inch long, buries itself in the sheep's liver. It is found in the liver of many ruminants and of other animals, including man. Many trematods abound in the sea, infesting cuttlefish and cephalopods. *Cestoda* is the subclass of tapeworms, which infest and work destruction in nearly all vertebrate animals. The form is elongate and flat, like a ribbon or tape, and the tapeworm is divided into sections — proglottids — forming a chain. Their manner of life has resulted in almost complete organic degeneration, as they have neither organs of locomotion nor a digestive canal, merely absorbing the juices of the host through the pores of their skin. There are two types: *Ligula,* having only a partially divided body; and *Tænia,* completely jointed, and each joint containing eggs for reproduction. The head is small, about the size of a pin, and is crowned with a ring of about 25 hooks, by which the worm anchors in the walls of its host's intestine. See TAPEWORM.

In the case of *Tænia solium* the larva must be twice swallowed, each time by a separate host. A pig takes in the egg mixed with its food. A cyst or cysticercus is formed and enters the tissue, producing "measly pork," which may be eaten by human beings, transferring the cysticercus to an attachment in the alimentary canal of the new host. In *Tænia echinococcus* the reverse process holds. The larval stage is passed within a human or other animal, while the adult appears in the dog or some other domestic animal. This parasite sadly afflicts the Icelanders, and appears to result from their uncleanly habits and from the large number of their dogs, these latter communicating the pests to plants gathered for food. Other species of *Tænia* are parasitic in dogs and sheep, promoting in the latter the disease commonly called «staggers.» The largest specimens of the cestod group belong to the family *Bothriocephalidæ*, which hold their mooring by two suckers on the head. The length of these worms sometimes reaches 30 feet.

The filiform, or threadworms, belong to the division *Nematoda*. *Filaria sanguinis-hominis* is referred to as the cause of elephantiasis, a disease common in Oriental tropical climes. The disease is said to be spread by the mediation of mosquitoes, which suck in the larvæ with the blood of the patient whom they bite. Then, when depositing their own eggs in the water, they die, setting free the threadworm embryos, the progeny of which are transferred to the human system through drinking the water. The nematoid trichina is the most dangerous of human parasites, finding its way into the body through the eating of pork, the larvæ having been developed in swine. After the meat has been swallowed the cyst containing the larva is dissolved in the digestive process; the larva is released, becomes mature, reproduces in multitudes of young, which make their way into the muscular tissue, where again they mature and may remain for years. Thorough cooking kills the larvæ in the pork. (See TRICHINA SPIRALIS.) Allied to trichinæ is *Trichocephalus dispar*, which is sometimes found in the human colon. Some genera of *Strongyllidæ* attack the human body, but other genera are the despair of poultry-raisers. *Syngamus trachealis* enters the respiratory passages of fowls, and produces the «gapes.» The afflicted bird, by coughing, expels the eggs of the parasite, which mingle with food and are eaten by other fowls, and the disease becomes epizootic. On the first discovery of the infection the afflicted subject should be isolated. *Ascares* is the nematoid known as the pinworm, and is a human entozoon of universal distribution. The eggs, being light, are easily distributed. In the human system they develop to the adult form. Happily this pest, and all others of the entozoan kind, rapidly diminish as public and domestic cleanliness, sewerage, and sanitary plumbing increase. The class *Anthrocephali* or spine-headed worms, enter pigs, fishes, and other animals as intestinal guests, and are said sometimes to afflict man. The proboscis is armed with barbs, like those of the tapeworm, by which the guest fastens itself in the tissues. The larval stage is supposed to be passed in the body of some aquatic animal. See also PARASITES.

Entre-Douro-E-Minho, ĕn'trĕ dō'roo ē mĕn'yoo, a province of Portugal, more generally known by the shorter appellation of Minho. Pop. (1900) 1,173,106.

Entre Rios, ĕn'trā rē'ōs, Argentine republic, a province bounded on the north by Corrientes, on the east by the republic of Uruguay, on the south and west by the provinces of Buenos Ayres and Santa Fé. As its name indicates, its territory lies «between the rivers»— Rio Paraná and Rio Uruguay. Area 45,000 square miles. Agriculture and immigration have been encouraged by the provincial government, which sells land to settlers in portions of 82½ acres, to be paid for in three years, at prices ranging from $600 to $2,000, according to location. In 1880 there were 32 agricultural colonies; in 1885 there were 54; 122 in 1891, and so on. The cultivated area in 1887 was 248,411 acres; in 1891 it had increased to 855,000 acres. This increase is noticeable especially in the area devoted to wheat, the quality of that product being uncommonly good. Other products are: Maize, lucerne, barley, flax, grapes, tobacco, fruit, and (on a very large scale) cattle, sheep, and horses. Its capital, the city of Paraná (population 20,000), was the capital of the republic from 1852 to 1861; it has a national college, a normal school, and several elementary schools, and is an important port for the traffic on the Paraná River. Population of the province more than 300,000.

Entrecasteaux, Joseph Antoine Bruni d', zhō zĕf äṅ twän brü nē dōṅtr-käs-tō, French navigator: b. Aix 1739; d. at sea near the island of Waigeoo 20 July 1793. He entered the naval service in 1754, gradually rose to the position of commandant of the French fleet in the East Indies (1786), and in 1787 became governor of Mauritius and the Isle of Bourbon. In 1791 he was sent by the French government in search of La Pérouse, who had not been heard from since February 1788. He failed in detecting any trace of him, but ascertained with great exactness the outlines of the east coast of New Caledonia, west and southwest coast of New Holland, Tasmania, and various other coasts. The D'Entrecasteaux Archipelago was named in his honor.

Entresol, ŏṅ tr-sŏl or ĕn'tėr-sŏl (Fr. «between the floors»), a low story between two of greater height, generally the ground and first stories. It is called also the Mezzanine.

Entro'pion, or **Entropium,** inversion or turning in of the edge of the eyelids, in consequence of which the lashes rub on the eyeball, causing annoyance and pain.

En'tropy, in thermodynamics, a certain mathematical expression whose value does not change when the substance under discussion undergoes a reversible compression or expansion, while not receiving any heat from external sources, nor giving any up to them. In general, the change of entropy that a body experiences when it passes from one state to another by a reversible process, is found by dividing the heat that the body absorbs during every infinitesimal part of the process of transformation by the absolute temperature of the body at the corresponding instant, and integrating the results. The term entropy does not appear to admit of any simpler explanation than has here been given; and, in fact, while the conception of entropy (which we owe to Clausius) is a valuable and almost indispensable aid in advanced thermodynamics, it has always proved a stumbling-block to the beginner. The entropy of a body, unlike its temperature, cannot be obtained by direct observation, but must always be inferred by the process given above, or by some graphical method equivalent to it. The transformation that a body undergoes when its entropy does not change at all is called an «adiabatic» or «isentropic» change. See THERMODYNAMICS.

Entry, Right of, the right of taking possession of lands or property by entering or setting foot on the same. This may be done either by the claimant personally, or through his agent or attorney.

Entry, Writ of, a formal declaration made by one exercising the right of entry in recovering property of which he has been disseized that he claims full possession of the said property. The common law action of Writ of Entry has some time been obsolete.

Ent'wistle, James, American naval officer: b. Paterson, N. J., 1837. He entered the engineering service United States navy 1861, became commander in 1888, and in 1899 was made captain and rear-admiral and was placed upon the retired list. He first served on the Aroostook under Farragut in the Western Gulf squadron, and on 21 other vessels, was inspector of machinery at the Bath (Maine) Iron Works 1890–5, while the ram Katahdin and the gun-boats Machias and Castine were in process of contruction, and assistant to the general inspector at Mare Island Navy Yard in 1895. He joined the Asiatic squadron at Yokohama during that year, being appointed fleet engineer 1897 and assigned to the Olympia. He took part in the battle of Manila Bay, 1 May 1898, being advanced in numbers for meritorious services upon that occasion.

Envelope, a paper case, sealable by means of an adhesive flap, and used for enclosing letters or other matter. Envelopes were not in general use in any country prior to 1840, when, after the passage of the penny postage bill, they became common in England. Until about 1845 nearly all letters in this country were folded so that an unwritten portion came on the outside, and the address was placed there. By that time envelopes were well known, and by 1850 all letters were enclosed in them. The first maker of envelopes in New York was an Englishman named Dangerfield, who began about 1846; and by 1850 Alderton and several others were in the field. Only 2,000 or 3,000 could be made in a day, as machinery had not yet been employed. The blanks were cut out by chisels and pasted and folded by hand. Machines were invented in England in 1845 by Warren de la Rue and Edwin Hill, but these were never employed in America. The machinery employed for this purpose in the United States was invented here, but not until just before the outbreak of the Civil War. Many improvements have been made, and the speed is now so great that on some of the machines the output will reach 55,000 a day. It is supposed that the consumption of envelopes in this country is from 8,000,000 to 10,000,000 a day, or not far from 3,000,000,000 a year, of which 600,000,000 are stamped envelopes. The latter are all supplied by the Morgan Envelope Company, of Springfield, Mass., and the Plimpton Manufacturing Company, of Hartford, Conn. There are about 30 large firms engaged in the business, besides a number of smaller manufacturers. The principal towns thus employed are New York, Philadelphia, Hartford, Rockville, Holyoke, Worcester, and Springfield.

Envir'onment, a modern scientific term applied to the modifying influences of an organism or surroundings. Neither plant nor animal can be understood as a rounded-off unity; the whole life or function is made up of action and reaction between the organism and its environment. Streams of matter and energy from without preserve the relative constancy of the organism, as of a special wave-crest in the sea; while changes in the streams have their corresponding changes within the organism. The plant or animal has obviously a strong unity of its own, but even that is in part due to ancestral welding under the hammers of the environment. It may seem, too, to vary of itself like a fountain in the air, but throughout all its rises and falls there blows the wind of the environment.

The influence of outside conditions has been recognized by most naturalists from the time of Hippocrates, and is taken for granted in our everyday speech and action. There is considerable difference of opinion, however, as to the importance and degree of this influence. Thus Buffon, Treviranus, and Geoffroy St. Hilaire regarded the surroundings as directly hammering changes on the organism; while to Erasmus, Darwin and Lamarck internal changes arose as indirect functional results of new environment. Charles Darwin allowed a measure of truth in both these positions, but emphasized the independent action of the organism itself in the direction of natural selection. These three positions are still held, some emphasizing one, others another, the majority combining the three. See DARWINIAN THEORY; EVOLUTION.

Envoy, a person deputed by a sovereign or government to negotiate a treaty, or transact other business, with a foreign ruler or government. We usually apply the word to a public minister sent on a special occasion or for one particular purpose; hence an envoy is distinguished from an ambassador. Envoy extraordinary and minister plenipotentiary is a permanent resident abroad, in some unimportant country officially representing his government, but of inferior rank to an ambassador.

Enzina, Juan de la. See ENCINA, JUAN DEL.

En'zyme (Gr. "leavened"), any of the unorganized ferments, such as diastase, cytase, trypsin, etc., which induce fermentive changes in organic substances. It was formerly thought that these "unorganized" ferments might be essentially different in their action from the so-called "organized" ferments, such as the yeasts, molds, and bacteria; but it is now known that the fermentive action of the "organized" class is due chiefly, and perhaps wholly, to the enzymes that they secrete. The chemistry of the enzymes is very imperfectly understood. According to some authorities they act merely by catalysis, being capable of effecting the fermentive change of indefinite quantities of the substances upon which they act, without being themselves used up, nor exhausted in any way. According to other authorities, they are gradually destroyed by their own activity, so that a definite mass of any given enzyme can produce only a definite (though surprisingly large) amount of fermentive transformation. See FERMENTATION.

Chemical ferments, elaborated in the cells of plants and animals, and capable of bringing about a peculiar series of biochemical reactions, which are produced without the intervention of physical factors or mineral substances. Under some conditions they have the properties of facilitating chemical interchanges between certain bodies without entering into the composition of the different products that result.

These enzymes, or ferments, zymases, or diastases, as they are frequently called, play an important role in the digestive processes, as well as being of vital importance in the general life-history of nearly all plants. A knowledge of enzymes dates back to very remote periods. In the beginning of the 16th century observations on the phenomena of digestion called attention to this class of bodies; but it remained for Dubrunfaut and Pasteur to place the science of fermentation on a stable basis. Enzymes are for the most part soluble in water, being thrown out of solution by a large number of chemical substances, such as alcohol, tannic acid, etc. They usually lose their activity at a temperature above 100° F. Most of them decompose hydrogen peroxide, and they act largely in proportion to their quantity. With reference to their chemical composition, it would appear that they belong to the proteid class. There is usually a large proportion of inorganic salts, particularly calcium phosphate, in their composition. A few, however, do not contain nitrogen. Although closely related to proteids, they do not give proteid color-reactions. As to their formation, it is considered by some that they are oxidation products of albuminoid substances, or zymogens. The transition of the zymogen into the ferment is termed zymogenesis. Destruction of enzymes is termed zymolysis. As to the manner of action of this interesting class of bodies, a vast variety of phenomena may be observed. They may bring about molecular changes either by hydration or by oxidation. They appear to occupy the position of intermediaries, as it were. Many thories are put forward in attempting to explain the action of enzymes; but as they present many analogies to living protoplasm, explanation of the phenomena of their activities is almost as difficult as to explain the phenomena of life. Attempts have been made to classify the various enzymes, but any classification must be of a transitory character, since knowledge concerning this group of bodies is increasing daily. The classification of the soluble ferments suggested by Effront is shown below.

The enzymes have many applications in the arts. Consult: Greene, 'Soluble Ferments'; Effront, 'Enzymes and Their Applications,' John Wiley, N. Y., 1902.

Eocene (ē'ō-sēn) **Epoch** (Gr. «dawn»), a term applied in geology to one of the divisions of the Tertiary, as originally suggested by Lyell; a geological period. See EOCENE SERIES; TERTIARY.

Eocene Series, a subdivision of geological time. Lyell in 1833 first used the term Eocene (dawn of the recent) for the earliest of his

CLASSIFICATION OF SOLUBLE FERMENTS.

Names of the Enzymes.	Substances on which the Enzymes Act.	Products of the reaction.
	A. SOLUBLE HYDRATING FERMENTS.	
	1. Soluble Ferments of Carbohydrates.	
Invertin or sucrase	Cane-sugar	Invert-sugar
Amylase	Starch and dextrin	Maltose
Glucase or maltase	Dextrin and maltose	Dextrose
Lactase	Lactose	Dextrose and galactose
Trehalose	Trehalose	Glucose
Inulase	Inulin	Fructose, levulose
Cytase	Cellulose	Sugars
Pectase	Pectin	Pectates and sugars
Caroubinase	Caroubin	Caroubinose
	2. Soluble Ferments of Glycosides.	
Emulsin	Amygdalin and other glycosides	Glucose, oil of bitter almonds, and hydrocyanic acid.
Myrosin	Potassium myronate	Glucose and allyl isosulphocyanate
Betulase	Gaultherin	Oil of wintergreen Glucose
Rhamnase	Xanthorhamnin	Rhamnatine, isodulcite
	3. Fatty Ferments of Fatty Substances.	
Steapsin } Lipase }	Fatty substances	Glycerin and fatty acids
	4. Soluble Ferments of Proteins.	
Rennet	Caseinogen	Casein
Plasmase	(Casein, Hammarsten)	(Para casein)
Casease	Fibrinogen	Fibrin
Pepsin	Casein	
Trypsin	Albuminoid substances	Proteoses, peptones
Papain	Albuminoid substances	Proteoses, peptones, amides
	5. Ferments of Urea.	
Urease	Urea	Ammonium carbonate
	B. SOLUBLE OXIDIZING FERMENTS.	
Laccase	Uruschic acid Tannin, anilin, etc.	Oxyuruschic acid Products of oxidation
Oxidin	Coloring matters of cereals	Products of oxidation
Malase	Coloring matters of fruits	Products of oxidation
Olease	Olive oil	Products of oxidation
Tyrosinase	Tyrosin	Products of oxidation
Oenoxidase	Coloring matter of wine	Products of oxidation
	C. FERMENTS CAUSING MOLECULAR DECOMPOSITION.	
Zymase or alcoholic diastase	Various sugars	Alcohol and carbonic acid

three subdivisions of the Tertiary. The term found favor quickly since early Tertiary life differed greatly from late cretaceous. Toward the close of cretaceous time, the sea receded from a large part of North America and by the end of Eocene time the continent had nearly its present form. Though the climate continued warm, Greenland and Alaska having a temperate climate, yet the elevation of the land must have affected the direction of prevailing winds and modified rainfall. Of cretaceous animals the reptiles suffered most, the ichthyosaurs, dinosaurs, and plesiosaurs passing away as well as many peculiar mollusks. Eocene fishes were mostly of modern character (teleosts), birds were more numerous and highly developed than in the Cretaceous Age; while mammals developed wonderfully. True carnivorous mammals (cynodictis) appeared, as also the ancestors of the horse (*Hyracotherium*), rhinoceros (*Heptodon*), tapir (*Systemodon*), pig (*Eohyns*), and the ruminants (*Trigonolestes*), besides bats, primitive camels (*Leptotragulus*), and monkeys (*Anaptomorphus*). A study of organic types indicates that Asia, North America, and Europe were connected in Eocene time and, by the Antarctic continent, South America, and Australia, while South America was separated from North America and Africa and southern Asia from Europe and northern Asia.

The Eocene formations in the United States are classified geographically as the Atlantic border, Gulf border, interior and Pacific border provinces. The Eocene rocks of the Atlantic border are nearly all loose sands and clays of marine origin and contain in New Jersey beds of greensand once of some economic importance as a source of phosphate of lime for agricultural use. The rocks of the gulf border were partly laid down in fresh or brackish water and partly in salt water. They comprise shales, sandstones, and limestones. In Florida are valuable deposits of phosphate rock, and in Texas are extensive beds of lignite, of workable size, but poor quality. The series is divided into the (1) Midway, (2) Lignitic, (3) Lower Clairborne, (4) Clairborne, (5) Jackson, and (6) Vicksburg stages. The interior province formations, mostly clays and sands, were laid down in brackish or fresh water lakes which stretched, though not contemporaneously, from Mexico to Alaska. The largest of these lakes covered eastern Utah, and western Colorado, and must have been 450 miles long and 250 miles wide. In Utah are lignite deposits of some importance. The lake deposits are divided into the (1) Puerco, (2) Wasatch, (3) Bridges, and (4) Uintah stages. In the Pacific border province the Lower Eocene stages are wanting and the epoch is represented by a single series, the Tejon, shales and sandstones with workable deposits of lignite in California and Oregon. See CENOZOIC ERA; GEOLOGY; TERTIARY SYSTEM.

Eohippus, ē-ō-hip'ŭs, a genus of fossil horses of the Eocene Epoch, with four complete toes in the fore foot and three in the hind foot, and with slender bony rudiments (splint-bones) representing the missing innermost digit in the fore foot and the outermost digit of the hind foot. The teeth are short-crowned, the premolars of simpler pattern than the true molars, and the molar cusps are incompletely converted into crests. The animal was as large as the domestic cat, and probably a direct ancestor of the horse. Its remains are found only in the Lower Eocene of North America. See HORSE, FOSSIL.

E'olus («the varied one»), in Greek mythology, god of the winds.

Eon de Beaumont, ā-ôn dė bō-mōn, **Charles Geneviève Louis Auguste André Timothée d'** (called till 1777, CHEVALIER D'EON), French writer, military officer, diplomatist, and publicist: b. Tonnerre 5 Oct. 1728; d. London 21 May 1810. His brilliant qualities enabled him to act a conspicuous part in the world, but he gained a greater notoriety by the mystery long kept up in regard to his sex. In 1755 he was sent as envoy on a difficult mission to the Russian court. Here he gained the favor of the Empress Elizabeth, and for about five years was the medium of a secret correspondence between her and the king of France. In 1762 he went to London as secretary of legation and lived for years in London as a kind of informal representative of his sovereign. In 1777 he returned to France, but Louis XVI., for what reason is not known, imposed on him the obligation of assuming female attire, and he now styled himself La Chevalière d'Eon. Even before this, however, doubts as to his real sex had arisen. After the French Revolution broke out, he offered his services to the National Assembly in 1792, was rejected, and went back to England. He now attempted to support himself by giving lessons in fencing (still dressed as a woman), but was not very successful, and depended for subsistence mainly on his friends. He was rather a voluminous writer, and his works appeared in 1775 under the title 'Loisirs du Chevalier D'Eon.'

Eos, ē'ŏs. See AURORA.

Eosinophiles, ē-ō-sĭn'ō-fīls, one of the types of leucocytes or white blood-cells found in the circulating blood and characterized by its specific reactions to acid stains, such as eosine, whence its name — «a lover of eosine.» Eosinophiles are present in the proportion of one half to two per cent of the white blood-cells. Their increase above two per cent is termed eosinophilia, and it has an important relationship to some forms of parasitism.

Eosinophil'ia, a condition in which there is an excess of eosinophile white blood-cells in the circulating blood. The exact causes of eosinophilia are not thoroughly understood. But it seems to be an almost constant accompaniment of certain diseases, notably of infection by intestinal parasites. So it is in trichiniasis, in anchylostomiasis, and in infection by the ordinary tapeworm. Consult: Ewing, 'Pathology of Blood' (1902).

Eōthen, ē-ō'thĕn, or **Traces of Travel Brought Home from the East,** a noted work by Alexander William Kinglake, published in 1844. Eōthen — a title meaning «From the Dawn» — is a lively and acute narrative of travel in the East, at a time when that region was comparatively new ground to English tourists. The author, starting from Constantinople, visits the Troad, Cyprus, the Holy Land, Cairo, the Pyramids, and the Sphinx; thence by the way of Suez he proceeds to Gaza and returns by the way of Nablous and Damascus. He apologizes for his frankness of style, and gives his impressions with refreshing directness, modified as little as possible by conventional opinion.

Eötvös, ĕt'vėsh, **Joseph**, Hungarian statesman and author: b. Ofen 3 Sept. 1813; d. Pesth 3 Feb. 1871. He completed his studies in philosophy and law at the University of Pesth in 1831, and before leaving the university, produced three dramas — 'Kritikusok,' 'Házasulók,' and 'Boszú' — the last a tragedy, all of which were well received. He published an important work on the reform of prisons (1838); became a friend of Kossuth, and distinguished himself as a journalist and in the diet. A collection of his political writings was published in Leipsic in 1846. He continued to give his leisure to literature, and published a succession of novels — 'The Carthusian' (1841); 'The Village Notary' (A'falu' jegyzöje, which has been translated into English), 1844–6; 'Hungary in 1514' (1847–8) — giving vivid pictures of Hungarian life in modern and more remote epochs. After the revolution of 1848 he became minister of public instruction under Batthyani, but soon retired to Munich, and remained in voluntary exile for three years, during which he published several works, among which was 'The Influence of the Ideas of the 19th Century on the State of Society' (1851). About the middle of 1851 he again returned to Hungary, where he was made vice-president of the Hungarian Academy in 1855, and president in 1866. In 1867 he again became minister of public instruction.

Eötvös, Roland, Hungarian scientist and statesman: b. 27 July 1848. He is a son of Joseph Eötvös (q.v.). He studied at Konigsberg and Heidelberg, receiving an appointment as lecturer at Budapest 1871 and as professor of experimental physics there 1875, being made a member of the Hungarian Academy of Sciences 1873, and becoming its president in 1893. Much of his attention has been given to the problems of gravitation and capillary attraction. He was made a life member of the Hungarian House of Magnates and was minister of public worship and education 1894–5.

Eozoic (ē-ō-zō'ĭk) **Era** (dawn of life), the Geologic Period during which life first appeared on the earth. The eozoic rocks, though often showing traces of organic origin, have in general been greatly metamorphosed and contain few, if any, fossils. Stratigraphically they are separated from the Archæan (or Azoic) rocks below and the Cambrian (or earliest Palæozoic) rocks above by unconformities, but the exact boundaries of the Eozoic are disputed by geologists. See ALGONKIAN SYSTEM; GEOLOGY; HURONIAN SERIES; KEWEENAWAN SERIES.

Eozoön, ē-ō-zō'ŏn. Sir J. W. Dawson, in 1864, described certain curious aggregates of calcite and serpentine in the Laurentian limestone of the lower St. Lawrence Valley as the remains of a foraminiferan which he called Eozoön Canadense. The so-called fossil was thought to represent the earliest known form of life on the globe. The evidence of organic origin is, however, not conclusive. Similar forms have been found in Bavaria. Moebius, who investigated Eozoön thoroughly, concluded that the serpentine in the calcite had infiltrated along a very regular system of fine fissure, and most geologists now believe that Eozoön is of inorganic origin.

Epacridaceæ, ĕp-a-krĭ-dā'se-ē, a small order of heath-like shrubs or small trees, usually reckoned as the Australian sub-order of *Ericaceæ*, from which they are chiefly distinguished by the epipetalous stamens destitute of the peculiar specializations of anther dehiscence or appendages. The flowers are red, white, or purple, generally in leafy spikes. Many species are cultivated in greenhouses along with the heaths proper. Among the most attractive of these is *E. grandiflora*, which has blossoms nearly an inch in length, of a brilliant reddish purple at the base and pure white at the apex. A few species produce edible berries resembling the American huckleberry, and which are known as Australian cranberries.

E'pacts (Gr. «additions»), in ecclesiastical chronology, a set of 19 numbers used for fixing the date of Easter and other Church festivals, by indicating the age of the moon at the beginning of each civil year in the lunar cycle (q.v.). At the reformation of the calendar in 1582 it was found that the Golden Numbers could no longer by themselves serve the purpose of adjusting the double reckoning by lunations and by the tropical or true year; and thus, instead of adopting the more rational computation, the Roman Church devised the artificial and involved method of epacts. The main point to determine is the age of the moon (in entire days) at the beginning of each civil year, or the number of days between the end of the ecclesiastical year in December and the first January succeeding. Thus, subtracting 354 days (12 lunations) from 365, we should have 11 days for the first annual epact, then 22 for the year following, then 3, 14, 25, 6, 17, 28, 9, 20, 1, 12, 23, 4, 15, 26, 7, 18, and 29; the series of 19 numbers being obtained in succession by adding 11, and when the sum exceeds 30, subtracting that number. This illustration, however, is simpler than any actual case, by reason of the leap-years, which require 12 to be added for the following epact, and of the fact that no lunation is exactly 30 days long. When the lunar cycle of 19 years is completed, the epacts recur again in the same order. In the Anglican reckoning, as distinguished from the Roman, it is noteworthy that the Gregorian epact for any year is the same as the Julian epact for the year preceding, owing to the coincidence that 11, the number of days lost on the Julian account before the English parliament adopted the reformed calendar (q.v.), is also the number of days between the lunar and the solar years. The epact determines by subtraction the date of the first new moon in January; then by adding 29 and 30 alternately the successive new moons throughout the year are assigned to their respective dates. Consult Delambre, 'Astronomie Moderne,' Vol. I. 4–32.

Epaminondas, ē-păm''ĭn-ŏn'dăs, Theban hero: b. about 418 B.C.; d. Mantineia, Arcadia, Greece, 362 B.C. He was distinguished for the friendship subsisting between him and Pelopidas. He was sent to Sparta 371 B.C. to represent Thebes in negotiating a peace with the Athenian envoys. As the Spartans refused to recognize Thebes as the representative of Bœotia, the Thebans were excluded from the peace. Cleombrotus was sent by the Spartans to invade Bœotia, but was defeated at Leuctra (371 B.C.), chiefly through the tactics of Epaminondas. Two years after Epaminondas and Pelopidas were made Bœotarchs. They detached several nations from the alliance of Lacedæmon, and delivered the Messenians, whose capital they rebuilt. Epaminondas then marched with his army to Sparta; but this city was so bravely and skilfully defended by Agesilaus that the Theban hero retreated. An accusation was brought against him on his arrival in Thebes, because he and Pelopidas had kept the Bœotarchate beyond the legal time; the accusation was literally true, but the infringement of the law was justified by his services, and after having pleaded his own cause, he was acquitted. In 368 he compelled Sicyon and Pellene to relinquish the Lacedæmonian alliance, and in the same year served in a Theban army sent into Thessaly to rescue Pelopidas, who was kept a prisoner at Pheræ. In the following year he commanded an expedition with the same object which was successful. In 362 he was compelled to make head against a formidable coalition of states, including Athens and Sparta. His tactics were never more brilliant and successful than in this campaign, but in the battle of Mantineia he was killed at the moment of victory.

Ep'aphus, the son of Jupiter and Io, who caused Phaëton's destruction by denying his divine descent.

Ep'arch (ἔπαρχος *eparchos*), an ecclesiastical term formerly in use as equivalent to archbishop or metropolitan. In the national Russian Church bishops are all called eparchs as well as bishops, as in English they are currently styled «ordinaries» (Lat. *ordinarii*) and «diocesans» (Lat. *diœcesani*). The sees or territorial jurisdictions of bishops in the Russian Church are eparchies.

Epaulement, ĕ-pâl'mĕnt, in fortification, a term originally employed to denote a mound of earth, raised to protect a body of troops at the extremity of their line; or a screen or rampart erected, as a sort of shoulder, to defend the flank of a battery from enfilading fire, which would dismount its guns. In modern artillery, the word is applied to the whole mass of earth, stone, or fascines raised to protect a battery both in front and at the flanks. It is also used of the breastwork set up to shelter reserve artillery.

Epaulet, ĕp'â-lĕt, an ornamental badge, consisting of a fringe hanging over the shoulder, worn in the English army up to 1855, and still worn in the English navy by all ranks above lieutenant. Epaulets were not partially discarded by the United States army until 1872, when none but general officers continued to wear them. In the United States navy the epaulet is worn by all officers above the rank of ensign. The French private soldiers wear epaulets of worsted.

Epée, Charles Michel, shärl mē-shĕl ā-pā, **Abbé de l',** French instructor of the deaf and dumb: b. Versailles, France, 25 Nov. 1712; d. Paris 23 Dec. 1789. Taking orders, he became a preacher and canon at Troyes, but later lived in retirement in Paris. In 1765 he first began to occupy himself with the education of two deaf and dumb sisters; and, as he asserted, without any previous knowledge of Pereira's efforts in the cause, invented a language of signs, by which persons thus afflicted might be enabled to hold intercourse with their fellow-creatures. He determined to devote his life to the subject. At his own expense he founded an institution for the deaf and dumb, which was first publicly examined in 1771, and from 1778 received an annual subsidy. It was not, however, converted into a public institution till two years after his death.

Epeira, ĕ-pī'ra, a genus of spiders, typical of the family *Epeiridæ*, comprising some of the largest and best-known spiders, those building orb-webs. They occur in all parts of the world, and are usually handsomely marked. See ORB-WEAVER, and SPIDER.

Epenceph'alon, one of the names to signify one of the primary stages in the development of the embryo brain. See BRAIN.

Eperies, ā-pār'yĕs (Slovak *Pressova*), Hungary, an old town on the Tarcza, 150 miles northeast of Budapest. It is the seat of a Greek Catholic bishop, and has a college, with 500 students. It manufactures earthen-ware, linens, and woolens, and has some trade in corn and Tokay wine; in the vicinity are the Sovar salt-works. Pop. 10,439.

Epernay, ā-pĕr-nā, France, in the department of Marne, in the midst of a rich vine-growing district; 19 miles northwest of Chalons. The earthen-ware called terre de Champagne is made in Epernay. Pop. 20,512.

Ephah, ē'fa, a dry measure of capacity among the ancient Hebrews, corresponding with the liquid measure bath. The ephah contained about 36 litres French, equal to 9½ gallons of the United States, or 8 gallons British. There were, however, two measures called ephah, of which the above estimate applies to the larger, and this contained one third more than the other.

Ephedra, ĕf'ĕ-dra, a genus of shrubs used for decorative purposes in landscape gardening. In general appearance they resemble the horse-tails. The flowers are small and inconspicuous. The species occur in all parts of the world, but are not hardy, and need protection from frosts. They flourish best in dry or rocky soils, and are easily propagated. Their fruit is said to be mucilaginous, eatable, sub-acid, and slightly pungent. The branches and flowers of the Asiatic species were formerly sold as styptics.

Ephem'era, -fem'e-rä, the typical genus of the insect family *Ephemeridæ* (q.v.).

Ephemeridæ, ĕf-ē-mĕr'ĭ-dē, a family of neuropterous insects characterized by the slenderness of their bodies: the delicacy of their wings, which are erect and unequal, the anterior being much the larger; the rudimentary condition of the mouth; and the termination of the 10-jointed abdomen in 3-jointed filiform appendages. The adult May-flies, or day-flies, as they are called, emerge from the chrysalis on the banks of the running streams in which the eggs are hatched, and, appearing usually toward sunset, are no less remarkable for their great activity than for their enormous numbers, and the brief period of their existence. The eggs, which are shed in a mass, drop into the water. The larvæ have elongated depressed bodies; setose antennæ, and long caudal filaments; and lamellar or tufted gills, symmetrically disposed on either side of the abdomen. They remain in the water for a year or two before undergoing further change, lying beneath stones, and leading a predaceous life, for which their strong jaws fit them. The rudiments of wings mark the commencement of the nymph stage, at the close of which they crawl out of the water, and cast the nymph integument. Their sexual immaturity prior to the second molt has led to their being named, at this stage, subimagos or pseudimagos. The larvæ, which are very similar throughout the family, are largely used as bait. There are many species in various parts of the world, divided into various genera. *Ephemera* and *Cœnis* have three caudal filaments; *Palingenia* and *Cloë* only two, but the larvæ have three. The posterior wings are absent in *Cloë* and *Cœnis*.

Ephem'eris, an astronomical almanac. The plural Ephemerides is applied to tables showing the places where the planets and heavenly bodies are found at noon of every day. It is from these tables that eclipses, conjunctions, etc., of the planets are determined. See ALMANAC (*Nautical*).

Ephe'sians, the Epistle to the, one of the books of the New Testament. It seems to have been sent by St. Paul to the people of Ephesus about 62 A.D., while he was a prisoner in Rome (Eph. iii. 1, iv. 1). He sent it to its destination by the hand of Tychicus (Eph. vi. 21). The Church at Ephesus had been founded by Paul himself, or at least he had raised it from the feebleness in point of numbers and knowledge in which it had been when he commenced his missionary work in that city. For two years he preached Christ, not merely to the permanent residents in Ephesus, but to the multitudes who resorted thither as pilgrims to visit the celebrated temple of Diana, then one of the wonders of the world (Acts xix. 10). When driven from the city, owing to a riot raised by one whose craft would have been in danger had idolatry fallen, he retained a deep interest in his converts; and, despatching Tychicus to inquire after their welfare (Eph. vi. 21), gave him the canonical 'Epistle to the Ephesians,' for the Church just named, with another to the Church at Colossa (Col. iv. 7). It is evident from the 'Epistle to the Ephesians' that the converts at Ephesus were mainly Gentiles (Eph. ii. 11, iii. 1), and prominent in the didactic part of the letter is the doctrine that Christ had broken down the middle wall of the partition which severs Jew and Gentile, putting both on the same level of privilege within his Church (Eph. ii. 11–22, iii. 1–6). The Epistle concludes with a series of practical exhortations.

Ephesus, ĕf'ĕ-sŭs, Asia Minor, a Greek city of Lydia; one of the 12 Ionian cities; near the mouth of the river Caystrus, now called Kutshuk Mendre. Ephesus is now represented by the village of Ayasoluk, about 36 miles from Smyrna, on the railroad to Aïdin. After belonging to the Ionians, it fell successively under the dominion of the Lydian and Persian kings. Its importance as a commercial city dates chiefly from the time of Alexander the Great. The apostle Paul lived for two years at Ephesus and established a Christian Church there, to which he addressed one of his epistles. Timothy succeeded St. Paul, and St. John is said to have had charge of the Church after Timothy, and to have died at Ephesus. It was long famous for its temple of Artemis (Diana), called Artemision, reckoned one of the seven wonders of the world. The temple was of the Ionic order, and was adorned with many pillars, each 60 feet high, and with numerous statues and paintings by the most celebrated Grecian masters. It had been destroyed seven or eight times before Pliny wrote, particularly by the notorious Herostratus, 356 B.C. The temple, however, was rebuilt by the Ephesians with more magnificence than ever, whose women contributed their trinkets to the general fund raised for this purpose. There were also many other temples here, a theatre, a stadium or race-course, gymnasia, odeum, etc. The site of the temple had become lost when it was discovered by Mr. Wood in 1867–9. In his excavations he found that the building measured about 343 feet by 164, and stood on a raised platform measuring 418 feet by 239. Important excavations have since been carried out here, and the theatre, important buildings connected with the gymnasium, and a splendid semicircular marble portico round the east side of the harbor have thus been disclosed. The Great Mosque or Church of St. John, the cave of the Seven Sleepers, and other interesting objects are to be seen here. Consult: Wood, 'Discoveries in Ancient Ephesus.'

Ephesus, Council of, the third general council of the Roman Catholic Church, held at Ephesus 431, principally to oppose the heresy of Nestorius, patriarch of Constantinople. It was convoked by the Emperor Theodosius II. at the instance of Pope Celestine I. and many Catholic bishops. Cyril, bishop of Alexandria, presided on behalf of Pope Celestine I. The number of bishops in the Council was about 200. Nestorius, adopting the teaching of Theodorus of Mopsuetia, denied the Church's doctrine of the incarnation, and held that instead of the Word being made man, he (the Word) simply had his special abode in the man Jesus Christ; and that hence Mary the Virgin was not θεοτοκος, God-bearing, mother of God, but only χρσστοτοκος, mother of the Christ. The Council declared that Mary is θεοτοκος, *Deipara*, and that Jesus Christ is God and man. (See COMMUNIO IDIOMATUM.) Another Council was held at Ephesus — the "robber synod," as it is called — in 449 convoked by the same emperor to deal with questions of faith connected with the teachings of Theodorus and Nestorius. The presiding bishop, Dioscurus of Alexandria, backed by a rabble of monks, soldiers, and servants overawed the 135 bishops, compelling them to sign blank papers on which he wrote what decrees he pleased.

Eph'od, a species of vestment woven of gold, blue, purple, scarlet, and fine twined linen, worn by the Jewish high-priest. It consisted of two main pieces, one covering the back, the other the breast and upper part of the body, fastened together on the shoulders by shoulder straps. On each shoulder was an onyx stone set in gold, on which were engraved the names of six tribes according to their order. A girdle or band, of one piece with the ephod, fastened it to the body. Just above the girdle, in the middle of the ephod, and joined to it by little gold chains, rested the square breastplate with the Urim and Thummim. The ephod was originally intended to be worn by the high-priest exclusively, but a similar vestment made of linen was worn in later times by priests of lower rank.

Ephors, ĕf'ôrs, or **Ephori,** magistrates common to many ancient Greek communities. The most celebrated were the Ephori of Sparta. They were five in number, and were elected by the people annually, their authority being designed as a counterpoise to that of the king and council. They superintended the morals and domestic economy of the community; scrutinized the conduct of all officials, and even summoned the kings before their tribunal. The judicial authority and executive power eventually fell almost entirely into their hands; they became autocratic; opposed the extension of popular privileges; and arousing the antagonism of the kings and people, were suppressed temporarily by Agis IV., and by Cleomenes III., the latter murdering the Ephors 225 B.C.

Ephorus, Greek historian, flourishing in the 4th century B.C., from about 400 to 330 B.C.; was born at Cyme, in Aeblis, Asia Minor. His master, Isocrates, after training him in rhetoric, persuaded him to abandon oratory for history, and it was upon his suggestion that he prepared his universal history. This work 'Ἱστορίαι', in 30 volumes, was the first history ever written in Greece and was remarkable for its wealth of material and also for the fact that each book, containing a compact portion of the history with an introduction, was complete in itself. The history deals with the Greeks (outside of the mythical age) from the return of the Heracleidæ to the siege of Perinthus (340 B.C.), covering a period of over 700 years. His style of writing was loose and feeble, well meriting the remark of Isocrates, that he needed the spur, as Theopompus the bit. The history was used and praised, however, by Polybius, Diodorus, and Strabo. The main portions of the manuscripts have perished, only a few fragments remaining, which were published in Muller's 'Fragments Historicorum Græcorum,' Vol. I., pp. 234–277 (Paris 1868).

Ephraem Syrus, ē'fra-ĕm sī'rŭs, **Ephrem,** or **Ephram** (the Syrian), Syrian theologian: b. Nisibis, Mesopotamia; d. Edessa 378. He lived in Nisibis till 363, but thereafter in Edessa till he died, except intervals which he spent in prayer and meditation in the desert. He held humble rank in the hierarchy, that of deacon, but as a preacher attained high celebrity. He refused to be ordained a priest because he thought himself unworthy. His writings were very numerous, and many are extant. He used a poetic form in his homilies and harangues; and St. Jerome tells us that his homilies (translated into Greek, for he wrote in Syriac) were wont to be read in many of the churches of Greece immediately after the Scripture lesson. He was a valiant defender of Catholic orthodoxy against the heretics of his time — Bardesanes, the Gnostic, the Arians, and the Sabellians, the Manichæans and the Novatians. Some of his lyrics are remarkable for their simplicity and genuine poetic spirit. Even his homilies are of a poetic cast and form; and in the translation of some of them they are styled «rhythms.»

Ephraim, the younger son of Joseph, and the founder of one of the 12 tribes of Israel. The tribe occupied one of the finest and most fruitful territories of Palestine; in the very centre of the land, and included the most of what was afterward called Samaria. It was bounded on the east by the River Jordan, on the west by the Mediterranean Sea and the tribe of Dan, on the south by the tribe of Benjamin, and on the north by that of Manasseh. The Ephraimites, when they left Egypt, numbered 40,500, and, being numerous and influential, often appear as the representatives of the 10 tribes, both in historical and prophetical passages of the scriptures. For a long time the ark and the tabernacle were situated at Shiloh. The tribe was the most warlike of all the Israelites as attested by their protests against Gideon (Judges viii. 1) and against Jephthah (Judges xii. 1–7) because they did not ask their aid in war. Joshua, who conquered the Holy Land, and Samuel, the prophet, were members of the tribe. Upon the death of Saul, the Ephraimites, in conjunction with all the other tribes except Judah, took part in the revolt of Saul's son Eshbaal (Ishbosheth), and recognized him as legitimate king in opposition to David (2 Sam. ii. 8–9), but upon his murder, submitted to the hegemony of Judah under David. Later, about 975 B.C., after the death of Solomon, the tribe revolted under Jeroboam against Rehoboam, the son of Solomon (1 Kings xii. 1–20), and with all the tribes except Judah, Simeon, part of Benjamin, and the Levites, merged into the northern kingdom of which they constituted the most important part. The separate kingdom still adhered to the name of Israel and made Shechem its capital. In 722 B.C. the kingdom was destroyed by the Assyrians.

Eph'rata, Pa., township and borough in Lancaster County; on the Reading & C. R.R.; about 50 miles northwest of Philadelphia. It is an agricultural and mining region with forests nearby. Ephrata was founded by Johann Conrad Beissel (q.v.) and his followers in 1735. The community established by Beissel was called «Order of the Solitary,» and it resembled somewhat the Seventh-Day Adventists. Ephrata contains several very ancient and singular buildings, particularly the brother and sister house. These houses are large four-story structures, each contains a chapel, and is divided into small apartments, so that six dormitories, barely large enough to contain a cot, a closet, and hour glass, surround a common room, in which each mess have their meals. The dress of the brethren and sisters is that of the Franciscans, or White Friars. They are remarkable for their rigid adherence to the precepts and ordinances of the New Testament; they insist upon the washing of the feet before administering the sacrament; and are very observant of the Sabbath. They are peaceful and temperate and are distinguished for their music, which is composed and arranged by themselves. Prior to the Revolution they seemed to flourish, but now only a few of the order remain in Ephrata. Pop. 2,400. Consult: Kuhns, 'German and Swiss Settlements of Colonial Pennsylvania'; Sachse, 'The German Sectarians of Pennsylvania,' 2 volumes.

Ep'iblast, one of the layers in the developing embryo from which the structures making up the skin and its appendages are developed; also called ectoderm. See EMBRYOLOGY.

Epic, from the Greek ἔπος, speech, ἐπικός a discourse, a poem of the narrative kind. This is all that the word properly signifies, although it is generally understood to be a poem of an elevated character, describing the exploits of heroes, as distinguished from the lyric representing emotion, and the dramatic representing action, these three classes comprising the different styles of poetical composition. As action is the object of the drama, so narration is that of the epic. But as the event related is something already past, the epic is less stirring, hence its more quiet tone, the pauses which may be allowed in the interest of the description, and the introduction of passages of philosophical reflections. Unity, however, governs the whole structure of the poem. The epic in a general sense is applied to all poems of a narrative character which illustrate the history of important mythological, religious, and national events, a distinction being made between epics of growth, which consist of collections of ballads or poems composed by different authors at different times, and dealing with a connected series of events, and art epics, in which the events are grouped around some great structural thought by a single poet. To the first class belong the Sanskrit 'Ramayana' and 'Mahábhárata,' the Finnish 'Kalevala,' the German 'Nibelungenlied,' and the mediæval French 'Chanson de Ron' or 'Roland.' In the second class are the 'Odyssey,' the 'Æneid,' 'Paradise lost,' and 'Gerusalemme Liberata.' Such epics as the 'Iliad' and the Persian 'Shah Nameh' again belong to both classes. The term heroic epic or heroic poem is applied to such works as Homer's 'Iliad' and 'Odyssey,' Virgil's 'Æneid,' Spenser's 'Faerie Queene,' Ercilla's 'Araucana,' Aristo's 'Orlando Furioso,' and others, which describe the achievements of the gods and heroes of antiquity, or of the knights of mediæval chivalry. Poems again like Milton's 'Paradise Lost,' Tasso's 'Gerusalemme Liberata,' Dante's 'Divina Commedia,' and Klopstock's 'Messiade,' are sacred epics. Lucan's 'Pharsalia,' Camoen's 'Lusiad,' and Voltaire's 'Henriade' are historical epics. Goethe's 'Herman and Dorothea' may be described as a domestic epic. Such poems as Scott's 'Marmion,' Longfellow's 'Evangeline' and 'Hiawatha,' are genuine miniature epics, while Tennyson's 'Idylls of the King,' from its artistic consecutiveness of motive, belongs also to the family. Of the mock-epic order are such poems as Pope's 'Rape of the Lock,' Butler's 'Hudibras,' and Boileau's comic epic 'Lutrin.' Epics also may utilize prose as a vehicle of thought and while less regular in form than the pure epic, may nevertheless be quite distinct from the common novel, or ordinary fiction; the best examples of prose epics are to be found in the Franch language, as such are: Fénelon's 'Télémaque,' Marmontel's 'Incas,' and St. Pierre's 'Paul et Virginie.' Consult Lang, 'Homer and the Epic' (1893).

Epicardium. See HEART.

Epichar'mus, Greek philosopher and comic poet: b. Cos about 540 B.C.; d. 450 B.C. He lived at Syracuse, and there wrote his celebrated comedies, now lost. Their number is reckoned at 52, and the titles of 40 of them have been preserved. Before commencing his career as a comic poet, which he did somewhat late in life, he lived at Megara, engaged in the study of philosophy, both physical and metaphysical. The fragments of his poems which are preserved abound with philosophical maxims, and with speculative discourses. His genius was highly esteemed among the ancients by such judges as Plato and Cicero. The Sicilian comedy of Epicharmus, prior to the Attic, grew out of the mimes, which were peculiar to this island, making a sort of popular poetry. He arranged the separate unconnected scenes, exhibited in the mimes, into continued plots, as in tragedy. His comedies were long regarded as models in this species of composition, and were as much distinguished by their knowledge of human nature as by their wit and lively dialogue. The Sicilian comedy, in opposition to the Attic-Ionic, is also designated as the Doric comedy.

Epicte'tus, Stoic philosopher: b. Hierapolis, Phrygia, about 60 A.D. He lived at Rome, where he was the slave of Epaphroditus, a brutal freedman of Nero, whose abuse and mal-treatment he bore with fortitude. Epictetus himself did not leave any written account of his doctrines, which appear to have been of the most elevated kind. In his discourses he aimed to impress his hearers with the love of practical goodness. The foundation of philosophy he held to be the perception of one's own weakness and inability to do what is needful. His doctrines approach more nearly to Christianity than those of any of the earlier Stoics, and although there is no trace in what is recorded of them of his having been directly acquainted with Christianity, it is at least probable that the ideas diffused by Christian teachers may have indirectly influenced them. The excellence of his system was universally acknowledged. Banished from Rome by Domitian, Epictetus settled in Epirus, and although he possessed the favor of Hadrian, there is no evidence that he returned to Rome. His pupil Arrian, the historian of Alexander the Great, collected his maxims with affectionate care, in the work entitled, 'Enchiridion' ('Handbook') and in eight books of 'Commentaries,' four of which are lost. These reveal the simple and noble earnestness of the philosopher's character, as well as that real heartfelt love of good and hatred of evil which is often assumed to be an exclusively Christian feeling.

Epicureanism. Epicureanism as a philosophical doctrine has its rise in the teachings of its founder Epicurus, who was born in Samos in the year 342 or 341 B.C. He was the son of Neocles and Chærestrata. His father's name being the same as that of the great statesman Themistocles, suggested to the poet Menander a verse in which he contrasts the son of Neocles, who freed his country from slavery, with him who freed it from foolishness. In his early life, Epicurus taught in several schools in Asia Minor and in the year 306 came to Athens, where he founded a school of his own. By the subtle charm of his personality he attracted to himself a group of admiring friends and followers who were not only devoted to the teacher but were also fired with enthusiastic zeal for his teaching. They were his companions and friends rather than his pupils. Their meeting place was the famous garden of the master which has become so closely associated with the very name of the school. After the death of Epicurus in 270 his followers carried on his work and maintained the teachings and traditions of their leader with unabated earnestness and loyalty. Among the successors of Epicurus, the most conspicuous perhaps are Hermarchus, Dionysius, Apollodorus, Zeno, and Phædrus. But no one of his followers achieved marked distinction until we come to the time of T. Lucretius Carus, the interpreter and chief apostle of Epicureanism. Though a Roman, he had caught that Greek spirit which had been so brilliantly illustrated in the garden of Athens.

Epicureanism as a distinct school flourished with varying fortunes until a period as late as the 4th century A.D. With the decay and disappearance of the school, its influences however did not cease, but lived on, and will live; for Epicureanism represents an attitude of mind which will ever appeal most strongly to certain natures, and in a way to all natures. It is not in a strict sense of the phrase, a system of philosophy. It is rather a theory of life. It is essentially practical in its purposes, methods and results. So far, however, as Epicureanism may be called a system of philosophy, it falls into three parts — a system of canonics, of nature and of morality. By canonics is meant a system which exhibits certain canons or tests of truth. With Epicurus the supreme test of truth was to be found in the sensations. It is the same thought as that which is contained in the old adage — seeing is believing. He held that only the actual facts of a sensory experience can furnish a scientific basis upon which to construct a body of knowledge. The notions are to be regarded merely as generalized sensations, and all opinions are inferences which at the last analysis must rest upon simple sensations. The sensation as such, therefore, is the court of last appeal. Concerning his philosophy of nature, Epicurus taught that there were only natural causes. Any belief in supernaturalism he regarded as a superstition which only a weak intellect could possibly entertain. As regards the constitution of matter, he followed Democritus in the essential features of his atomic theory of the universe. He did not follow, however, with complete rigor the logic of his materialistic conceptions, for he allowed that there must be a distinction between the irrational, or more sensory part of the soul on the one hand, and on the other, the rational part which he regarded as the superior and controlling power of man's nature. Moreover, while denying the existence of the gods, as gods of providence sustaining the forces of nature, and ruling the destinies of man, he nevertheless believed in their existence as beings apart and wholly separate from mundane affairs. From the standpoint of his ethical system, the gods were of very necessity beings supremely happy, and such they could not be were they supposed to be in any way cognizant of the darker side of nature and the manifold ills of human life. According to Epicurus the great end to be attained through the study of nature was to disabuse the mind of any lurking superstition concerning the possibility of the supernatural.

It is, however, the ethical system of Epicurus which is the heart of his teaching, and it is this system that the term Epicureanism usually suggests to one's mind. With Epicurus man's chief end is the attainment of pleasure,— not in the sense, however, that life is a heedless pursuit of pleasure here, there, and everywhere. The end is pleasure, not pleasures. The supreme pleasure, the constant source of all other pleasures is the tranquil and happy mind. In placing the true source of pleasure within, Epicurus here differs from the earlier Cyrenaic who regarded man's happiness as consisting in the full round of delights, the sum total of all his actual enjoyments. Epicurus taught that mere bodily pleasures were not an end in themselves, but only as they minister to peace of mind. Violent excesses disturb, extreme asceticism torments the inner spirit of man. Therefore be not too indulgent, nor too rigorous with self. Study to attain the maximum of enjoyment with the minimum of distress. Let a wise prudence transmute both the good and the evil of life into a tranquillity of soul. In this conception of conduct, virtue is never an end in itself. It is always a means to an end. The end is happiness and so far as a life of virtue contributes to well being, so far only is it to be commended.

We find in Epicureanism and in Stoicism alike, the common endeavor to free man from the dominion of circumstance, and to establish an inner world of mind wholly independent of the outer world of chance events, of untoward influences, of hostile forces and fleeting delights. The Stoic, however, urged the repression of all desire; the Epicurean, on the other hand, urged its wise regulation. As Epicurus himself puts it, "It is not an unbroken succession of drinking feasts and of revelry, not the pleasures of sexual love, nor the enjoyment of the fish and other delicacies of a splendid table, which produce a pleasant life, it is sober reasoning, searching out the reasons for every choice and avoidance, and banishing those beliefs through which greatest tumults take possession of the soul. Of all this, the beginning and the greatest good is prudence. Wherefore prudence is a more precious thing even than philosophy: from it grow all the other virtues,— for, it teaches that we cannot lead a life of pleasure which is not also a life of prudence, honor and justice, nor lead a life of prudence, honor and justice which is not also a life of pleasure. For the virtues have grown into one with a pleasant life, and a pleasant life is inseparable from them." JOHN GRIER HIBBEN,

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Epicurus, ĕp-ĭ-kū'rŭs, Greek philosopher: b. Samos, 342 B.C.; d. Athens 270 B.C. He went to Athens 323 B.C., where he is said to have enjoyed the instructions of Xenocrates, then at the head of the Academy, but this he himself does not admit. Epicurus generally denied his obligations to other philosophers. Although some parts of his system are evidently borrowed from his predecessors, he claimed to be self-instructed, and treated his teachers with hostility and contempt. His stay at Athens, however, was brief; and on leaving it he went to Colophon, where his father was engaged in teaching, and began himself to give lessons in grammar. It was here, according to some accounts, that his attention was first turned to philosophy. He himself says he began his philosophical studies at the age of 14, but they may have subsequently taken a more distinct development. The inability of the grammarians to explain a passage about Chaos and the accidental possession of a copy of the works of Democritus are variously assigned as the cause of this new or more decided direction of his mind. From Colophon he went to

Mytilene and Lampsacus, where he engaged in teaching philosophy. He returned to Athens in 306, and purchased a garden in a favorable situation, where he established a philosophical school. Here he spent the remainder of his life. His mode of life appears to have been simple and temperate. He abstained, as a principle, from politics, and took no part in public affairs. During the latter part of his life he was afflicted with severe physical suffering which was borne with heroic courage.

Epicurus was a very voluminous writer. His works, however, are represented as full of repetitions and quotations. In ancient times his philosophy appears to have been more popular in Greece than in Rome, although his disciples were numerous in both. This is easily comprehended, as it was in fact a system engendered by the decline of public virtue in Greece, while the severest stoical philosophy was better adapted to the still active public spirit of Rome. Little is left of his numerous writings. Some fragments of a 'Treatise on Nature' were found at Herculaneum, and published by Orelli (1818). All other fragments have been published by Usener in his 'Epicurea' (1887). The chief account of his philosophy is contained in the great poem of Lucretius, 'De Rerum Natura,' one of the masterpieces of Roman literature.

Ep'icycle, in ancient astronomy, a small circle supposed to move round the circumference of a larger, a hypothetical mode of representing the apparent motion of the planets, which were supposed to have such a motion round the circumference of a large circle, called the deferent, having the earth in its centre. In modern times, the epicycle is used in order to express in a few words the numerical value of periodical functions of an unknown law. Thus if the fluctuations of the thermometer for a day be observed, the size and initial position of several circles may be calculated, such that if the centre of the 2d move uniformly round the 1st once in 24 hours, the 3d round the 2d once in 12 hours, the 4th round the 3d once in 8 hours, etc., the height of the centre of the 4th or 5th circle will be the same as that of the mercury. See ASTRONOMY.

Epicy'cloid, in geometry, is a curve generated by a point in one circle, which rolls on the circumference of another circle, either on the concavity or the convexity, and it thus differs from the common cycloid, which is generated by a point in a circle that rolls along a right line. The latter has sometimes been assimilated with the former, by considering the right line as the circumference of a circle whose diameter is infinite. The invention of epicycloids is ascribed to M. Roemer, the Danish astronomer. See GEOMETRY.

Epicy'cloidal Wheel, a wheel or ring fixed to a framework, toothed on its inner side, and having in gear with it another toothed wheel of half the diameter of the first, fitted so as to revolve about the centre of the latter. It is used for converting circular into alternate motion, or alternate into circular.

Epidaurus, ĕp ĭ dâ'rŭs, one of the most important towns and commercial seaports of ancient Greece, situated in Argolis, in the Peloponnesus, particularly celebrated for its magnificent temple of Æsculapius, which stood on an eminence not far from the town. An inscription over the entrance declared it to be open only to pure souls. Crowds of invalids resorted to the place in hopes of obtaining a cure from the beneficent divinity, in whose honor festivals were celebrated yearly. It received its name from Epidaurus, a son of Argus and Evadne. It is now called Pidavro, or Edidairo, and is the place where in 1821 the first Greek Congress assembled. The modern town contains about 100 inhabitants. Consult: Diehl, 'Excursions in Greece' (1893).

Epidemiology, ĕp-ĭ-dē-mĭ-ŏl'ō-jĭ, the study of epidemics or the science that treats of those diseases that are known to attack a number of persons at the same time or in close succession. The essential feature is that epidemic diseases belong to a group of infective or microparasitic maladies which have the common property of spreading from time to time in a community. It is well known that many diseases of an epidemic character have their favorite haunts. In such places they are always present, and there they are said to be endemic. It is only when they appear in large numbers of people in their favorite habitats that they assume epidemic proportions. Thus there is little distinction between the two classes of disease, since the same disease may be at one time both endemic and epidemic. When an epidemic disease, for instance, influenza, spreads the entire world over, the word pandemic is applied. The essential feature in an epidemic disease is that it must have a definite contagium. The contagia may be either of bacterial or protozoan character. Thus cholera, dysentery, the plague are caused, as is known, by bacteria which, being carried in the ordinary paths of commerce, or by bodies of a moving population, are spread about the world. Occasionally epidemic disease is due to an animal parasite. This is presumed to be the case in yellow fever, and is known to be true of malaria. In malaria, as is now positively demonstrated, the agent that is all-important in the spreading of the disease is one genus of mosquito, *Anopheles*. The parasite lives normally in the human body, and is conveyed by means of the blood into the mosquito, where it undergoes a special cycle of development, until it is inoculated into another human being, who develops the disease.

Further, it may be said that the essential features for the development of epidemic conditions are: (1) A virus; (2) a susceptible population; (3) free intercommunication between the sick and the susceptible. In the group in which the animal parasites belong there must be: (1) A virus; (2) a breeding-place outside of man; (3) a means of transport from place to place, either naturally or artificially; (4) a vehicle for the diffusion of the disease, such as the mosquito, for instance, or a contaminated water-supply, or a person suffering from the disease who travels from place to place, and (5) a susceptible population. It is well known that variation in the susceptibility of populations is a very important element in the consideration of epidemics. Thus measles, whooping-cough, diphtheria, and similar affections ravaged Hawaiian (formerly Sandwich) Islands with a fierceness and mortality unknown to modern times. Seasonal movements, sectional fluctuations, time fluctuations, and oscillations are interesting features in the study of epidemics. By some writers the word epidemic is very loosely used to indicate certain waves of mental excitation which have caused and still cause mental storms throughout a community, as the dancing mania and similar occurrences. These cannot be spoken of as epidemics in the true sense unless one wishes to use the broad term of "emotional contagion." Some of the most interesting epidemics of modern years have been the influenza epidemic of 1890, which traveled round the world in from three to four years, and the plague epidemic that was raging from 1895 to 1902, slowly traveling over the habitable globe. There have been no severe extensive epidemics in the United States, save the epidemic of influenza, for a great many years, and in civilized countries at the present time the chances for the spreading of more severe epidemics are greatly lessened by the application of the laws of modern hygiene as well as by procedures arising from the newly acquired knowledge concerning immunity. The time does not seem far distant when immunity to many forms of infectious disease may be conferred by proper serum therapy. Consult: Hirsch, 'The Geographical Distribution of Disease' (1893); Weichselbaum, 'Epidemiologie' (1900); and 'Epidemiology' in 'Encyclopedia Medica' (1900).

Epiden'drum, a large genus of tropical American orchids, most of the species of which are epiphytic, growing on trees. There are upward of 600 species in South America alone. The stems are pseudo-bulbs, the leaves are strap-shaped and leathery, and the flowers are single or in spikes, panicles, or racemes. The flowers of some species are very handsome, and a large number of the species are in cultivation. Two of the finest cultivated species are the Mexican plants *E. nemorale* and *E. vitellinum*, the former with rose-colored and the latter with orange-colored flowers. The plants are much used in hybridization, as they are hardy and rigorous, and are valuable for crossing with the less hardy species of other genera, the result being in many cases long-stemmed flowers of fine appearance.

Epider'mis. See SKIN.

Epidid'ymis. See TESTICLE.

Epididymi'tis, inflammation of the epididymis, resulting in pain, redness, heat, and swelling of the testicle, with general constitutional malaise. Treatment consists in rest in bed and soothing applications.

Ep'idote, a common mineral, usually yellowish-green in color, and crystallizing in prismatic forms belonging to the monoclinic system. It is a silicate of calcium, iron, and aluminum, with the general formula $HCa_2(Al, Fe)_3Si_3O_{13}$, the ratio of the aluminum to the iron varying, in different specimens, from 6:1 to 3:2. Its hardness is from 6 to 7, and its specific gravity is about 3.4. Epidote occurs throughout the world. Fine crystals are found in France; the Tyrol: Haddam, Conn.; Calumet, Colorado; and Alaska. The epidote group contains, in addition to epidote proper, the minerals piedmontite and allanite, which resemble it in general nature but contain manganese and cerium respectively; and also the calcium epidote, zoisite, which crystallizes in the orthorhombic system.

Epigæa, ĕp-ĭ-jē'a. See ARBUTUS, TRAILING.

Epigas'trium, the upper fore part of the abdomen, reaching from the pit of the stomach to an imaginary line above the umbilicus (navel) supposed to be drawn from the one extremity of the last false rib, on one side, to the corresponding point on the other.

Epigene, ĕp'ĭ-jĕn, a term applied to those geological agents of change which affect chiefly the superficial portions of the earth's crust, as the atmosphere, water, plants, and animals.

Epigenesis, ĕp-ĭ-jĕn'ĕ-sĭs, in biology, the development of the animal from the simple protoplasm of the egg. This term therefore expresses the theory and process of embryology as now understood, and is opposed to the prevailing theory, previous to the researches of Harvey, and especially of Wolff and Von Baer, which was then known as the *emboitment* theory, an account of which is given under PREFORMATION. See also EMBRYOLOGY.

In physiology the supposed production in organized beings of or additional formations by means of new vital influences, as opposed to the idea that new parts are simply the result of developments or changes in pre-existing structures.

Epiglot'tis, the cartilage at the root of the tongue forming a valve which partly closes the aperture of the larynx during the process of swallowing. When respiration takes place the epiglottis is vertical but falls back and covers the larynx on the approach of food. Any portion of food, however minute, entering the sensitive larynx, causes distress and is automatically ejected by a spasm of coughing.

Epigoni, a name given in Greek legend to the sons of the seven Greek chiefs who conducted the expedition against Thebes in the war between Eteocles and Polynices. The name literally means descendents, successors, or heirs, and the second expedition in command of the sons to avenge the first disastrous defeat was thus called the "war of the epigoni." The name is also applied to students who attempt to develop the ideas of the great masters of a previous period.

Epigram. The Greek noun from which the word epigram comes was originally used to denote a prose inscription on a temple, tomb, statue, votive-offering to a god, or the like. Conciseness and brevity were, therefore, essential qualities. To give pleasure to the ear and help the memory, the Greeks next chose some poetic form for them, preferably the elegiac distich. Their use for practical purposes eventually suggested their composition as a form of literature, with subject-matter sometimes wholly imaginary. These poems now often embraced several distichs, and appeared in other metres, but continued to be ordinarily of a simple, expository or descriptive nature. In the Alexandrine period, however, when poets affected almost exclusively short but highly elaborate poems, epigram lost much in simplicity while attaining its highest popularity among the Greeks. Its composition had become the pastime, and even the serious ambition of authors of first rank, and its recitation and improvisation one of the favorite entertainments at symposia and other social gatherings. Collections of epigraphical epigrams were made. Meleager of Gadara followed these early in the first century B.C. with his "Garland" of literary epigrams, the prototype of our Greek Anthology or "Bouquet of Flowers." This numbers about 4,500 poems by over 300 writers in two collections, the Palatine Anthology of Constantinus Cephalas (early 10th A.D.), and that which Planudes made four centuries later, supplying important additions. These collections with countless poetical inscriptions found in modern times constitute for us Greek epigrammatic literature. The Greek Anthology not only throws valuable light on human life from the time of the Persian wars to the age of the Byzantine collectors, but through widespread translation and imitation has deeply affected modern languages and thought. For the names of the prominent writers and a characterization of their work see the special article "Anthology." As a literary genre imported from the Greeks, epigram enters Latin literature with Ennius, but as an inscriptional poem much earlier. Latin is peculiarly adapted to a lapidary, epigrammatic style, and certain racial characteristics, in particular their devotion to the practical, made the Romans naturalize this species of poetry at once. At first they modeled after the Greeks, and we have a few specimens of the erotic epigram as the Alexandrines wrote it. By Cicero's time most of the literary men of importance were writing epigram, and its value as a political weapon was fully appreciated. Catullus is, however, the only writer from whom we have any considerable collection. Although we find in him lyric qualities as fine as in the poems of the Anthology, it is still clear that the national aptitude for satire has already turned epigram strongly in that direction. It is the Latin satiric epigram and not the more lyrical Greek that becomes the model for modern writers. In the Augustan Age, Domitius Marsus and Pedo Albinovanus were, according to Martial, the greatest epigrammatists, but we have not enough of their work to judge it. Martial himself brought this branch of poetry to its acme. None of the eminent poets who followed in his steps, Petronius, Apuleius, Ausonius, and Claudian, have equalled him in epigram. In the sixth century Luxorius maintains the tradition, but at a low level. About this time the Salmasian collection was made which forms the nucleus of the modern compilations which we call the Latin Anthology. In the time of Charlemagne epigram enjoyed a veritable renaissance, taking the inscriptional form to describe the material glories of Christianity as well as to sing the praises of the dignitaries of the church. Then the humanists, to whom Latin was almost a second mother tongue, revived this form once more. But the Latin scholars who have written epigrams are too numerous to name here. One, John Owen of Oxford, should not perhaps be passed by, since he devoted himself wholly to this field and with marked success. In English literature the composition of epigram has long been out of fashion, but for centuries it was popular with literary men. Notable achievements in this line are to be found in the works of Herrick, Johnson, Dryden, Swift, Prior, Addison, Johnson, Goldsmith, Congreve, Hood, Hook, Byron, and Burns. Pope's poems might be reckoned a conglomeration of epigrams. Some of the best in our language are by Landor, who cutting loose from the Latin type, at times becomes a Greek in spirit. Epigram has enjoyed wide favor in other modern tongues. In Italy, it long played an important part in politics, as both the Pasquino and Marforio in Rome would testify, could they speak, but it has gradually given way to the madrigal and sonnet. In France from the time of Clément Marot, who introduced it from the Latin, the satiric sort has enjoyed a wonderful popularity. Boileau, J. B. Rousseau, Piron, Lebrun, and Chénier have shown its possibilities in many lines. The poetic Priamel of the 14th century may be said to begin epigrammatic literature in Germany, where indeed it has always inclined more to the moral and didactic than in the Latin countries. Among her more eminent epigrammatists are Opitz, Friedrich von Logau who is the best of all, Wernicke, Kästner, Klopstock, Lessing, Herder, Schiller, and Goethe, who brought out their "Xenien" together in 1797, Haug, and in more recent times Bodenstedt, Vischer, and Fulda. We pass from the history to the theory of epigram. Since it is unlimited in its choice of subject, the form and not the contents must determine whether a poem is an epigram or not. Lessing has shown much acumen in tracing the essential elements of the epigram in its modern conception to the primitive type, the inscription. Just as a monument arouses in a spectator a curiosity about the author and purpose of its construction, which the inscription then satisfies, so the first part of a literary epigram, whether dealing with some material object, or not, is intended to excite an interest which the close of the poem must duly satisfy. The suspense may be increased by making the prefatory portion of some length. The more remotely separated and apparently contradictory the ideas that are brought together, and the briefer and more unexpected the commentary or explanation at the end, the more successful we deem the poem. This point or conclusion becomes in the satiric epigram a sting. Hence the frequent comparison of an epigram to a bee or wasp. While the above applies to most epigrams as written to-day, no definition is quite satisfactory with reference to much that the ancients included under the term.

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Ep'ilepsy, a disease of the nervous system, c..racterized for the most part by a sudden brief disturbance of the brain functions, and usually attended with a loss or a diminution of consciousness, with some degree of convulsive muscular action. In the vast majority of cases the temporary loss of consciousness permits of the loss of muscular control, and the patient falls; hence the old name, the "falling-evil," or "falling-sickness." Epilepsy is a disease which was recognized in its pure type by the most ancient observers. Hippocrates described it, and evidences are found in the earliest Indian writings of Charaka that the disease was then known. The present belief is that the primary disturbance of function which induces the epileptic attack takes place in the cortex of the brain, usually involving the motor centres; but this is not essential, since it may spread from other centres to the motor region, or the disturbance may be confined entirely to other portions of the brain, resulting in anomalous epileptic seizures.

A single convulsion does not constitute an epileptic attack, nor do a few convulsions. Convulsions of reflex origin are extremely common in childhood and infancy, and get well on the removal of an irritant, such as impacted fæces or a tight prepuce, or muscular defects in the eye-apparatus. These are not epilepsies. One of the distinguishing features of epilepsy is the tendency to a recurrence of the attacks. Gowers says: "As a disease, it consists in the repetition of attacks which depend upon the fact that every functional state of the brain, normal or abnormal, leaves behind it a condition in which the same functional state occurs with greater readiness. The effect is the greater the more often the functional attack has occurred. The tendency to the recurrence of attacks of epilepsy of every form is increased by each one. Every fit, slight or severe, is in some degree the effect of those that have preceded it, the cause of those that follow it. This residual disposition of repetition of the same activity is the physical basis of memory, of muscular training, of all cerebral education, and it is the basis of the morbid education of the brain which underlies epilepsy. The recognition of this is essential for an adequate comprehension of the causation of epilepsy and also its successful treatment." Further, as Gowers observes, "If we can perceive the conditions that underlie normal action in the nerve-centres, the phenomena of epilepsy will become in some degree less mysterious. In health, energy is liberated in instant response to a definite stimulus. Such capacity for instant activity involves a delicate equipoise of the processes for the liberation of nerve-force and for its restraint or control. The balance must depend upon the processes of nutrition in the nerve-structures, for the liberation of energy depends upon the occurrence of chemical processes under the influence of life — processes which must be ever on the verge of disturbance. But the conditions of nutrition must involve constant tranquil molecular changes, and, as a consequence, some degree of equally tranquil functional activity. The store of latent energy must be maintained by nutritional processes, which involve a constant overflow of energy, as from a vessel filled to the brim and delicately poised, into which water is gently flowing, but the equilibrium of which is easily disturbed, with a resulting energetic discharge."

The symptoms of epilepsy in all its forms are too numerous to be treated outside of medical works. Suffice it to say, in general, that the kinds of epileptic attacks are, for purposes of convenience, divided into two classes — the severe form, to which the term *grand mal* has been applied, and in which there is loss of consciousness often prolonged, with severe muscular spasms; and the slight attacks or *petit mal*, in which there may be slight temporary loss of consciousness with slight muscular spasm, or only slight muscular spasm without loss of consciousness, or slight disturbance in the conscious field without recognizable muscular movements. There are minor attacks, often called "faints," "turns," "queer feelings," etc., but they should not be mistaken for closely similar phenomena attendant on menstruation, indigestion, weak heart and circulation, etc.

In a typical *grand mal* attack, eschewing all refinements, the patient may have some sort of a warning of the oncoming storm. This is called the *aura*, and is usually present in from 30 to 40 per cent of all cases. This aura may be motor, sensorial, or intellectual. Thus the patient may feel a wave of hot air passing over the body; may have a sensation of griping at the throat; there may be a feeling of great buoyancy or exaltation. There may be abnormalities in taste, smell, sight, or some flashes of light, dark objects; partial blindness, roaring in the ears, noises in the head, bad taste in the mouth, indescribable sensations in the pit of the stomach — all these are types of the initial warning. Suddenly after this warning, or almost simultaneously with it the patient falls to the ground. Consecutively on this sudden fall severe tonic spasms of the muscles take place. Occasionally these spasms follow a definite order. Thus the fingers may be clutched, the arm raised backward and forward, one side of the body convulsed, this condition extending to the legs, the chest, the abdomen; and in *each succeeding attack the same order be followed*. When this occurs the disease is termed "Jacksonian" epilepsy, and this is one of the forms of the affection in which a localization of the cause can sometimes be made out. More usually, however, the attack is generalized. There are rigid, violent muscular contractions, which fix the limbs in irregular positions. It has been aptly described as a "clotted mass of movements." The head and eyes may be turned to one side, the features are distorted, the face becomes flushed and then pale and livid from fixation of the chest and the loss of movements of respiration. The eyes may be opened or closed, the pupils more or less dilated as the patient becomes more and more livid. After this tonic intense contraction has lasted for a few seconds, the backward clonic movements of the reaction occur, and the most violent energetic movements of the muscles of the entire body may take place. The jerking movements gradually become less, or terminate in one violent distortion, and the patient lies senseless and prostrate and usually sleeps for some time. During the attack the urine, fæces, or semen may be passed.

As for the minor attacks (*petit mal*), they exhibit an endless procession of variations. In some there may be but a slight loss of consciousness; the patient, sitting down or leaning against a table or chair, suddenly stops in the middle of his play or conversation; a shade passes over the face, and in a moment he is himself again. Occasionally the patient feels sleepy, lies down for a second, and then gets up perfectly well. Occasionally there is a slight convulsion, an involuntary contraction and extension of some of the muscles without loss of consciousness, and the patient resumes his regular course of work or play. Occasionally the patient suffers from what is known as psychical attacks, during which there is an entire modification in the personality; and during the attack various automatic movements may be performed and a patient be entirely unaware of what he is doing. These automatic movements may persist for some time, a few seconds, minutes, an hour, a day, a week, in certain cases as long as a month, although these longer intervals are extremely rare and perhaps are something different. During such automatic condition the patient may wander from home frequent resorts, the character of which is unknown to him in his waking state, and may even commit homicide or suicide. The patients usually show great irritability and restlessness during these automatic states. These states are extremely common following *grand mal.* There are patients with epilepsy who show no other signs of the epileptic attack than this automatic condition.

Etiology.— The causes of the disease are predisposing and exciting: those that exist in the family history, and those that occur during the life of the individual. A great many cases of epilepsy are due to accidents during childbirth, especially when the labor has been prolonged and difficult: sometimes when it has been precipitate; both resulting in hemorrhage into the meninges of the brain or into the brain substance proper. Perhaps 70 per cent of the cases of infantile epilepsy are due to this cause. A neuropathic tendency is almost a *sine qua non* for the development of idiopathic epilepsy. Almost 40 per cent of these cases are found to exist in families that show this neurotic, run-down character. Alcoholism in the parents is of immense importance. Syphilis and tuberculosis are also important features acting as predisposing causes. Females suffer more from epilepsy than males, the proportion being about 52 to 48 per cent. Gower's analysis of 3,000 cases, bearing on the question at what age this disease commences, shows that 27 per cent commenced below the age of 10; 46 per cent between the age of 10 and 20; 15 per cent between 20 and 30; 10 per cent between 30 and 40; 1 per cent between 50 and 60; and ½ per cent between 60 and 80.

The course of the disease will naturally vary very widely. Actual mortality from epilepsy is very difficult to determine. The danger to life during an attack is not great, and although the patients may seem to be in an alarming condition, it is extremely rare for death to occur during a fit. Gowers has summed up the prognosis in idiopathic epilepsy as follows: "The prognosis is slightly more favorable if the patient is of the female sex, and distinctly more favorable if the disease begins over 20 than if it commences between 10 and 20. It is better the shorter the duration of the disease, and when the disease is inherited than when no heredity can be traced. It is better the greater the interval between the severe fits, and is least so in the cases in which attacks occur almost daily. It is better if the attacks occur in the sleeping or the waking state only than if they occur in both. It is better if there is no considerable mental change, and if the attacks are all of the severe variety, than if there are minor seizures, and better if the attacks are preceded by an aura than if they occur without warning. It must be recognized, however, that a really good prognosis can seldom be given unless all attacks are averted by bromide in moderate doses, such as 50 or 60 grains a day. Larger doses may diminish the fits but seldom effect a cure, and this is true also of the substitute for bromide. Successful results are sometimes obtained, but they are few. The prognosis in cases which "cannot bear" bromide is generally unfavorable so far as the prospect of a cure is concerned. But in all cases the ultimate result largely depends on the ability to secure persistence with effective treatment for a sufficient time, two or three years. Less does not secure the stability that allows the controlling agent to be discontinued with impunity. It is the case whatever the agent is. Premature cessation of treatment is certain to involve recurrence, and the fresh start is harder than the first. There is no short road to a cure, and the prognosis must be largely influenced by the presence of the necessary patience and wisdom.

Occasionally patients, while in the epileptic condition, suffer mortal accidents; a few die of asphyxia. Some, especially those with mild epilepsy, get well of themselves; but those with severe epilepsy usually continue to have their attacks at varying intervals, from several a day to one a day, one a month, one a year, throughout their lifetime, and die of intercurrent troubles. The end, however, that can be looked for in a great many cases of epilepsy is the condition known as *status epilepticus.* It may be regarded as the terminal stage in epilepsy. It consists of repeated and continued epileptic attacks, associated with high fever and usually ending in death. Patients in the condition of *status* may have as many as 300 or 400 convulsive attacks a day.

The prognosis of the disease, or the outcome, is a subject that cannot be decided on general grounds. It is always a question of the individual; but epilepsy in general should be considered as a very grave disorder with a poor prognosis, although careful treatment by a specialist may result in great alleviation if not permanent cure. There is probably no disease of the nervous system that requires more highly specialized knowledge to treat than epilepsy.

The diagnosis is extremely difficult, and epilepsy is confounded with a number of other conditions that have no relationship whatever to it. The lack of ability to make a correct diagnosis, with the extreme mendacity of the charlatan, is the basis of the many quack remedies on the market for the treatment of epilepsy. In the United States there are no less than 1,000 sure cures manufactured by various proprietors of quack medicines, most of which are solutions of bromides. Suffice it to say that most of these are worthless, and the cures brought about, as evidenced in many of the circulars, have been cures of other diseases than epilepsy.

The treatment of epilepsy is always a special problem. There is no such thing as the treatment of the disease; it is always the treatment of the patient. No general rules can be laid down in an article of this kind apart from the general observance of hygienic laws. An outdoor life, with a mild, healthy occupation, plain, digestible food, the absence of alcohol, tobacco, and other stimulants, a free intestinal canal, and surroundings in consonance with the mental capacity of the patient, are very desirable features. Medicinal treatment lies solely in the province of the family physician or the specialist. During an attack the patient should have a pillow thrust under the head, the clothes about the neck loosened, and he should be placed in a position that will not permit of self-harm. Otherwise the epileptic fit is best left untreated. For the treatment of the epileptic poor, modern philanthropy has devised epileptic colonies (q.v.).

Medico-Legal Relations.— Very frequently epileptics are a menace to society. In the automatic conditions which they exhibit, as already described, they frequently commit crime, and it becomes a matter of much importance to determine their responsibility at the time of the perpetration of such anti-social acts. Special consideration should be given to the heredity of the patient, to the previous course of the disease, and to the conditions surrounding the patient at the time of the act. It is at the present time a very popular plea for murderers to allege that they were epileptic at the time of the commitment of certain acts. This is a plea that is entitled to careful weight on the part of an intelligent jury, although there is little doubt but that at the present time it is greatly abused. Consult: Gowers, 'Epilepsy and Other Chronic Convulsive Diseases' (2d ed. 1901); Féré, 'L'Epilepsie' (1899); Binswanger, 'Die Epilepsie' (1900); Voisin, 'L'Epilepsie' (1899); Letchworth, 'Care and Treatment of Epileptics' (1900); Starr, 'Text-book of Nervous Diseases' (1903).

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Epileptic Colonies. The treatment and care of epileptics in special institutions may be said to be one of the developments of applied philanthropy of distinctly recent origin. By the founding of epileptic colonies is meant the setting apart of distinct tracts of ground for buildings and for the exclusive care and training of epileptics. The position of the epileptic in society is altogether anomalous. As Letchworth well says: "As a child he is an object of solicitude to his parents and guardians. The streets to him are full of dangers, and if sent to school he is apt to have seizures on the way or in the class-room. His attacks shock his classmates and create confusion. He cannot attend church or public entertainments, nor participate in social gatherings with those of his own age and station. In consequence of his infirmity the epileptic grows up in idleness and ignorance, bereft of companionship outside of the family, and friendless. He silently broods over his isolated and helpless condition." The recognition of these truths has caused philanthropists to found such colonies. In continental countries more has been done for epileptics than elsewhere, but in the last 10 years the movement for taking care of this unfortunate class of society has grown to large proportions and, as expressed by Peterson in his presidential address to the National Association for the Treatment and Care of Epileptics 1902, "there is hardly a community in the civilized world that is not now thoroughly aroused to the necessity for the treatment of this class of defectives."

This awakening took place about 1887, and has continued to the present time. The first distinct attempt to provide for epileptics was inaugurated by a Lutheran pastor, Friedrich von Bodelschwingh, who founded at Bielefeld, in Westphalia, Germany, the Bethel Colony, which, from small beginnings, has grown up to a village inhabited solely by epileptics. Here everything has been provided to meet their special needs, to make up for their deprivations in the outside world. They are supplied with schools to improve their minds, industrial teachers to make them more or less self-supporting, and physicians to study and treat their cases. Outdoor occupations are provided, special diet is arranged for, recreations, amusements, religious instruction, in fact all of the devices that go to make up a home, have been provided under this man's guidance, so that in 1903 at least 4,000 people, not less than half of whom are epileptics, are being taken care of in Bethel.

The success of the Bielefeld Colony prompted movements elsewhere. Other colonies were founded in Germany and other European countries. Ohio established the first institution for epileptics in the United States, although this was built on the hospital rather than the colony plan. New York has Craig Colony at Sonyea, one of the most elaborate and beautiful institutions of this class, closely modeled on the Bielefeld plan, and now (1903) with a population of nearly 1,000. Massachusetts has a colony at Palmer; Pennsylvania a colony farm at Oakburn; and there is a New Jersey State village for epileptics at Skillman. A colony for epileptics was begun in 1902 at Abilene, Texas, and there are movements on foot for similar establishments in Connecticut, Indiana, Illinois, Kansas, North Carolina, Missouri, Minnesota, and California. In England the first colony founded was at Chalfont in 1893 and another at Warford in 1900. There is also a colony, the Waghull Home, near Liverpool; another at Godalming; a large colony at Chelford, and finally a fifth institution in England is nearing completion (1903) for the city of London, not far from Croydon. Other colonies have been founded in Brazil, Belgium, Switzerland, Sweden, Russia, Italy, Turkey, India, Japan and Australia.

The Craig Colony, of Sonyea, N. Y., being one of the most modern and ideal, is selected as a type of this institution. Consult: Letchworth, 'Care and Treatment of Epileptics' (1900).

Epileptic Insanity, a mental complex accompanying epilepsy. It is characterized by a certain degree of mental deterioration, as shown in the impairment of intellect and memory, by impulsiveness, mental irritability, loss of moral sense, and partial or complete loss of productiveness. It is also accompanied by periodic disturbances, transitory attacks of anger, dream-states, or automatic phenomena. Many cases of epilepsy do not develop into epileptic insanity, but the mental deterioration may appear at almost any period following the onset of the epilepsy. In practically all cases of epileptic insanity there is pronounced weakness, mentally, morally, and emotionally. One's sense of one's surroundings is usually preserved, and consciousnes may be clear save during the dream-states or automatic periods. Comprehension is usually not markedly impaired, but the field of attention is diminished and easily diverted. Hallucinations are infrequent, illusions are common during an attack or following a grand mal seizure, and delusions are transitory, being found usually only in the dream-states. Morbid and sudden impulses are quite frequent, sometimes approaching distinct nerve-storms, during which suicidal and homicidal attacks may occur. The conduct otherwise is usually orderly, and the ordinary rules of propriety are observed. There is greatly diminished capacity for work in practically all epileptics. The subject of epileptic insanity is one deserving wide recognition as there are unquestionably a number of phenomena termed "psychical" epilepsy that need recognition by specialists. In some of these attacks the patients are confused. They move in a mechanical or automatic manner. They wander aimlessly about, recognizing no one, although sometimes answering incoherently when addressed. Occasionally they exhibit symptoms of excitement, at other times depression, and not infrequently they may set fire to their beds or furniture, commit theft, assaults, homicides, expose their persons, and otherwise conduct themselves in an irrelevant and insane manner. Treatment is always unsatisfactory. The patient should be kept in a sanatorium or asylum. See EPILEPSY.

Epilo'bium, the willow-herbs, a genus of plants belonging to the evening primrose family (*Onagraceæ*). The species are herbs or under-shrubs with pink or purple, rarely yellow, flowers, single in the axils of the leaves, or having terminal leafy spikes. The seeds are tipped with a pencil of silky hairs, and are contained in a long four-celled capsule. There are about 65 species scattered over the arctic and temperate regions of the world, 40 of them being found in the western and northwestern portions of North America. *E. hirsutum*, or codlins-and-creams, a great hairy willow-herb, is a common and conspicuous plant of waste places in New England and northern New York. Its flowers are pink and rather large, and the whole plant is very downy. Some species are cultivated, but are more common in England cottage gardens than in America.

Ep'ilogue (from the Greek *epi*, upon, and *logos*, word, speech), the closing address to the audience at the end of a play. The epilogue is the opposite of the prologue, or opening address. Many of Shakespeare's plays have an epilogue as well as prologue, in which the poet sometimes craves the indulgence of the spectators for the faults of his piece and the performance, and sometimes intimates in what light his work is to be considered. The epilogue is sometimes a necessary appendage, to tell us something of a composition, which cannot be gathered from the composition itself.

Epimenides, ĕp-ĭ-mĕn'ĭ-dēz, Cretan philosopher and poet: b. Crete, in the 7th century B.C. By some he is reckoned among the seven wise men, instead of Periander. When the Athenians were visited with war and pestilence, and the oracle declared that they had drawn on themselves the divine anger by the profanation of the temple, in which the followers of Cylon had been put to death, and must expiate their offense, they sent for Epimenides, who was renowned for his wisdom and piety, from Crete, to purify the temple. On his departure he refused to accept any presents, and only asked the friendship of the Athenians on behalf of Cnossus, his home. There is a story of his having, when a boy, slept in a cavern for 57 years. On awakening, he found, to his astonishment, everything changed in his native town. This story is the ground-work of Goethe's poem, the 'Waking of Epimenides,' for the anniversary of the battle of Leipsic. According to some accounts he is said to have lived for upward of 150, according to others for nearly 300, years. He is supposed to be the prophet referred to by St. Paul in Titus i. 12.

Epimetheus, ĕp-ĭ-mē'thūs, in Greek mythology, a son of Iapetus and Clymene, and the brother of Prometheus. Against the latter's advice he married Pandora, who opened the box in which the foresight of Prometheus had hid all the ills by which mortals were liable to be afflicted. All kinds of diseases and torments issued out of the box, and hope alone remained behind. According to other accounts it was Epimetheus himself who opened the box. (See PANDORA.) It is to be remarked that, in the Greek tradition, curiosity and disobedience are made the origin of evil, as in the Mosaic account of the fall.

Epinal, ā-pē-näl, France, town, capital of the department of the Vosges, in a narrow valley on the Moselle, 190 miles east-southeast of Paris. It has a communal college, a public library of 20,000 volumes, a museum, a theatre, and hospital. The manufactures consist of articles in iron and brass, leather, oil, and chemicals; freestone and marble are quarried in the vicinity. Pop. 28,523.

Epinay, ā-pē-nā, **Madame de la Live d'** (LOUISE FLORENCE PÉTRONILLE TARDIEU D'ESCLAVELLES), French writer: b. Valenciennes 11 March 1725; d. Paris 17 April 1783. She was the daughter of M. Tardieu Desclavelles, and married her cousin D'Epinay. But his extravagance soon compelled her to separate from him. During the earlier part of her life she formed an acquaintance with Rousseau, who, quick and susceptible in all his feelings, devoted himself to the fascinating and accomplished woman with an ardor, the depth and strength of which he describes himself in his 'Confessions.' She was not insensible to the homage of her "bear," as she used to call him, on account of his eccentricities, and did all that was in her power to place him in a situation corresponding to his wishes. She gave him a cottage (the Hermitage, since so famous) in her park of Chevrette, in the vale of Montmorency. Here the author of the 'Nouvelle Héloise' passed many days, rendered happy by his romantic attachment to Madame d'Epinay; until he became jealous of Baron Grimm, whom he had himself introduced to her; and in consequence of this feeling, which he took no pains to conceal, a coolness, and finally an aversion, took place between him and the lady, which is but too plainly expressed in his 'Confessions.' A defense of the later conduct of Madame d'Epinay toward Rousseau may be found in Grimm's 'Correspondence,' where an account is also given of some works written by her, of which the most celebrated is 'Les Conversations d'Emilie.' In this the authoress, in a rather cold but neat style, sets forth the principles of moral instruction for children, with equal elegance and depth of thought. It obtained, in 1783, the prize offered by Monthion (the chancellor to the Count d'Artois) for useful works of this kind, in preference to the 'Adèle et Théodore' of Madame de Genlis. She also wrote 'Lettres à mon fils,' and 'Mes moments heureux.' An abridgment of her memoirs, and correspondence, showing her relations with Duclos, Rousseau, Grimm, Holbach, Lambert, etc., appeared in 1818. They give a true picture of the refined but corrupt manners which prevailed among the higher classes in France during the government of Louis XV.

Epior'nis, an extinct ratite bird of Madagascar (*Æpyornis maximus*), interesting not only for itself, but because its remains appear to have formed the basis for the Arabic tale of the gigantic roc. It was much like an ostrich in size and structure, except for the massiveness of its limbs and the extraordinary size of its eggs. These have been found in considerable numbers in muck-swamps, or sometimes floating in the river-mouths, often in perfect condition, and are the largest and strongest eggs known, measuring about 13 inches by 9½. These dimensions are twice those of an ostrich's egg, and an egg of the epiornis would hold the contents of six ostrichs' eggs, yet the epiornis was little if any larger. First made known to science about 1850, so many remains have since been found that about 12 species have been indicated, and a second genus (*Mullerornis*), which has been joined with *Æpyornis* into the family *Æpyornithidæ*. Tradition and the evidences of some bones indicate that these birds were exterminated since human occupation of Madagascar began. See MOA.

Epiphanius, ĕp-ĭ-fā'nĭ-ŭs, **Saint**, Greek father of the Church: b. of Jewish parents near Eleutheropolis, Palestine, about 315; d. at sea near Cyprus 403. In his youth he went to Egypt where at first he came under the influence of teachers of Gnosticism; but afterward he embraced monasticism, and returning to his own country there became head of a community of monks. In Palestine he made the acquaintance of the two western churchmen, Jerome and his associate, Rufinus; the friendship of the three men was cordial and intimate till Rufinus' defense of the teachings of Origen angered Epiphanius, whose special mission seemed to be to obliterate every line written by Origen. He was made bishop of Constantia (the older name Salamis), in Cyprus 367, and held that see till his death. On one occasion, 394, he visited Jerusalem to denounce Origenism. He must have been more than 80 years old, perhaps near 90, when he went to Constantinople to charge the patriarch of that see, Saint John Chrysostom, with the sin of favoring the Origenists, but a few words from Chrysostom opened his eyes. Of his numerous writings few remain; among them: 'Panarion, a history of Heresies'; 'Commentary on the Book of Canticles,' and some others. Consult: Tillemont, 'La Vie de S. Epiphane, avec l'Analyse des Ouvrages de ce Saint, et son Apologie.'

Epiphany, ē-pĭf'a-nĭ, a festival of the Catholic Church held on 6 January to commemorate the manifestations of Jesus Christ as son of God: (1) to the Wise Men of the East (Magi) at Bethlehem; (2) at his baptism by John in the Jordan, when the voice from heaven proclaimed, "Thou art my beloved son; in whom I am well pleased"; (3) at the marriage feast at Cana in Galilee, where Jesus wrought his first miracle. The observance of this festival can be traced to an earlier period in the eastern Church than in the western. In the Greek Church it was observed as early as the 2d century, but the event commemorated by the Greeks was not the visit of the Magi to Nazareth, but the manifestation of Jesus at the Jordan as the Messiah. Not till the 4th century does the Epiphany appear to have been observed in the Latin Church. In the Greek and Oriental churches it is customary to administer baptism on the eve of this festival with unwonted solemnity: this because of the relation of the festival to the baptism of Jesus by St. John. In those churches, too, the Epiphany (Epiphaneia, Theophaneia) was the festival commemorative of the birth of Jesus; for it was believed that the baptism in Jordan took place precisely on the 30th anniversary of the birth. A popular name for this festival in English is "Twelfth Day," that is, twelfth day from Christmas; it is also called "Little Christmas." In various other languages it is known as "Three Kings' Day," or "Day of the Kings." See MAGI.

Epiphyllum, ĕp-ĭ-fĭl'ŭm, a genus of plants of the natural order *Cactaceæ*. The few species seem to be confined to Brazil, where they are epiphytic upon trees. They have flat-jointed stems with blunt ends, from which the new branches and flowers are produced. These are borne in great abundance, on which account, and because of their brilliant red tints, this group of cacti is exceptionally popular in greenhouses, being probably the most useful of all cacti. They are easily propagated by means of cuttings or by grafting, particularly upon erect-growing species of other genera, and are generally used as hanging-basket plants, for which purpose their drooping habit specially recommends them. They need a porous, poor, fibrous soil and little water. The species most widely grown are *E. truncatum*, the crab or Christmas cactus, with numerous horticultural hybrids between it and related species, and *C. Gærtneri*, the Easter cactus.

Epiph'ysis. See BONE.

Epiphyte, ĕp'ĭ-fīt, or **Air-plant**, a plant attached to a tree or other support, organic or inorganic, living or dead, but from which it obtains no nutriment. The term air-plant has been popularly applied because these plants are typically neither parasitic, saprophytic, nor terrestrial, but depend upon the dust which lodges around them and upon the water of dew and rain. Strictly speaking, they are not air-plants, because this term implies no other source of life than air. Besides the typical epiphytes, which have representatives in many plant families, particularly the tropical orchids, bromelias, and ferns, there are many forms which are only partially epiphytic. In structure many of them exhibit adaptations for checking transpiration and for securing even minute quantities of water from the air or from objects to which they are attached. (See PITCHER-PLANTS.) Others (certain orchids) have storage organs which are usually specialized stems. Some have roots which serve only to anchor the plants to their support. In these, which are the most typical, the absorption of food takes place in the leaves and other green parts. Others are only epiphytic at first, since they later develop true roots which obtain food from the soil. The home of the largest number of epiphytes is in the moist region covered by tropical forests, the trees of which are often so covered with these plants that their branches are wholly concealed by a very miscellaneous growth. In the temperate and colder climates the epiphytal forms are confined almost wholly to lower orders of plant life such as liverworts, mosses, algæ, and lichens. These are also represented in the tropics, some of them even becoming attached to leaves of higher plants. Many of the flowering epiphytes are cultivated in greenhouses for ornament. Among the favorites are various species of *Nepenthes* (q.v.), orchids, and bromelias. One of the best-known American species, common in the southern United States, is the so-called Florida or Spanish moss (*Tillandsia usneoides*) of the natural order *Bromeliaceæ*.

Epirus, ē-pī'rŭs, a province of ancient Greece. It was separated from Grecian Illyria by the Ceraunian Mountains, and by the famous river Pindus from Thessaly. The river Acheron, also famous in mythological story, flowed through the limits of this province, and here were also the celebrated temple and sacred oak grove of Dodona, famous for its oracles. Pyrrhus, king of Macedon, was a native of Epirus, which country passed successively into the hands of the Romans and the Turks. It was ceded to Greece by the Turks in 1881. See GREECE.

Epis'copacy, that form of Church government in which one order of the clergy is superior to another; as bishops to priests and deacons. Much discussion has taken place on the subject of episcopacy. Nothing conclusive can be gathered concerning it in the New Testament; but there can be no doubt that it existed universally in the Church from the earliest historic ages down to the time of the Reformation, and it is inferred, as no change can be shown to have taken place, that the same constitution existed from the time of the apostles. Presbyterians and others argue, on the other hand, that, as there is nothing definite concerning it in Scripture, Christians are left a discretionary power of modeling the government of their Church in such a manner as may seem to them most meet; and that every Christian society has a right to make laws for itself, provided these laws are consistent with charity and peace, and with the fundamental doctrines and principles of Christianity. The power vested in the bishops or higher clergy differs very much among the different episcopal bodies. The Roman Catholic and the Greek Churches, as also the Church of England and the Methodist Church, are espicopalian. See BISHOP; ENGLAND, CHURCH OF; GREEK CHURCH; METHODIST CHURCH; CATHOLIC CHURCH, ROMAN.

Epis'copal Church. See ENGLAND, CHURCH OF; METHODIST EPISCOPAL CHURCH; PROTESTANT EPISCOPAL CHURCH; REFORMED EPISCOPAL CHURCH.

Episcopal Church, Reformed. See REFORMED EPISCOPAL CHURCH.

Episcopal Theological School, an institution situated at Cambridge, Mass. It was established in 1867 by Benjamin Tyler Reed, as a college for candidates studying for the ministry for the Episcopal Church. Students holding bachelors' degrees may obtain the degree of B.D., but those not holding such a degree receive only certificates.

Episcopal Theological Seminary, the name of an institution in Alexandria, Va., founded for the education of candidates for the ministry of the Protestant Episcopal Church. It was chartered in 1854, although the school was founded in 1823. Several scholarships have been established for worthy students. One of its renowned pupils was Phillips Brooks (q.v.).

Episco'pius, Simon, Dutch theologian: b. Amsterdam 1 Jan. 1583; d. there 4 April 1643. The religious movement known as Arminianism was fostered by him, and he was its leader after the death of Arminius. He was educated at Leyden, where in 1606 he received his degree of M.A. In 1610 he was ordained pastor at the village of Bleyswyck near Rotterdam. In 1611 the states-general, with the intention of putting an end to the agitations created by the controversies between the Gomarists or Calvinistic party and the Arminians or Remonstrants, ordered a conference to be held in their presence at The Hague between six ministers of each party. Episcopius was one of the six charged with the advocacy of Arminianism, and highly distinguished himself by good temper, ability, and learning. In 1612, the curators of the University of Leyden appointed him professor of theology in place of Gomar, who had gone to Seeland. This enraged the leaders of the orthodox party, who accused Episcopius of Socinianism, and of having entered into an alliance with the Roman Catholics for the destruction of Protestantism. By this the fanaticism of the populace was roused; he was insulted and abused in the street, and on one occasion narrowly escaped being stoned to death. The house of his brother in Amsterdam was sacked, under the pretext that it was a rendezvous of the Remonstrants. In 1618 occurred the famous Synod of Dort. Episcopius was present, with several other Arminians. The Calvinists, who were in an overwhelming majority, would not allow him to speak; they told him that the synod was met not to discuss, but to judge; and all the proceedings exhibited much bigotry and tyranny. Expelled from the church, and banished from the country, Episcopius betook himself first to Antwerp, afterward to Rouen and Paris, but 1626 returned to Rotterdam, where the *odium theologicum* against his party had become less virulent. Here he married in 1630, and four years later was made primarius professor of divinity in the newly established college of the Remonstrants. Episcopius held enlightened principles in regard to religious toleration. Not placing a high value on merely doctrinal views, but trusting rather to the efficacy of the Christian spirit to elevate and purify the character, and seeing, moreover, the presence of this spirit in men holding the most conflicting opinions (when not inflamed with controversial hates), he was desirous of a broader and more catholic bond of unity among Christians than the opinionative creeds of his day permitted. He wrote 'Institutes of Theology'; 'Apology'; 'Confession,' etc. See Calder, 'Memoirs of Simon Episcopius' (1838).

Episode (Lat. *episodium*, from the Gr. ἐπεισόδιον, *epeisodion*, something adventitious). This term is employed by Aristotle in two significations. Sometimes it denotes those parts of a play which are between the choruses, and sometimes an incidental narrative, or digression in a poem, which the poet has connected with the main plot, but which is not essential to it. In modern times it has been used in the latter sense only. With the best poets the episode is not an unnecessary appendage, serving merely to swell the size of the work, but is closely connected with the subject, points out important consequences, or develops hidden causes. Of this kind is the narrative of the destruction of Troy, in Virgil's Æneid. This was the cause of the hero's leaving his country; but the poet does not commence with it because he wishes to bring the plot into a narrower space. He therefore inserts it in the course of the story, but so skilfully that we expect it in this very place; and it not only serves as a key to what has gone before, but prepares us for what is to come, namely, the passion of Dido. In this way the episode becomes an essential part of the whole, as it must necessarily be, if it is of any importance to preserve the unity of the poem. So with the tale in Wieland's 'Oberon'; it appears incidental, but explains to us the reason of Oberon's singular interest in the fate of

Huon. In epic poetry there is much more room for the episode than in dramatic, where the poem is confined to a present action. An excellent instance of the skilful use of the episode in the modern novel is given in Manzoni's I promessi sposi, in the tale of the 'Nun of Monza.' The term episode has also been transferred to painting, especially historic painting, in a sense analogous to that which it has in poetry.

Epistaxis. See NOSEBLEED.

Epistemology (ἐπιστήμη, knowledge or science, and λόγος, theory or discourse), or theory of knowledge, is an account of the nature of knowledge, treating of its origin and laws of development, its validity and relation to human experience as a whole. Investigations of this character fall within the field of general philosophy, and have usually been included under the heading of metaphysics. The word «Epistemology» is said to have been first used by J. F. Ferrier in his *Institutes of Metaphysics* (1854). Since its general adoption it has sometimes been taken to denote a field of inquiry co-ordinate with, and largely independent of, Metaphysics. It has been proposed to keep the investigation of the nature of knowledge distinct from the problems regarding the nature of being, and to call the former epistemology, and the latter metaphysics. The best usage of the present time, however, seems to retain the historical sense of the term metaphysics as the name for the more general field of philosophical inquiry which embraces both epistemology and ontology. (See also articles on PHILOSOPHY and METAPHYSICS.) Moreover, a logical justification for this usage is furnished by the fact that it is impossible to carry on the two branches of inquiry in isolation. It must undoubtedly be granted that for an ultimate ontology, or final view of the world, it is necessary to go beyond the merely cognitional aspect of experience and include in our synthesis judgments based on other orders of value than the merely logical. But it is at once obvious that we cannot take one significant step in investigating the nature of reality without some criterion of knowledge, *i. e.*, some theory of the conditions under which reality is known, and of what constitutes truth. It is perhaps not so evident that the nature of knowledge cannot be made the subject of inquiry without any reference to metaphysical theory. Indeed, it is not uncommon to speak of epistemology, as Locke does, as «a preliminary clearing of the ground» which is to be completed before any more ultimate metaphysical inquiries are to be undertaken,— if, indeed, these are to be undertaken at all. But this way of conceiving the matter is quite misleading. The figures which compare the knowing faculty to an instrument whose nature must first be understood, are here quite inapplicable. For knowledge has no existence by itself, or apart from and external to its objects. What we want, as Hegel has observed, «is to combine in our process of inquiry the action of the forms of thought with a criticism of them. The forms of thought must be studied in their essential nature and complete development; they are at once the object of research and the action of that object. Hence they examine themselves; in their own action they must determine their limits and point out their defects.» In other words, knowledge is never a mere series of ideas or mental representations that can be investigated apart from its relation to objects. In so far as it is knowledge it refers to and implies reality. To investigate its nature, then, is at the same time to test its conclusions regarding the nature of the objects with which it deals. But even if one refuses to take this standpoint, one must still admit the close connection of epistemology and metaphysics. For all theories of the nature of knowledge are based implicitly or explicitly on certain metaphysical assumptions regarding both the mind which knows and its relation to the objects known. Epistemology, then, cannot take one step without involving the ontological problems which some of its representatives seek to avoid.

It is likewise impossible to distinguish sharply the discussion of epistemological problems from logic. If a division can be made at the present time it is only in degree of ultimateness. It is possible, though perhaps not advisable, to limit the term «logic» to the somewhat narrow and abstract treatment which takes as its object the discovery of certain correct forms of thinking, or certain rules which are of practical value in testing arguments. When, however, logic breaks away from this narrow programme, as has been done by the more important recent writers, and carries on its inquiries in a philosophical spirit, it becomes identical with epistemology. Epistemology, logic, and metaphysics may thus be said to denote certain main points of view, differing somewhat in the treatment of various writers in emphasis and inclusiveness, rather than three independent and isolated sciences.

Psychology, as a natural science, however, occupies a different field, and has quite a different problem from epistemology. It is true that attempts have frequently been made to explain knowledge by beginning with cognitive mental states viewed as psychological processes. But the characteristics of the mental states and functions with which psychology deals have no immediate bearing on the problem of knowledge. For psychology is concerned only with the mode in which ideas exist; it investigates their quality, duration, intensity, etc., as well as their various modes of combination, viewing them as particular forms of psychical reality. Epistemology, on the other hand, is interested not in the existential aspect of ideas, but in their significance, in the universal and objective validity of experience as a body of truth. It thus seeks to bring to light the forms and functions of intelligence, noting the conditions and presuppositions under which it works, and the laws by which knowledge develops from its simpler and more fragmentary stages to the more complicated and coherent structure of science. It is a philosophy of experience rather than a description of individual states of consciousness.

Reflection on the nature of knowledge does not arise until a somewhat late stage in the development of the thought of the individual and the race. Thought first announces its conclusions confidently and fearlessly. It is not until this naïve confidence fails and scepticism arises that it is forced to reflect upon the nature of knowledge and its grounds of certainty. This is illustrated in the history both of ancient and of modern philosophy. The early Greek philosophers, as Hegel remarked, thought away fearlessly regarding the nature of reality. It was the collapse of those early systems and the scepticism of the Sophists (q.v.) which forced Socrates to take up the epistemological problem. In the same way the Stoic and Epicurean discussions regarding the canon of truth arose in response to the more outspoken and thorough-going scepticism of later times. In modern times the epistemological interest did not come into the foreground until Locke's 'Essay.' Locke's account of the origin of this work brings out very clearly the way in which problems of this character naturally arise: "Five or six friends meeting at my chamber, and discoursing on a subject very remote from this, found themselves quickly at a stand by the difficulties that rose on every side. After we had awhile puzzled ourselves, without coming any nearer a resolution of those doubts which perplexed us, it came into my thoughts that we took a wrong course, and that before we set ourselves upon inquiries of that nature, it was necessary to examine our own abilities and see what objects our understandings were, or were not, fitted to deal with . . . . Some hasty and undigested thoughts on a subject I had never before considered, which I set down against our next meeting, gave the first entrance into this discourse; . . . . and at last it was brought into that order thou now seest it."

Kant's 'Kritik of Pure Reason' was the work which placed epistemology in the foreground of continental philosophy. In the Preface to that work, he shows that the motives that led to his undertaking were very similar to those which influenced Locke. The scepticism of his time, he says, "is clearly the result, not of the carelessness, but of the matured judgment of an age, which will no longer rest satisfied with the mere appearance of knowledge. It is, at the same time, a powerful appeal to reason to undertake anew the most difficult of its duties, namely, self-knowledge, and to institute a court of appeal which should protect the just rights of reason, but dismiss all groundless claims, and should do this not by means of irresponsible decrees, but according to the eternal and unalterable laws of reason." Kant has a poor opinion of Locke's account of knowledge, and characterizes it as "a certain physiology of the human understanding." He himself proposed to inaugurate a method of Criticism which should give a new direction to philosophical inquiry, and at the same time furnish to it a sure foundation for further advance. Since Kant's time epistemological problems have largely dominated modern philosophy; and indeed, it has been maintained by many thinkers that the criticism of knowledge is the sole function which philosophy is able to perform, and that ontological speculation is vain and fruitless.

In the Pre-Kantian philosophy Rationalism (q.v.) and Empiricism (q.v.) were the main types of epistemological theory. The basis of the former was laid by Descartes (q.v.), who sought to universalize the method of mathematics, and by this means to secure the certainty of absolute demonstration in all fields. As mathematics starts from axioms and principles which are intuitively certain, and proceeds by means of reasoning to deduce all its other propositions from these as necessary consequences, so all science must derive its conclusions from fundamental and indemonstrable principles. These principles exist in the mind as *a priori* truths, and are universal and necessary in character. All science is thus built up by reasoning from general principles. Sense-perception and observation of particular facts were neglected, since it was held to be impossible to arrive in this way at the universal and necessary form of truth which science demands. It is evident that this theory of knowledge could more readily be applied to the general features of reality than to a determination of its particular details. And in the hands of Wolff (q.v.) and other continental rationalists it was occupied mainly in furnishing formal proofs of the existence of God, the nature of the soul, and the external features of the physical universe. Empiricism (q.v.), on the other hand, emphasizes sense-perception as the basis of all knowledge. Experience is described as a series of particular sensations and ideas in consciousness which are given to the mind from some external source. The mind itself is regarded as merely receptive, without any store of innate ideas, or of organizing principles. It was not strange, then, that in the hands of a genius like David Hume (q.v.), who carried this point of view to its logical outcome, empiricism should issue in scepticism. For if experience is nothing but a series of conscious states, each of which is "loose and separate" from all the others, it is impossible to know anything except these particular states in their isolation; impossible, therefore, to reach any universal propositions such as science demands. Again, if knowledge is limited to states of consciousness, it follows at once that there can be nothing known either of the nature of objects or of the subject or soul.

Kant (q.v.) did much to overcome the one-sidedness of these theories, and to give a more adequate account of the nature of knowledge. For, while he insists that knowledge must begin with experience, he points out that experience itself is a compound, implying both a given sense material and forms and principles of organization on the part of the mind. By his doctrine that "thoughts without perceptions are empty, while perceptions without thoughts are blind," he passed beyond the one-sided views of both Rationalism and Empiricism. By his transcendental method of inquiry he seeks to show what are the fundamental forms and categories which the mind employs in building up a coherent and universally valid system of experience. But, in spite of the great reform which he effected, he did not wholly succeed in reaching an organic view of experience. This was partly the result of presupposition which he inherited from the past, and partly due to his own tendency to make hard and fast divisions and distinctions. There always remained for him an unresolved dualism within experience between the datum of sense and the forms of thought. Again, thought, as he conceives it, does not pass beyond subjectivity and include in itself the nature of its object, but is occupied with bringing order and unity into sensations and mental representations. Although these states of consciousness, when thus acted upon by thought, become objective in the sense that they are parts of a universal and necessary system, nevertheless they are still only "phenomena," objects in the mind, while the world of real being (the things in themselves) remains inaccessible to knowledge. The spirit of Kant's philosophy undoubtedly leads beyond any such absolute dualism. But from Kant's day to the present time this distinction has appeared the final word of philosophy to many thinkers who continue to accept the presuppositions and categories of the past century, and who fail to apply to this problem the organic and evolutionary conceptions which are now within their reach.

Modern epistemological investigation may be described as seeking to exhibit the organic unity of experience. To reach this result, new theories regarding the nature of the mind and its relation to objects are necessary. In the first place, the conception of the mind as made up of a number of distinct faculties, must give place to the idea of the mind as a unitary system of functions which mutually coöperate and determine each other in the progressive development of experience. Secondly, the mind can no longer be regarded as a system of merely subjective functions related only in an external and accidental way to the real world of objects. The course of philosophical discussion has rendered it evident that if we begin by defining experience in terms of mental processes there is no way of deriving from these the world of objects. If our epistemological theory is to be adequate to experience as we know it, objectivity must be included within it. Thought, that is, is real only as a relation to objects; by itself, and apart from the world of real objects, it has no reality. It is only by thus recognizing from the beginning the essential relation of subject and object that it is possible to exhibit the real organic unity of experience as a system of knowledge. It was Kant's successors in Germany, and preeminently Hegel (q.v.), who first developed this organic view of experience. But partly on account of the form in which these systems were expressed, and partly as a result of the decline of philosophical interest, their most valuable and characteristic ideas failed for a long time to be appreciated. The credit of freeing these fruitful ideas from the somewhat obscure and uninviting form in which they were presented in the German systems of a century ago, belongs in the main to the English Neo-Hegelians and their co-laborers in America, among the latter of whom a place of honor must be given to Dr. William T. Harris, the late U. S. Commissioner of Education. The fundamental doctrine of these writers is that what is real is rational, *i. e.*, knowable in terms of reason, and therefore that all forms of cognitive experience can be exhibited as organically interconnected as a system of rational ideas or meanings. Conscious experience is from the first regarded, not as a series of psychological states, but as taking the form of a judging activity whose function is to interpret and reveal the nature of the objective world. Moreover, knowledge proceeds in its development through differentiation and integration in accordance with the fundamental laws of logical evolution. Its later and more highly developed forms are then to be understood as the differentiation and systematization of its more elementary forms and functions. The final truth regarding the nature of the real world must accordingly correspond with the ideal of completely developed and perfectly rationalized experience. As representatives of this general type of objective Idealism we may mention the late T. H. Green, Edward Caird, the late D. G. Ritchie, A. S. Pringle-Pattison B. Bosanquet, W. T. Harris, John Watson, and Josiah Royce.

There are, however, prominent philosophical writers of the present day who employ to some extent Hegelian methods and principles in dealing with experience, but who yet maintain that the account of knowledge in terms of reason requires to be modified and supplemented in various ways. Two main points of view may be here mentioned, which have much in common, and which are both often emphasized by the same writers. On the one hand, it is claimed that logical thinking operates with universal concepts, and can therefore never do justice to the individual aspects of real objects. Thought, in other words, is concerned only with universal relations, and is unable to apprehend the uniqueness and particularity of real existence; it gives us only descriptions of things in general terms, and has to receive as a datum from another form of knowing the particular facts which form its subject-matter. This latter aspect of reality, it is maintained, can be apprehended only in some form of immediate experience. In fact, it is often maintained that logical experience must both start from and pass into direct intuition or feeling. In its beginning, logical thinking presupposes the awareness of objects in sense-perception; for it is claimed it is only in this way that thought comes into contact with individual things and gets a foothold in reality. Again, since the total system of things must exist in individual form, the final synthesis of knowledge must transcend logical relations and be realized, if it can be attained at all, in immediate intuition—a mode of cognition that may perhaps be described as analagous to æsthetic contemplation. Although the neo-Hegelian writers have not been backward in meeting these arguments, and have successfully shown the difficulties involved in their opponents' antithesis of universal and individual, of thought and immediate knowing, yet the discussion cannot be regarded as closed at the present time.

In a similar spirit the function of will and purpose as a fundamental element in experience is at present emphasized in many quarters. The intellectual or rationalistic account of cognitive experience is maintained to be inadequate, since it abstracts from the volitional element which alone gives to knowledge its function and significance. Concrete experience is the process of living, and living consists in the realization of purposes. So much may, I think, be granted: experience is essentially a teleological process and must be interpreted in terms of purpose. But purposes are only defined and realized through thought. Pragmatism (q.v.) (as the popular theory of the present day is called) goes further, and interprets knowledge solely in its relation to action. Knowledge is the instrument which the will employs to discover the means whereby practical purposes may be realized. It is thus never an end in itself, nor does its function consist in revealing the nature of a reality beyond experience. The function of thought is to effect the practical control of experience, and the only realities which it can define are terms within experience itself. Its problems are set by the particular situations and concrete demands which the developing process of experience presents. There is no intelligible problem regarding the nature of reality in general, or reality that does not exist as a particular functional element in concrete experience. Against this position various objections have been urged by many writers; the chief of which are: (1) that it does not reach a real organic unity of experience; (2) that it overlooks the fact that knowledge is an end in itself; (3) that it is subjective, and fails to recognize the objective and rational ends without which no real experience can exist.

At the present time perhaps the most important function of Epistemology consists in a criticism and evaluation of the fundamental conceptions and principles which underlie the procedure of the special sciences. These sciences set out from certain definite assumptions regarding the nature of the phenomena which they investigate, and with certain demands which their method of investigation has to fulfil. It is the function of Epistemology to make explicit the nature of these initial assumptions, and to show that the accounts given by these sciences are essentially determined by the character of these assumptions. Instead of assuming that the results of the special sciences are to be accepted at their face value as direct statements about the nature of reality, both philosophical epistemologists and workers in these sciences who have reflected on the problems of method (as *e. g.*, E. Mach and Karl Pearson) now agree that the view of the world given by natural science —and especially the mechanical theory—is itself a logical construction, based on certain assumptions which are necessary to carry out the purpose of the scientific co-ordination and explanation of facts. This construction must not be read apart from the purpose for which it was designed. Indeed, the prevailing tendency is to emphasize the merely methodological character of scientific results to such an extent as to make them appear almost arbitrary and devoid of any ontological significance. This is undoubtedly an extreme position. It must, of course, be admitted that the results of the special sciences are largely hypothetical and possess only relative truth. But they are never mere logical constructions in the sense that they are entirely divorced from reality. The ultimate purpose of science, as of all thinking, is to exhibit the structure of the real world, and the assumptions and hypotheses of the special sciences derive their significance and justification solely from their employment as means for the accomplishment of that end. In its task of criticising the assumptions of the special sciences, then, Epistemology cannot escape the consideration of metaphysical problems regarding the nature of the external world and its relation to the human mind.

Bibliography.—The bibliography of this subject is coextensive with that of general philosophy. A few works may be mentioned which deal with the more recent development of the subject:—Ormond, 'Foundations of Knowledge' (1894); Ladd, 'Philosophy of Knowledge' (1897); James, 'The Will to Believe'; Ward, 'Naturalism and Agnosticism'; Rickert, 'Die Grenzen der naturwissenschaftlichen Begriffsbildung' (1902); Münsterberg, 'Psychology and Life' and 'Die Grundzüge der Psychologie'; Dewey, 'Studies in Logical Theory' (1902); Seth, 'Epistemology and Metaphyics' and 'The Problem of Epistemology' (*Philosophical Review*, Vol. I, 1892); Seth, 'The Utilitarian Estimate of Knowledge' (*Philosophical Review*, Vol. X, 1901); Creighton, 'Methodology and Truth' (*Philosophical Review*, Vol. X, 1901); Albee, 'The Significance of Methodological Principles' (*Philosophical Review*, Vol. XV, 1906).

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Epistolæ Obscurorum Virorum, ē-pĭs'tō-lē ŏb-skū-rō'rŭm vī-rō'rŭm (Lat. "Letters of obscure men"), a collection of satirical letters which appeared in Germany in 1515-19, and professed to be the composition of certain ecclesiastics and professors in Cologne and other German towns. It is considered one of the most masterly sarcasms in the history of literature, and its importance is enhanced by the effect it had in promoting the cause of the Reformation through its attacks upon scholastics and monks. The authorship of this satire has been a fertile subject of controversy, but the major portion has been attributed to Reuchlin, Ulrich von Hutten, and Erasmus. The best edition is that of Böcking, supplementing his edition of the works of Hutten (Leipsic 1864-70).

Ep'itaph (Gr. ἐπιτάφιος, *epitaphios*, funeral, from ἐπι, *epi*, upon, and τάφος, *taphos*, tomb), an inscription upon a tomb. The earliest known are those upon Egyptian sarcophagi. Epitaphs were in use among both the Greeks and Romans. Many of the later Greek epitaphs were of considerable length, while those of the Romans commonly recorded only brief particulars regarding the deceased. The tombs of the Romans were placed near the highways, and their epitaphs generally commenced with, *Sta viator!* (Stop, traveler!). On Christian tombstones, epitaphs frequently express the pious hopes of survivors in reference to the doctrines of the Christian faith. In the catacombs of Rome, which were made a place of refuge by the persecuted Christians under the pagan emperors, are many remarkable epitaphs of this description.

Among memorable epitaphs, one of the happiest is that of Sir Christopher Wren, in St. Paul's, London, of which he was the architect:

Si monumentum quæris, circumspice.
"If you seek for his monument,—look about you."

The following is the epitaph of a Roman matron:

Domum servavit,
Lanam fecit.
"She kept the house and span the wool."
Sta, viator: heroem calcas,—
"Traveler, pause: thou treadest upon a hero,"

has been ascribed both to Montecuculi and to Gen. Merci.

Sufficit huic tumulus, cui non suffecerat orbis,—
"This tomb suffices for him for whom the world did not suffice,"

was the epitaph of Alexander the Great.

Count Tessin, a governor under Gustavus III. of Sweden, ordered the words

Tandem felix —
"Happy at last."

to be inscribed on his tomb. The following is Sir Isaac Newton's epitaph:

Isaacum Newton,
Quem immortalem
Testantur Tempus, Natura, Cœlum,
Mortalem hoc Marmor
Fatetur.
"This marble acknowledges Isaac Newton mortal, to whose immortality time, nature, and heaven bear witness."

St. Anne's Church, at Cracow, has the following suggestive epitaph, dedicated by Count Sierakowski to Copernicus:

Sta, sol, ne moveare.
"Stand, O sun! move not."

Many so-called epitaphs are merely epigrams, never intended for serious use as monumental inscriptions. Among such may be cited that of Piron, on Marshal de Belle-Isle, who was buried next to Turenne:

Ci-git le glorieux à côté de la gloire,
"Here beside glory lies the vainglorious."

For Greek inscriptions consult the 'Corpus Inscriptionum Atticarum' (Berlin 1878–82); for the Latin, the great 'Corpus Inscriptionum Latinarum' (Berlin 1863, et seq.); for those of modern times, Andrews, 'Curious Epitaphs' (London 1883).

Epithalamium, ĕp"ĭ-thā-lā'mĭ-ŭm, (Lat., from the Gr. ἐπιθαλάμιος, *epithalamios*, nuptial, from ἐπί, *epi*, upon, and θάλαμος, *thalamos*, a chamber), a nuptial song. Among the Greeks and Romans it was sung by young men and maids at the door of the bridal chamber of a new-married couple. It consisted of praises of the bridegroom and bride, with wishes for their happiness. Examples may be seen in Theocritus' epithalamium of Helen, and the three epithalamia of Catullus, in which the Greek form is much modified. Some Roman epithalamia were collected by Wernsdorf in Vol. IV. of his 'Poetæ Latinæ Minores' (Helmstedt 1789).

Epithelium, ĕp-ĭ-thē'lĭ-ŭm, one of the simplest forms of epithelial tissue, characterized by its non-vascularity, and consisting of flattened or columnar cells united into continuous membranes by an intercellular cement substance. Epithelium serves for the most part to protect exposed surfaces of the body, and performs the functions of absorption, secretion, and excretion. The epithelial tissues are developed from all three layers of the developing embryo. They themselves secrete their own cement substance. This takes on the form of thin plates between the cells, gluing them together. Occasionally the epithelial cells develop short lateral projections (prickles), forming with similar structures of neighboring cells intercellular bridges, between which are intercellular spaces filled with lymph for the nourishment of the cells. Inasmuch as practically all epithelial cells have one exposed surface and one surface lying in contact with tissues beneath, the upper and lower surfaces show certain variations of structure. Occasionally the free surface develops fine hairs or cilia. These are found in various localities. The outer surface of the cell, being exposed, develops more truly animal functions, the inner more vegetative. Blood vessels and lymph vessels do not penetrate, as a rule, into epithelial tisues, but they are richly supplied with nerve-end organs.

According to their shape and relation, the epithelial cells are divided into these varieties: (1) Simple epithelial cells, with or without cilia, comprising (a) squamous epithelium; (b) cubical epithelium; (c) columnar epithelium; (d) pseudostratified columnar epithelium. (2) Stratified epithelium, comprising (a) stratified columnar epithelium, with superficial flattened cells without cilia; (b) transitional epithelium; (c) stratified columnar epithelium. (3) Glandular epithelium. (4) Neuro-epithelium.

1. *Simple Epithelium.*—This is that type in which the cells lie in a single continuous layer. This form is found lining almost the entire alimentary tract, the smaller air-passages, the majority of the gland-ducts, the ovarian ducts, the uterus, the central canal, the spinal cord, and the ventricles of the brain. In (a) simple squamous epithelium the cells are flattened, forming a mosaic with the nuclei lying in the middle of the cell. It is found in the alveoli of the lungs. In (b) simple cubical epithelium the appearance is that of short polyagonal prisms. It occurs in the smaller bronchioles of the lung, in certain portions of the uriniferous tubules, the liver, pancreas, salivary and mucous glands. In (c) simple columnar epithelium the cells are pyramidal or prismatic. This type is found in the intestinal tract from the cardiac end of the stomach to the anus, and in certain portions of the kidney. Ciliated columnar is found in the ovarian duct and uterus, in the central canal of the spinal cord, and in some of the smaller bronchi.

2. *Stratified Epithelium.*—When the cells of simple epithelium increase to such an extent that layer upon layer is developed, the epithelium no longer remains simple, but becomes stratified. The lower layers are richly supplied with blood vessels, and multiply very rapidly, pushing out the upper layers that are constantly dying and being cast off. The various forms are: (a) Stratified columnar epithelium, with superficial flattened cells, forming the outer covering of the body, the epidermis and its continuations inside of the body, as, for instance, the walls of the œsophagus, the epithelium of the conjunctiva, the external auditory canal, the sheath of the hair-follicles, the walls of the rectum, the anus, and the vagina. The deeper cells are usually cubic-cylindrical, and are followed, as a rule, by one or more layers of sightly flattened cells, until finally the outmost layers become very much flattened and horny, or they may be developed into distinct horn-like substances such as that found in the nails. (b) Transitional epithelium, a type of stratified epithelium found in the kidney, uterus, urethra, and bladder. It is somewhat similar to the stratified columnar epithelium, but does not show the characteristic deep papillæ in the basal membrane, so characteristic of the former. (c)

Stratified columnar epithelium, consisting of a superficial layer of columnar cells and deeper layers of irregular, triangular, cubical or spindle-shaped cells. This type is found in the larger duct-glands, in the mucous membrane of the nose, portions of the male urethra, and in parts of the larynx. Many of this type of cells have cilia, particularly those found in the back of the nose, larynx, respiratory tract, larger bronchi, Eustachian tube, epididymis, and portions of the vas deferens.

3. *Glandular Epithelium.*—This is a type of epithelium occasionally found scattered among other epithelial cells, and which shows the characteristic of gland-structures. See GLANDS.

4. *Neuro-epithelium.*— Neuro-epithelial cells are highly specialized cells in which the nerve-end organs are to be found. See NERVE-END ORGANS.

Consult: Boehm and Davidorff, 'Text-book of Histology' (1900).

Epizo'a, in a general sense, external parasites, as contrasted with Entozoa, or internal parasites. These are not exact terms in scientific classification. Among them are the fleas, lice, ticks, itch-mites, and similar minute "vermin" infesting man or beast.

In a more restricted sense the term is applied to the degraded, distorted copepod crustaceans parasitic upon the skin, gills and other parts of marine animals, especially fishes. See FISH-LICE.

Epoch, or **Era** (Gr. ἐποχή, *epoche,* epoch, pause). In history, a fixed point of time, commonly selected on account of some remarkable event by which it has been distinguished, and which is made the beginning or determining point of a particular year from which all other years, whether preceding or ensuing, are computed. Some writers distinguish between the terms epoch and era. According to them, both mark important events, but an era is an epoch which is chronologically dated from; an epoch is not marked in this way. The birth of Christ was thus both an epoch and an era from this point of view.

The more important historical epochs are here enumerated. For further details on the mode of reckoning see CALENDAR.

The Creation.— The biblical record of the creation has formed the foundation of numerous chronologies. Of course the authorities (Jewish and Christian) on these various modes of reckoning do not agree as to the time signified by the common authority for the event dated from. The more important of these epochs, of which there are about 140 different varieties, are: (1) The epoch adopted by Bossuet, Ussher, and other Catholic and Protestant divines, which places the creation in 4004 B.C. (2) The Era of Constantinople (adopted by Russia), 5508 B.C. The civil year begins 1 September, the ecclesiastical year about the end of March. (3) The Era of Antioch, used till 284 A.D., placed the creation 5502 B.C. It was merged in the following year in (4) The Era of Alexandria, which made the creation 5492 B.C. This is also the Abyssinian Era. (5) Jewish Era. The common era of the Jews places the creation in 3760 B.C. Their year is lunar-solar, that is, lunar with intercalary months, forming a cycle of 19 years, of which 12 have 12 months and 7, 13 months. The year thus varies from 353 to 385 days. The civil year begins with the new moon following the autumn equinox. The eras dating from the creation are distinguished by the initials A. M. Const., Abyss., etc., are sometimes added to distinguish the particular epochs.

Julian Period.— This begins 4713 B.C. It is an arbitrary epoch, fixed for the purpose of computing all dates forward, as in the case of the creation epochs.

The Olympiads.—The Greeks computed their time by periods of four years, called Olympiads. Their year was lunar, with intercalary months. The first Olympiad, being the year in which Corœbus was victor in the Olympic games, was in the year 776 B.C. The period of the commencement of the year, which was variable, was about July. The contraction used for the Olympic epoch is Olymp.

The Roman Era (Ab Urbe Condita).— The Romans dated from the supposed era of the foundation of their city, 21 April, in the third year of the sixth Olympiad, or 753 B.C. (according to some authorities 752 B.C.). This epoch is designated by the initials A. U. C. The Roman mode of computation was the foundation of our modern chronology.

Era of the Seleucides.—Begins 1 Oct. 312 B.C., the epoch when Seleucus I. (Nicator) took possession of Babylon. The year consisted of 365 days, with a leap year every fourth year. This era is used in the book of Maccabees.

Spanish Era.— This dates from 1 Jan. 38 B.C. The months and days were the same as those of the Julian calendar. It was disused in Aragon in 1350; in Valencia, 1358; in Castile, 1383; in Portugal, about 1415.

Christian Era.—Our mode of computing from supposed data of the birth of Christ, was first introduced in the 6th century, and had not been generally adopted until the year 1000. Since the first year of the 1st century was 1 A.D., the last year of the same century was 100 A.D. Similarly the year 1900 A.D. was the last year of the 19th century. The same holds good in reckoning backward. For particulars of the mode of reckoning the years of the Christian era and the changes which it has undergone, see CALENDAR.

Armenian Era.—This began 7 July 552, and was superseded by the Julian era about 1330. The year consisted of only 365 days.

Mohammedan Era, or Hegira.—This begins on 16 July 622. The conversion of the Mohammedan into Christian chronology causes more difficulty and confusion than arises with any of the other modes of reckoning. The Mohammedan year is purely lunar. It consists of 12 months, and each month commences with the appearance of the new moon. Hence their years have no correspondence with the recurrence of the seasons, and to know the period when a Mohammedan year begins it must be reckoned from the beginning of the era. In chronology, history, etc., they use months of 29 and 30 days alternately, making the year consist of 354 days. Eleven times in 30 years 1 day is added to the last month, making 355 days in the year. The mean length of the year is thus $354\frac{11}{30}$ days, of the month $29\frac{191}{360}$, differing from the true lunation by little more than three seconds, or less than a day in 2,260 years. As 33 Mohammedan years amount to only 6 days (including intercalary days and leap years) more than 32 of our years, by deducting one year from each 33 Mohammedan years, and adding 621½ years, the year of the Christian era will approximately be found. The Hegira is distinguished by the initials A. H.

Persian Era.—The era of Yezdegird III. began 16 July 632. The year consisted of 365 days. It was reformed in 1075 by the addition of a day whenever it was necessary to make the commencement of the year occur on the day of the sun's passing the same degree of the ecliptic. The months have each 30 days, with 5 or 6 days intercalated. This era is still used by the Parsees in India.

Indian Chronology.— The best-known eras computed by solar time are the Kaliyuga, which dates from 3101 years before Christ and the Salivahana from 77 A.D. Both are computed astronomically, losing one day in 60 years by our computation. The era of Vikramaditya, beginning 57 years B.C., is computed by lunar months, with intercalations made according to astronomical observation, and bringing the year up to 365 or 366 days. The Bengali year was formerly identical with the Hegira, but is now reckoned by solar computation.

Chinese Chronology.—The Chinese, like all the nations of northeast Asia, reckon their time by cycles of 60 years. Instead of numbering them as we do, they give a different name to every year in the cycle. The Chinese months are lunar, of 29 and 30 days each. Their years have ordinarily 12 months, but a 13th is added whenever there are two new moons while the sun is in one sign of the zodiac. This will occur 7 times in 19 years. The boasted knowledge of the Chinese in astronomy has not been sufficient to enable them to compute their time correctly. The first cycle, according to Roman Catholic missionaries, began February 2397 B.C. To find out the Chinese time, multiply the elapsed cycle by 60, and add the odd years; then if the time be before Christ subtract the sum from 2,398; but if after Christ, subtract 2,397 from it; the remainder will be the year required.

Primitive American Chronology.— The natives of America, previous to its discovery by Europeans, particularly the Peruvians and Mexicans, appear to have had a considerable acquaintance with astronomy and to have reckoned their time with great care. The Mexican year consisted of 365 days, composed of 18 months of 20 days, and 5 added days. At the end of a cycle of 52 years 12 and 13 days were added alternately, making the mean year very near the truth.

In geology, Epoch has now a very different meaning from that which it formerly had. Instead of corresponding to a period in the history of the earth, it answers to a period in the history of a particular locality. Epochs are determined by the occurrence of particular kinds of animal and vegetable life in a group of strata which are marked off by unconformity above and below; the rocks were deposited and the organisms lived in that locality between the two great geological changes, one of which preceded the earliest deposit of the particular group of rocks, while the other closed the series. The conformably sequent strata of this series belong to one epoch; but the dissimilar animals and plants which lived elsewhere at the same time were either not preserved at all in deposits or were entombed in deposits of a different kind. In the latter case the assemblage would represent an epoch for that particular locality. Thus the Old Red Sandstone and the Devonian strata, the former lacustrine, the latter marine, were probably identical in epoch as they were contiguous in area. If we imagine the floors of the German Ocean and the Australian seas, just as they now are, to be covered by thick deposits of strata, these strata would, judged by their fossil contents, belong to different epochs; but we know that they only belong to different zoological provinces. Natural groups of strata represent, therefore, the epochs during which the animals and plants they contain lived and died in a particular area, and where a closely similar assemblage is found in strata at a distant locality we have therefore proof that during an epoch of unknown length similar organisms flourished there; but the epoch may have been before, identical with, or later than that first studied.

Used in this sense epoch is a term of only local application, and the proof that though the assemblage of rocks may be a natural one for one locality, it is not so for a great area, is found in the fact that the unconformities which indicate great geological change do not occur at identical points everywhere. Thus the Silurian and Old Red formations are conformable in England, unconformable in Scotland, and unconformities in both series are differently placed in America.

In astronomy, epoch is the longitude which a planet has at any given moment of time. To predict this for any future period the longitude at a certain instant in the past must be known; that instant is termed the epoch of the planet.

Epode (Lat. epodus, Gr. ἐπῳδός, *epōdos*). In Greek choral poetry the term is used of an ode succeeding a strophe and antistrophe, or a series of strophes and antistrophes. The name was also given by grammarians to any poem the metrical unit of which is a distich consisting of a long, followed by a short verse. In this sense it was especially used of the iambic trimeter followed by the iambic dimeter, as in Epodes 1–10 of Horace.

Eponym, ĕp'ō-nĭm, a mythical personage created to account for the name of a tribe or people; thus Tros is the eponymous hero of Troy, Italus was assumed as ancestor of the Italians, etc.

Ep'ping, England, market town, in Essex, 17 miles from London, and in the midst of the forest to which it gives name. This ancient royal forest once a part of Waltham forest, and all much larger than at present, has an area of 5,600 acres, and presents some fine woodland scenery. It was secured to the nation by legislative enactment, and was opened by Queen Victoria in 1882 as a public recreation ground. The town consists of a single broad street on a ridge of hills. Pop. (1901) 3,789.

Epping Forest. See EPPING.

Eprouvette, ĕ-proo-vĕt', the name of an instrument for ascertaining the strength of gunpowder, or of comparing the strength of different kinds of gunpowder. The simplest kind is the hand eprouvette, in the form of a very short pistol. The barrel or powder-chamber is closed by a plate communicating with a strong spring. On the explosion the plate is driven back to a greater or less distance according to the strength of the powder, and is retained at the extreme distance by a ratchet-wheel.

Ep'som, England, town in the county of Surrey, 15 miles southwest of London. Epsom was formerly celebrated for a mineral spring, from the water of which the well-known Epsom salts were manufactured. A number of the sons of medical men are educated at the Royal Medical College, and adjoining the school is a home for aged physicians or their widows. The principal attraction Epsom can now boast of is the grand race-meeting held on the Downs, which is attended by hundreds of thousands of persons. The races begin on Tuesday, and continue to the end of the week preceding Whitsuntide; the Derby stakes are run for on Wednesday, which is the principal day, and the Oaks on Friday. There is also racing on two days earlier in the season; the town being otherwise characterized as "a dull little place for 50 weeks in the year." Epsom gives name to one of the parliamentary divisions of the county. Pop. (1901) 10,915.

Ep'som Salt, a hydrous sulphate of magnesium, having the formula $MgSO_4 + 7H_2O$. It occurs abundantly in nature, and takes its name from its occurrence, in dissolved form, in a mineral spring at Epsom, England. It may be prepared also from dolomite, by decomposing the mineral by the addition of sulphuric acid. Epsom salt, proper, is known to the mineralogist as epsomite, and more popularly as hair-salt, from the delicate fibrous efflorescent deposits in which it often occurs on the walls of mines, quarries, and caves. Epsomite crystallizes in the orthorhombic system, and large quantities of it are found in the limestone caves of Kentucky, Tennessee, and Indiana, mingled with earthy matter. In the Mammoth Cave it occurs in loose masses suggestive of snowballs, adhering to the roof and walls. An allied mineral known as kieserite, which has the composition $MgSO_4 + H_2O$, and occurs abundantly at Stassfurt, is largely used as a source of epsom salt. Magnesium sulphate is used as a fertilizer, as a raw material for the manufacture of the sulphates of sodium and potassium, and in sizing and dyeing cotton goods. The epsom salt is also extensively used as a purgative, in medicine.

Epu'lis. See MOUTH.

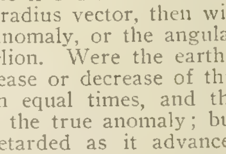
Epworth League, a society of young people of the Methodist Episcopal Church; formed 15 May 1889, in Cleveland, Ohio, by the union of five societies affiliated with the Methodist Church. It adopted as its motto: "Look up, Lift up," and its declared object is to "promote intelligent and loyal piety in the young members and friends of the Church; to aid them in the attainment of purity of heart and constant growth in grace, and to train them in works of mercy and help." The following pledge is required of its members: "I will earnestly seek for myself, and do what I can to help others to attain, the highest New Testament standard of experience and life. I will abstain from all forms of worldly amusement forbidden by the discipline of the Methodist Episcopal Church, and I will attend, as far as possible, the religious meetings of the chapter and the Church, and take some active part in them." The league is governed by a board of control, partly appointed by the bishops and partly elected by the General Conference districts, one member for each district; represented by an executive cabinet, consisting of a president, four vice-presidents, general secretary, general treasurer, and a German assistant treasurer. The league has grown rapidly, extending to foreign lands, and there are chapters in India, Mexico, South America, Italy, Norway, Sweden, Denmark, Finland, China, Japan, and Hawaii. On 1 Oct. 1902, there were in the league 29,600 chapters and 2,000,000 members. Its official organ is the 'Epworth Herald,' published in Chicago.

Equal Rights Party, in 1835. See LOCOFOCOS.

Equal Rights Party, in 1884. Belva Lockwood nominated herself for the presidency, on a platform of woman suffrage; and gave her voters this title.

Equality, a sociological work by Edward Bellamy (1897). Consult 'Equality'; 'Looking Backward.'

Equation, a term based on the idea of equality, in general use throughout the various branches of calculus. (1) In mathematics it is the statement in algebraic expressions of the equality of two or other mathematical expressions. The assertion of equality is made by writing the sign = (read "is equal to" or "equals") between the expressions. Thus: $5x + 7 = 32$, and $ax^2 + bx + c = O$, are equations, each of which indicates the equality of the quantity written on the left of the sign (=) to that written on the right of the sign. Usually the object of writing down an algebraic equation is to express in symbols known relations between given and unknown quantities, so that by algebraic processes the latter may be determined in terms of the former. (See ALGEBRA.) (2) In astronomy is the correction by addition to or subtraction from the mean motion of any heavenly body, in order to determine its true place at any given time. The mutual attraction among the planets renders each one capable of producing a perturbation in the orbits of all the others. An equation is required for every such perturbation before it is possible to calculate accurately the course of the planet. Thus we have the equation of the centre, a quantity to be added to or subtracted from the anomaly, in order to determine the true position of a heavenly body. For instance, let the curve E C F represent the earth's orbit (which is an ellipse), E F the line of the apsides, and A the position of the sun. When the earth is in any position as C, the line A C drawn from the sun to the planet is the radius vector, then will the angle C A F be the anomaly, or the angular distance from the perihelion. Were the earth's motion uniform the increase or decrease of this angle would be equal in equal times, and the mean anomaly would be the true anomaly; but the earth's motion is retarded as it advances from F to C, is slowest at E, and is accelerated from that point, the aphelion, through the other half of its orbit till it arrives at F, the perihelion. The quantity to be added to the mean angular motion, during one portion of the orbit, or subtracted from it in the other, in order to find the true anomaly, is called the equation of the centre. (3) In chemistry, is a collection of symbols to denote that two or more definite bodies — simple or compound — have been brought within



the sphere of chemical action, that a reaction has taken place, and that new bodies are produced. It is called an equation because the total weight of the substances concerned remains the same. See CHEMISTRY.

Equation, Personal, an important correction that must be considered in connection with refined measurements in astronomy and physics, and which originates in the fact that no two observers agree precisely as to the instant at which a phenomenon occurs, nor as to the setting of a micrometer-wire so as to bisect a division mark on a scale. Differences of this sort are exceedingly irregular among inexperienced observers, but among the more experienced ones the regularity, while not absolute, is strongly marked. In some kinds of work the personal equation of the observer can be eliminated by the method in which the observations are made. Thus, in the determination of differences of longitude by telegraphic methods, it is usual to eliminate the effect of personal error from the final result by having the observers change places when the work is half done; so that if the difference of longitude as determined by the first half of the work was too large, that determined during the second half will be too small by an equal amount, and the effect of personal equation will disappear from the final mean. In other cases it is impossible to eliminate the effects of personal error in any such way, and in these cases the attempt is often made to determine the magnitude of the personal equation, and apply the proper correction to the results as directly observed. Thus Otto Struve, in connection with his measurements on double stars, had artificial double stars constructed, upon which he made regular observations for the purpose of studying his personal equation in such work, and he applied, to his results for the genuine stars, a series of corrections deduced in this way. When the thing to be measured is an interval of some kind, the personal equation can usually be neglected, provided the same observer makes all the measures. For example, in determining the length of a bar, the reading of the micrometers will be in error (so far as the personal equation is concerned) by the same amount at both ends of the bar, and hence the difference of these readings; or, in other words, the observed length of the bar will be independent of the observer's personal equation.

Equations, Differential. — 1. *Introduction.*— The invention of the calculus, made necessary by the demands of natural science, was followed immediately by the most brilliant applications. The names of Newton, Leibnitz, Euler, Lagrange, and Laplace are attached to the principal discoveries of this period, whose importance from a scientific and philosophical point of view can hardly be overestimated. A simple example will suffice to explain the ruling idea of this epoch. From the observations of Tycho Brahe, Kepler had obtained the laws of planetary motion still known by his name. Newton had shown that Kepler's laws were but a consequence of the law of universal gravitation, which assumes that every particle in the universe acts upon every other according to a definite law. The effect of Newton's law upon a system of moving bodies can be formulated in mathematical symbols without any difficulty. This formulation gives rise to a system of equations involving the coordinates of the moving bodies and their accelerations, *i.e.*, the second derivatives of these coordinates with respect to the time. The problem of expressing the coordinates as functions of the time, *i.e.*, the problem of integrating this system of differential equations, was solved by Newton for the case of two mutually attracting bodies, and its solution is given precisely by Kepler's laws. Newton himself and his successors, especially Laplace and Lagrange, studied the further consequences of the law of gravitation as applied to the solar system. The accord between theory and observation became closer and closer, so that it was reasonable to suppose that the true law of nature had been found. Gradually other branches of physical science were treated in a similar way. In all cases, the fundamental laws being assumed, the mathematical formulation of the problems led to the question of integrating differential equations. It should be noted that, although in some cases this method of arriving at the formulation of the physical problems has now been abandoned, differential equations are now, more than ever, used as the expressions for the fundamental phenomena in physical science. For the applications of mathematics there is no field so important as the theory of differential equations. That the whole world is a mathematical problem was the point of view gained by Laplace, an insight gained in a different way also by Leibnitz and Spinoza. But the mathematician is more specific; we learn from him that this world-problem belongs to the domain of the theory of differential equations. Even if the details of the picture have changed, the formulation of this general idea is one of the positive achievements of the philosophical thought of the eighteenth century.

Ordinary Differential Equations. Elementary Theory.—Let y be determined as a function of x by means of an equation,

$$\phi(x, y, a) = 0, \tag{1}$$

which involves an arbitrary constant a. If x and y be interpreted as the coordinates of a point in the plane, equation (1) represents a family of curves, one curve for each value of a. By differentiation we find, from (1),

$$\frac{\partial\phi}{\partial x} + \frac{\partial\phi}{\partial y}\frac{dy}{dx} = 0. \tag{2}$$

Between these two equations a may be eliminated; the result will be an equation of the form

$$f\left(x, y, \frac{dy}{dx}\right) = 0, \tag{3}$$

free from a. Equation (3) is a *differential equation.* Since it does not contain the constant a it gives the expression of a property which is common to all of the curves of the family (1). The main object of the theory of differential equations is to invert the process which we have just carried out, *i.e.*, the equation (3) being given, the equation (1) involving an arbitrary constant, from which (3) may be derived by differentiation, is to be found. This process is known as the *integration of the differential equation.*

In general let there be given an equation of the form

$$f\left(x, y, \frac{dy}{dx}, \frac{d^2y}{dx^2}, \ldots \frac{d^ny}{dx^n}\right) = 0,$$

between x, the function y of x and its derivatives up to the nth order; it is called an *ordinary differential equation of the nth order*. The adjective *ordinary* implies that y is considered as a function of only *one* independent variable x. Under certain restrictions as to the continuity of the function f (a question to which we shall recur later), it may be shown that there exists a function y of x and of n arbitrary constants which satisfies the differential equation; it is known as the *general integral of the differential equation;* the determination of this function is the object of the theory of differential equations. The equation is then said to have been integrated.

The simplest case of such a differential equation presented itself in the problem of finding the area included between a curve $y = f(x)$, the x-axis, and two ordinates erected for $x = a$ and $x = x$. The differential equation satisfied by the area z considered as function of x is

$$\frac{dz}{dx} = f(x),$$

and the area itself becomes

$$z = \int_a^x f(x)dx.$$

This simple case served as a model for the earlier investigators in this field. Confining ourselves for the moment to equations of the first order, it may be possible to reduce such an equation to the form

$$\frac{dx}{R(x)} + \frac{dy}{S(y)} = 0,$$

where $R(x)$ is a function of x, and $S(y)$ a function of y alone. The variables are then said to be *separated*, and we may write

$$\int \frac{dx}{R(x)} + \int \frac{dy}{R(y)} = c,$$

where c is an arbitrary constant. Owing to the fact, which has just been mentioned, that the problem of areas is solved by the computation of an integral of the form $\int_a^x f(x)dx$, such an integration is known as a *quadrature*. If the variables can be separated, the differential equation may, therefore, be integrated by quadratures.

The earlier analysts believed that any differential equation could be integrated by the elementary functions then in use, and by quadratures. This we now know not to be the case, just as we know, since the days of Abel, that all algebraic equations cannot be solved by the mere extraction of roots. (See ALGEBRA; THEORY OF EQUATIONS; GALOIS' THEORY.) Moreover, even if the reduction to quadratures can be effected, such a reduction is, properly speaking, the beginning and not the end of the investigation. For it does not suffice to give a formal indication of the relation between x and y; this relation must be thoroughly understood in its essential properties before the integration can be said to have been accomplished. Nevertheless the consideration of the simpler cases, in which integration by means of elementary functions or by quadratures is possible, constitutes a first important chapter of the theory of differential equations. We may characterize this chapter as the *elementary* theory of differential equations.

Elementary Theory of Differential Equations.—We have already referred to the case in which the variables are separated. In many cases a simple transformation will accomplish the separation. Consider, for example, the equation

$$(4) \qquad \frac{dy}{dx} + Py = 0,$$

where P is a function of x only. We may write

$$\frac{dy}{y} + Pdx = 0,$$

whence

$$\log y + \int Pdx = \log c,$$

or

$$(5) \qquad y = ce^{-\int Pdx}.$$

This example will be useful in enabling us to treat, at once, a more general equation; we shall do so, moreover, by making use of a method frequently employed, and especially important in the applications to theoretical astronomy, the method of *variation of constants*. We consider the equation

$$(6) \qquad \frac{dy}{dx} + Py = Q,$$

where P and Q are functions of x only. This equation is the most general linear differential equation of the first order, a linear equation being one which contains y and its derivatives in no higher than the first power. Equation (6) differs from (4) only in having Q in the right member in place of zero. The expression (5) will certainly not satisfy (6) since it satisfies (4). Clearly, however, it must be possible to satisfy (6) by an expression of the form analogous to (5), viz.,

$$(7) \qquad y = ue^{-\int Pdx},$$

where u is a properly chosen function of x instead of being a constant. Moreover, as we shall see, we can actually determine the function u by quadratures. In fact, we find from (7)

$$\frac{dy}{dx} = \left(\frac{du}{dx} - Pu\right)e^{-\int Pdx},$$

which gives, on substitution into (6)

$$\frac{du}{dx} = Qe^{\int Pdx},$$

so that we shall have

$$(8) \qquad y = e^{-\int Pdx}\left[C + \int Qe^{\int Pdx}dx\right],$$

as the general integral of (6). This formula was found by Jacob Bernoulli, who also showed that the equation

$$(9) \qquad \frac{dy}{dx} + Py = Qy^{-m+1}$$

could be reduced to (6) by putting $u = y^m$.

The *homogeneous* equations of the form

$$(10)\qquad \frac{dy}{dx}=\phi\left(\frac{y}{x}\right),$$

where $\phi\left(\frac{y}{x}\right)$ depends only upon the ratio of y to x, may also be solved by quadratures. In fact, if we put $y=vx$, the equation becomes

$$\frac{dx}{x}+\frac{dv}{v-\phi(v)}=0,$$

whence

$$(11)\qquad \log x+\int\frac{dv}{v-\phi(v)}=c.$$

Euler's method of the *integrating factor* is sometimes useful. It rests upon the following considerations. Let $\phi(x, y)=\text{const.}$ be the equation of any integral curve of the equation

$$(12)\qquad P(x, y)dx+Q(x, y)dy=0.$$

We shall have, by differentiation from $\phi(x, y)=\text{const.}$,

$$\frac{\partial\phi}{\partial x}dx+\frac{\partial\phi}{\partial y}dy=0,$$

an equation which must have the same significance as (12). We must, therefore, have

$$(13)\qquad \mu P(x, y)=\frac{\partial\phi}{\partial x},\quad \mu Q(x, y)=\frac{\partial\phi}{\partial y},$$

if μ is a properly chosen function of x and y. If μ is known, the determination of ϕ by quadratures can be immediately accomplished on account of the two equations (13). For this reason μ is called an integrating factor. Equations (13) show that μ must satisfy the partial differential equation

$$(14)\qquad \frac{\partial(\mu P)}{\partial y}-\frac{\partial(\mu Q)}{\partial x}=0.$$

In general, the determination of an integrating factor is just as difficult as the integration of the equation. But Euler succeeded in finding a number of equations with known integrating factors. Herein lies the value of the method.

By means of these various methods there was obtained in the course of time a considerable number of equations which could be integrated by quadratures. Lie showed that this rather scrappy theory could be understood as the consequence of a single principle. This we shall now proceed to explain, making use of geometric images for the sake of clearness as well as brevity.

The equations

$$x_1=\phi(x, y),\quad y_1=\psi(x, y),$$

are said to constitute a *transformation* of the point (x, y) into the point (x_1, y_1) if they can be solved for x_1 and y_1.

These equations may contain a certain number of arbitrary constants $a_1, \ldots a_r$; they are then said to constitute an r-parameter family of transformations. Let us consider the simplest case of a one-parameter family which we may write

$$(15)\qquad x_1=\phi(x, y;\ a),\quad y_1=\psi(x, y;\ a).$$

If the parameter a has a definite value, this transformation converts every point (x, y) into a definite other point (x_1, y_1). Let us transform this new point (x_1, y_1) by equations of the *same* form, but with a different parameter b, into a third point (x_2, y_2), so that we shall have

$$(16)\qquad x_2=\phi(x_1, y_1;\ b),\quad y_2=\psi(x_1, y_1;\ b).$$

In general, if we eliminate x_1, y_1 between (15) and (16) we shall find x_2 and y_2 as functions of x, y, a, and b. It *may* happen that these functions assume the form

$$(17)\qquad x_2=\phi(x, y;\ c),\quad y_2=\psi(x, y;\ c)$$

where c is a function of a and b, and where the functions ϕ and ψ are the *same* as in (15) and (16). If this is the case, the transformations (15) are said to form a one-parameter *group*. The one-parameter family of transformations (15) then has the property that the transformation, obtained by combining any two of its transformations, is itself a member of the family. It is for this reason that the family is then called a *group*. (See GROUPS, THEORY OF.) It is obvious how this definition may be extended to cover r-parameter groups.

The one-parameter group (15) will contain, in general, the identical transformation; *i.e.*, for a certain value a_0 of a (15) will reduce to $x_1=x$, $y_1=y$. If now we denote by ∂t an infinitesimal, and put in (15) $a=a_0+c\partial t$, we shall find a transformation which transforms (x, y) into a point (x_1, y_1) such that the differences $x_1-x=\partial x$ and $y_1-y=\partial y$ will be infinitesimals of the order of ∂t. This will be true unless certain exceptional cases arise which we need not, at present, discuss. From every one-parameter group we may deduce in this way an *infinitesimal transformation*, and Lie has shown that conversely every infinitesimal transformation determines a one-parameter group. There is a similar connection between an r-parameter group and a corresponding set of r infinitesimal transformations, between which certain relations must then be satisfied.

A one-parameter group always has an *invariant*; *i.e.*, there exists a function $\Omega(x, y)$ such that, for all transformations (15) of the group, $\Omega(x_1, y_1)=\Omega(x, y)$. Such a function is said to *admit* the one-parameter group of transformations. It admits, in particular, the infinitesimal transformation of the group. Similarly, a differential equation may admit one or more infinitesimal transformations. Lie has shown that in the cases in which the variables may be separated, *i.e.*, in which integration by quadratures is possible, it is possible to write down infinitesimal transformations which leave the equations invariant. He has developed a general theory showing what advantage is gained for the integration of a differential equation by the knowledge that it admits one or more infinitesimal transformations. Let us remark, explicitly, that this theory is not confined to equations of the first order nor even to ordinary differential equations.

Before passing to the consideration of the elementary theory of equations of higher order, we proceed to explain the important notion of *singular solution*. Geometrically, an equation of the first order $\frac{dy}{dx}=\phi(x, y)$ determines the tangent of an integral curve at every point of the plane. If we start from any point P, the tangent of the integral curve passing through that point is completely determined. We follow the direction thus indicated for an infinitesimal distance to the point $(x+\partial x, y+\partial y)$. At this point the tangent is again given by the differential equation, etc. We obtain in this way, synthetically, the family of integral curves, say $F(x, y, c)=0$. Any one of these curves is obtained by giving a definite value to the constant of integration c. The envelope of this system of curves, however, will also be a solution of the differential equation. For it will also be a curve whose tangent satisfies the requirements of the equation. But, in general, the envelope will not be itself a member of the family of curves, *i.e.*, it will not be possible to find its equation by giving a special value to c. The envelope is then said to give a singular solution of the equation. If it exists, it may be found without any integration, that is to say, without a knowledge of the general integral of the differential equation.

The most important case of a differential equation of a higher order, which may be treated by elementary methods, is that of the linear homogeneous differential equation of the nth order with constant coefficients. A linear homogeneous differential equation of the nth order has the form

$$(18)\qquad \frac{d^n y}{dx^n}+p_1\frac{d^{n-1}y}{dx^{n-1}}+\ .\ .\ .\ +p_n y=0.$$

If $y_1, y_2, \ldots, y_n$ are particular solutions of the equation, $y=c_1y_1+c_2y_2+\ .\ .\ .\ +c_ny_n$, where $c_1, \ldots c_n$ are constants, is also a solution. Moreover, if $y_1, \ldots y_n$ are linearly independent, *i.e.*, if they satisfy no relation of the form $\gamma_1y_1+\gamma_2y_2+\ .\ .\ .+\gamma_ny_n=0$, where $\gamma_1, \ldots \gamma_n$ are constants, the above expression for y is the general solution. $y_1, \ldots y_n$ are then said to constitute a *fundamental system* of solutions. In the case that $p_1, \ldots p_n$ are constants a fundamental system may be easily obtained. In fact we find that $y=e^{\rho x}$ is a solution of (18) if ρ is a root of the equation

$$\rho^n+p_1\rho^{n-1}+\ .\ .\ .\ +p_{n-1}\rho+p_n=0.$$

Moreover, if $\rho_1, \ldots \rho_n$ are the roots, supposed distinct, of this equation, $e^{\rho_1x}, e^{\rho_2x}, \ldots e^{\rho_nx}$ actually form a fundamental system. If λ roots, say $\rho_1, \rho_2, \ldots \rho_\lambda$, coincide, the λ identical functions $e^{\rho_1x}, \ldots e^{\rho_\lambda x}$ are replaced by $e^{\rho_1x}, xe^{\rho_1x}, x^2e^{\rho_1x}, \ldots x^{\lambda-1}e^{\rho_1x}$.

Total Differential Equations.—In the case of an equation between two variables which we have considered so far, one important distinction, which we shall now have to make, has not been necessary. If $P(x, y)dx+Q(x, y)dy=0$ is such an equation, it is always possible to find a single function $\phi(x, y)$ such that $\phi(x, y)=$const. shall represent the general integral. Either the expression $Pdx+Qdy$ is the complete differential of $\phi(x, y)$ so that $P=\frac{\partial\phi}{\partial x}$ and $Q=\frac{\partial\phi}{\partial y}$, or else upon multiplication with Euler's integrating factor $\mu(Pdx+Qdy)$ becomes such a complete differential. This is not the case when there are more than two variables. Consider such an equation in three variables,

$$(19)\qquad Pdx+Qdy+Rdz=0,$$

where P, Q, R are functions of x, y, and z. For the sake of symmetry assume that x, y, z are regarded as functions of a fourth variable t. The problem before us is to find all sets of functions x, y, z of t which will satisfy (19). It *may* happen that the left member of (19) becomes a complete differential upon multiplication with a function μ of x, y, z, so that

$$\mu P=\frac{\partial\phi}{\partial x},\quad \mu Q=\frac{\partial\phi}{\partial y},\quad \mu R=\frac{\partial\phi}{\partial z}.$$

The elimination of μ from these three equations shows that this can be the case only if P, Q, R satisfy the so-called integrability condition:

$$(20)\quad P\left(\frac{\partial Q}{\partial z}-\frac{\partial R}{\partial y}\right)+Q\left(\frac{\partial R}{\partial x}-\frac{\partial P}{\partial z}\right)+R\left(\frac{\partial P}{\partial y}-\frac{\partial Q}{\partial x}\right)=0.$$

Moreover it may be shown that if P, Q, R satisfy this condition, there exists a function $\phi(x, y, z)$ and an integrating factor $\mu(x, y, z)$ such that

$$\mu(Pdx+Qdy+Rdz)=d\phi,$$

so that integration of (19) will give the result $\phi(x, y, z)=$const. But if (20) is not satisfied, no integration of (19) in this sense is possible. The reason for this distinction as well as the discussion of the non-integrable case will be clearly understood if we make use of a geometric interpretation. Let x, y, z be Cartesian coördinates of a point in space. If x, y, z are known as functions of t, there will be determined a certain space-curve. It is our problem to determine such space-curves

$$x=f(t),\quad y=g(t),\quad z=h(t)$$

as satisfy (19). Through every point (x_0, y_0, z_0) of space there may be drawn an infinity of such curves. The tangents of all of these curves which pass through the point (x_0, y_0, z_0) form a plane pencil with (x_0, y_0, z_0) as vertex and the plane

$$P(x_0, y_0, z_0)(x-x_0)+Q(x_0, y_0, z_0)(y-y_0)\\ +R(x_0, y_0, z_0)(z-z_0)=0$$

as plane. Thus there is for every point P a plane p containing P, to which all of the integral curves of (19) which pass through P must be tangent. We may now imagine an integral curve of (19) constructed as follows: Start from a given point P and construct the corresponding plane p. We go from P to a point Q infinitesimally close to P but otherwise arbitrarily situated in the plane p. At Q we construct the plane q corresponding to it, and in this plane we pick out a point R infinitesimally close to Q. Proceeding in this way we gradually build up an integral curve. It *may* happen that *all* of the integral curves of (19) which pass through the point P are situated upon a certain surface S. If this is the case for all points P, the integrability condition is satisfied; there exists a single infinity of surfaces $\phi(x, y, z)=c$, such that an arbitrary curve upon each of these surfaces satisfies the differential equation. In general, however, such a family of surfaces does not exist. We may then integrate (19) as follows: Take an *arbitrary* surface $\psi(x, y, z)=0$. Let P be any point upon it. Let p be the plane of the pencil of directions which the differential equation assigns to P, and let p' be the plane tangent to the surface $\psi(x, y, z)=0$ at P. The intersection t of p and p' will be at the same time tangent to an integral curve of (19) and tangent to the surface $\psi=0$. From P we go along t to a point Q infinitesimally close to P and there repeat this process. We may build up in this way all of the integral curves of (19) which are situated upon an arbitrary surface. Upon every arbitrary surface there will be a single infinity of such curves. Analytically this process may be carried out as follows: From $\psi=0$ we find

$$\frac{\partial\psi}{\partial x}dx+\frac{\partial\psi}{\partial y}dy+\frac{\partial\psi}{dz}dz=0.$$

From this equation and $\psi=0$, dz and z may be expressed in terms of x, y, dx, and y. Substitution of these values into (19) gives rise to an equation of the form

$$M(x, y)dx+N(x, y)dy=0,$$

which may be integrated in the form $\phi(x, y)=c$. This latter equation together with $\psi(x, y, z)=0$ gives the required solution. By giving all possible forms to the functions ψ all possible solutions will be obtained.

Similar considerations are necessary in the general case of n variables. The first considerable contribution to this theory is due to Pfaff. For this reason such an equation is known as a *Pfaffian equation*, and the problem of its integration as *Pfaff's problem*. The problem leads to a system of no more than n integral equations when the number of variables is $2n$ or $2n-1$. If the equations are of higher than the first degree in the differentials, Lie speaks of them as *Monge equations*. Many problems of differential geometry, especially in relation to the theory of complexes, are connected with Pfaffian and Monge equations.

Partial Differential Equations.—Frequently functions of several variables are defined by relations between those functions and their partial derivatives. Such equations are called partial differential equations. For the sake of simplicity we will confine ourselves to the case of a single unknown function, and for the most part to the case of two independent variables. As in the case of ordinary differential equations, it will be instructive to see first how such equations may arise as the result of elimination of arbitrary elements from equations which do not involve the derivatives. Let z be given as a function of x, y and of the two arbitrary constants a, b by the equation

$$f(x, y, z;\ a, b)=0. \tag{21}$$

Let p, q represent $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$ respectively. Then differentiation will give

$$\frac{\partial f}{\partial z}p+\frac{\partial f}{\partial x}=0,\quad \frac{\partial f}{\partial z}q+\frac{\partial f}{\partial y}=0. \tag{22}$$

Between the three equations (21) and (22) a and b may be eliminated. Let

$$F(p, q;\ x, y, z)=0 \tag{23}$$

be the result of this elimination. It is the partial differential equation which corresponds to (21); (21) is called the *complete* integral of (23).

But a and b in (21) may be functions of x, y and still the result of the elimination may be the same equation (23). In fact we find from (21), assuming that a and b are functions of x and y,

$$\frac{\partial f}{\partial z}p+\frac{\partial f}{\partial x}+\frac{\partial f}{\partial a}\frac{\partial a}{\partial x}+\frac{\partial f}{\partial b}\frac{\partial b}{\partial x}=0,$$

$$\frac{\partial f}{\partial z}q+\frac{\partial f}{\partial y}+\frac{\partial f}{\partial a}\frac{\partial a}{\partial y}+\frac{\partial f}{\partial b}\frac{\partial b}{\partial y}=0,$$

which equations will reduce to (22), and therefore give rise to the same equation (23), if

$$\frac{\partial f}{\partial a}\frac{\partial a}{\partial x}+\frac{\partial f}{\partial b}\frac{\partial b}{\partial x}=0,\quad \frac{\partial f}{\partial a}\frac{\partial a}{\partial y}+\frac{\partial f}{\partial b}\frac{\partial b}{\partial y}=0. \tag{24}$$

Let the determinant of these equations be denoted by Δ, so that

$$\frac{\partial a}{\partial x}\frac{\partial b}{\partial y}-\frac{\partial a}{\partial y}\frac{\partial b}{\partial x}=\Delta;$$

then we may write, in place of (24), the equivalent equations

$$\Delta\frac{\partial f}{\partial a}=0,\quad \Delta\frac{\partial f}{\partial b}=0. \tag{24a}$$

If $\Delta\neq 0$, we must therefore have

$$\frac{\partial f}{\partial a}=0,\quad \frac{\partial f}{\partial b}=0.$$

From these equations a and b may be obtained as functions of x and y; if these values are substituted in (21), a function z of x and y is obtained, independent of any arbitrary constants, but still a solution of the partial differential equation (23). This solution is called a *singular* integral of (23). It may or may not be a special case of the complete integral.

Equations (24a) are also satisfied if $\Delta=0$, *i.e.*, if

$$b=\phi(a), \tag{25}$$

where $\phi(a)$ denotes an arbitrary function of a. If we multiply the left members of (24) by dx and dy respectively, and add, we find

$$\frac{\partial f}{\partial a}da+\frac{\partial f}{\partial b}db=0,$$

whence, since $db=\phi'(a)da$,

$$\frac{\partial f}{\partial a}+\frac{\partial f}{\partial b}\phi'(a)=0. \tag{26}$$

If we eliminate a and b from the equations (21), (25), and (26), we find z as a function of x and y, the expression of which depends upon the arbitrary function ϕ. Moreover this function z will again be a solution of (23). It is known as the *general integral*, and involves an arbitrary function. It may be shown that every integral of such a partial differential equation belongs to one of these three classes.

Geometrical interpretation will again render the matter perfectly clear. Let x, y, z be coordinates of a point in space; (21) will represent a two-parameter family of surfaces, or, as we may say, a family of ∞^2 surfaces. The equation of the plane tangent to one of these surfaces at a point (x, y, z) will be

$$\zeta-z=p(\xi-x)+q(\eta-y).$$

For a fixed value of x, y, z, (23) gives therefore an infinity of planes through that point (enveloping a cone); any integral surface of (21), which passes through that point, must have one of these planes as its tangent plane. In other words, the differential equation determines a certain cone corresponding to every point of space, and with this point as vertex;

an integral surface must be tangent at each of its points to the corresponding cone. Now let a complete solution of the equation be given, so that we know a family of ∞^2 surfaces each of which fulfills the requirements of the problem. If we put $b=\phi(a)$, where $\phi(a)$ is any function of a, we obtain a one-parameter family of surfaces included among the ∞^2 surfaces just mentioned. The envelope of this one-parameter family is given by the general integral. The singular integral is the envelope of all of the ∞^2 surfaces of the complete integrals, provided that such an envelope exists.

Since the surface represented by the general integral is the envelope of a single infinity of surfaces represented by the complete integral, each of these latter surfaces will touch the former along a certain curve; such a curve is known as a *characteristic*. If the partial differential equation is not linear in $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$, there are ∞^3 characteristics. A linear equation has only ∞^2 characteristics. The integral surfaces may be looked upon as generated by characteristics, and the usual method of integrating the partial differential equation consists in setting up a system of ordinary differential equations which determines the characteristics.

The Points of View in the Higher Theory.—In speaking of ordinary differential equations, we have already mentioned the fact that the point of view of the elementary theory is inadequate even in those cases in which the reduction to quadratures is possible. Given, for example, the equation

$$\left(\frac{dy}{dx}\right)^2=(1-y^2)(1-k^2y^2),$$

which may be reduced to a quadrature,

$$x=\int\frac{dy}{\sqrt{(1-y^2)(1-k^2y^2)}}.$$

The reduction of the equation to this form is a mere formal process which, in itself, teaches us nothing. We shall have to ask ourselves the following questions: to what extent does a given differential equation define a function y of x? what are the characteristic properties of this function? what analytical processes involving known functions, infinite series, products, etc., will serve for the computation of the values of the function for all of the values of its argument? In the case of the above differential equations these questions have been completely answered by the creation of the theory of elliptic functions by Abel and Jacobi. In general it is to be expected that every differential equation defines a transcendental function; it is the theory of these transcendentals which constitutes properly the most important portion of the theory of differential equations.

In order fully to understand the properties of functions it has been found necessary to look upon the variable as being capable of assuming not only all real but also all complex values. In the hands of Cauchy, Riemann, Weierstrass there has grown up in this way the *theory of functions of a complex variable* (q.v.). This theory serves as a base for our further discussions. We shall, however, confine ourselves to a few of the simplest cases, merely indicating the general point of view.

Let

$$\frac{dy}{dx}=f(x, y)$$

be the given differential equation. Let $f(x, y)$ be analytic in the vicinity of (x_0, y_0), *i.e.*, let it be possible to develop $f(x, y)$ into a series proceeding according to positive integral powers of $x-x_0$ and $y-y_0$. Then, as was first proved by Cauchy, there exists a function y of x which may be developed according to positive integral powers of $x-x_0$, which reduces to $y=y_0$ for $x=x_0$, and which satisfies the differential equation. This theorem, which may be easily generalized to apply to equations of higher order, or to systems of equations of the first order, is generally known as the fundamental theorem of the theory of differential equations. It proves the existence of analytic functions which are uniquely defined as solutions of analytic differential equations and which satisfy the subsidiary condition of reducing to given values for a given value of the argument. The theorem may be proved by the so-called «Calcul des limites.» This consists in finding a series which formally satisfies the differential equation and reduces to y_0 for $x=x_0$; its convergence is then demonstrated by comparing it term for term with a corresponding series, which is formed in the same way from another differential equation, and which is known to be convergent. The exact circle of convergence cannot, however be generally stated. A great many papers have been written on questions which easily suggest themselves in connection with this theorem. If the function $f(x, y)$ is not developable in the given form; if, for example, its development contains negative or fractional exponents, how far are its solutions determined and what is the form of their developments? Besides the analytic solutions whose existence Cauchy has demonstrated, are there other non-analytic solutions? The first investigations of these equations are due to Briot and Bouquet. They have since been completed by a great many authors.

Cauchy's existence theorem can be made more precise in the case of *linear* differential equations. Let

$$\frac{d^ny}{dx^n}+p_1\frac{d^{n-1}y}{dx^{n-1}}+\ldots+p_ny=0 \tag{27}$$

be a homogeneous, linear differential equation of the nth order. In the vicinity of $x=x_0$ let the coefficients p_κ be expressible as power-series, proceeding according to positive integral powers of $x-x_0$, and convergent for all values of x for which $|x-x_0|<r$, where r is a real positive quantity, *i.e.*, for all points of the plane of the complex variable which are within a circle of radius r and of center x_0. Then, there exists a function y of x, expressible as a power series convergent in the *same* domain, which satisfies the differential equation, and which, together with its first $n-1$ derivatives, assumes arbitrarily prescribed values for $x=x_0$.

The proof of this theorem, due to Fuchs, is also based on the «calcul des limites.» The important point is the fact that the true radius of convergence of the series is determined by inspection from the differential equation itself. The existence of a fundamental system of solutions expressible by power-series follows at once.

Let $y_1, \ldots y_n$ be the members of such a fundamental system. Let $a_1, \ldots a_m$ be the singular points (poles) of the coefficients $p_1, \ldots p_n$ which we shall assume to be rational functions of x. Let $y_1, \ldots y_n$ be continued analytically along a path passing, in the positive direction, around one of these singular points a, and let $\bar{y}_1, \ldots \bar{y}_n$ be the new branches of the functions $y_1, \ldots y_n$ which are thus defined by power-series in the vicinity of $x = x_0$ after this process. We must have

(28) $\bar{y}_\kappa = \alpha_{\kappa 1} y_1 + \alpha_{\kappa 2} y_2 + \ldots + \alpha_{\kappa n} y_n$, $(\kappa = 1, 2, \ldots n)$,

where $\alpha_{\kappa i}$ are constants, since $\bar{y}_1, \ldots \bar{y}_n$ must constitute again a system of solutions (moreover a fundamental system). A new fundamental system may be chosen in the following manner. Put

$$z = c_1 y_1 + c_2 y_2 + \ldots + c_n y_n,$$

where $c_1, \ldots c_n$ are constant coefficients. After the continuation around a, z will be changed into

$$\bar{z} = c_1(\alpha_{11} y_1 + \ldots + \alpha_{1n} y_n) + \ldots + c_n(\alpha_{n1} y_1 + \ldots + \alpha_{nn} y_n).$$

This will be equal to ωz, where ω is a constant, if

$$(29) \quad \begin{aligned} c_1(\alpha_{11} - \omega) + c_2\alpha_{21} + \ldots + c_n\alpha_{n1} &= 0, \\ c_1\alpha_{12} + c_2(\alpha_{22} - \omega) + \ldots + c_n\alpha_{n2} &= 0, \\ \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot & \\ c_1\alpha_{1n} + c_2\alpha_{2n} + \ldots + c_n(\alpha_{nn} - \omega) &= 0, \end{aligned}$$

whence

$$(30) \quad F(\omega) = \begin{vmatrix} \alpha_{11} - \omega, & \alpha_{21}, & \ldots & \alpha_{n1} \\ \alpha_{12}, & \alpha_{22} - \omega, & \ldots & \alpha_{n2} \\ \cdot & \cdot & \cdot & \cdot \\ \alpha_{1n}, & \alpha_{2n}, & \ldots & \alpha_{nn} - \omega \end{vmatrix} = 0.$$

If ω_1 is a root of (30), and the ratios of $c_1, \ldots c_n$ are determined from (29) after ω has been put equal to ω_1, we shall therefore find a solution z_1 of (27) which changes into $\omega_1 z_1$ when the variable x describes a closed path around the singular point considered. If the equation $F(\omega) = 0$ has n distinct roots, we shall find n such solutions, and we may write

$$(31) \qquad \bar{z}_i = \omega_i z_i, \qquad (i = 1, 2, \ldots n)$$

in place of (28). Moreover these n solutions $z_1, \ldots z_n$ will constitute a fundamental system. We shall not attempt to discuss the case of coincident roots of the equation (30), which is known as the *fundamental* or *characteristic* equation.

Now the function

$$(x-a)^{r_i} = e^{r_i \log (x-a)}, \quad r_i = \frac{1}{2\pi i} \log \omega_i$$

has precisely the same property. Therefore the quotient $\dfrac{z_i}{(x-a)^{r_i}}$ is a function uniform in the vicinity of $x = a$, and therefore expressible by a so-called Laurent series proceeding according to positive and negative but integral powers of $x - a$. Let $\phi_i(x)$ be such series; then we have

$$(32) \quad z_i = (x-a)^{r_i} \phi_i(x), \quad (i = 1, 2, \ldots n).$$

The Laurent series will be convergent for all points, excepting a itself, of the circle which has a as center and which reaches up to the nearest singular point of the differential equation. The main questions to solve are: 1st. Determine the exponents r_i; 2d. Find the coefficients of the Laurent series ϕ_i. These questions are capable of a direct and general solution in the special case in which the Laurent series contains only a finite number of terms involving negative powers of $x - a$. In that case the differential equation (27) may be written in the form

$$(33) \quad \frac{d^n y}{dx^n} + \frac{P_1(x)}{x-a} \frac{d^{n-1} y}{dx^{n-1}} + \frac{P_2(x)}{(x-a)^2} \frac{d^{n-2} y}{dx^{n-2}} + \ldots + \frac{P_n(x)}{(x-a)^n} y = 0,$$

where $P_1, P_2, \ldots P_n$ are expressible as power-series proceeding according to *positive*, integral powers of $x - a$. The exponents r_i are then the roots of the *determinating fundamental equation* of the nth degree

$$(34) \quad r(r-1) \ldots (r-n+1) + P_1(a) r(r-1) \ldots (r-n+2) + \ldots + P_n(a) = 0.$$

After r_i has been obtained from this equation, the method of indeterminate coefficients enables one to find the coefficients of the power-series. In the case of equal roots some of the solutions may contain such terms as $\log (x-a)$, $\{\log (x-a)\}^2$, etc.; the general discussion of the various cases which may arise is rather complicated.

The case in which the equation may be written in the form (33) is usually described as that in which the solutions are *regular* about $x = a$. If they are regular in the vicinity of each singular point, including $x = \infty$, the equation is said to be of the *Fuchsian type*, and may be written as follows:

$$(35) \quad y^{(n)} + \frac{G_{\rho-1}}{\psi} y^{(n-1)} + \frac{G_{2(\rho-1)}}{\psi^2} y^{(n-2)} + \ldots + \frac{G_{n(\rho-1)}}{\psi^m} y = 0,$$

where y', y'', etc., denote the derivatives of y of the first, second order, etc., where

$$(35a) \quad \psi = (x - a_1)(x - a_2) \ldots (x - a_m),$$

$a_1, \ldots a_m$ and ∞ being the singular points, and where G_λ denotes a polynomial in x of degree no higher than λ. The most important special case of such an equation is that of the hypergeometric series, the so-called Gauss equation, which is of the second order and has three singular points, 0, 1, and ∞. Historically, the theory of the Gauss equation, as treated by Riemann, was the origin of the general theory of linear differential equations. A large number of the most important conceptions of the theory of functions are closely connected with this equation. The question of finding the cases in which the general solution is algebraic led Schwarz, Fuchs, and Klein to the remarkable algebraic functions which are connected with the five regular solids. This equation also leads to the general theory of automorphic functions, of which the elliptic functions are a special case.

If, in the vicinity of a singular point, the solutions are regular, they may be developed in series whose coefficients may be determined in the manner indicated. The problem of finding the developments of the solutions in the vicinity of a point where they are not regular is far more difficult and still awaits a satisfactory general solution. A solution, not regular at $x = a$, may have the special form

$$e^{\Omega} (x-a)^{\rho} \psi(x),$$

where ρ is a constant, where $\phi(x)$ is an ordinary power-series in $x-a$, and where

$$\Omega=\frac{a_1}{(x-a)^s}+\frac{a_2}{(x-a)^{s-1}}+\ldots+\frac{a_s}{x-a},$$

so that it differs from a regular integral only by the presence of the factor e^{Ω}. Such an integral, if it exists, is called a *normal integral*. There may also be integrals of a similar form in which, however, $(x-a)^{1/k}$ appears in place of $x-a$, where k is a positive integer. They are called *subnormal*. The conditions for the existence of normal and subnormal integrals have been investigated, but none of these investigations is as yet in a final form. Moreover these normal and subnormal integrals are clearly nothing but very special examples of non-regular integrals. A general theory on such a basis requires a systematic and complete theory of essential singular points of uniform functions of a complex variable. Such a theory, however, does not exist.

It becomes necessary, therefore, to change the method of attack. The general theory shows that, in the vicinity of the singular point $x=a$, a solution exists of the form $(x-a)^{\rho}\phi(x)$, where $\phi(x)$ is, in general, a Laurent series. The question is this: how to determine the exponent ρ and the coefficients of $\phi(x)$. In the regular case, when $\phi(x)$ is an ordinary power-series, substitution of this expression into the differential equation, and comparison of powers of $x-a$, solves the problem. One may do the same thing in general. But then one finds it necessary to solve a system of linear equations infinite in number and with an infinity of unknown quantities. This leads to the notion of *infinite determinants*, due primarily to G. W. Hill. Hill applied infinite determinants just as though they were finite, paying no attention to convergence or rigorous definitions. This deficiency was made up and the whole theory placed upon a solid basis by Poincaré and Koch.

The theory of linear differential equations has served as a basis for practically all that is known about non-linear equations. There are two fundamental properties of the linear equations which render them peculiarly accessible. In the first place it is known, *a priori*, how the arbitrary constants enter into the expression of its general integral; in the second place the singular points of its solutions are *fixed*, *i.e.*, independent of the constants of integration. Other classes of differential equations may be defined which have one or both of these properties. The first-mentioned point of view leads to the differential equations with fundamental solutions. These may be defined in various ways, and have been investigated by Guldberg, Vessiot, Lie, and Wilczynski. The idea of investigating the differential equations with fixed branch-points is due to Fuchs. For equations of the first order he succeeded in formulating the conditions in a very simple theorem. Poincaré then showed that all such equations can be transformed into a Riccati equation, *i.e.*, an equation of the form

$$(36)\qquad \frac{dy}{dx}=a_0+a_1y+a_2y^2,$$

where a_0, a_1, a_2 are functions of x, or else are integrable by quadratures or algebraic functions. Differential equations of the first order with fixed branch-points do not, therefore, as was at first expected, lead to new transcendental functions. For, the Riccati equation may, by the transformation $y=-\frac{1}{a_2z}\frac{dz}{dx}$, be converted into a linear differential equation of the second order. It may be noted, incidentally, that this remark enables us to prove, in a simple manner, the theorem that the anharmonic ratio of any four solutions of a Riccati equation is constant. This is important in geometric applications.

The most important recent investigations in the theory of differential equations, from the standpoint of the theory of functions of a complex variable, are due to Painlevé. A brief account of some of them will indicate their fundamental nature. Let

$$(37)\qquad \frac{dy}{dx}=f(x,y)$$

be an algebraic differential equation of the first order. The general integral will be a function of x and u, u being the constant of integration. We may, instead, consider u as a function of x and y defined by the partial differential equation

$$(38)\qquad \frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}f(x,y)=0.$$

The general integral of (37) is said to be *reducible* if other equations, algebraic in x, y, u, $\frac{\partial u}{\partial x}$, $\frac{\partial u}{\partial y}$, $\frac{\partial^2 u}{\partial x^2}$, etc., may be adjoined to (38) compatible with it without being deducible therefrom. All of the equations of the first order which have been studied are reducible in this sense; for instance, the Riccati equation, the linear equation, etc. In the case of a linear equation the condition $\frac{\partial^2 u}{\partial y^2}=0$ may be thus adjoined; if the equation admits an algebraic integrating factor λ, we may adjoin the condition $\frac{\partial u}{\partial y}=\lambda$; etc. This definition of reducibility may be extended to equations, or systems of equations, of any order.

Applied to equations of the first order, the following theorem results. If an equation of the first order is reducible, only four cases are possible: 1st, the equation is algebraically integrable; 2d, it has an algebraic integrating factor; 3d, the logarithm of the integrating factor has algebraic first derivatives; 4th, a first integral is given by a system of differential equations whose general solution is of the form $u=\frac{au_1+b}{cu_1+d}$, (a, b, c, d being arbitrary constants,) and which may be reduced to a Riccati equation.

Irreducible equations of the first order lead to known results, if we confine ourselves to the case that y shall be a uniform function of x. This is not the case, however, for equations of higher order. Among the equations of the second order, the simplest case is that of the equation

$$(39)\qquad y''=6y^2+x.$$

Its general integral is a uniform function of x, which may be represented as a quotient of two integral transcendental functions in the form $y=\frac{d^2\log u}{dx^2}$, where u is an integral transcendental function which satisfies the equation

(40) $$\tfrac{1}{2}(z'')^2+2(z')^3+xz'-z=0,$$

where $z=\frac{u'}{u}$, and which may, therefore, be represented by an ordinary power-series convergent for all values of x.

Although great progress has been made in this direction, and although greater progress is to be expected as the efforts of mathematicians are being gradually rewarded, the results are meager from the point of view of the mathematical physicist, who would like to refer to the mathematician the questions connected with the integration of a differential equation which may have appeared in some of his investigations. For, very rarely will it happen that such an equation belongs to one of the classes with which the mathematician is prepared to deal. It remains necessary to study such equations directly by methods of successive approximation especially adapted to them, usually upon the assumption that all of the variables that enter be confined to real values. The restriction to real variables in such cases, the systematic and rigorous application of the method of successive approximations, has been productive of many valuable results in recent years, especially in the hands of Picard and Hilbert. The theory of partial differential equations, primarily, has made rapid progress through their efforts, and many mathematicians are following their example. It may, however, be predicted that, even in the theory of partial differential equations, the restriction to real variables will gradually pass away. For, in the case of analytic functions, and these after all are the most important, the characteristic properties are veiled by such a restriction. But a necessary prerequisite for a theory of partial differential equations with complex variables is the theory of functions of several complex arguments; this theory, however, is still in its infancy.

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Equations, Galois' Theory of.—In the 16th century the Italian mathematicians succeeded in solving the cubic and biquadratic equations. Their brilliant achievements must have made it seem probable that the solution of the equations of fifth and higher degrees would soon be found. Such, however, was not to be the case. For two centuries the first mathematicians of the day essayed in vain to solve the quintic. Tschirnhaus, Euler, Vandermonde, Malfatti, and Lagrange have embodied their researches in valuable memoirs, but at the close of the 18th century the solution of the equation of fifth degree seem farther away than ever.

In their apparent defeat, however, lay the germs of ultimate victory. As a result of all these investigations it became manifest that the solution of algebraic equations and certain groups of substitutions of their roots were intimately related. In the case of the general equations of degrees three and four this relation was very clear indeed; it was less clear in regard to the general equation of degree n, and still more hazy in regard to the special equations which had been considered up to that time. It was reserved to Evareste Galois to put these loose ends together and to develop a theory of the solution of algebraic equations at once simple and far-reaching. Indeed, the ideas of Galois are not only fundamental in most algebraic investigations, but they have also been ex ended by Lie and others with great effect to the theory of differential equations. But even here they do not stop. It is in Galois' theory that the notion of a group first came prominently before the mathematical public; a notion which to-day pervades a good part of the whole domain of mathematics.

Galois died at the age of twenty-two (1832). Twice he presented memoirs to the Paris Academy, containing an account of his theory. The first was lost, the second was returned to its youthful author by Poisson as unintelligible. Galois' theory was first made public to the mathematical world in 1846 when Liouville published this latter memoir without comments. In 1858 Betti published an exposition of Galois' theory with complete proofs and some valuable extensions.

Lagrange in his great memoir of 1770–71 developed what he styled a *calcul des combinaisons* and which is in fact the origin of Galois' Theory of Equations. This new *calcul* was further developed in a number of papers by Ruffini, beginning 1799, who tried to demonstrate the impossibility of the algebraic solution of the general equation of degree greater than four by this means; by Gauss (1801) and Lagrange (1808) in the solution of the equations on which the roots of unity depend; and finally by Abel, who, besides being the first to rigorously demonstrate the insolvability of the quintic by radicals (1826), discovered a new class of algebraic solvable equations which occur in the division of the elliptic functions (1829).

The first work on Algebra to contain an account of Galois' theory was the second edition of Serret's ‘Algèbre’ (1866). Since then Galois' theory has been improved and greatly extended by many writers. In particular we mention Jordan, ‘Math. Annalen’ (vol. 1, 1869); ‘Traité des Substitutions’ (1870); Hölder, ‘Math. Annalen’ (vol. 34); Hilbert, Crelle's Journal (vol. 110); Kronecker, 'Festschrift' (1881; reprinted in Crelle, vol. 92). The best exposition of the theory to-day is to be found in H. Weber, 'Algebra' (2 vols., 2d edition, 1898–99). In English there is the translation of Netto's 'Substitutionentheorie' by F. N. Cole and Cajori, 'Theory of Equations' (1904). Brief accounts of the theory are Bolza, 'Theory of Substitution-Groups and its Application to Algebra,' Am. Jour. Math., vol. 13; Pierpont, 'Galois' Theory of Algebraic Equations,' Annals of Math. (1899–1900, vols. 1, 2).

Basal Notions.

Domain of Rationality.—One of the most fundamental notions in Galois' theory is that of a domain of rationality which was first clearly formulated by Abel. When an equation

$$f(x) = a_0x^n + a_1x^{n-1} + \ldots + a_{n-1}x + a_n = 0 \quad (1)$$

offers itself for solution, its coefficients are supposed known. It often happens that other quantics are known, or are assumed as known. Suppose $\lambda, \mu, \ldots \omega$ are such quantics, finite in number. The totality of rational functions of these letters with rational numbers as coefficients constitutes a domain of rationality which we denote by

$$R(\lambda, \mu, \ldots \omega).$$

Thus any element of this domain may be obtained by a finite number of additions, subtractions, multiplications, and divisions performed on the letters $\lambda, \mu, \ldots \omega$. The domain of rationality which we lay at the base of a given algebraic investigation is to some degree a matter of choice. In any case, however, the coefficients of the equations we start with should lie in it.

Every domain must contain the domain $R(1)$, called the absolute domain, and which is simply the totality of rational numbers. For the domain $R(\lambda, \ldots \omega)$ must contain the element $\lambda/\lambda = 1$. It is often desirable to add certain elements $\eta, \zeta, \ldots$ to a domain $R(\lambda, \mu, \ldots)$, forming the new domain $R'(\lambda, \mu, \ldots \eta, \zeta, \ldots)$. The elements $\eta, \zeta, \ldots$ are said to be *adjoined* to R.

Rational Functions in R.—In elementary algebra and in the function theory a rational function of $x, y, z, \ldots$ is an expression of the form

$$\frac{Ax^{m_1}y^{m_2}z^{m_3}\ldots + \ldots}{Bx^{n_1}y^{n_2}z^{n_3}\ldots + \ldots}, \quad (2)$$

where the exponents m, n are non-negative integers and the coefficients are merely independent of the variables $x, y, z, \ldots$ In Galois' theory the term rational function is a much narrower one. In fact the term rational has no meaning unless in connection with a specific domain of rationality. Thus the expression (2) is a rational function of $x, y, \ldots$ in Galois' theory with respect to the domain R, when and only when the coefficients $A, B, \ldots$ lie in R. Thus such a function as (2) may be rational with respect to one domain and not with respect to another. For example,

$$x + \sqrt{-3}y$$

is a rational function of x, y with respect to the domain $R(\rho)$, $\rho = e^{\frac{2\pi i}{3}}$; but it is not rational with respect to $R(1)$ or $R(\sqrt{-5})$. When the denominator in (2) reduces to a constant, it becomes a rational *integral* function.

An equation as (1) is *rational* with respect to R when its coefficients $a_0, a_1, \ldots a_n$ lie in R.

Reducibility and Irreducibility is another basal notion of Galois' theory. The rational integral function of $x, y, z \ldots$,

$$F(x, y, z, \ldots) = Ax^{m_1}y^{m_2}z^{m_3}\ldots + \ldots + Lx^{r_1}y^{r_2}z^{r_3}\ldots, \quad (3)$$

with respect to the domain R is *reducible* in R when it is the product of two or more rational integral functions of $x, y \ldots$ with coefficients in R, viz., $F = G \cdot H \cdot I \ldots$ In this case we say F is divisible by $G, H, \ldots$, which are factors or divisors of F in the domain R. If the expression (3) cannot be split up into two such factors, it is *irreducible* with respect to R. An equation as (1) is reducible or irreducible in R according as its left side is reducible or irreducible in R.

An equation as (1) may be irreducible in one domain and reducible in another. Thus

$$x^2 + x + 1 = 0$$

is irreducible in $R(1)$, but is reducible in $R(\sqrt{-3})$. In fact,

$$x^2 + x + 1 = (x - \rho)(x - \rho^2), \quad \rho = e^{\frac{2\pi i}{3}}.$$

If $\xi_1, \ldots \xi_n$ are the roots of (1), it is obviously reducible in $R(\xi_1, \ldots \xi_n)$. In fact its left side splits up into rational linear factors,

$$f(x) = a_0(x - \xi_1) \ldots (x - \xi_n).$$

A theorem of utmost importance in Galois' theory is the following:

Let $f(x) = 0$, $g(x) = 0$ be rational equations for the domain R, and let $f(x) = 0$ be irreducible in R. If $g(x) = 0$ admits a root of $f(x) = 0$, it admits all the roots of $f(x) = 0$, and $g(x)$ is divisible by $f(x)$.

Equality.—As a third pillar on which Galois' theory rests is the distinction between *formal* and *numerical* equality, as we may designate it for lack of better terms. It is only by such a distinction that Galois was able to extend Lagrange's methods so as to apply to any type of algebraic equation. As long as we are dealing with constants, equality and inequality are of course the same as in arithmetic—they are numerical. What do we mean, however, by the equation

$$\phi(p, q, \ldots) = \psi(p, q, \ldots),$$

ϕ, ψ being rational functions of the variables $p, q, \ldots$ for a domain R? In general R will contain variable elements which then may enter the coefficients of ϕ, ψ. Let us write the above equation

$$\phi(v_1, v_2, \ldots c_1, c_2, \ldots) = \psi(v_1, v_2, \ldots c_1, c_2, \ldots),$$

where v_1, v_2 represent now all the variable elements in ϕ, ψ, among which will be $p, q, \ldots$, while $c_1, c_2, \ldots$ represent constants. By an equation of the above type we mean: *that for each and every set of numerical values $v_1, v_2, \ldots$ can take on consistent with their definition, the resulting numerical value of ϕ is identical with that of ψ.*

When no two of the quantities $\phi, \psi, \chi, \ldots$ are equal we shall call them *distinct* or *unequal.*

The Galoisian Resolvent and Group.

Construction of n!-valued Functions; Indeterminants.—Let

$$f(x) = a_0x^n + a_1x^{n-1} + \ldots + a_n = 0 \quad (1)$$

be an equation whose solution is to be effected. The first thing to do is to choose a domain of rationality R. As already remarked, the nature of R depends partly upon (1) and partly upon our own pleasure. In any case it must contain the coefficients.

Without loss of generality we may suppose its roots unequal. For by means of the greatest common divisor of $f(x)$ and $f'(x)$ we may obtain by rational operations an equation whose roots are the distinct roots of (1).

Let us now adjoin n new variables $u_1, \ldots u_n$ to R, forming a domain R', and introduce the rational function

$$V_1 = u_1x_1 + u_2x_2 + \ldots + u_nx_n. \qquad (4)$$

If we permute the $x_1, x_2, \ldots x_n$ in all possible ways, or, as we say, apply the $n!$ substitution

$$\begin{pmatrix} x_1 & x_2 & \ldots & x_n \\ x_{\iota_1} & x_{\iota_2} & \ldots & x_{\iota_n} \end{pmatrix}$$

of the symmetric group, we get the $n!$ functions

$$V_1, V_2, \ldots V_{n!}. \qquad (5)$$

With these we form the equation

$$F(t; u_1, \ldots u_n) = (t - V_1)(t - V_2) \ldots (t - V_{n!}) = 0, \quad (6)$$

whose coefficients lie in R'. In the discriminant of (6), $D(u_1, \ldots u_n)$, we may give to $u_1, \ldots u_n$ values, $\alpha_1, \ldots \alpha_n$, in R, integral values, even, if we choose, in an infinity of ways so that $D \neq 0$. In that case the quantics (5) are distinct and the roots of (6) thus unequal. The function (4) has thus $n!$ values under the symmetric group. A special case of this function (4) was used by Lagrange; in its general form it was first employed by Abel. Its fundamental importance in the solution of algebraic equations was first brought out by Galois. For this reason the function V in (4) is called the *Galoisian resolvent function*. Besides the function (4) there are obviously an infinity of other $n!$-valued functions. The function (4) is employed on account of its simplicity.

On replacing the u's by the α's these variables disappear. Their introduction was to show the existence of $n!$-valued rational functions of the roots $x_1, \ldots x_n$. Such auxiliary variables which we introduce into our reasoning, and which at any moment can be made to disappear by giving them appropriate special values, are called *indeterminates*. In a primitive way they are used by all mathematicians. Kronecker has shown that they are an implement of immense power in algebraic investigations. Since in the end we can always replace the indeterminates by values lying in our domain, we shall suppose that our domain contains in advance as many of these auxiliary variables as we care to use.

Galoisian Resolvent and Group.—In general the equation (6) is reducible in R, so that

$$F(t) = G(t, u_1, \ldots u_n)G(t, u_1, \ldots u_n) \ldots$$

Let us take now any one of these irreducible factors, say that one which admits V_1 as root, to form the equation

$$G(t, u_1, \ldots u_n) = 0. \qquad (7)$$

This is called the *Galoisian Resolvent of* (1) *for the domain R*. Let its degree in t be m.

Galois showed now that the solutions of (1) and (7) are equivalent problems. In fact every rational function of the roots of (1), and in particular the roots themselves and hence also the roots $V_2, V_3, \ldots V_m$ of (7), are rational functions of V_1. We have therefore for any rational function of the x's

$$\phi(x_1, \ldots x_n) = r_0 + r_1V_1 + r_2V_1^2 + \ldots + r_{m-1}V_1^{m-1}.$$

The advance that is made by considering the equation (7) instead of the original equation (1) lies in the fact that the roots of (7) are rational in any one of them. Let the roots of (7) be

$$V_1, V_2, \ldots V_m.$$

These are obtained from the expression (4) by effecting certain substitutions,

$$s_1 = 1, s_2, \ldots s_m, \qquad (G)$$

on the roots $x_1, \ldots x_m$. These m substitutions G enjoy now three remarkable properties:

1° *Every rational function $\phi(x_1, \ldots x_m)$ of the roots of* (1) *which remains unaltered by G lies in R, or, as we say, is rationally known.*

2°. *If the rational function of the roots $\phi(x_1, \ldots x_m)$ is rationally known, it remains unaltered for the substitutions G.*

3°. *The substitutions G form a group, and there is no other group of substitutions having the properties* 1°, 2°.

This group is called *the Galoisian group of the equation* (1) *for the domain R*. We say for the domain R, because by changing R the irreducible factors of (6) will in general change, and therefore the substitutions G will in general change. The importance of the Galoisian group, or, as we shall say more shortly, *the* Group, of an equation $f(x) = 0$ lies in the fact that an investigation of its structure reveals many of the most important properties the algebraic irrationalities defined by this equation. In particular it affords a rational and uniform scheme for effecting the solution of any algebraic equation. Before entering on this topic let us consider

Some Properties of the Galoisian Group G.

Since the group G of an equation

$$a_0x^n + a_1x^{n-1} + \ldots + a_n = 0 \qquad (1)$$

is unique for a given domain of rationality R, it follows: 1° that the group is independent of the particular $n!$-valued function we take; 2° that we get the same group whichever of the irreducible factors $G(t)$, $G_1(t)$, ... of (6) we may choose; and 3° that these functions G, G_1, ... are all of the same degree.

4°. *In any rational equation*

$$\phi(x_1, \ldots x_n) = \psi(x_1, \ldots x_n)$$

between the roots of (1) *the substitutions of G may be applied, and the result is a true equation.*

This is not true for all substitutions. For example, let

$$f(x) = x^3 - 1 = 0,$$

whose roots are

$$x_m = e^{\frac{2\pi i m}{3}}. \qquad m = 0, 1, 2.$$

Take as domain $R(1)$, and as rational relation

$$x_1x_2 = 1.$$

On applying the substitution

$$\begin{pmatrix} x_0 & x_1 & x_2 \\ x_1 & x_2 & x_0 \end{pmatrix} = (0, 1, 2)$$

this relation becomes,

$$x_0x_2 = 1,$$

which is false.

Group belonging to a Rational Function of the Roots and Rational Functions belonging to a Group.—Let

$$\phi(x_1, \ldots x_n)$$

be a rational function of the roots of (1). Since the group G of (1) contains the identical substitution, ϕ remains unaltered by at least one substitution of G and may remain unaltered by others. *These substitutions form a subgroup of* G called the group belonging to ϕ. On the other hand, let H be a subgroup of G. Any rational function $\phi(x_1, \ldots x_n)$ which remains unaltered by the substitutions of H but is changed by all other substitutions of G is said to belong to H. It is important to note that while the substitutions of the Galoisian group which leave a rational function $\phi(x_1, \ldots x_n)$ unaltered from a group, this property does not hold for substitutions which lie outside G. For example, the sub titutions of the symmetric group S_6 which leave

$$\phi = x_1x_5, \quad x_m = e^{\frac{2\pi i m}{6}}, \quad m = 0, 1, 2, 3, 4, 5,$$

do not form a group. This is due to the fact that the group of the equation

$$x^6 - 1 = 0,$$

the domain being $R(1)$, is not S_6 but a smaller group.

If $\phi(x_1, \ldots x_n)$, $\psi(x_1, \ldots x_n)$ belong to the same subgroup H of the Galoisian group, each can be expressed rationally in terms of the other.

Rational Resolvents.

Let $\phi(x_1, \ldots x_n)$ be a rational function of the roots of

$$a_0x^n + a_1x^{n-1} + \ldots + a_n = 0, \qquad (1)$$

whose group for the domain R is G. Let ϕ belong to a subgroup H of G of index r. Then on applying the substitutions of G to ϕ it will take on r distinct values,

$$\phi, \phi_1, \ldots \phi_{r-1}, \qquad (8)$$

which are called *conjugate functions*. They are in fact roots of an irreducible equation

$$\Phi(y) = (y-\phi)(y-\phi_1) \ldots (y-\phi_{r-1}), \qquad (9)$$

whose coefficients lie in R. It is thus a rational equation. Suppose one of its roots, say ϕ, can be found. If we adjoin it to R, forming a domain R', the group of (1) is no longer G, but H.

Suppose not only ϕ but all the roots of (9) can be found. Their adjunction to R forms a domain R'' for which the group of (1) is the greatest invariant subgroup of G contained in H. In any case the adjunction of one or more roots of (9) produces a reduction of the group of the given equation (1). But in reducing the group of this equation we have made a step in its solution. For when the domain of rationality has been enlarged to such an extent that the group of the equation (1) embraces only the identical substitution, the roots of (1) are rationally known, that is, can be expressed rationally in terms of quantities lying in that domain of rationality. The equation (9) is called a resolvent equation, or more specifically a *rational resolvent*, since its roots $\phi, \phi_1, \ldots$ are rational functions of the roots of the given equation (1).

The group of the resolvent equation (9) is of importance sometimes. In the functions (8) considered as functions of the x's, let us effect the substitutions of the group G. This gives rise to a substitution group Γ in the ϕ's, and this group is the group of the resolvent equation (9), the domain of rationality being that of G, viz., R. The groups G and Γ are isomorphic. To the identical substitution of Γ corresponds the group I above mentioned, viz., the subgroup of G, which leaves all the roots (8) unaltered. To any subgroup Γ_1 of Γ will correspond a subgroup G_1 of G, and conversely. In particular if Γ_1 is an invariant subgroup, G_1 is also invariant.

Galois' Solution of an Equation.

Let G be the group of the equation

$$a_0x^n + a_1x^{n-1} + \ldots + a_n = 0 \qquad (1)$$

for the domain R. Let H_1 be a subgroup of G of index r_1. Let $\phi_1(x_1, \ldots x_n)$ be any one of the infinity of rational functions belonging to H_1. Then ϕ_1 is root of a rational resolvent $\Phi_1(y) = 0$ of degree r_1. On solving $\Phi_1 = 0$ and adjoining one or more of its roots to form a new domain R_1, the group of (1) is now a subgroup of G_1 of G. Let H_2 be a subgroup of G_1 of index r_2, to which belongs the rational function $\phi_2(x_1, \ldots x_n)$. This is the root of a resolvent $\Phi_2(y) = 0$ of degree r_2. On solving $\Phi_2 = 0$ and adjoining one or more of its roots to form a new domain R_2, the group of (1) is now a subgroup G_2 of G_1. As the order of the groups $G, G_1, G_2, \ldots$ decreases, we must eventually arrive at the identical group when the roots of (1) are rationally known. Since the group G usually admits quite a variety of subgroups, and since the functions ϕ belonging to a given subgroup are infinite in number, Galois' theory shows that the number of ways for solving a given equation is endless. At the same time it clearly shows that the number of distinct ways is usually quite limited, depending on the subgroups of G.

Among the solutions of the equation (1) which Galois' theory offers, one class is particularly interesting, depending on a

Series of Composition.—This is defined as follows: Let G_1 be an invariant subgroup of G, such that G contains no invariant subgroup containing G_1. It is then a *maximum invariant* subgroup of G. If G has no maximum invariant subgroup besides the identical group, it is *simple*. The series of groups

$$G, G_1, G_2, \ldots G_\lambda = 1, \qquad (10)$$

such that each is a maximum invariant subgroup of the preceding group, is called a *series of composition of* G. If the index of G_m under G_{m-1} is r_m, the numbers $r_1, r_2, \ldots r_\lambda$ are called *the factors of composition*. It may be possible to decompose a group G into a series of composition in more than one way. Thus the cyclic group C_6,

$$1, s, s^2, s^3, s^4, s^5,$$

where $s = \begin{pmatrix} x_1 x_2 x_3 x_4 x_5 x_6 \\ x_2 x_3 x_4 x_5 x_6 x_1 \end{pmatrix} = (1, 2, 3, 4, 5, 6)$ admits the series

$$C_6, A, 1$$

and

$$C_6, B, 1,$$

where

$$A = \{1, s^2, s^4\}, \quad B = \{1, s^3\}.$$

The factors of composition of the first series are 2, 3, while those of the second series are 3, 2. They are thus the same aside from their order. A theorem of *Jordan* states that *however a group be decomposed in a series of composition, the factors of composition are the same aside from their order.*

What makes the solution of an equation by means of a series of composition so remarkable is the fact that the resolvents $\Phi_1 = 0$, $\Phi_2 = 0, \ldots$, $\Phi_\lambda = 0$ corresponding to the subgroups G_1, $G_2 \ldots G_{\lambda-1}$ of (10) have groups $\Gamma_1, \Gamma_2, \ldots \Gamma_\lambda$ for their respective domains which are simple. Their orders are the factors of composition. Moreover, any root of one of these equations is a rational function of any root of that equation. Thus on adjoining one of its roots the same effect is produced as adjoining all. Finally, the resolvent equations $\Phi = 0$ are the simplest possible.

Cyclic Equation of Prime Degree.—When the group G of an equation $F(x) = 0$ is a cyclic group of prime order p its solution is readily effected, as Abel showed. Let the roots of $F = 0$ be $x_0, x_1, \ldots x_{p-1}$, and let $\gamma = (0, 1, \ldots p-1)$. Then

$$G = \{1, \gamma, \gamma^2, \ldots \gamma^{p-1}\}.$$

For the case in hand we may suppose the pth roots of unity $\rho, \rho^2, \ldots$ lie in the original domain of rationality. Consider the rational functions

$$\theta_h = x_0 + \rho^h x_1 + \ldots + \rho^{h(p-1)} x_{p-1}; \quad h = 1, 2, \ldots p-1.$$

On applying γ they go over into $\rho^{-h}\theta$. Hence $\theta_h^p = \theta_h$ are unaltered by γ and hence for G. They are therefore rationally known. On extracting a pth root we get

$$x_0 + \rho^h x_1 + \ldots + \rho^{h(p-1)} x_{p-1} = \sqrt[p]{\theta_h}.$$

This system of $p-1$ equations together with

$$x_0 + x_1 + \ldots + x_{p-1} = \sqrt{\theta_0}$$

gives

$$x_s = \frac{1}{p} \sum_{h=0}^{p-1} \rho^{-hs} \sqrt[p]{\theta_h}, \quad s = 0, 1, \ldots p-1.$$

The pth roots which enter here must be determined uniquely in terms of one of them, say $\sqrt[p]{\theta_1}$. The others are rational in this one, for

$$(x_0 + \rho^h x_1 + \ldots + \rho^{(p-1)h} x_{p-1})$$
$$(x_0 + \rho x_1 + \ldots + p^{p-1} x_{p-1})^{p-h} = A_h$$

remains unchanged for γ and hence for G. Hence these A_h are rationally known. We have now

$$x_s = \frac{1}{p\theta_1} \sum_h \rho^{-hs} \left(\sqrt[p]{\theta_1}\right)^h A_h.$$

This result gives the theorem: *Cyclic equations of prime degree can be solved algebraically*, i.e., *by the extraction of roots from known quantities.*

Algebraic Solution of an Equation.—Let the equation

$$a_0 x^n + a_1 x^{n-1} + \ldots + a_n = 0 \qquad (1)$$

have a group G for a certain domain R, whose factors of composition

$$r_1, r_2, \ldots$$

are all primes. Then (1) can be solved algebraically. For the corresponding chain of resolvents

$$\Phi_1 = 0, \quad \Phi_2 = 0, \ldots$$

have groups of prime orders $r_1, r_2, \ldots$; they are therefore cyclic equations, whose solution has just been effected. Since, as will be set forth later at more length, it is never necessary to employ other than rational resolvents, the above result leads to Galois' Criterion for the Solution of an Equation by Radicals. *In order that* (1) *admit an algebraic solution it is necessary and sufficient that the factors of composition of its Galoisian group consist of primes only.*

Application to the Solution of the Biquadratic

$$x^4 + a_1 x^3 + a_2 x^2 + a_3 x + a_4 = 0. \qquad (11)$$

For simplicity let us suppose its coefficients are independent variables. Let the original domain of rationality R embrace besides the coefficients a cube root of unity ρ. Then the group of (11) is the symmetric group S_4. As subgroups of S_4 we note the alternate group A_4, the axial group $G_4 = \{1, (12)(34), (13)(24), (14)(23)\}$, and the semiaxial group $G_2 = \{1, (12)(34)\}$. The groups S_4, A_4, G_4, G_2, 1 form a series of composition whose factors are obviously

$$2, 3, 2, 2.$$

As they are primes, the equation (11) admits an algebraic solution. To solve (11) let us proceed with Starkweather as follows: To form our first resolvent, let us use the subgroup A_4, and take as function belonging to this group

$$\phi = (x_1 - x_2)(x_1 - x_3)(x_1 - x_4)$$
$$(x_2 - x_3)(x_2 - x_4)(x_3 - x_4) \qquad (12)$$

The corresponding resolvent is

$$\Phi = \phi^2 - \Delta = 0, \qquad (13)$$

where Δ is the discriminant of (11).

On adjoining $\phi = \sqrt{\Delta}$ our domain is $R_1(R, \sqrt{\Delta})$, for which the group of (11) is A_4.

A subgroup of A_4 is G_4. A rational function belonging to this is

$$\psi = x_1 x_2 + x_3 x_4.$$

This gives the resolvent

$$\Psi = \psi^3 - a_2 \psi^2 + (a_1 a_3 - 4a_4)\psi$$
$$- \{a_4(a_1^2 - 4a_2) + a_3^2\} = 0. \qquad (14)$$

The solution of this cubic, which is a cyclic equation, gives ψ as a known explicit function of quantics in R_1. On adjoining ψ we get the domain $R_2(R, \sqrt{\Delta}, \psi)$, for which the group of (11) is G_4. The next subgroup we take is G_2 to which belongs

$$\chi = x_1 + x_2 - (x_3 + x_4).$$

This gives the resolvent

$$X = \chi^2 - (4\psi + a_1^2 - 4a_2) = 0.$$

The extraction of a square root gives χ, whose adjunction produces the domain $R_3(R, \sqrt{\Delta}, \psi, \chi)$, for which the corresponding group of (11) is G_2. The last group we take is the identical group, to which belongs x_1. The corresponding resolvent is

$$x^2+\tfrac{1}{2}(a_1-\chi)x+\tfrac{1}{2}\left(\psi+\frac{2a_3-a_1\psi}{\chi}\right)=0.$$

The solution of this quadratic gives x_1. Its adjunction gives the domain $R_4(R, \sqrt{\Delta}, \psi, \chi, x_1)$, for which the group consists only of the identical substitution. Hence all the other roots of (11), viz., x_2, x_3, x_4, must lie in R_4. This is indeed so, for

$$x_2=x_1-\tfrac{1}{2}a_1+\tfrac{1}{2}\chi.$$

To get x_3, x_4, we note that if ψ', ψ'' denote the two other roots of (14),

$$\alpha=\psi'-\psi''=\frac{(\psi-\psi')(\psi-\psi'')(\psi'-\psi'')}{(\psi-\psi')(\psi-\psi'')}.$$

Here the numerator is the square root of the discriminant of (14), which, as is well known, is the same as the discriminant Δ of (11). The denominator is obviously $\dfrac{d\Psi}{d\psi}$. Thus

$$\alpha=\frac{\sqrt{\Delta}}{\Psi'}=(x_1-x_2)(x_3-x_4),$$

a quantity lying in R_4.

Moreover, x_1, x_2 being already found, $x_1-x_2=\beta$ and $x_1+x_2=\gamma$ are known; also $x_1+x_2+x_3+x_4=\gamma+x_3+x_4=-a_1$ is known. This last with $\beta(x_3-x_4)=\alpha$ gives x_3 and x_4.

Lagrange's Solution instead of employing a series of composition uses the following subgroups, A_4, O, G_2, 1, where

$$O=\{1, (1324), (13)(24), (1423), (12), (34), (12)(34), (14)(23)\}.$$

As rational function belonging to A_4 Lagrange uses the function (12), which gives rise to the resolvent (13). As rational function belonging to O, Lagrange takes

$$\theta=\{x_1+x_2-(x_3+x_4)\}^2,$$

whose conjugate values are

$$\theta_1=\{x_1+x_3-(x_2+x_4)\}^2,\quad \theta_2=\{x_1+x_4-(x_3+x_2)\}^2.$$

The corresponding resolvent is

$$\Theta=\theta^3-(3a_1^2-8a_2)\theta^2+(3a_1^4-16a_1^2a_2+16a_2^2+16a_1a_3-64a_4)\theta-(a_1^3-4a_1a_2+8a_3)^2=0.$$

For the subgroup G_2 he takes

$$\eta=x_1+x_2-(x_3+x_4),$$

which gives the resolvent

$$H=\eta^2-\theta=0.$$

For the identical group 1, Lagrange uses

$$\omega=x_1+x_3-(x_2+x_4),$$

which gives the resolvent

$$\Omega=\omega^2-\theta_1=0.$$

For the domain $R'(R, \sqrt{\Delta}, \theta_1, \theta_2, \theta_3, \eta, \omega)$, the group of the biquadratic is (1), and its roots therefore lie in R'. In fact we have

$$x_1+x_2-x_3-x_4=\sqrt{\theta},$$
$$x_1+x_3-x_2-x_4=\sqrt{\theta_1},$$
$$x_1+x_4-x_3-x_2=\sqrt{\theta_2},$$
$$x_1+x_2+x_3+x_4=-a_1.$$

From which we get

$$x_s=\tfrac{1}{4}(-a_1+\sqrt{\theta}+\sqrt{\theta_1}+\sqrt{\theta_2}),\ s=1, 2, 3, 4.$$

Here we choose at will the signs of $\sqrt{\theta}$, $\sqrt{\theta_1}$. The sign of $\sqrt{\theta_2}$ is then determined, for

$$\sqrt{\theta}\sqrt{\theta_1}\sqrt{\theta_2}=4a_1a_2-a_1^3-8a_3.$$

Abelian Equations.—Let G be the group of an equation $f(x)=0$ for a certain domain. If the substitutions of G are commutative, that is, if $s_\iota s_\kappa=s_\kappa s_\iota$ for any two substitutions s_ι, s_κ of G, the equation $f=0$ is called Abelian in honor of Abel, who first studied them. We may show at once that every subgroup of G is invariant and that its factors of composition are all primes. Hence *all Abelian equations can be solved algebraically.* The most important equations of this type are the equations of degree $\phi(n)$ on which the nth roots of unity depend. Here $\phi(n)$, called the *totient of n*, is

$$n\left(1-\frac{1}{p}\right)\left(1-\frac{1}{q}\right)\ldots,$$

where p, q, ... are the different prime factors of n. The domain of rationality is $R(1)$.

Equation of Degree >4.—The group of the equation (1) when no restrictions are placed on the coefficients, *i.e.*, when they are independent variables, and when the domain of rationality contains not only the coefficients but any constants, is the symmetric group. When $n=2$, 3, 4, its factors of composition are primes. Not so when $n>4$. In this case its only invariant subgroup besides the identical group is the alternate group whose order is $\frac{1}{2}n!$. Thus the factors of composition are 2, $\frac{1}{2}n!$. The latter is not a prime. We have thus *Abel's Theorem: Equations of degree >4, whose group is the symmetric group, cannot be solved algebraically; i.e.*, their roots cannot be found by extracting roots from known quantities.

We have just observed that when the coefficients of an equation of degree >4 are independent variables, it cannot be solved algebraically. From that we cannot, however, deny that *every* equation of degree >4 with constant coefficients *may* admit an algebraic solution. This important question was finally settled by Hilbert, who showed that there are an infinity of equations of any degree with rational integral coefficients whose group in $R(1)$ is the symmetric group.

Irrational Resolvents.

Up to the present we have considered the effect on the Galoisian Group of an equation, of adjoining roots of rational resolvents to the current domain of rationality. In many investigations it is important to consider the adjunction of roots of equations which may not be rational functions of the roots of the given equation. Equations whose roots are not rational functions of the roots of the given equation are called *irrational resolvents* when used in the solution of the given equation. A theorem which lies at the foundation of this subject is due to Kronecker. *Let $f(x)=0$, $g(y)=0$ be two rational irreducible equations for the domain R of degrees m, n respectively. If on adjoining a root x_1, of $f=0$, $g(y)$ becomes reducible, the adjunction of a root y_1, of $g=0$, will make $f(x)$ reducible. If $\phi(x)$, $\psi(x)$ of degrees α, β, respectively, be the* *irreducible factors for the new domains that x_1, y_1 satisfy, then*

$$\frac{m}{\alpha}=\frac{n}{\beta}.$$

As an important corollary of Kronecker's theorem we have: Let the adjunction of y_1 reduce the group G of $f(x)=0$ to an invariant subgroup of index i. Then n is a multiple of i and hence never less than i. When $n=i$ (and this is always the case if n is a prime) $g(y)=0$ is a rational resolvent.

Another theorem of great importance in this connection is due to Jordan. *If the adjunction of all the roots of $g(y)=0$ reduces G to a subgroup G_1 of index i, the adjunction of all the roots of $f(x)$ reduces the group H of $g(y)$ to a subgroup H of index k. The two groups G_1, H_1 are invariant and $i=k$. Finally, when H is simple $g(y)=0$ is a rational resolvent.*

Application to Some Celebrated Problems.—The Delian Problem or duplication of the cube requires the solution of

$$x^3-2=0$$

by rule and compass. The construction of the regular polygons by rule and compass is another famous problem of antiquity. Its solution depends upon the irreducible equation of degree $\phi(n)$ already referred to. That the Delian Problem is impossible follows at once from the theorem: *In order that a root, real or imaginary, of an irreducible equation $f(x)=0$ can be constructed geometrically it is necessary that the degree of f be a power of two.* From this theorem we also conclude: *The necessary and sufficient condition that a regular polygon of n sides can be constructed by rule and compass is that the totient of n is a power of two.*

Another famous question is the *Casus Irreducibilis* of cubic equations. The theory of irrational resolvents enables us to prove readily the following general theorem: *An irreducible equation of degree n whose roots are all real can never be solved by real radicals alone if n contains other factors than two.*

That the casus irreducibilis is indeed such follows as corollary of this theorem.

Hölder's Theorem.—One of the most important and fundamental contributions to Galois' theory in recent years is a theorem of Hölder. Speaking roughly, it asserts that however the solution of a given equation $f(x)=0$ be conducted, sometime in the course of the solution certain simple equations whose groups are uniquely determined and known in advance must be employed. When the group of $f(x)=0$ is simple (in which case we say $f(x)$ is simple) it can be solved by no other simple equation $g(y)=0$ essentially different from $f=0$. The solution of any given equation therefore depends upon a chain of simple equations. But of all simple equations belonging to a given group certain ones will enjoy peculiar properties which will recommend their selection as *normal* equations. The reduction of the given equation to these normal equations is a problem by itself.

The Solution of the Quintic.

We have seen that the equation of fifth degree $Q=0$ whose group is the symmetric group cannot be solved by means of radicals, *i.e.*, by resolvents of the type $x^m-a=0$. On adjoining the square root of its discriminant $\sqrt{\Delta}$, the group of $Q=0$ reduces to the alternate group A_5 of 60 substitutions. But A_5 is simple. Thus $Q=0$ is a simple equation for the domain $R(\sqrt{\Delta})$. Other algebraic equations having this group arise in the theory of linear differential equations, and also in the theory of elliptic functions. In fact the hypergeometric function

$$F(\alpha,\beta,\gamma,x)=1+\frac{\alpha\cdot\beta}{1\cdot\gamma}x+\frac{\alpha\cdot\alpha+1\cdot\beta\cdot\beta+1}{1\cdot2\cdot\gamma\cdot\gamma+1}x^2+\ldots$$

is a solution of a very simple differential equation of the second order $G=0$. For variable α, β, γ it represents a new transcendent; but for certain values of these parameters it reduces to the elementary functions; *e.g.*, it may become algebraic. In seeking for these latter cases Schwarz was led to introduce a new variable s, the quotient of two fundamental integrals of $G=0$. This variable for certain values of α, β, γ satisfies the equation

$$J(s)=1728x\,f^5(s)+H^3(s)=0,$$

where

$$f(s)=s(s^{10}+11s^5-1),$$
$$H(s)=s^{20}-288s^{15}+494s^{10}+288s^5+1.$$

The equation $J=0$ stands in so intimate relation with the icosahedron that it is called the icosahedral equation. Indeed if we project stereographically the icosahedron on the s-plane, the centre being at the origin, the 12 vertices and the middle points of the 20 faces will be precisely the roots of f and H respectively.

From this it is easy to conclude that the group of $J=0$ is formed of the 60 rotations which leave the icosahedron unchanged. Klein has shown that the icosahedral equation whose roots are very simple known functions of $F(\alpha,\beta,\gamma,x)$ can be put in connection with $Q=0$. The equation $J=0$ may thus be considered as a normal resolvent of the quintic.

A normal resolvent which springs from the elliptic functions is the following: In trigonometry one of the problems is to express $\sin\frac{x}{n}$ in terms of $\sin x$, n a prime number. This may be done algebraically, as is readily shown. In the elliptic functions the same problem arises. Here the algebraic relation between $\mathrm{p}\left(\frac{u}{n},\ \omega_1\ \omega_2\right)$ and $\mathrm{p}(u,\ \omega_1\ \omega_2)$ is of degree n^2-1. The solution of this equation depends upon an equation of degree $n+1$ called an equation of transformation. For $n=5$ such an equation is

$$\Delta^2y^6+10\Delta y^3-12g_2y+5=0, \tag{15}$$

whose group is the above A_5 and whose roots are

$$\left(\mathrm{p}\frac{2\omega_1}{5}-\mathrm{p}\frac{4\omega_1}{5}\right)^{-1}$$

and

$$\left(\mathrm{p}\frac{2\omega_2+48r\omega_1}{5}-\mathrm{p}\frac{4\omega_2+96r\omega_1}{5}\right)^{-1},$$
$$r=0,1,2,3,4.$$

Here Δ is the discriminant $g_2{}^3-27g_3{}^2$. How equations of this type could be set in relation with the quintic was first shown by Hermite in 1858. The equation (15) was used by Kiepert. It forms a very convenient normal resolvent of the quintic.

Having found in the elliptic functions convenient normal resolvents for the quintic, we might hope to employ the equations of transformation of higher orders to solve the general equations of higher degrees. The consideration of their groups, however, shows very easily that this is not possible. To find suitable equations we must pass from the elliptic to the hyperelliptic functions. By their aid the general equation of every degree can be solved.

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Equations, General Theory of. The theory of equations finds its origin in efforts to solve the equations which arise in the applications of algebra to problems in pure geometry or in applied mathematics. In the exposition of this theory a rational integral algebraic function of x arises which may be defined as follows:

$$f(x) \equiv a_0x^n + a_1x^{n-1} + a_2x^{n-2} + \ldots + a_{n-1}x + a_n.$$

It is assumed here that the exponent n is a positive integer and that the coefficients a_0, a_1, $a_2, \ldots, a_n$ are algebraic numbers independent of x. If this polynomial is put equal to zero, we have an equation of the nth degree. Any value of the variable x which makes the value of the polynomial zero is said to «satisfy the equation» $f(x)=0$ and is called a «root» of the equation. Thus, -1 is a root of the equation $x^3+x+2=0$, because $(-1)^3+(-1)+2=0$.

Fundamental Theorems about Roots.—That at least one root of the equation $f(x)=0$ always exists is a fundamental theorem which it is somewhat difficult to establish rigorously. The proofs usually given in elementary texts lack rigor. Among the most satisfactory demonstrations are the four given by C. F. Gauss and the one based on the theory of functions, given by A. L. Cauchy. Granted that every equation of the nth degree has at least one root, it is easy to show that it has n roots and no more. An equation of the second dergee (a «quadratic equation») has two roots, one of the third degree (a «cubic equation») has three roots, one of the fourth degree (a «quartic» or «biquadratic equation») has four roots, and so on. The proof of this theorem may be outlined as follows: If r_1 is a root of $f(x)=0$, then $f(x)$ is divisible by $x-r_1$ without a remainder, so that $f(x)=(x-r_1)f_1(x)$, where $f_1(x)$, the quotient, is of the $(n-1)$th degree. If r_2 is a root of $f_1(x)=0$, then in the same way $f_1(x)=(x-r_2)f_{,,}(x)$, and $f(x)=(x-r_1)(x-r_2)f_{,,}(x)$. Proceeding in this manner, the degrees of the successive quotients diminish by unity at every step, until finally a binomial quotient of the first degree of the form $a_0(x-r_n)$ is obtained. We then have $f(x)=a_0(x-r_1)(x-r_2)\ldots(x-r_n)=0$. There are here n binomial factors and no more, each of which, when equated to zero, yields a root. In special cases some of these roots may be equal to each other. Such roots are called «equal» or «multiple» roots.

There are important relations existing between the roots and the coefficients of an equation. From the equalities

$$(x-r_1)(x-r_2)=x^2-(r_1+r_2)x+r_1r_2=0;$$

$$(x-r_1)(x-r_2)(x-r_3)=x^3-(r_1+r_2+r_3)x^2 + (r_1r_2+r_1r_3+r_2r_3)x-r_1r_2r_3=0;$$

$$\cdots\cdots\cdots\cdots$$

$$(x-r_1)(x-r_2)\ldots(x-r_n)=x^n -(r_1+r_2+\ldots+r_n)x^{n-1} +(r_1r_2+r_1r_3+\ldots+r_{n-1}r_n)x^{n-2} -\ldots+(-1)^nr_1r_2\ldots r_n=0$$

we see that in the equation $f(x)=0$, when $a_0=1$, the coefficient a_1 of the second term is equal to minus the sum of the roots; the coefficient a_2 of the third term is equal to the sum of the products of the roots, taken two by two; the coefficient a_3 of the fourth term is equal to minus the sum of the products of the roots, taken three by three; and so on, until finally we arrive at the last coefficient, a_n, which is equal to $(-1)^n$ times the product of all the roots. The coefficients of the equation are said to be *symmetric functions* of the roots, that is, functions in which any two roots may be interchanged without altering the value of the function. As an illustration take $2x^3+4x^2+6x-5=0$. To make $a_0=1$, divide through by 2. Then the sum of the three roots is -2, the sum of their products, taken two by two, is 3, the product of all three roots is $\frac{5}{2}$.

The roots of an equation may be complex (*i.e.*, imaginary) quantities. (See ALGEBRA.) Thus the equation $x^2+x+1=0$ has the two complex roots $\frac{1}{2}(-1+i\sqrt{3})$ and $\frac{1}{2}(-1-i\sqrt{3})$, where $i\equiv\sqrt{-1}$. If the coefficients of the equation $f(x)=0$ are all real, then it can be shown that, if complex roots occur at all, they occur in conjugate pairs; that is, if $a+ib$ is a root, then $a-ib$ is likewise a root. From this it follows at once that no cubic or other equation of odd degree and with real coefficients can have all its roots complex. Considerable information on the character of the roots can usually be secured from «Descartes' Rule of Signs,» which may be stated as follows: *An equation with real coefficients has as many positive roots as it has variations in sign, or fewer by an even number.* A variation is said to exist whenever two successive terms have opposite signs. Thus there are two variations in $+--+$. The theorem may be proved from the consideration that every time that a new positive root is introduced into an equation, by multiplying $f(x)$ by $(x-r)$, the number of variations is increased by an odd number. Applying Descartes' Theorem to the equation $x^6-x^5+x^4+2x^2-5=0$, observe that the sequence of signs is $+-++-$. There are three variations; hence, the equation has either three or one positive root. To apply the theorem to negative roots, we first transform the given equation into a new one whose roots are the same as those of the given equation, excepting in sign. This can be done by writing $-x$ in place of x. The above sextic then becomes $x^6+x^5+x^4+2x^2-5=0$. This transformed equation has one variation; hence, by Descartes' Rule (*q.v.*), it has one positive root, and the given equation has one negative root. As the total number of roots is six and the number of real roots is four or two, it follows that either two or four of the roots are complex. By the same reasoning we can show that $x^5-1=0$ has one positive and four complex roots and that $x^4+x^2+1=0$ has all its roots complex. In some cases, as in $x^4+x^3-x^2+5=0$, Descartes' Rule gives but little information.

Strenuous efforts have been put forth by mathematicians to discover theorems by which the exact number of real and of complex roots of equations with real coefficients can always be determined. The most noted result of these efforts is the theorem of J. C. F. Sturm, discovered in 1829. Sturm's theorem tells the number of complex roots, and the number of real roots within a given interval, with unfailing certainty; but it labors under the disadvantage of being laborious in its application. Hence it is commonly used only when the simpler methods fail to give the wanted information. We state the theorem for the special case when $f(x)=0$ has no equal roots. Let $f'(x)$ be the first derived function of $f(x)$. (See CALCULUS.) Then proceed with the process of finding, by division, the highest common factor of $f(x)$ and $f'(x)$, with this modification, that the sign of each remainder be changed before it is used as a divisor. Continue the process until a remainder is reached which does not contain x, and change the sign of that also. The functions $f(x)$, $f'(x)$, together with the several remainders with their signs changed, viz., $f_2(x)$, $f_3(x)$, . . . , $f_n(x)$, are called «Sturm's functions.» Sturm's theorem is as follows: *If $f(x)=0$ has no equal roots, let any two real quantities a and b be substituted for x in Sturm's functions, then the difference between the number of variations of sign in the series when a is substituted for x and the number when b is substituted for x expresses the number of real roots of $f(x)=0$ between a and b.* To make this clearer, take $f(x)=x^3-x^2-10x+1$, then $f'(x)=3x^2-2x-10$, $f_2(x)=62x+1$, $f_3(x)=38{,}313$. For the indicated values of x the signs of the Sturmian functions are as follows:

x	$f(x)$	$f'(x)$	$f_2(x)$	$f_3(x)$
∞	+	+	+	+
4	+	+	+	+
3	−	+	+	+
1	−	−	+	+
0	+	−	+	+
−2	+	+	−	+
−3	−	+	−	+
$-\infty$	−	+	−	+

Since $x=\infty$ gives no variations and $x=-\infty$ gives three variations, there are three real roots between ∞ and $-\infty$. Hence there are no complex roots. The real roots lie between 3 and 4, 0 and 1, −2, and −3.

Transformations of Equations.—The study of the properties of an equation is frequently facilitated by the transformation of the given equation into a new one whose roots (coefficients) bear a given relation to the roots (coefficients) of the original equation. Thus, in applying Descartes' Rule to negative roots we transformed the equation into another whose roots were numerically the same, but differed in sign. If the roots of the new equation are to be m times those of the one given, we place $y=mx$ and substitute y/m for x. For instance, if the roots of the transformed equation are to be ten times those in

$x^3-x^2-2x+5=0$, we get $\frac{y^3}{1000}-\frac{y^2}{100}-\frac{2y}{10}+5=0$,

or $y^3-10y^2-200y+5000=0$. The result is obtained more easily by the rule: *Multiply the second term by m, the third by m^2, and so on.* If the roots of the new equation are to be the reciprocals of the roots of the old we write $x=\frac{1}{y}$. A more important transformation is the one of diminishing the roots by a given number h. We have here $y=x-h$. Substituting $y+h$ for x in $a_0x^n+a_1x^{n-2}+a_2x^{n-2}+\ldots+a_n=0$, we obtain

$$a_0(y+h)^n+a_1(y+h)^{n-1}+a_2(y+h)^{n-2}+\ldots+a_n=0.$$

Expanding the binomials and collecting like terms, we obtain, let us suppose,

$$A_0y^n+A_1y^{n-1}+A_2y^{n-2}+\ldots+A_n=0.$$

Writing $x-h$ for y we get

$$A_0(x-h)^n+A_1(x-h)^{n-1}+\ldots+A_{n-1}(x-h)+A_n=0,$$

which differs from the original equation merely in form. This new form suggests an easy way for carrying out the actual computation. Dividing the left member by $x-h$, the remainder obtained is seen to be A_n, the absolute term. Dividing the quotient thus obtained by $x-h$, the remainder is A_{n-1}. By repeating this process the remaining coefficients of the required equation are secured. The process, called «synthetic division,» is very convenient in this transformation. Suppose we desire to transform $x^4+8x^3-x+6=0$ into another in which the second term is wanting. The sum of the roots is −8; hence, to cause x^3 to disappear, we must increase each root by 2 (*i.e.*, diminish by −2). Dividing successively by $x+2$ we obtain the coefficients −40, 63, −24, 0, 1, and the required equation is $x^4-24x^2+63x-40=0$.

The transformations thus far considered are all special cases of the so-called *homographic* transformation, in which $y=\frac{ax+b}{cx+d}$, a, b, c, d being constants. Thus, if $a=d=1$ and $c=0$, we have the preceding transformation. The homographic transformation is of interest in geometery, in the study of homographic ranges of points. The most general rational algebraic transformation of the roots of an equation $f(x)=0$ of the nth degree can always be reduced to an integral transformation of a degree not higher than the $(n-1)$th, and can, therefore, be represented by the relation

$$y=d_1+d_2x+d_3x^2+\ldots+d_nx^{n-1}.$$

This last is known as the «Tschirnhausen transformation,» by which Tschirnhausen in 1683 hoped to be able to reduce the general equation of the nth degree to the binomial form $x^n-a=0$, which is always solvable. But this transformation to the binomial form can be effected only for general equations that are lower than the fifth degree.

Solution of Equations.—This subject resolves itself into two quite distinct parts: (1) The solution of numerical equations (*i.e.*, equations whose coefficients are given numbers) by some method of approximation to the exact value of the roots; (2) the solution of equations, whose coefficients are either given numbers or letters, by operations which will give the accurate values of the roots, expressed in terms of the coefficients,—such expressions to involve no other processes than addition, subtraction, multiplication, division, and the extraction of roots. The former is called a solution *by approximation*, the second is called the *algebraic* solution of equations. In the former each root may be found separately, in the latter a general expression is obtained which represents all of the roots indifferently. The former is of importance to the practical computor, the latter is of special interest to the pure mathematician. The solution by approximation can be effected for equations of any degree; the algebraic solution is impossible for general equations of the fifth or of higher degrees. (See EQUATIONS, GALOIS' THEORY OF.)

Algebraic Solution of Equations.—The algebraic solution of the quadratic equation $ax^2+bx+c=0$ is well known. (See ALGEBRA.) The algebraic solution of the cubic, due to Scipio Ferro and Tartaglia, and first published by H. Cardan in 1545, is known as «Cardan's solution.» To effect it, first transform the general cubic equation so that the second term shall be wanting. This done, we have $x^3+ax+b=0$. Putting $x=y+z$ we obtain

$$y^3+3yz(y+z)+z^3+a(y+z)+b=0,$$

or $$y^3+z^3+(3yz+a)(y+z)+b=0.$$

We may subject y and z to any second condition which is not inconsistent with $x=y+z$. It will be convenient to assume $3yz+a=0$. Then $y^3+z^3+b=0$, or, substituting for z its value $-a/3y$, we obtain $y^6+by^3=\frac{a^3}{27}$ and

$$y^3=-\frac{b}{2}\pm\sqrt{\frac{b^2}{4}+\frac{a^3}{27}}.$$

$$z^3=-y^3-b=-\frac{b}{2}\mp\sqrt{\frac{b^2}{4}+\frac{a^3}{27}}.$$

Since $x=y+z$, we have

$$x=\sqrt[3]{-\frac{b}{2}+\sqrt{\frac{b^2}{4}+\frac{a^3}{27}}}+\sqrt[3]{-\frac{b}{2}-\sqrt{\frac{b^2}{4}+\frac{a^3}{27}}}.$$

Since y^3 and z^3 have each three cube roots, it might seem as if $y+z$ or x had altogether nine values. As the cubic has only three roots, this cannot be. Of the nine values, six are excluded by the relation $3yz+a=0$, which y and z must satisfy. Eliminating z between $x=y+z$ and $3yz+a=0$, we get $x=y-\frac{a}{3y}$, where y has the three values obtained from the expression for y^3 given above. This last expression for x does not involve the difficulties of the first expression. If the numerical values of the coefficients a and b are given, the numerical values of the roots may be obtained by substituting the values of a and b in the above expression for x. In any case, this mode of computing x is more laborious than Horner's method of approximation (explained below), but when all three roots of the cubic are real and distinct, an unexpected difficulty is encountered. In this case $\frac{b^2}{4}+\frac{a^3}{27}$ represents a negative number. As the square root of a negative number is a complex (imaginary) number, we are required to find the cube root of a complex number. But there exists no convenient arithmetical process for doing this. Nor is there any way of avoiding the complex radicals and of expressing the values of the real roots by real radicals. This is the famous «irreducible case» in the solution of the cubic. Its interest is purely theoretical. The practical computor experiences no difficulty, for he can always find the values of x by the methods of approximation

Since Cardan's time a great many different algebraic solutions of the cubic and also of the quartic have been given. They are brought together for convenient reference in L. Matthiessen's ‹Grundzüge der Antiken und Modernen Algebra,› Leipzig, 1878. We proceed to give Euler's algebraic solution of the general quartic. By transforming it, bring it to the form $x^4+ax^2+bx+c=0$. Assume the general expression for a root to be $x=\sqrt{u}+\sqrt{v}+\sqrt{w}$. Squaring,

$$x^2-u-v-w=2\sqrt{u}\sqrt{v}+2\sqrt{u}\sqrt{w}+2\sqrt{v}\sqrt{w}.$$

Squaring again and simplifying,

$$x^4-2x^2(u+v+w)-8x\sqrt{u}\sqrt{v}\sqrt{w}$$
$$+(u+v+w)^2-4(uv+uw+vw)=0.$$

Equating coefficients of this and the given quartic we have

$$a=-2(u+v+w),\quad b=-8\sqrt{u}\sqrt{v}\sqrt{w},$$
$$c=(u+v+w)^2-4(uv+uw+vw).$$

But $-(u+v+w)$, $(uv+uw+vw)$, $-uvw$ are the coefficients of a cubic whose roots are u, v, w. This cubic, called «Euler's cubic,» is

$$y^3+\frac{a}{2}y^2+\frac{a^2-4c}{16}y-\frac{b^2}{64}=0.$$

Solving it, we have the values of u, v, and w, and, therefore, the values of x. Of the eight apparent values of x, four are excluded by the relation $b=-8\sqrt{u}\sqrt{v}\sqrt{w}$. To solve the quartic by the present method we must, therefore, first solve «Euler's cubic,» called the *resolvent*. When this resolvent has a rational root, then its other two roots can be expressed in terms of square roots and the quartic can be solved algebraically without the extraction of cube roots. All methods of solving algebraically the general quartic depend upon the solution of some resolvent cubic.

Binomial equations of the form $x^n-1=0$, or more generally, of the form $x^n-a=0$, can always be solved algebraically. They possess also many interesting properties. We shall give a *trigonometric* solution and mention a few of these properties. Let $x^n=a=r[\cos(2k\pi+\theta)+i\sin(2k\pi+\theta)]$, where a may be a complex quantity, where k may be any integer, and where r and θ are known from the value of a. (See TRIGONOMETRY.) By De Moivre's theorem we obtain

$$x=\sqrt[n]{r}\left\{\cos\frac{2k\pi+\theta}{n}+i\sin\frac{2k\pi+\theta}{n}\right\}.$$

By assigning to k any n consecutive integral values we obtain n distinct values for x and no more than n, since the n values recur in periods. These values are the roots required.

Among the properties of $x^n-1=0$ are the following: It has no multiple roots; if r is a root, then any positive integral power of r is a root; if m and n are relatively prime, then $x^m-1=0$ and $x^n-1=0$ have no roots in common, except 1; if h is the highest common factor of m and n, then the roots of $x^h-1=0$ are common to $x^m-1=0$ and $x^n-1=0$; if r is a complex root of $x^n-1=0$, n being a prime number, then $1, r, r^2, \ldots, r^{n-1}$ are the roots; the roots of $x^m-1=0$ and $x^n-1=0$ satisfy the equation $x^{mn}-1=0$; $x^n-1=0$ has always *primitive* roots, *i.e.*, roots which are not also roots of unity of a lower degree than n. For the proofs consult Burnside and Panton, ‹Theory of Equations,› vol. I. The theory of roots of unity is closely allied with the problem of inscribing regular polygons in a circle, or the theory of the «division of the circle» Consult P. Bachmann, ‹Kreistheilung,› Leipzig, 1872.

Solution by Approximation.—Of the various methods which have been given for the solution of numerical equations, the most satisfactory, all things considered, is the one known as «Horner's method.» It is commonly used for finding *incommensurable* roots (*i.e.*, such as involve an interminable decimal which is not a repeating decimal), but it may be used also for finding *commensurable* roots (*i.e.*, such as are integers or rational fractions). It is desirable here to begin with the theorem that *a rational fraction cannot be a root of an equation of the nth degree with integral coefficients, the coefficient of x^n being unity.* To prove this, let, if possible, $\frac{h}{k}$ be a root of $f(x)=0$, where h and k are integers and $\frac{h}{k}$ a fraction reduced to its lowest terms, and where $a_0=1$. Substitute $\frac{h}{k}$ for x, then multiply both members of the equation by k^{n-1}, and we obtain, after transposing, $\frac{h^n}{k}=-a_1h^{n-1}-a_2h^{n-2}k-\ldots-a_nk^{n-1}$. This equation is impossible, since a fraction in its lowest terms cannot equal an integer. Hence $\frac{h}{k}$ cannot be a root. This being the case, it follows that all commensurable roots are exact divisors of a_n, for a_n is numerically the product of all the roots. We know that if (fx) is divisible by $x-r$, without a remainder, r is a root. Hence we are enabled to find all commensurable roots of numerical equations of the type now under consideration by testing in succession each factor of a_n. For instance, in the equation $x^3+8x^2+13x+2=0$ the factors of a_n are ±1 and ±2. Taking the factor -2, we find that $f(x)$ is exactly divisible by $x+2$. The test for each of the three other factors yields a remainder. Hence -2 is the only commensurable root.

Before we can apply Horner's method we must know the first significant figure of the root to be found. In other words, we must «locate» the root. This can always be done by Sturm's theorem, but usually the following theorem is more convenient. *If two real numbers a and b, when substituted for x in $f(x)$, give to $f(x)$ contrary signs, an odd number of roots of the equation $f(x)=0$ lies between a and b.* Thus, to locate the roots of $x^3-3x^2-46x-71=0$, substitute for x, in succession, the values -6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. It is found that $f(-5)$ and $f(-4)$, $f(-2)$ and $f(-1)$, $f(8)$ and $f(9)$ are pairs of values of $f(x)$ having opposite signs. As there are three roots in all, we conclude that there is just one root between each of the pairs of values -5 and -4, -2 and -1, 8 and 9. To reduce the number of trials in more difficult examples, there are theorems on the upper and lower limits of roots which may be applied.

Horner's method consists of successive transformations of an equation. Each transformation diminishes the root by a certain amount. If the required root is 1.955, then the root is diminished successively by 1, .9, .05, .005. Synthetic division is employed. Suppose we desire to find, to three decimals, the root between -1 and -2 in the above example. It is convenient first to transform the equation so that the root becomes positive. We get $x^3+3x^2-46x+71=0$. The first significant figure in the root is 1. To diminish the roots by 1 we perform by synthetic division the following operation:

1 + 3	−46	+71	1
1	+ 4	−42	
4	−42	+29	
1	+ 5		
5	−37		
1			
6			

The transformed equation, whose root under consideration now lies between 0 and 1, is $x^3+6x^2-37x+29=0$. This root being less than unity, x^2 and x^3 are less than x. Neglecting x^3 and $6x^2$, we obtain an approximate value for x from $-37x+29=0$, viz., $x=.7$. As in the process of ordinary long division or in the extraction of roots, so here the digit obtained by the first approximate division may be too large or too small and may need correction. An error of this sort will reveal itself later in the attempt to find the third digit of the root. Such correction is needed here. Actually $x=.9$. Diminish the roots of the last transformed cubic by .9, then find the third digit by the process just indicated for finding the second digit, then diminish the roots again, and so on. The entire operation is as follows:

1 + 3	−46	+71	1.055
1	4	−42	
4	−42	+29	
1	5	−27.711	
5	−37	+ 1.289	
1	6.21	− 1.166625	
6	−30.79	+ .122375	
.9	7.02		
6.9	−23.77		
.9	.4375		
7.8	−23.3325		
.9	.4400		
8.7	−22.8925		
.05			
8.75			
.05			
8.80			
.05			
8.85			

The broken lines indicate the conclusion of the successive transformations. For advanced reading on the solution of numerical equations consult E. McClintock in 'Am. Jour. of Maths.,' vol. XVII, pp. 89–110; M. E. Carvallo, Résolution numérique complète d. Equations algébriques ou transcendantes,' Paris, 1896; Karl v. Mor, 'Anwendung der Horner'schen Methode zur Berechnung der imaginären Wurzeln numerischer Gleichungen,' Innsbruck, 1884.

Multiple Roots.—Suppose that in $f(x)=0$ there are m multiple roots; that is, m roots are equal to each other. Then $f(x)=(x-r)^m\phi(x)$, and the first derivative is $f'(x)=(x-r)^m\phi'(x)+m(x-r)^{m-1}\phi(x)$. The fact that $f(x)$ and $f'(x)$ have the factor $(x-r)^{m-1}$ in common suggests the following rule for the discovery of multiple roots: Find the highest common factor of $f(x)$ and $f'(x)$. If that factor is $(x-r)^s$, then r occurs as a root $s+1$ times. If the highest common factor is $(x-r)^s(x-r_1)^t$, then r occurs as a root $s+1$ times and r_1 occurs $t+1$ times. If $f(x) \equiv 8x^3 - 20x^2 + 6x + 9$, then $f'(x) \equiv 24x^2 - 40x + 6$, and the H.C.F. is $2x-3$. Hence $\frac{3}{2}$ is a double root.

Elimination.—Take the equations,

$$f(x) \equiv x^2 + a_1x + a_2 = 0,$$

$$F(x) \equiv x^2 + b_1x + b_2 = 0,$$

and let r_1 and r_2 be the roots of the second equation. The necessary and sufficient conditions that the two equations shall have a root in common is that $f(r_1)$ or $f(r_2)$ shall vanish; that is, that the product $f(r_1) \cdot f(r_2)$ shall be zero. Multiplying together,

$$f(r_1) \equiv r_1^2 + a_1r_1 + a_2,$$

$$f(r_2) \equiv r_2^2 + a_1r_2 + a_2,$$

we get

$$r_1^2r_2^2 + a_1(r_1r_2^2 + r_1^2r_2) + a_2(r_1^2 + r_2^2) + a_1^2r_1r_2 + a_1a_2(r_1 + r_2) + a_2^2.$$

Expressing the symmetric functions of r_1 and r_2 in terms of the coefficients of the second of the given equations, we get $r_1^2r_2^2 = b_2^2$, $r_1r_2^2 + r_1^2r_2 = -b_1b_2$, $r_1^2 + r_2^2 = b_1^2 - 2b_2$, $r_1r_2 = b_2$, $r_1 + r_2 = -b_1$. Substituting these values, we have $b_2^2 - a_1b_1b_2 + a_2b_1^2 - 2a_2b_2 + a_1^2b_2 - a_1a_2b_1 + a_2^2$.

This expression, involving the coefficients of the two given equations, is called the *eliminant* or *resultant*. Its vanishing is the condition that these equations have a root in common. More generally, if from n equations with $n-1$ variables we eliminate the variables and obtain an equation $R=0$, involving only the coefficients, the expression R is called the *eliminant* or *resultant* of the given equations.

In the above example the elimination was performed with the aid of symmetric functions. Of other methods of elimination the best known are those of Euler, Bezout, and Sylvester. We outline the last, known as Sylvester's Dialytic Method. To eliminate x between

$$f(x) \equiv a_0x^n + a_1x^{n-1} + \ldots + a_n = 0,$$

$$F(x) \equiv b_0x^m + b_1x^{m-1} + \ldots + b_n = 0,$$

multiply the first successively by $x^0, x', x^2, \ldots, x^{m-1}$, and the second successively by $x^0, x', x^2, \ldots, x^{n-1}$, and we obtain $m+n$ equations. The highest power of x is $m+n-1$. If $f(x)=0$ and $F(x)=0$ have a common root, it will satisfy all the $m+n$ equations. If the different powers of x, viz., $x, x^2, \ldots, x^{m+n-1}$, be taken as $m+n-1$ unknown quantities, satisfying $m+n$ linear equations, a relation will exist between the coefficients. This condition of consistency is the vanishing of the resultant. This resultant Sylvester expresses neatly in the form of a determinant. (See DETERMINANTS.)

Discriminants.—It has been shown that a multiple root of $f(x)=0$ is also a root of $f'(x)=0$. But the condition that these two equations have a common root is expressed by the vanishing of the resultant.

The resultant of $f(x)=0$ and $f'(x)=0$ is called the *discriminant* of $f(x)=0$. It may be otherwise defined as the simplest function of the coefficients, or of the roots, whose vanishing signifies that the equation has equal roots.

To the references already given, we add the following: 'Encyklopädie der mathematischen Wissenschaften,' Band I.; E. Netto, 'Vorlesungen über Algebra' (Leipzig, vol. I, 1896, vol. II, 1900); Serret, J. A., 'Cours d'Algèbre Supérieure' (Paris, 2 vols.); Todhunter, 'Theory of Equations' (London, 1880); H. Weber, 'Lehrbuch der Algebra' (Braunschweig, vol. I, 1898, vol. II, 1896); 'Encyklopädie der elem. Algebra und Analysis' (Leipzig, 1903); F. Cajori, 'Introduction to the Modern Theory of Equations' (New York, 1904).

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Equator, an imaginary great circle of the celestial vault or on the surface of the earth. As used in astronomy the term signifies a great circle of the celestial vault at right angles to its axis, and dividing it into a northern and a southern hemisphere. It is constituted by the plane of the earth's equator, produced in every direction till it reaches the concave of the celestial sphere. The sun is twice a year in the celestial equator—namely, at the equinoxes, whence the equator is also known as the equinoctial line, or simply the equinoctial (see EQUINOX). The point in the equator which touches the meridian is raised above the true horizon by an arc which is the complement of the latitude. The sun and planets all have equators. They rotate around their several axes, and the plane at right angles in each case is the equator of the heavenly body. In geography, the equator is a great circle on the surface of the earth equidistant from its poles, and dividing it into two hemispheres. Its latitude is zero; it is therefore marked on maps as 0. Other parallels of latitude are counted from it, augmenting in their numerical designation as their distance from it north or south increases, the poles being 90°. The plane of the terrestrial equator is a plane perpendicular to the earth's axis and passing through its center. The magnetic equator is a somewhat irregular line, nearly but not quite a great circle of the earth, in which there is no dip of the magnetic needle. It is hence called also the aclinic line. It is inclined to the horizon at an angle of 12°, and cuts it at two points almost exactly opposite to each other, the one in the Atlantic and the other in the Pacific. It is not far from the geographical equator, but its situation slowly alters year by year, there being a slow oscillation of the magnetic poles, while the geographical equator and poles are fixed.

Equato'rial («of the equator»), a geographical and astronomical term. In astronomy it is usually applied to a telescope so mounted as to have a motion in two planes at right angles to each other; one parallel to the axis of the earth, and the other to the equator. Each axis has a graduated circle, one for measuring declination and the other right ascension. Clockwork is sometimes attached to the instrument to give the motion in right ascension, and thereby keep the object constantly in the field of the instrument. See ASTRONOMY.

Equatorial Coudé («Elbow Equatorial»), a form of equatorial telescope invented by Loewy, of the Paris Observatory. The observer can remain stationary in a comfortable position, with a desk-table built around the eye-piece end, and can have all this part enclosed from the cold, and warmed if desired, at the same time commanding the whole heavens without rising from his chair. See ASTRONOMY; TELESCOPE.

Equatorial Current. See CURRENTS, *Marine*

Equerry, ĕk'wĕ rĭ or ē-quer'ĭ, an officer of the royal household of Great Britain in the department of the master of the horse. There are six equerries, who are in attendance monthly, one at a time, their principal duty being to precede the sovereign in a coach, when the ruler rides abroad in state. The clerk-marshal, as the chief equerry is styled, has a salary of £500 per annum, and the equerries in ordinary £300.

Equestrian Order, or **Equites,** the order of knights in ancient Rome. The equites or knights originally formed the cavalry of the army. They are said by Livy to have been instituted by Romulus, who selected 300 of them from the three principal tribes. Soon after the first Punic War the equites became a distinct order in the state, and the juries and the farmers of the revenue were selected from their ranks. They held their position in virtue of a certain property qualification, and toward the end of the republic they possessed much influence in the state. They had particular seats assigned to them in the circus and theatre, and the insignia of their rank, in addition to a horse, were a gold ring and a tunic with two narrow purple stripes. Their privileges were curtailed by Sulla and under the later emperors the order disappeared from the stage of political life.

Equidæ, ĕk'wĭ-dē, the horse family, the most highly specialized of the perissodactyl ungulates, characterized by the fact that only one toe (the third) in each foot is now functional, traces ("the splint bones") remaining of the two other toes (the second and fourth) in the "splint bones" hidden beneath the flesh on each side of the shank of the foot. (For the relationships of this family to the titanotheres, tapirs, and rhinoceroses, see UNGULATA; and for the evolution of the characteristic foot-structure see HORSE, EVOLUTION OF.) The family contains but a single genus (*Equus*), structural distinctions not being of sufficient importance to separate generically the modern horses from several extinct species, or from the asses or zebras, or these from each other. Apart from the dependence upon a single toe, the family is characterized by the facts that the orbit is completely surrounded by bone; the incisor teeth are chisel-shaped; the canines or "tushes" are rudimentary (when present), and the premolars (except the first or "wolf tooth") resemble the hypselodont molars. Externally the members of this family are robust, with comparatively slender limbs, the feet "booted" in a single horny hoof, encasing the terminal phalanx; the body thickly clothed with short close hair, which, however, becomes longer, and in some species profuse, forming a mane, on the nape and tail. The colors are apt to be disposed in dark stripes on a yellow or brownish ground, most strikingly in the zebras, but traceable in most others. There are never any horns, and speed is depended on to escape from enemies which cannot be beaten off by kicking with the hind feet, while struggles between rival males for the leadership of the bands of mares are carried on mainly by biting and striking with the fore feet. The fore-limbs, or both pairs, have a callous pad upon the inside, "which," says Beddard, "is possibly to be looked upon as an aborted gland, probably originally of use as secreting some odorous substance calculated to enable strayed members of the herd to regain their companions." The whole structure of the equidæ has been developed in adaptation to a life upon open dry plains, where ability to travel with rapidity and to live upon grass and herbage has been perfected to a high degree. The stomach has no such complicated arrangement for the assimilation of this comparatively innutritious diet as has been acquired by the ruminants (q.v.). The alimentary canal is of great length (about eight times the length of the body); and the stomach, simple in form, is divided into a cardiac, and a pyloric part, sharply distinguished by the dense epithelium lining of the former. The cæcum is twice as large as the stomach, and there is no gall-bladder. The teats are two in number and situated in the groin. One or two foals are produced at a birth after a gestation of about 11 months. All the species are gregarious and polygamous: and like most such animals are readily tamable, though the zebra has proved somewhat intractable and useless to mankind.

The family in the course of its history has occupied all the larger land-areas of the globe except Australia; but although its ancestors abounded in both Americas in the past, and modern horses run wild have multiplied and flourished exceedingly upon their grassy plains, no living species inhabited the New World. In the Old World the horse or horses and one of the asses were Asiatic and European; a second species of ass and the various zebras were wholly African. See ASS; HORSE; QUAGGA; ZEBRA.

Equilib'rium, a state of equipoise, produced by the mutual counteraction of two or more forces; as the state of the two ends of a lever or balance when both are charged with equal weight. Equilibrium is characterized by three phases. When a body suspended by a string, for example, on being slightly moved out of any position, always tends to return to its position, that position is said to be one of *stable equilibrium;* when a body like a stick or other object balanced on its point will not thus return to its previous position, its position is said to be one of *unstable equilibrium;* and when a body such as a sphere resting upon a horizontal plane will rest in any position in which it is placed, it is said to be of *neutral* or *indifferent equilibrium.*

Equilibrium, in physiology, the ability to maintain the body by proper muscular force under nervous control, so that it can perform co-ordinated movements, or resist the force of gravity. By equilibrium is here meant the control of the body in the upright position, apart from the localized processes of co-ordination. Loss of equilibrium shows itself particularly in walking and running. Here the centre of gravity of the body is constantly changing and the ability of the individual to hold himself erect depends upon a number of features. The eye, the tactile sense of the feet, the joint-senses, the muscular sense that weighs the various muscular movements, and the higher cerebral centres are all involved, and loss of equilibrium or inco-ordination may result from disease or injury to any of these functions. Loss of eyesight does not necessarily involve any loss of equilibrium, but loss of tactile sense of the feet, such as is seen in locomotor ataxia, or in people who have had their feet frozen, almost invariably produces a loss of equilibrium. In the same disease (locomotor ataxia), and in forms of neuritis, the loss of muscular sense and joint-sense produces similar phenomena. For the higher cerebral centres of control there is good reason to believe that the semicircular canals in the internal ear constitute a special sense-organ for the determination of the direction of the movements of the head which are so essential in the preservation of general equilibrium. Diseases of the semicircular canals are frequently accompanied with dizziness and vertigo. It also seems probable that certain areas in the cerebellum are closely associated with the equilibrium. See CEREBELLUM; INCO-ORDINATION; LOCOMOTOR ATAXIA; SEMICIRCULAR CANALS.

Equilibrium, Chemical. In mechanics a system is said to be in equilibrium when the forces that act upon it are precisely balanced, so that their resultant is everywhere zero. A system is similarly said to be in chemical equilibrium when its state is such that there is no tendency toward a sensible chemical change, in any of its parts. The absence of chemical action may be absolute, or merely apparent. In other words, there may be no chemical changes going on at all, or there may be opposite changes going on simultaneously, in such a way that no resultant modification can be observed in any part of the system, however small the part selected for observation may be. In the latter case the existence of the simultaneous and opposite reactions can only be indirectly inferred from a study of the system when it is not in equilibrium.

According to the theory of chemical affinity that was held before the importance of mass-action was understood, two substances either would combine or would not, according as their "affinities" were more or less completely satisfied in the combined state, or in the uncombined state. That this view is entirely inadequate to explain the facts of chemistry is made evident by the following simple example: When steam is passed over red-hot iron filings, it is decomposed into oxygen and hydrogen, the iron absorbing the oxygen with the formation of oxide of iron, while the hydrogen escapes in the free state; but if hydrogen is passed over red-hot oxide of iron, the oxide is reduced to the metallic state, its oxygen combining with the hydrogen to produce steam, which passes on in the hydrogen current. This apparent contradiction may be best explained by assuming that when a mixture of steam and hydrogen is in contact with a red-hot mixture of iron oxide and metallic iron, both of the foregoing reactions take place simultaneously. If the metallic iron and the steam are present in excessive amounts, the resultant action will be, on the whole, the oxidation of the iron and the decomposition of the steam; while if the iron oxide and the hydrogen are present in excess, the resultant action will be the reduction of the oxide to the metallic state, and the simultaneous formation of steam. It is therefore apparent that in some reactions, at any rate, the relative masses in which the various constituents are present must be considered with much care, before any prediction of the chemical deportment of the mixture can be made. Attention was first directed to this fact by Claude Louis Berthollet ('Essai de statique chimique,' 1803). In the example cited above, if the iron, iron oxide, hydrogen, and steam were left in contact in a closed vessel, a state of apparent equilibrium would be finally attained, in which the formation and decomposition of the steam would occur with equal rapidity, so that no visible change would take place thereafter. When this state of "chemical equilibrium" is attained, the abstraction of hydrogen or of iron oxide, or the addition of steam or of metallic iron, will destroy the equilibrium, and more iron will be oxidized, until a new state of equilibrium is established. Similarly, the abstraction of steam or of metallic iron, or the addition of hydrogen or of iron oxide, when the system is in equilibrium, will be followed by the reduction of a portion of the iron oxide, and the establishment of a new state of equilibrium. According to Berthollet, all reactions are fundamentally of this kind. When sodium chloride is added to a solution of silver nitrate, we know that the silver is all thrown down in the form of an insoluble chloride. In this case, Berthollet would consider that the sodium chloride, sodium nitrate, silver chloride, and silver nitrate tend toward a state of chemical equilibrium, but that since the silver chloride is continually removed from the solution by reason of its insolubility, it is impossible for the state of equilibrium ever to be attained, just as it would be impossible for such a state to be attained in our previous illustration if one of the constituents (say the iron oxide) were removed, or rendered inactive in any way, as fast as it were formed.

The ideas of Berthollet have been found to be sound in their essentials, and they have served as the foundation stones for the modern theory of chemical action, though their full development cannot be explained without the use of the differential calculus. The basis of the theory of mass-action, so far as solutions are concerned at all events, appears to be substantially as follows: Two substances in solution cannot combine with each other, except when a molecule, or ion (see SOLUTION) of the one, in its wandering through the solution, chances to encounter a molecule or ion of the other. Now while we do not know the actual number of encounters that take place in a given time between molecules of different kinds, we do know that in a homogeneous solution the chance that any one given molecule of the first kind will encounter some molecule of the second kind within (say) the next second, is strictly proportional to the number of molecules of the second kind that are present in the solution; and conversely, the chance that any given molecule of the second kind will encounter some molecule of the first kind, within the next second is strictly proportional to the number of molecules of the first kind that are present. Since the number of molecules of each kind that are present in an actual solution is practically infinite, this amounts to saying that the actual number of encounters between molecules of different kinds, in one second, is proportional to the product of the numbers of molecules of the first and second kinds that are present. As an illustration of the usefulness of this principle, we may consider the equilibrium of a mixture of acetic acid and ethyl alcohol. Some of the acid combines with some of the alcohol to form water and ethyl-acetic ester (see ESTER), but the reaction is never complete, since a state of equilibrium is attained after a time, in which the inverse combination takes place just as fast as the direct one. The molecular weight of acetic acid ($CH_3COO.H$) is 60, that of ethyl alcohol (C_2H_5OH) is 46, that of ethyl-acetic ester or ethyl acetate ($CH_3COO.C_2H_5$) is 88, and that of water (H_2O) is 18. A mass of any substance which contains as many grams as there are units in the molecular weight of the substance is known as a «gram-molecule» of the substance. This name is rather unhappily chosen, but the idea itself is a useful one, and is commonly employed in modern writings upon theoretical chemistry. Let us suppose that one gram-molecule of acetic acid (60 grams) is originally mixed with M gram-molecules of ethyl alcohol (46M grams), and with N gram-molecules (18M grams) of water, and let us inquire what the composition of the mixture will be when the state of final chemical equilibrium has been attained. The advantage of taking the gram-molecule as the unit of mass is, that when this unit is used the number of grams of acetic acid, alcohol, and water that are originally present will be proportional to 1, M and N, and we may speak of M and N, and write them in our equations precisely as though they were really the number of actual molecules present. The acetic acid and alcohol act upon each other as indicated by the equation $CH_3COO.H + C_2H_5OH = CH_3COO.C_2H_5 + H_2O$. Now let us assume that when the state of equilibrium has been attained, X gram-molecules of the alcohol have been decomposed. This implies that X gram-molecules of the acetic acid have also been decomposed, and that X gram-molecules, each, of water and of ethyl acetate have been formed. The total numbers of gram-molecules of the various substances that are present when the final state of equilibrium is attained are therefore as follows: Acetic acid, $1 - X$; alcohol, $M - X$; water, X; ethyl acetate, $N + X$. The number of molecular collisions per second, in which a molecule of acetic acid encounters a molecule of alcohol, is therefore (in the final state) proportional to $(1 - X)(M - X)$; and since the chemical action is itself proportional to the number of such collisions, we may assume that the number of gram-molecules of ethyl acetate formed per second, in the state of equilibrium, is $A(1 - X)(M - X)$, where A is a constant whose value we do not know. The same line of reasoning shows that the number of gram-molecules of ethyl acetate that are lost from the solution, in the same time, through combining with water to reproduce acetic acid and alcohol, is $B(N + X)X$, where B is another constant, whose value is also unknown. Since the existence of equilibrium requires that the quantity of ethyl acetate present shall be constant, we have $A(1 - X)(M - X) = B(N + X)X$. Now it is known by experiment that when the original mixture is free from water, and contains chemically equivalent amounts of acetic acid and alcohol, so that $M = 1$ and $N = O$, the state of final equilibrium is attained when $X = \frac{2}{3}$. If these values of M, N and X are substituted in the foregoing equation, we find that A and B are connected by the necessary relation $A = 4B$. If we replace A by 4B and then divide through by B, the foregoing equation reduces to $4(1-X)(M-X) = (N+X)X$, or $3X^2 - (4 + 4M + N)X + 4M = O$, a quadratic equation from which the value of X (that is, the number of gram-molecules of acetic acid decomposed) may be inferred, in the final state of equilibrium, for any desired initial mixture of acetic acid, alcohol, and water. This example has been given at some length, both because it illustrates clearly the principles of chemical equilibrium and the law of mass-action, and because reactions of this very kind, in which esters are formed by the direct action of an acid upon an alcohol, have a special historic interest, since their study has contributed in no small measure toward placing the modern theory of chemical equilibrium upon a firm foundation.

When it is desired to determine the state of a chemical system after the lapse of a definite interval from an initial instant for which its state is given, we must form a differential equation in which the condition is expressed that the chemical change, per unit of time, is proportional (as above) to the product of the number of gram-molecules of the reacting substances that are present at the instant considered; and having formed this equation and integrated it, we obtain an expression in which the composition of the system is expressed as a function of the time. When several substances that may react upon one another are present, the differential equation is more complicated in form, as might be expected; but for details of this sort reference must be made to works on theoretical chemistry. When the system contains several acids and one or more bases, the distribution of the bases among the various acids may be investigated in accordance with similar principles, and by comparing the numerical results that are thus obtained with the facts of observation, estimates of the true relative «affinities» of the acids may be had.

When, as is often the case, the course of a reaction depends upon the temperature, the principles of mass-action apply as before, but regard must also be had for the laws of thermodynamics (q.v.), which usually impose certain limitations upon the equations. The full theory of chemical changes in which thermodynamical considerations play an important part was given by J. Willard Gibbs, in a paper of great power and originality entitled 'On the Equilibrium of Heterogeneous Substances,' published in the 'Transactions of the Connecticut Academy of Arts and Sciences' for 1875. This paper is exceedingly difficult reading on account of its generality, but it contains the germs of many discoveries that were made years afterward. Consult: Nernst, 'Theoretical Chemistry.'

Equine Antelope. See BLAUBOK.

Equinoc'tial, in astronomy, synonymous with equator. When the sun is on the equator there is equal length of day and night over all the earth: hence the name equinoctial. See EQUATOR; EQUINOX.

Equinoctial Gale, a gale popularly supposed to occur at the time of the spring or autumn equinox. See EQUINOX.

Equinoctial Points are the two points wherein the equator and ecliptic intersect each other; the one, being the first point of Aries, is called the vernal point; and the other, in the first point of Libra, the autumnal point. See ECLIPTIC; EQUINOX; EQUINOXES, PRECESSION OF THE.

Equinovalgus. See DEFORMITIES.

Equinovarus. See DEFORMITIES.

E'quinox, in astronomy, is that time of the year when the day and night are equal: the length of the day is then 12 hours; the sun is ascending 6 hours, and descending the same time. This is the case twice a year, in spring and in autumn, when the sun is on the equator. When the sun is in this situation the horizon of every place is divided into two equal parts by the circle bounding light and darkness; hence the sun is visible everywhere 12 hours, and invisible for the same time in each 24 hours. The vernal equinox is on 21 March, and marks the beginning of spring; the autumnal is on 23 September, which is considered the commencement of autumn; at all other times the length of the day and of the night are unequal, and their difference is the greater the more we approach either pole, and in the same latitude it is everywhere the same. On the equator this inequality entirely vanishes; there, during the day, which is equal to the night, the sun always ascends six hours and descends six hours. In the opposite hemisphere of our earth the inequality of the days increases in proportion to the latitude: the days increase there while they diminish with us, and *vice versa.* The points where the ecliptic intersects the equator are called equinoctial points. The vernal equinoctial point was formerly at the entrance of the constellation of Aries; hence the next 30 degrees of the ecliptic, reckoned eastward from it, have been called Aries; but this point long ago deserted the constellation of Aries, and now stands in Pisces; for it is found by observation that the equinoctial points, and all the other points of the ecliptic, are continually moving backward or westward; which retrograde motion of the equinoctial points is what is called the precession of the equinoxes. It appears from the result of calculations that the path of either of the poles is a circle, the poles of which coincide with those of the ecliptic, and that the pole will move along that circle so slowly as to accomplish the whole revolution in about 25,800 years nearly. The diameter of this circle is equal to twice the inclination of the ecliptic to the equator, or about 47°. Now, as the ecliptic is a fixed circle in the heavens, but the equator, which must be equidistant from the poles, moves with the poles, therefore the equator must be constantly changing its intersection with the ecliptic. And from the best observations it appears that the equator cuts the ecliptic every year 50.25″ more to the westward than it did the year before; hence the sun's arrival at the equinoctial point precedes its arrival at the same fixed point of the heavens every year by 20 minutes 23 seconds of time, or by an arc of 50.25″. Thus, by little and little, these equinoctial points will cut the ecliptic more and more to the westward, till, after 25,800 years, they return to the same point. See DAY; ECLIPTIC; EQUATOR.

Equinoxes, Precession of the, the motion of the equinoxes along the ecliptic due to the change in the direction of the earth's axis of rotation, caused by the attraction of the moon and sun on the protuberant equatorial ring of the earth. See EQUINOX.

Equiseta'ceæ. See *Equisetales* under FERNS AND FERN ALLIES.

Equise'tum. See *Equisetales* under FERNS AND FERN ALLIES.

Equites, ĕk'wĭ-tēz. See EQUESTRIAN ORDER.

Equity is "that system of justice which was administered by the high court of chancery in England in the exercise of its extraordinary jurisdiction." Bispham, 'Principles of Equity.'

In England, prior to the American Revolution, the courts were divided into courts of law and courts of equity. In the law courts the parties were compelled to proceed strictly according to the law and the practice, and the forms of pleading were so intricate that many cases were decided on the pleadings without the merits of the case ever being heard; and often when the cause was heard it was impossible to administer justice on account of the form of action, the parties to the action, and the cause of action on which suit had been brought. In the courts of equity they were not restricted by the technical pleadings; amendments could more readily be granted; the parties to the action could be changed by either dropping some or adding others; and the decree could be framed to meet the particular question involved, so that justice would be done to all the parties interested.

After the Revolution the States adopted the English system; but while some of them have kept strictly to that system and have had distinct courts of law and of equity, other States have law and equity administered by the same judges and courts, at one time sitting as courts of law and at another time as courts of equity.

Some of the rules and maxims of equity are: "Equity considers that as done which ought to be done." "Equity acts *in personam.*" "He who comes into equity must do so with clear hands." "Between equal equities priority of time will prevail." "Between equal equities the law will prevail." "No right without a remedy." "When a court of equity has once acquired jurisdiction of a cause it will continue to act until the matter is finally disposed of."

Equity is divided into three great classes or divisions: Equitable titles, equitable rights, and equitable remedies. Equitable titles are those which are recognized only by a court of equity, as where, when a person gave value for a chose in action which was assigned to him, the assignment was not recognized at law, as it would violate the rules against champerty and maintenance, but equity allows the assignee to bring suit in the name of the assignor. Equitable rights arise where a guardian enters into a transaction with his former ward a very short time after the ward has obtained his majority. If within a reasonable time the ward returns what he received from the guardian the guardian will, in equity, be compelled to return the property to the ward. Equitable remedies arise in those cases in which the law recognizes a right but cannot enforce it, as where a contract is made for the sale of a piece of property, if the seller refuses to convey, the purchaser's remedy at law is for damages for breach of the contract; but in equity the court will decree specific performance. Generally this applies only to real estate, because if it is personal property, after the damages are recovered other personal property of the same kind can be purchased; but if the personal property is of such nature that it cannot be duplicated, such as a painting by a particular artist, equity will affirm relief in the way of specific performance.

Suits in equity are commenced by a bill or petition. The bill may be amended, or, if the proceeding have gone too far for that, a supplemental bill may be filed. The defense is by demurrer, plea, or answer. The judgment of the court is called a decree, and the relief granted is such as to affect all the parties, and is adapted to the facts and circumstances of that particular case. The general rules of evidence are the same as in a proceeding at law, but the answer to the bill, if made under oath, is evidence for the defendant in so far as it is responsive to the bill.

Equity, Courts of. See COURT.

Equity of Redemption. Upon a mortgage, although the estate, upon non-payment of the money, becomes vested in the mortgagee, yet equity considers it only a pledge for the money, and gives the party a right to redeem, which is called his equity of redemption. If the mortgagee is desirous to bar the equity of redemption he may oblige the mortgagor either to pay the money or be foreclosed of his equity, which is done by proceedings in chancery by bill of foreclosure. See CHANCERY; EQUITY; FORFEITURE; MORTGAGE; REDEMPTION.

Equiv'alent, having equal value, power, area, or volume. As the quantities by weight of bodies which combine with hydrogen, oxygen, and one another are fixed, there is always one simplest proportion in which they can be regarded as combining with or substituting one another. This quantity was called by Dalton the atomic weight, because he considered these proportions as the comparative weights of the atoms, or ultimate particles of the bodies. The term, however, was regarded as hypothetical, and both combining proportion and equivalent were proposed instead. The latter, which was suggested by Dr. Wollaston, was accepted, and was till quite recently applied to elements and compounds. It has been shown, however, that quantities were thus styled equivalent which were not so in any sense of the term. Thus, while one part by weight of hydrogen combines with 8 of oxygen, and 8 of oxygen with 14 of nitrogen, this quantity of nitrogen combines not with 1 but with 3 of hydrogen. Strictly, therefore, the quantity of nitrogen equivalent to 1 of hydrogen is $4\frac{2}{3}$. The older equivalent notation was consequently irregular and unsystematic,— equivalents being used in some cases but not in others. Hence has arisen the modern use of the word, in which it is expressly distinguished from the combining proportion or atomic weight. The latter is the number which best denotes the proportion in which the substance reacts chemically with all other bodies, and which is fixed by reference not to mere proportional weight, but also to vapor density, specific heat, crystalline form, diffusion, etc.; physical phenomena, in which certain relations are so constant that they presumably indicate natural laws. The former simply denotes the proportion by weight in which a body combines with or replaces a unit of hydrogen. See CHEMISTRY.

Equuleus, ĕ-kwoo'lē-ŭs, in astronomy («the Colt» or «Little Horse»), one of the 48 original constellations of the Almagest, situated just between the head of Pegasus and Delphinus. It has Aquarius on its south side. It is a very inconspicuous constellation, its brightest star being of the fourth magnitude. Also a name given to the rack, or instrument of torture.

Era. See CHRONOLOGY; EPOCH.

Era of Good Feeling, 1817–23. In American political history, Monroe's two administrations, up to the canvass for his successor. There were practically no issues, and but one party. The issue on which the Federalist party was founded had long since been appropriated by the Democrats, and it had foolishly taken theirs in exchange; the embargo and the war had created a sectional issue, but the peace ended that and left absolutely no pretext for division. The Hartford Convention (q.v.) had killed the old leaders politically; the new ones had joined the Democrats, because the embargo and the war had driven New England capital from commerce into manufactures, and it wished to demand tariff favors from the administration. But it was a decade before the tariff and internal improvements, the next division lines, assumed theoretic consistency. Monroe issued an inaugural in 1817 especially to placate the Federalists; and followed it by a tour through New England where he was received with immense ovations from both parties. He was unanimously re-elected in 1820, save for the whim of one elector who did not object to him. The personal factions which contested the field in 1824, the coalition (q.v.) which decided the result, and the Jacksonians' fury over it, effectually ended the good feeling.

Eragros'tis, a large genus of the grass family, represented in America by about 30 species, either native or naturalized. The species are from a few inches to several feet in height, and are found in nearly all parts of the United States. None are of commercial importance, and such as are used for hay are accidental growths among cultivated grasses. The strong-scented eragrostis (*E. major*), is an ill-smelling grass, but tall, erect, and rather handsome, owing to the shape and size of its leaves. It is found in almost every part of the United States and Ontario, naturalized from Europe.

Erard, ā-rär, **Sebastien,** French musical instrument maker: b. Strasburg 5 April 1752; d. Passy, near Paris, 5 Aug. 1831. He went to Paris at 18, and with his brother, Jean Baptiste, produced pianofortes so superior to any previously made in France that his fame quickly spread, and orders flowed in upon him from all quarters. During the Revolution he went to England and established a manufactory in London, and when peace was restored his life was passed between that city and Paris. His improvements upon the harp, more especially that of the double movement, the principle of which he afterward communicated to the piano, entitle him to high merit as an inventor.

Erasistratus, ĕr-a-sĭs'tra-tŭs, Greek physician. He lived in the 3d century before the Christian Era. He was the court physician of Seleucus Nicator, king of Syria, and rendered himself famous by the sagacity with which he discovered the malady of Antiochus, the king's son. He subsequently went to Alexandria, where he devoted himself to the study of anatomy. He was the first who systematically dissected the human body, and his description of the brain and nerves is much more exact than any given by his predecessors. He classified the nerves into nerves of sensation and of locomotion, and it is said had almost stumbled upon the discovery of the circulation of the blood. He was remarkably averse to blood-letting and the giving of purgatives, relying chiefly upon diet and regimen, bathing, exercise, friction, and the most simple articles of the vegetable kingdom, for the restoration and preservation of health. He wrote several works on anatomy, practical medicine, and pharmacy, of which only the titles remain, together with a great number of short fragments preserved by Galen and other ancient medical writers.

Erasmus, ĕ-răz'mŭs, **Saint,** Syrian bishop and martyr. He was put to death under Diocletian by disemboweling, and his martyrdom is frequently represented in art. As he was counted as one of the 14 Succorers of the Distressed, so was his aid especially invoked in affections of the stomach. The remaining 13 Succorers are Saints Acasius, Blasius, Christopher, Cyriacus, Dionysius the Areopagite, Egidius, Eustathius, George the Martyr, Pantaleon, Vitus, Barbara, Catharine, and Margaret.

Erasmus, Desiderius, Dutch scholar: b. Rotterdam probably 28 Oct. 1467; d. Basel, Switzerland, 12 July 1536. He was the illegitimate son of one Gerhard of Gouda. The name by which he is known is merely the Latin and Greek rendering of Gerhard, Desiderius the Latin, and Erasmus, or, more correctly, Erasmius, the Greek equivalent. He was a singing-boy in the Cathedral of Utrecht till his 9th year, then entered the school at Deventer, where he displayed such brilliant powers that it was predicted that he would be the most learned man of his time. At the age of 17 he assumed the monastic habit, but the bishop of Cambray delivered him from this constraint by taking him as a secretary. In 1492 he traveled to Paris to perfect himself in theology and polite literature, and there became the instructor of several rich Englishmen, from one of whom — Lord Montjoy — he received a pension for life. He accompanied them to England in 1497, where he was graciously received by the king. He returned soon after to Paris, and then traveled into Italy to increase his stock of knowledge. He now asked a dispensation from the vows of his order, which the Pope granted him. He visited Venice, Padua, and Rome; but brilliant as were the offers here made him, he preferred the invitation of his friends in England. When he visited the lord-chancellor, Sir Thomas More, without making himself known to him, the chancellor was so delighted with his conversation that he exclaimed, "You are either Erasmus or the devil." He was offered a benefice, but was unwilling to fetter himself by an office of this kind. He was for a short time professor of Greek at Oxford. He afterward traveled through Germany and the Netherlands, and went to Basel, where he had his works printed by Froben.

To profound and extensive learning Erasmus joined a refined taste and a delicate wit. Naturally fond of tranquillity and independence, he preferred the pleasure of literary ease and retirement to the pomp of high life. His caution and worldly prudence offended many of the best men of his times, but he did great and lasting service to the cause of the revival of learning. Like many notable men of his day who recognized the need of reforming ecclesiastical abuses, he sympathized with the beginnings of the Reformation, but repudiated it when it went to the excess of rebellion. He wished for a general ecclesiastical council, to be composed of the most learned and enlightened men, but had not the satisfaction of seeing his wish accomplished. What he did to serve the world was effected by his writings, which will always be prized for their interesting matter and graceful style. Besides his editions of various classics, the first edition of the Greek Testament from MSS. (with Latin translation), and his other philological and theological writings, may be only mentioned his well-known book in praise of folly 'Encomium Moriæ,' and his 'Colloquies.' His letters are very valuable in reference to the history of that period. See Lives by Knight (1726); Jortin (1748); Burigny (1752); Durand de Laur (1874); Feugère (1874); Drummond (1873); Froude (1894).

Eras'tians, in England, a name applied to a party that arose in the 17th century, denying the right of autonomy to the Church — a right neither maintained nor denied by Erastus. The Erastian controversy broke out at the time of the Westminster Assembly. The leading Erastians in that assembly were Lightfoot and Coleman, who were supported by Selden and Whitelocke in the House of Commons. Since the time of the Reformation the controversy has been confined chiefly to the Church in Scotland.

Eras'tus, Thomas (properly LIEBLER or LIEBER), German theologian and physician: b. Auggen, near Mühlheim, 1524; d. Basel, Switzerland, 1583. He studied theology at Basel (where he Grecized his name), and philosophy and medicine at Bologna and Padua. After nine years in Italy, he was appointed physician to the counts of Henneberg; then professor of medicine at Heidelberg, and court-physician to the elector palatine. He removed from Heidelberg to fill the chair of medicine at Basel in 1580. Shortly before his death he had been appointed professor of ethics. Erastus was a skilful physician and a man of upright character, an equally vigorous writer against "the new medicine of Philip Paracelsus" (1572) and in favor of the burning of witches (1577 et seq.). In theology he was a follower of Zwingli, and his fame now rests on his strenuous opposition to Calvinist discipline and Presbyterian order. Erastus was excommunicated on a false suspicion of heresy, founded on a correspondence with Unitarians of Transylvania, but was restored in 1575. His chief work is a treatise on excommunication entitled: 'Explicatio gravissimæ quæstionis utrum Excommunicatio . . . mandato nitatur divino, an excogitata sit ab hominibus.' This was answered by Beza in his 'De vera Excommunicatione et Christiano Presbyterio' (1590). Erastus maintained that no member of the Church should be excluded from her communion as a punishment for sin. Punishment is "the special duty and office" of the civil magistrate. See Bonnard, 'Thomas Eraste et la discipline ecclésiastique' (1894).

Erato, ĕr'a̤-tō (Gr. *eraō,* I love), one of the nine Muses, whose name signifies loving, or lovely. She presides over the songs of lovers, and touches, as Ovid, in his 'Art of Love,' informs us, the hearts of the coldest maidens by her tender lays. (See MUSES.) Erato is also the name of one of the planetoids.

Eratosthenes, ĕr-a̤-tŏs'thē-nēz, Alexandrian astronomer, geographer, and philosopher: b. Cyrene, Africa, 276 B.C.; d. about 196 B.C. He became librarian at Alexandria, and improved the science of mathematical geography, which he reduced to system, but gained his greatest renown by his investigations of the size of the earth, his estimate of the circumference of which was surprisingly near the truth. He wrote also on chronology, grammar, etc. and was considered no mean poet. He rendered much service to astronomy and first observed the obliquity of the ecliptic. He is said to have starved himself to death after becoming blind. The extant fragments of his writings were collected by Bernhardy in his 'Eratosthenica' (1822); his geographical fragments were published by Berger in 1880.

Er'ben, Henry, American naval officer: b. New York September 1832. He was graduated at the United States Naval Academy in 1854; became commander in 1868; rear-admiral in 1894; and was retired in the latter year. During the Civil War he served with Admiral Farragut in the Gulf of Mexico and on the Mississippi River with Admiral Dupont, etc. In 1866–9 he was on duty in South America; later, in command of the Tuscarora, he made deep-sea soundings in the Pacific; afterward commanded the Pensacola in a trip round the world; and in 1891–2 was commandant of the New York Navy Yard.

Er'bium, a rare metallic element, occurring in the form of a tantalate or silicate in the minerals gadolinite, fergusonite and euxenite, and as a phosphate in the mineral xenotime. It has the chemical symbol Er, or E, and an atomic weight of about 166. The oxide of erbium, Er_2O_3, has a pale rose color, is infusible, and, when strongly heated glows with a brilliant green light. It is not affected by water, but dissolves slowly in hot acids with the formation of the corresponding erbium salts. Most of the salts are rose-colored, and the haloid compounds are also deliquescent. The name erbium is derived from Ytterby, Sweden, where the mineral gadolinite is found. The recognition of erbium as a new element is attributed to Mosander (1843); but the metal itself has not yet been isolated.

Er'cildoune, Thomas of (called the Rhymer, and Learmont), a Scottish poet and seer, who flourished probably between 1220 and 1297, and wrote a poem called 'Sir Tristrem.' He occupies a very conspicuous position in the annals of Anglo-Saxon literature, but not very much is known of his life, and there is even some dispute respecting his authorship of various pieces attributed to him.

Ercilla y Zuniga, ār-thēl'yä ē thoo-yē'gä, **Alonzo de,** Spanish soldier and poet: b. Madrid 7 Aug. 1533; d. there 29 Nov. 1594. An insurrection breaking out among the Araucanians, a tribe of Indians on the coast of Chile, Ercilla joined an expedition sent against them. The difficulties the Spaniards had to encounter, the heroic resistance of the natives, and the multitude of gallant deeds by which the war was signalized, inspired the young and brave Ercilla with the idea of making it the subject of an epic poem, to which he gave the name of 'La Araucana.' He returned to Spain after having finished the first part of his epic. In 1570 he married Maria Bazan at Madrid, whose charms and virtues are celebrated by him in various passages of his poem. In 1569 the first 15 cantos of his poem, in 1578 a second, and in 1590 a third part were added, making in all 37 cantos; he did not live, however, to complete the work, but died in great poverty and obscurity. The 'Araucana' is an historical epic in the octave measure, in which the author confines himself, with the exception of some episodes and a few fictions, to the exact historical course of events. Hence the poem often assumes almost the character of a chronicle. Lope de Vega has taken from the epic of Ercilla the materials for his piece 'Arauca Conquered.' The best editions are those published at Madrid in 1776 and 1828. It has been translated into Italian, and twice into French. See ARAUCANIANS.

Erckmann-Chatrian, ĕrk'män - shä-trē-äṅ', the combined surnames of two Frenchmen, natives of Alsace, who collaborated in writing romances. EMILE ERCKMANN: b. Phalsbourg 20 May 1822; d. Paris 14 March 1899. Having completed his studies in the communal college of his native town, he went to Paris in 1842 to study law. Returning to Phalsbourg in 1847 because of a serious illness, he began to turn his attention to romance writing during his convalescence. It was about this time (1848) that he met his collaborateur, LOUIS GRATIEN CHARLES ALEXANDRE CHATRIAN, b. Soldatenthal 18 Dec. 1826; d. Raincy 5 Sept. 1890. Chatrian's father was a glass-blower, and it was intended that he should follow the same craft. Instead of doing so, however, he left his native village and became a teacher in Phalsbourg, where he made the acquaintance of Erckmann. For several years the stories produced by this co-partnership were published in obscure newspapers, both in Strasburg and Paris, but about 1860 their graphic romances of eastern France in the time of Napoleon I. gained a rapid popularity. Their success was continued in a series of which the best known are: 'Le Fou Yégof (1862); 'L'Ami Fritz' (1864); 'Histoire d'un Conscrit de 1813' (1864); 'Waterloo' (1865); 'Le Blocus' (1867); 'Histoire d'un Paysan' (1868); and 'Contes Populaires.' They also published three plays — 'Le Juif Polonais' (known in its English adaptation as 'The Bells'), a dramatized version of 'L'Ami Fritz' and 'Les Rantzau.' When the two friends met they elaborated the scheme of a work; then Erckmann wrote it. Chatrian corrected it, and sometimes put it in the fire. Erckmann would even be required by his friend to write his story over three times. Latterly the two friends disagreed, and the world received no more of their minute transcripts from the daily life of the Alsatian peasant.

Erdmann, Johann Eduard, yō'hän ĕd'oo-ärd ĕrd'män, German philosopher: b. Wolmar, in Livonia, 13 June 1805; d. Halle 12 June 1892. In 1829 he became a clergyman in his native town, and in 1836 professor extraordinary of philosophy at the University of Halle, being appointed ordinary professor in 1839. He wrote numerous philosophical works, characterized for the most part by their Hegelian tendencies. Of these some of the chief are: 'Body and Soul'; 'Nature and Creation'; 'Outlines of Psychology'; 'Outlines of Logic and Metaphysics'; 'Psychological Letters'; 'Belief and Knowledge,' etc. His greatest work, however, is his 'Outlines of the History of Philosophy,' of which an English translation appeared in 1889.

Erdmann, Otto Linné, ŏt'tō lin-nā', German chemist: b. Dresden 11 April 1804; d. Leipsic 9 Oct. 1869. His researches embrace a wide range of subjects. He examined minutely the technology of nickel, and described some of its compounds; analyzed a number of minerals and slags, and experimented on several other points of inorganic chemistry. In organic chemistry his chief research is upon indigo, in the course of which he discovered isatin. The most important work in which he engaged was that upon the combining weights of several of the elements. In company with Marchand he made determinations of oxygen, carbon, hydrogen, sulphur, calcium, copper, mercury, and some others, and his numbers have been fully confirmed by subsequent experimenters. He was the author of a chemical text-book and for many years conducted the 'Journal für technische und ökonomische Chemie,' which was afterward changed to the 'Journal für praktische Chemie.'

Erdmannsdörfer, ĕrd'mänz-dėrf-ĕr, **Bernhard,** German historian: b. Altenburg 24 Jan. 1833; d. 1901. He held professorships of history at several German universities, and among his more important works are: 'Das Zeitalter der Novelle in Hellas' (1870); 'Deutsche Geschichte vom Westfälischen Frieden bis zur Regierungszeit Friedrichs des Grossen' (1890–4).

Erdmannsdörfer, Max, German musician: b. Nuremberg 1848. He conducted the court orchestra at Sondershausen 1871-80, becoming director of the Imperial Musical Society at Moscow 1882 and professor in the conservatory in that city. He was leader of the Philharmonic Society at Bremen 1889–95, and became leader of the court orchestra at Munich 1896. His chief works are: 'Prinzessin Ilse' (1870); 'Schneewittchen' (1873); and 'Traumkönig and sein Lieb.'

Er'ebus, in Greek mythology, the son of Chaos and Darkness. He married his sister, Night, and was the father of the Light and Day. The Moirai, or Fates, by some are called his daughters. He was transformed into a river, and plunged into Tartarus, because he aided the Titans. From him the name Erebus was given to the infernal regions, particularly that part of it designated as the abode of virtuous shades, whence they pass over immediately to the Elysian fields.

Erebus, Mount, an active volcano on Victoria Land, in lat. 78° 10' S., rising 12,367 feet above the sea. It was discovered in 1841 by Ross, who named it after one of his vessels. His progress further south was barred by a wall of ice.

Erechtheum, ē-rek-thē'ŭm, the temple of Erechtheus (q.v.) on the Acropolis at Athens. It was built in honor of Athene, Poseidon, and Zeus. The name of Erechtheus is associated, as a local hero or demigod, with that of Athene. In this temple was preserved the oldest existing statue of Athene, which was fabled to have fallen from heaven, and the sacred olive-tree created by Athene as a gift to the city, of which she is worshipped as Athene Polias, the protector of the town and state. The building is one of the finest remaining examples of Greek architecture, having been rebuilt during the Peloponnesian war in pure Ionic style. Its ground plan is unusual, resulting from the union under one roof of three separate chapels, or halls of worship. The porch of the caryatides is one of its distinguishing features. In this porch the place of columns is taken by colossal figures of women whose heads support the capitals on which the entablature rests.

Erechtheus, ē-rĕk'thūs, Attic hero or demigod, worshipped in the earliest period of Athenian history. He was brought up by Athene, who placed him while yet a babe in a chest, which was entrusted to Agraulos, Pandrosos, and Herse, the daughters of Cecrops, with the strict charge that it was not to be opened. Unable to restrain their curiosity, they opened the chest, and discovering a child entwined with serpents, were punished with frenzy, and threw themselves down the most precipitous part of the Acropolis. Afterward Erechtheus was the chief means of establishing the worship of Athene in Attica, where he instituted the Panathenæa in her honor. See ERECHTHEUM.

Eremacausis, ĕr'ē-ma-kâ'rĭs, slow combustion (from Greek *ērēma,* gently, and *kausis,* burning), a term employed by Liebig to denote the gradual combination of the constituents of a combustible substance with the oxygen of the air.

Eremites (ĕr'e-mīts) **of St. Francis,** and **Eremites of St. Jerome,** two religious orders of the Roman Catholic Church. The order of the Eremites of St. Francis de Paula was founded by Francis, a native of Paula, in Calabria, 1436, and had there its first house. It received the approval of the Holy See 1474; it is properly styled Order of Minim Hermits of St. Francis de Paula (Ordo Minimorum Eremitarum Sancti Francisci de Paula). Their founder chose the name "Minims" (*minimi,* least, littlest) to keep the brethren ever in mind of the Christian humility to which they were vowed. The order of Eremites of St. Jerome, styled also Hieronymites, consisted originally of hermits, but they adopted the cenobite rule of St. Austin with the approval of Gregory XI., 1373. This order was confined to the Spanish peninsula.

Ere'tria, Greece, an ancient Ionic trading and colonizing town on the southwest coast of Eubœa, which was destroyed by the Persians in 490 B.C., and rebuilt by the Athenians. The recent excavations and explorations made by the American school at Athens and the Greek Archæological Society, have resulted in finding an old temple and many other buildings.

Erfurt, ĕr'foort, Germany, (1) town, in the Prussian province of Saxony, formerly the capital of Thuringia, and a fortress till 1873), situated on the river Gera, about 13 miles west of Weimar. In the 15th and 16th centuries Erfurt was a flourishing commercial and manufacturing place, but its university made it one of the most famous of German cities. The university, established in 1378, was suppressed in 1816. Its trade and manufactures have rapidly increased in recent times along with its population. The most characteristic industry is that of flower-growing, plants and seed being exported in enormous quantities to almost all parts of the world. The most important edifice is the cathedral. The large bell called *Maria gloriosa,* made of the finest bell-metal, and weighing 275 hundredweights, hangs in one of the towers. The cell in which Luther lived while an Augustinian monk, from 1505 to 1512, containing his Bible, portrait, etc., was in the Martinsstift or orphan-house into which the old Augustinian convent had been converted, but was destroyed by fire, along with the relics of Luther, in 1872. According to tradition Erfurt was founded as early as the 5th century, by a certain Erpes. It was not a free imperial city, but always maintained a sort of independence. Saint Boniface established here an episcopal see. In 1483 it concluded a treaty with Saxony, by which it agreed to pay an annual sum for protection. In the 17th century the Elector of Mainz obtained possession of it. The Congress of Erfurt (September–October 1808) was attended by Napoleon, Alexander of Russia, and many German sovereigns. In 1813 the town was taken by the Prussians, after a severe bombardment. In 1814 it was granted to Prussia by the Congress of Vienna. Pop. 73,581. (2) The government of Erfurt of which it is the capital has an area of 1,263 square miles. Pop. 434,180.

Erg (Gr. «work»), in physics, the unit of work in the C. G. S. system. It is the work done in overcoming a force of one dyne, through a distance of one centimetre. See UNITS.

Er'gograph, The, a machine for testing a child's capacity for study, and which shows the degree of fatigue that is experienced by pupils. Its operation is based on the fact that the fatigue of a set of muscles, if accurately measured, will show the extent of the general weariness. The physical deterioration of many school children has been a source of anxiety to both physicians and instructors; if by means of this instrument the exact power of endurance of each pupil can be demonstrated, the course of study can be so arranged as to suit different temperaments and so lessen the mental strain. Also a machine for registering the exact effort made in any feat of strength, testing the comparative and relative strength of various sets of muscles.

Ergot, ėr'gŏt, according to the United States Pharmacopœia, «is the sclerotium of the fungus *Claviceps purpurea* replacing the seed of the rye.» Thus the Pharmacopœia calls for a certain definite kind of ergot for medicinal use; but there are a number of allied species of parasitic fungi that infest not only the rye, but a number of other grasses; other species of the same genus (*Claviceps*), and other genera. Both the botanical and physiological relationships of these forms are close. The ordinary ergot of commerce consists of purplish grain-like masses, one half to three quarters of an inch long and one eighth to one quarter of an inch wide, and somewhat resembling large grains of rye. Microscopically the ergot is made up of the closely matted mycelium of the fungus, which has entirely replaced the cells of the seed.

The fungus is propagated by means of minute spores. These are blown about by the wind, or carried about by insects, and lodge upon rye or other grasses. They there germinate and form a more or less viscid yellowish mass filled with spores of another type, the conidia. These in turn may be carried by insects to other grasses. As the fungus grows and, little by little, replaces the tissue in the grain, there results a brownish to blackish mass which in different species assumes different shapes. These are collected with the different grasses and may be the cause of various types of poisoning in cattle. The fungus growing on rye constitutes the ergot of commerce, which has been used in medicine for many years. The principal sources of ergot at the present time are Spain and Russia.

Chemically considered, ergot is an extremely complex body, and it cannot be said that even at the present time a full knowledge of its composition has been gained. It contains large quantities of an inert fixed oil, a resin, and one or two active principles which, from the earliest chemical investigation to the present, have been called by no less than 50 or 60 different names, among these being ergotine, ecboline, ergotin, cornutine, sphacelic acid, ergotic acid, etc. The unsatisfactory condition of organic drug analysis accounts for these varying results and confusions. The investigations of Kobert (1890) and his students are the first of real merit, and Kobert isolated a body cornutine to which he ascribed the chief activity of ergot. More recently, however, Jacobi, a student of Schmiedeberg, has isolated two bodies, sphacelotoxin and chrystoxin which are, he claims, the active principles.

Taken internally, ergot has the singular power of stimulating an involuntary muscle, causing it to contract. In this manner it produces a number of reactions on those organs which are rich in this type of muscular fibre. Acting on the heart and blood vessels, it contracts the cardiac muscle and the arterial walls, causing an increase in the force of the heart's contraction and a marked rise in the blood-pressure. It also stimulates the unstriped muscular tissue of the stomach and intestines, occasionally causing purging with violent peristalsis. The organ in the body containing the greatest amount of unstriped muscular tissue is the uterus, and naturally the action of ergot would be most forcibly manifested in this organ. It here causes contractions, the uterus becoming hard and pale, and forces the blood out of the uterine blood vessels. During pregnancy the action is much more pronounced, since the uterus is so much more dilated. Ergot has many applications in medicine, but its chief uses are to control blood pressure and to treat uterine disorders.

Er'gotism. In the article on ergot it has been shown that there are a great many closely related parasitic fungi, growing on different varieties of grasses. A number of these infected grasses, belonging to the ergot family produce, when eaten by cattle, forms of acute and chronic poisoning. These are characterized by changes, particularly in the blood vessels, causing swellings below the knees or ankles, with gangrene of the skin, and at times symptoms of paralysis of the extremities. In years in which unusual humid conditions have permitted the wide and abundant growth of these parasitic fungi, large areas of pasture land have become infected, resulting in widespread poisoning of cattle, almost resembling epidemics.

In Europe, where the eating of rye bread is much more common than in this country, particularly in Russia and Italy, cases of chronic poisoning by ergot occur in man from eating the bread made from infected grain. The chief symptoms here are those referable to changes in the blood vessels of different parts of the body, with secondary consequences. Thus, in some, there is a loss of touch-sensations in the hands and feet, a condition which may go on to the formation of ulcers and gangrene. This is the result of the cutting off of the blood supply to the periphery of the body by the contracting influence of the poison on the walls of the blood vessels. In some cases disease of the spinal cord results. This is thought to be due to the artificially induced anæmia with secondary degenerations in the columns of the cord. This disease, called pellagra, closely resembles a toxic neuritis, or locomotor ataxia. See ERGOT; PELLAGRA.

Eric, ē'rĭk or ā'rĭk, the name of several Danish and Swedish kings. ERIC VII., king of Denmark, b. 1382; d. Rügenwald 1459; the son of Duke Wratislaw of Pomerania, was selected as her successor by Queen Margaret of Denmark, and in 1412 mounted the throne of Denmark, Norway, and Sweden, united by the treaty of Calmar. Cruel and cowardly in character, he lost Sweden in 1437 through a revolt of the peasants of Dalecarlia, and in 1439 was deposed also in Denmark. ERIC VIII., "THE SAINT," became king of Sweden in 1155, did much to extend Christianity in his dominions, and to improve the laws, and fell in battle with the Danes in 1160. ERIC XIV., the last of the name who reigned in Sweden, succeeded in 1560 to the throne of his father, the great Gustavus Vasa, and at once began to exhibit the folly that disgraced his reign. He married a Swedish peasant girl, who acquired an influence over him which was ascribed by the superstitious to witchcraft; she alone was able to control him in the violent paroxysms of blind fury to which he was subject. His capricious cruelties and the disastrous wars that followed on his follies at length alienated his subjects, who threw off their allegiance in 1568 and elected his brother John to the throne. In 1577 he ended his miserable life half voluntarily by a cup of poison. He had a genuine love of letters, and solaced his captivity with music and the composition of psalms. His story has been worked into dramatic form by Swedish poets; in German by Kruse in his tragedy, 'King Erich' (1871).

Eric the Red, the colonizer of Greenland: b. Norway about 950. After committing homicide he fled to Iceland and in 984, again seeking asylum as a murderer, he reached Greenland. Here he built a chief town, called Gardar, which he settled with Norwegians. His son, Leif Ericson, introduced Christianity, but after flourishing for about four centuries the colony was wiped out, probably by some such plague as black death, although recent authorities attribute its disappearance to famine.

Ericaceæ, ĕr-ĭ-kā'sē-ē, the heaths, a family of shrubs or under-shrubs with small leaves, evergreen in some of the genera, rigid, whorled, or opposite, and without stipules. The flowers are arranged in various styles of inflorescence, and are generally very beautiful, the heath probably excelling all other families in the universal beauty of its blossoms. Different writers number the genera from 40 to 70, and the species from 1,000 to upward of 1,300. They are of very wide distribution, the greater number being natives of South Africa. In the North American flora, at least 20 genera are represented, among them such plants as the azaleas, rhododendrons, kalmias, trailing arbutus, and the heaths.

Er'ichsen, SIR **John Eric,** English surgeon: b. Copenhagen, Denmark, 19 July 1818; d. Folkestone, England, 23 Sept. 1896. He became a member of the Royal College of Surgeons in 1839, and in 1850 professor of surgery at University College. In 1865 he succeeded Quain as professor of clinical surgery in the same college, a post which he held till his retirement in 1875. He was appointed president of University College in 1887, and held that post till his death. His most important work was his 'Science and Art of Surgery' (1853), which has gone through many editions, and has been translated into several languages. He also published a volume on 'Concussion of the Spine' (1875).

Ericht, ĕr'ɪʜt, **Loch,** a lake in the Grampian Mountains, in Scotland, on the boundary between the counties of Perth and Inverness; it is 60 miles northwest of Perth. It is 14⅝ miles long, from ¼ to 1⅛ miles wide, and 1,153 feet above sea-level. It has two outlets, one flows into Loch Lydoch and one into Loch Rannoch.

Erichthonius, in Greek mythology, the son of Dardanus and Bateia, and grandson of Zeus. He obtained the kingdom of Troy by the death of his brother Ilus without children. He married Astyoche, the daughter of Simos, by whom (or according to some by Callirrhoë, the daughter of Scamander) he became the father of Tros. The myth or tradition of Erichthonius is sometimes blent or confused with that of Erectheus.

Ericson, Leif, līf ĕr'ik-sŏn, Icelandic discoverer. According to Sagas he was the son of Eric the Red (q.v.) and at the beginning of the 11th century discovered a transatlantic country, which he called Vinland, from the vines which abounded there. Here an Icelandic settlement was established, but whether the coast was Labrador, Newfoundland or some region farther south has not been decided. A much idealized statue of Leif Ericson adorns Commonwealth Avenue, Boston, the work of Miss Anne Whitney, the sculptor.

Er'icsson, John, American inventor: b. Wermland, Sweden, 31 July 1803; d. New York 8 March 1889. He entered the Swedish army in 1820, but resigned in 1827, and soon became known as an inventor. In 1828 he made the first application to navigation of the principle of condensing steam and returning the water to the boiler; later he brought out a self-acting gunlock by means of which naval cannon could be automatically discharged at any elevation without regard to the rolling of the ship. In 1833 he designed a caloric engine; and in 1836

JOHN ERICSSON,

INVENTOR OF THE MONITOR.

invented the screw propeller, which revolutionized navigation. Ericsson came to the United States in 1839 and two years later built the screw-propelling warship Princeton for the government. This was the pioneer of modern naval construction and the foundation of the steam marine of the world. The achievement, however, which made him most famous in the United States was the construction in 1861 of the ironclad Monitor, which was built under a patent granted by the United States government to Theodore Ruggles Timby (q.v.), the inventor of the revolving turret, etc., was launched 100 days after its keel was laid, and arrived in Hampton Roads just in time to defeat, on 9 March 1862, the Confederate ironclad Merrimac, which had destroyed several wooden warships. But for this signal victory the result of the War would doubtless have been changed and European interference attempted. A fleet of monitors was soon built and did important service during the remainder of the War. His remains were taken to Sweden on the cruiser Baltimore, and interred with imposing ceremonies. The centenary of his birth, 31 July 1903, was observed in New York by the unveiling of a bronze statue of the inventor in Battery Park and in Worcester, Mass., which has a Swedish population of 2,000, by public orations and eulogies.

Ericsson, Nils, Swedish engineer: b. Stockholm 31 Jan. 1802; d. there 8 Sept. 1870. He was a brother of John Ericsson (q.v.). He received the appointment as colonel of the Naval Engineering Corps 1850, becoming director of government railroad construction 1858. Among his engineering achievements were the construction of the Stockholm docks, the canal between Lake Saima and the Gulf of Finland and the Trollhättan Canal sluices.

Eridanus, ē-rĭd'a-nŭs, a river famous in mythology, mentioned in the return of the Argonauts. It is located in northern Europe and by some said to mean the Rhône, but generally thought to refer to the Po, in Italy. When Phæthon was struck by the thunderbolts of Zeus he fell into this river — and his three sisters, the Heliades, lamented him until they were changed into poplars. They did not cease to weep for him even in this condition; and their tears falling into the water of the river, became transparent amber.

Erie, Kan., city, county-seat of Neosho County; 115 miles west by south of Wichita; on the Atchison, T. & S. F. and the M. K. & T. R.R.'s. It is surrounded by a good farming country; and contains flour-mills, grain elevators, and lumber yards. There are oil and natural gas fields nearby. Pop. 1,318.

Erie, Pa., city, port of entry, county-seat of Erie County, on Lake Erie, and on the Lake Shore, the Pennsylvania, the Erie, and several other railroads; 85 miles southwest of Buffalo; 100 miles northeast of Cleveland. Erie is on a bluff having a grand view of the lake, is laid out with broad streets at right angles with each other, and has several large and attractive parks. It is lighted with gas and electricity, and has a bountiful supply of water from the lake. The peculiarly advantageous location of Erie has given it high rank as a shipping and manufacturing point. It has the largest land-locked harbor on Lake Erie. The harbor has been greatly improved, and is now 5 miles long by 1 mile wide, depth 9 to 25 feet. Presque Isle, lying directly in front of the city, furnishes means of ample protection; three lighthouses stand at the entrance to the harbor, and substantial wharves, where merchandise is transferred directly from vessels to cars, extend along the entire front. The principal industries are manufactures of iron, steam engines, machinery, car-wheels, car-work, and stoves; flour and grist mill products, brick, leather, organ, pump, furniture, and various kinds of woodwork factories, petroleum refineries, breweries, and malt-houses. The leading articles of shipment are lumber, bituminous and semi-bituminous coal, iron ore, petroleum, and manufacturing products, and these are conveyed by railroads, steamboats, and sailing vessels that ply regularly between Erie and other ports on the Great Lakes. Among the notable buildings are the City Hall, Union Depot, Government Building (including Post-office, Custom House, and other departments), State Soldiers' and Sailors' Home on Garrison Hill, Hamot Hospital, St. Vincent Hospital, Protestant Home for the Friendless, United States Marine Hospital, and Central School. Near the city is a memorial in the form of a blockhouse, erected by the State, in honor of Anthony Wayne. The city has excellent public and private schools, a public library, daily and weekly newspapers, three national and several savings banks. Erie occupies the site of a French fort, called Fort de la Presque, built in 1749; was laid out as a town in 1795; had a portion incorporated as a borough in 1805; and the whole was given a city charter in 1851. It was the headquarters of Commodore Perry in the War of 1812; the fleet with which he defeated the British in the battle of Put-in-Bay (10 Sept. 1813) was built and equipped here. Natural gas was discovered in 1889. Pop. (1900) 52,733.

Erie Canal. See CANALS.

Erie, Fort. See FORT ERIE.

Erie, Lake, one of the Great Lakes of North America; situated between lat. 41° 30′ and 42° 52′ N., and lon. 78° 53′ and 83° 25′ W. It lies between Lakes Huron and Ontario and is bordered on the north by Canada, on the east and south by New York, Pennsylvania, and Ohio, on the west by Ohio and Michigan. Its greatest extent is northeast and southwest; it is about 245 miles long, 50 miles wide (from 28 to 58), and has an area of about 9,900 square miles; is 573 feet above sea-level, 8 feet below Lake Huron; has a maximum of 210 feet, and an average depth of 100 feet. It receives, through the strait, Detroit River, the waters from all the other Great Lakes except Ontario; and the chief streams exclusive of the waters from the Great Lakes which flow into it are the Grand, from the north, the Maumee, Sandusky, Huron, Grand, and Cuyahoga from the south. Its outlet is Niagara River which flows into Lake Ontario. Some of the indentations are the bays of Sandusky and Maumee, on the south coast, and Long Point Bay on the north. In the western part is a group of islands, some of which are Point Pelee, Kelly's, North, Middle, and South Bass. Lake Erie is the shallowest of all the Great Lakes, and dangers to navigation are increased by the heavy ground-swell. In 1670 the Weather Bureau of the United States established a number of stations on the Great

Lakes, and since have made accurate observations and reports on the rainfall, the changes taking place, and other matters connected with these lakes. In 1872 the water in Lake Erie was below normal, and the rainfall was below normal at every station on the Great Lakes (Ontario stations not considered in these statements). In 1876 the water in Lake Erie was higher than usual, the rainfall at all stations above normal except Marquette, where it was nearly an inch below. In 1878 the Lake was again high; the rainfall also above normal except at Duluth and Grand Haven, where it was below normal. In 1882 the Lake was again above normal, and at 10 stations the rainfall was above normal, but at Milwaukee, Detroit, and Buffalo it was below normal. In 1902 the rainfall at all stations was heavy and Lake Erie was above normal. The effect rainfall has on the level of Lake Erie has been shown from the observations made since 1870. The destruction of lakes is largely due to filling from deposits brought by inlets or tributaries; every particle of sediment brought into a lake tends toward its destruction. Another danger is in changes in outlets. Where the Niagara River emerges from Lake Erie there has been but little change for centuries. It flows through a plain, and the channel is to-day, apparently, what it was hundreds of years ago; but «Niagara is wearing back its falls toward Lake Erie; and in given time, as a result of this work, it will so lower the outlet as to completely drain Lake Erie.» The importance of Lake Erie for commercial purpose has been greatly enhanced by its canal connections. The Welland Canal around Niagara Falls removes obstacles to direct navigation from the Atlantic; the Erie Canal connects the Lake by a short route, with the Hudson River; canals crossing Ohio connect the Lake with the Ohio River. There are many excellent harbors, not all of them in use by the large steamship lines. Some of the principal ports are Buffalo, Erie, Cleveland, Sandusky, and Toledo. At Put-in-Bay, near Sandusky on 10 Sept. 1813, took place the Battle of Lake Erie (q.v.) The Americans were successful, and the result was most important to the United States; it had much to do with the regaining of the territory of Michigan, which at the time was in possession of the British. Consult: Russell, ‹Lakes of North America›; Smithsonian An. Report, ‹Modification of Great Lakes by Earth Movement› (1898).

Erie, Lake, Battle of, 10 Sept. 1813: a naval battle which annihilated the British fleet on that lake, and gave the Americans their northwest at the Treaty of Ghent. In 1813 it had become evident that the reconquest of the northwest from the British, who had captured Detroit and were building a fleet at Malden, near by to control the Lake, depended on wresting the control from them; and Oliver Hazard Perry spent from 27 March till September building a rival fleet at Presque Isle, now Erie, Pa. It had nine vessels: the Lawrence, flagship, 20 guns; the Niagara, Capt. J. D. Elliott, 20 guns; the Caledonia, three-gun brig; five two-gun schooners and a one-gun sloop; in all 54 guns with 714 pounds metal at a broadside. The British had six vessels averaging much heavier, with 63 guns averaging much lighter — about 430 pounds to a broadside; but most of them were far longer range than the American, whose policy therefore was close action. The crews were about equal, some 500 each. The British commandant was Capt. Robert H. Barclay, a veteran of Nelson's; two of the captains were veterans also. The fleets engaged off the islands north of Sandusky Bay, near noon of 10 September. Perry in the Lawrence, with two gunboats, came to close quarters shortly after, and if the whole fleet had followed, the British would soon have been overwhelmed; but for some reason (hotly disputed and a sore point for many years) the other vessels kept off and played away at long range, while for two hours the British vessels concentrated their fire on the Lawrence. Such carnage was scarcely ever known on the ocean; of 103 officers and men, but 20 were unhurt; the vessel was literally shot to pieces, and the very wounded were killed on the surgeon's board by the crashing balls. Seeing that no more could be done with it, Perry turned over the command to a lieutenant, transferred himself in a small boat to the Niagara, now tardily drawn nearer, brought that and the rest into close action, and in 15 minutes (about 3 P.M.) forced the entire British fleet to surrender. The latter was in a dreadful condition, too; the English had fought with heroism and skill, but a third of its force was disabled or dead. The losses were: Americans, 27 killed, and 96 wounded; British, 41 killed and 94 wounded. The battle raised Perry to the summit of naval fame, justly, for no victory was ever more due to the genius and energy of one man, and few naval battles have had such momentous results. The remains of the slain officers were buried at Put-in-Bay Island in 1858. Maclay's ‹History of the Navy› (Vol II. 1894); Spears' ‹History of Our Navy› (1899); Roosevelt's ‹History of the Naval War of 1812› (1882); Henry Adams, ‹History of the United States› (Vol. VII. 1891).

Erie Railroad. Chartered 24 April 1832, by the New York State Legislature to construct a railroad from Lake Erie to the Hudson river, the New York & Lake Erie Railway Company was organized with a capital of $3,000,000, the credit of the State being extended to a like amount. The charter provided that the road should make no connection with any railroad in New Jersey or Pennsylvania without special legislative consent and also provided that it should run through the southern tier counties of New York. This plan was in accordance with the idea advanced by W. C. Redfield in 1830 when he proposed a railroad from the Atlantic to the Mississippi river. His plan was that it should be a great national road to follow the so-called «Appian Way» advocated by Generals Clinton and Sullivan in 1780 to further the development of what then constituted the United States.

In 1841, the railroad was opened from Piermont, at the extreme southern point of New York State on the Hudson river, inland to Goshen, Orange County, a distance of 46 miles. Opposed at it was by the canal counties and their representatives in both the State and National Legislatures, the Erie had to fight for its existence from its birth through a series of legislative obstructions and financial manipulations that developed even in its early days. Before its completion to Dunkirk, which was the objective point on Lake Erie, and as a consequence of these obstacles to progress, the road had to be placed in the hands of a receiver. In 1845, the State released its claim for the money advanced for construction and through the energetic efforts of the Erie's friends, it was finally opened by President Fillmore, Daniel Webster, his Secretary of State, and other government and state officials, from Piermont to Dunkirk, on 22 April 1851, a distance of 463 miles. From Piermont, passengers were conveyed to New York by steamer. This operated so much to the disadvantage of the road that its charter was amended in 1852 permitting it to pass through New Jersey to its present terminal in Jersey City, and Piermont was abandoned as a terminal in May, 1861. Previous to that abandonment, the road was again — in 1859 — in the hands of a receiver and was sold to the Erie Railway Company in 1861. This new company also bought the Buffalo and New York City Railroad and so secured independent entrance into Buffalo, which was made its principal lake terminal in place of Dunkirk. It has so remained up to this time. The company also took over the Union Steamboat Company, operating on Lake Erie, in the same year and so added Cleveland and Detroit to its lake terminals.

In accordance with English ideas, the road was built with a six foot gauge, a mistake in construction that for years acted as a deterrent to its successful operation, owing to the fact that contents of cars had to be transferred at connecting points. Another mistake of its early managers was a refusal of the Erie to accept entrance into New York City over the New York & Harlem lines, then being constructed and which later passed to the control of the New York Central. But this management did see the value of the coal traffic and in 1861, it entered the anthracite coal fields of Pennsylvania and later through its Bradford branch, reached the bituminous fields. But in the meantime, it had become a financial foot-ball in Wall street, partly through a desire to combine with the Atlantic & Great Western, then building through Ohio, for the purpose of making a route to St. Louis on the Mississippi river. A connection to the Ohio river at Cincinnati was ultimately effected through a combination with the Atlantic & Great Western and an operating connection with the C., H. & D. completed 33 years after the first work on the Erie was begun.

In 1867, Jay Gould and Colonel James Fisk came into possession of the Erie and from 1868 to 1872 a fight ensued between Gould, Vanderbilt, Fisk, James McHenry, and Daniel Drew for the possession of the property, resulting in its spectacular wreckage after one of the bitterest and most vindictive railway wars in history. The contest for the possession of the property and the financial manipulations indulged in enriched all who were interested excepting the actual owners of the road and these it impoverished as it did the road itself. At the conclusion of this historic fight, Hugh J. Jewett came in as president in 1874 and a year later was made receiver, the property having been purchased by the security holders to prevent its complete wreckage. It was reorganized in 1878 as the New York, Lake Erie & Western. It then owned 525 miles of road and leased 400 more. The road was converted into a standard gauge road at a cost of $25,000,000 and was double tracked from Jersey City to Buffalo.

Attempts to enter Chicago, first over what is now known as the "Panhandle Route," and later over the Pittsburg, Fort Wayne & Chicago were successfully blocked by rivals and it was not until 1883 that it secured an entrance into the western metropolis over the Chicago & Atlantic Railway. Under succeeding managements, the road, in spite of the enormous financial obligations which hampered it, was operated as a paying and successful property until the panic of 1883–4. The obligations accruing because of its purchase of the Chicago & Atlantic and Pennsylvania coal properties led the road to still further embarrassment and finally to another receivership in 1893. Two years later, the company was reorganized as the Erie Railroad Company and assumed possession of the property on 1 Dec. 1895, which it has since operated.

The history of the Erie Railroad is briefly the history of railroading in the United States. The total mileage of the Erie is 2,147, made up as follows: *Erie Division*: New York Div., 197 miles; Delaware Div., 128 miles; Susquehanna Div., 140 miles; Jefferson Div., 43 miles; Tioga Div., 65 miles; Rochester Div., 146 miles; Buffalo Div., 203 miles; Alleghany Div., 131 miles; Bradford Div., 83 miles; Wyoming Div., 59 miles. *Ohio Division*: Meadville Div., 225 miles; Cincinnati Div., 197 miles; Mahoning Div., 164 miles; Lima Div., 127 miles; Chicago Div., 123 miles; Greenwood Lake Div., 52 miles; Northern R. R. of New Jersey, 26 miles; New Jersey & N. Y. R. R., 38 miles.

For the year ending 30 June 1905, the total earnings were $45,724,737, other income $1,048,689, operating expenses $33,142,208, leaving a total net income of $13,631,218.

A pioneer as a trunk line, it was also the first railroad to adopt what are now universal methods — among these, the running of trains by telegraph, the use of a printed time table, the running of Sunday trains, emigrant trains, and special service for suburban passengers, the use of parlor cars, the establishment of dining rooms along the line, the establishment of special milk trains, the running of a newspaper special train (this being done in 1842). It was also the first road to run an excursion train of the modern type with a brass band and a reduced round trip fare, the first road to use a bell cord to signal from the conductor to the engineer, the first to build up local industries by furnishing to manufacturing companies the use of switching and terminal tracks, a custom now so universal, and in more modern days, the first road to adopt all-steel baggage, express, and mail cars.

J. H. Maddy,
Special Representative.

Erigena, ĕ-rĭj'ĕ-na, **Johannes.** See Scotus, Johannes Erigena.

E'rin, an old name for Ireland. Now used only in poetry.

Erinite, a basic copper arsenate having the formula $Cu_5(OH)_4As_2O_8$, occurring as a dark green crystalline coating of fibrous structure in Cornwall, England, and the Tintic district, Utah. The name is also applied to an aluminum silicate from the Giant's Causeway, Ireland.

Erinna, ē-rĭn'a, Greek poetess: b. Rhodes or Teos, about 600 B.C.; d. at age of 19. According to some she was a Lesbian, and the intimate friend of Sappho. Others aver that she was born at Teos, Rhodes, or Telos, and that she lived in the age of Demosthenes; while others again assert that there were two poetesses of the same name. She left behind her a few poems which were thought equal to those of Homer in point of merit. The chief of them was a work of about 300 lines, called 'Elakatē' (The Distaff), of which nothing has come down to us.

Erinyes, ĕ-rĭn'ĭ-ēz. The Furies (q.v.).

Eriocaulon, ĕr-ĭ-ō-kâ'lòn, the typical genus of the pipewort family (*Eriocaulonaceæ*). See Pipewort.

Eriodendron, ĕr-ĭ-ō-dĕn'dròn, a genus of tropical trees of the natural order *Malvaceæ*. There are about a dozen species, which are characterized by digitate leaves, medium to large, white or reddish, solitary or clustered flowers, and thick, woody seed-capsules containing a cotton-like fibre which suggested the name silk cotton-tree. Some of the species exceed 100 feet in height, and furnish wood used in making boats. The seeds of several species are used for food to some extent. But the principal economic value for which these trees are noted is in the fibre which surrounds the seeds. This is too short to be successfully woven like cotton, but is highly valued in upholstery for stuffing cushions, lounges, etc., for making floss and, it is said, as a substitute for animal hair in making felt for hats. The chief source of supply is Java. It is known in various countries as kapok, rimi, bentang, etc. Various South American species of *Bombax,* a related genus, also furnish a similar fibre. Like many other species of the natural order *Malvaceæ*, the species of these two genera also furnish a valuable bast fibre which is used for rope and cordage-making. One species, *E. occidentale,* is grown in California to a small extent as an ornamental tree under the name *Ceiba occidentalis.*

Eriom'eter, an optical instrument for measuring the diameters of minute particles and fibres from the size of the colored rings produced by the diffraction of the light in which the objects are viewed.

Eriphyle, ĕr-ĭ-fī'lē, in the Greek mythology, the daughter of Talaus, and wife of Amphiaraus, whom she betrayed for a necklace presented to her by Polynices. The necklace was made by Hephæstus (Vulcan), and had the power of rendering whoever wore it unlucky.

Eris, ē'rĭs or ĕr'ĭs, in Greek mythology the goddess of discord, daughter of Night, and sister of Nemesis, and the Parcæ or Fates. Not being invited to the marriage of Peleus, she revenged herself by means of the apple of discord. See Paris.

Er'ith, England, town in Kent, on the Thames, about 14 miles east of London, contains the Maxim-Nordenfeldt gun-factory, engineering works, and other manufactories. Several yacht clubs have their headquarters here. Pop. 25,862.

Eritrea, ā-rē-trā'a, or **Eryth'ræa** (from Greek *erythros,* red, referring to the Red Sea), the official name of an Italian colonial possession stretching along the African shore of the Red Sea from Cape Kasar in lat. 18° 2' N. to the Sultanate of Raheita on Bab-el-Mandeb in lat. 12° 30' N. The coast-line is between 500 and 600 miles in length, and the area of the colony is about 94,800 square miles. The chief town is Massowah. Pop. of the colony about 400,000, the majority of whom are Arabs.

Erivan, ĕr-ĭ-vän', Russia, (1) a fortified town, capital of the government of the same name in Transcaucasia; on the Sanga River, 33 miles northeast from Mount Ararat. The manufactures consist of cottons, earthenware, and leather; and the situation of the town, on the caravan route between Russia and Persia, gives it a considerable transit trade. Pop. 30,275. (2) The government of Erivan has an area of 10,745 square miles, and a pop. of 1,128,003.

Erlangen, ĕr'läng ĕn, Bavaria, town on the Regnitz, 12 miles north of Nuremberg. As old as the 10th century, it owes its prosperity to the settlement here of French Huguenots after the revocation of the Edict of Nantes (1685), and to its university. The chief manufactures are articles made from wood, ivory, and horn, and some cotton goods. It has large breweries. Pop. 23,113.

Erlangen, University of, a Lutheran institution founded in 1742 in Baireuth, but the following year moved to Erlangen (q.v.). In 1760 Alexander, the then margrave of Baireuth, gave valuable assistance to the university and the name was changed to its present legal title, «Friedrich-Alexander University.» Owing to the changes of government of the country the growth of the institution was retarded until 1880. Since that time the school has increased in attendance and influence. In 1903 the number of pupils enrolled was about 1,200. Consult: Minerva.

Erlau, ĕr'low, or **Eger,** ā'ger, Hungary, town, capital of the county Heves, on the Eger, 75 miles east-northeast of Budapest. The manufactures consist chiefly of woolen and linen cloth, hats, combs, leather, shoes, and harness. The finest red wines of Hungary are made from grapes grown in the neighborhood. There are two thermal springs, one on each side of the river. Pop. 25,102.

Erl'king (Ger. *Erlkönig*), a mythical personage first introduced into German poetry, through Herder's translation of a Danish ballad, 'The Erlking's Daughter,' and made familiar to all readers by Goethe's ballad, 'Der Erlkönig,' or translations of it. This goblin is represented as exercising a malignant and fatal influence upon men, and especially children, by alluring promises or visions which lead to their destruction. The word is of Danish origin (*Ellerkonge,* or *Elverkonge,* king of the elves).

Erman, ĕr'män, **Adolf,** German Egyptologist: b. Berlin 31 Oct. 1854. He was educated at Leipsic and Berlin, receiving an appointment as associate professor of Egyptology in the University of Berlin 1883, becoming director of the Egyptian department of the Royal Museum 1855 and attaining full professorship in the university in 1892. He has paid special attention to Egyptian grammar and has written many works on Egyptology, among which are: 'Die Pluralbildung des Ägyptischen' (1878); 'Neuägyptische Grammatik' (1880); 'Die Sprache des Papyrus Westcar' (1889); 'Die Märchen des Papyrus Westcar' (1890); 'Altägyptische Grammatik' (1894); 'Gespräche eines Lebensmüden mit seiner Seele' (1896); 'Die Flexion des Ägyptischen Verbums' (1900); 'Zaubersprüche fur Mutter Kind' (1901); 'Ägypten und Ägyptisches Leben im Altertum' (1885), translated into English by Tirard with title of 'Life in Ancient Egypt' (1894).

Ermine, ėr'mĭn, any weasel (q.v.) which turns white in winter, as is the habit of all those living in snowy regions; or its pelt made up as a fur. The animal's coat becomes completely yellowish white, except the tip of the tail, which remains black. When this fur is made up into tippets, coat trimmings or garments, the black tails are attached as ornaments in rows, which gives the regularly spotted effect characteristic of ermine furs, and imitated in heraldry, under the terms "ermine" and "erminois," expressive of furs as a bearing. In mediæval times the use of this kind of fur was restricted to royalty, and later it became a part of the insignia of judges in high courts, perhaps as a symbol of the majesty of the law; whence the expression "the ermine" as a metonym for the judiciary office. Ermine is mainly derived from northern Russia and Siberia, where it is the fur of the stoat (*Putorius erminea*); but a great amount is supplied by northern Canada, from two or three American species of weasels.

Ermine Moth, any of several white moths marked with black spots as in ermine furs. The name is given in America to various bombycids, but was originally applied to a European zygænid (*Ypomoneuta pellida*).

Ermine or **Ermyne Street,** one of the four great roads constructed in England by the Romans. It led from Bishopsgate, London, by way of Durolipons (Godmanchester), Lindum (Lincoln), Danim (Doncaster) to Eburacum (York), whence it continued northward past Hadrian's wall into Scotland. At Lincoln it formed a junction with the Foss Way, leading to the southwest. The Vicinal Way, a branch from London, led through Essex, Suffolk, and Norfolk to Venta Icenorum (Caistor near Norwich) and connected with the main road at Durolipons by a branch from Camulo-dunum (Colchester).

Ern, or **Erne,** a name in poetic rather than common or scientific use for any of the sea-eagles; specifically the European white-tailed eagle of which the American bald-eagle (*Haliæctus leucocephalus*) is a near relative. See EAGLE.

Ernest Maltravers, a novel by Bulwer-Lytton, published 1837. Its sequel is entitled, 'Alice; or The Mysteries' (1838). In the preface to the first-named novel, the author states that he is indebted for the leading idea of the work — that of a moral education or apprenticeship — to Goethe's 'Wilhelm Meister.' The apprenticeship of Ernest Maltravers is, however, less to art than to life. 'Ernest Maltravers' is written in the Byronic strain, and is a fair example of the English romantic and sentimental novel of the thirties.

Ernesti, Johann August, yō'hän ow'goost ĕr-nĕs'tē, German scholar: b. Tennstädt, Thuringia, 4 Aug. 1707; d. Leipsic 11 Sept. 1781. He studied at Wittenberg and Leipsic, and, devoting himself to classical studies, became rector of the Thomas School at Leipsic in 1734, a post which he held till 1759. He became professor of theology in the university in 1759. He prepared editions of Homer, Callimachus, Polybius, Suetonius, and Tacitus, and of Xenophon's 'Memorabilia' and Aristophanes' 'Clouds,' and an excellent edition of Cicero (3d ed. 1776–7), to which he added a valuable 'Key to Cicero,' often reëdited. He was the founder of a true exegesis of Scripture by the laws of grammar and history, independent of dogmatic prepossessions. His 'Latin Speeches' gained him the name of the "German Cicero."

Ernouf, ār-noof, **Alfred Auguste,** French historical writer and publicist: b. Paris 21 Sept. 1817; d. there 15 Feb. 1889. 'New Studies of the French Revolution' (1852–4); 'The French in Prussia, 1807–8' (1872); and other works by him evince research and impartiality.

Ernst (ĕrnst) **I.** (surnamed "THE PIOUS"), Duke of Saxe-Gotha: b. castle of Altenburg 24 Dec. 1601; d. 1675. He was the son of John, Duke of Weimar, and brother of the famous Bernard of Saxe-Weimar. He fought with distinction as colonel of horse under Gustavus Adolphus, at the battles of Nuremberg, Lützen, and Nördlingen during the Thirty Years' War, and was one of the signatories to the Peace of Prague in 1635. He afterward became famous for the wisdom of his administration, for the reforms that he instituted, and for the progress his principality made during his reign. He was the founder of the Gotha line which became extinct by the death of Frederick IV. in 1824. Consult: Beck's 'Ernst der Fromme' (1865).

Ernst II., Duke of Saxe-Gotha and Altenburg: b. 1745; d. 1804. On succeeding his father in the dukedom he set about to reform the government, and ameliorate the condition of his people. He refused to allow his army to join the forces of his near relative George III., in fighting against the American colonies, although large sums were offered as an inducement. He was a patron of science; instituted for the first time a measurement of an arc of the meridian in Germany, and established an observatory near Gotha. He wrote on astronomy, and among his works are: 'Astronomische Tafeln' (1799).

Ernst II., Augustus Charles John Leopold Alexander Edward, Duke of Saxe-Coburg-Gotha: b. Coburg 1818; d. 1893. He was brother of Prince Albert, consort of Queen Victoria of England, and seems to have resembled him in tastes and character. He was instrumental in winning the battle of Eckeonporde in the war against Denmark, fought on the side of Prussia in the Austro-Prussian and Franco-Prussian wars. He wrote some successful operas.

Ernst August, ŏw'goost, King of Hanover and Duke of Cumberland: b. 5 Jan. 1771; d. 18 Nov. 1851. He was the 5th son of George III. of England. He took up his abode at Berlin, but returned to England while the discussions on Catholic emancipation were going on, and endeavored by every means in his power to prevent the passing of that measure. On the death of William IV. in 1837 he ascended the throne of Hanover, in consequence of the succession to the sovereignty of that country being limited to male heirs. His arbitrary and tyrannical disposition, which had hitherto shown itself in opposing every step in the way of political reform and progress, was now manifested by his abrogating the constitution which had been granted in 1833. In 1848, however, he was compelled to accede to popular demands, and accord the nation a more liberal form of government. He was succeeded by his son, George V., the last of the Hanoverian kings. The unpopularity of the Duke of Cumberland in Britain was extreme, and the contingency of his succeeding to the throne was regarded as one of the greatest misfortunes that could befall the nation. See Wilkinson ‘Reminiscences of King Ernest of Hanover’ (1880).

Ernst Ludwig, Grand Duke of Hesse: b. Darmstadt 1868. He succeeded to the throne in 1892.

Ernst, August Frederic, American educator: b. Hanover, Germany, 25 June 1841. He was graduated at the gymnasium, Celle, Hanover, in 1859; studied later at the University of Göttingen, and came to the United States in 1863. He was pastor of Lutheran congregations till 1869, when he became a professor in the Northwestern University. He was chosen president of the university in 1870; and was president of the Joint Lutheran Synod of Wisconsin, Minnesota, and Michigan, in 1892–5–7–9.

Ernst, Harold Clarence, American bacteriologist; b. Cincinnati, Ohio, 31 July 1856. He was graduated at Harvard University in 1876 and at its Medical School in 1880; and became professor of bacteriology there. He has published: ‘Infectiousness of Milk’ (1896); ‘Infection and Immunity’ (1898); ‘Prophylactic Hygiene’; etc., and numerous articles in scientific medical periodicals.

Ernst, Heinrich Wilhelm, hīn'rĭн vil'hĕlm ĕrnst, Austrian composer and violinist: b. Brünn 1814; d. Nice, France, 8 Oct. 1865. He was educated at the Vienna Conservatory and made his début in Munich 1830, and subsequently met with a warm reception in the principal cities of Germany. A like success attended him all over the continent. His principal compositions are his ‘Elegy’, and the ‘Phantasy from Othello.’

Ernst, Henry, American educator: b. Anspach-Uringen, Germany, 17 May 1842. He was educated in Germany and in the United States; was graduated at Concordia Seminary, St. Louis, Mo., and at the Capital University, Columbus, Ohio. He entered the Lutheran ministry in 1865, and remained actively in it till 1885, when he became president and professor of theology in the Lutheran Theological Seminary, St. Paul, Minn.

Ernst, Oswald Herbert, American military officer: b. near Cincinnati, Ohio, 27 June 1842. He was graduated at the United States Military Academy and was commissioned a brigadier-general of volunteers 1898. He was engineer in charge of western river improvements in 1878–86; had charge of harbor improvements in Texas in 1886–9; and while on the latter service began the great work which resulted in the dredging of the channel at the entrance of Galveston harbor from 12 to 26 feet. In 1893–8 he was superintendent of the United States Military Academy. In the war with Spain he went with Gen. Miles to Porto Rico in July 1898, and, on 9 Aug. led the troops in the action at Coamo. He has published ‘Manual of Practical Military Engineering.’

Ernulf, ĕr'nŭlf, or **Arnulf,** English prelate: b. France 1040; d. 15 March 1124. He was appointed prior of Canterbury by Anselm, and was subsequently abbot of Peterborough (1107) and bishop of Rochester (1114). He was equally remarkable for skill in canon law and personal saintliness; and compiled a great collection of documents about his own Church, laws, papal degrees, etc. He is alluded to in Sterne's ‘Tristram Shandy.’

Eroica Symphony, The, a famous symphony by Beethoven, first given at Vienna in 1805, under the title of ‘Bonaparte.’ It was afterward renamed *Sinfonia eroica.* See BEETHOVEN.

Eros, in astronomy, one of the minor planets, discovered photographically by Witt in 1898, at the Urania Observatory, Berlin. The orbits of most of the other known asteroids lie wholly beyond that of Mars; but Eros approaches much nearer to the sun, and at times it may be within 14,000,000 miles of the earth. It is this fact which gives the planetoid its great astronomical interest. The relative dimensions of the solar system are known with high precision, and if any dimension can be accurately measured in miles, all the other dimensions become known at once, in terms of the same unit. It is apparently possible to determine the parallax of Eros (and hence its distance from the earth in miles) with relatively high precision, and a correspondingly accurate determination of the absolute dimensions of the solar system in general will result. As Eros approaches the earth more closely than any other heavenly body except the moon, its parallax is relatively large; and the fact that its diameter is only about 20 miles, so that it appears in the telescope as a mere point of light without a sensible disk, indicates that extremely precise micrometric measures of its position on the heavens may be had. Astronomers are keenly alive to the possibilities offered by this seemingly insignificant little planet, and at every favorable opposition Eros will be studied with exceeding care. It is considered probable that by the end of the century the observations of Eros will have led to a determination of the sun's distance that will not be in error by more than 25,000 miles, the present uncertainty in this distance being probably fully 150,000 miles.

Eros, the Greek equivalent of the Latin Cupid, the god of love. See CUPID.

Ero'sion, or **Denudation,** the process of slow removal in air or water of the products of rock decay whereby the surface features of the earth are obliterated. It includes the destructive work of winds, of streams, of glaciers, and of the ocean. Its various aspects may be considered under three heads, (1) subaërial; (2) marine, and (3) submarine erosion.

1. Under subaërial erosion comes the action of air and water on all land surfaces above sea-level. Changes of temperature crack off flakes from rock-ledges and reduce them to smaller flakes.

Chemical processes, due to moisture and CO_2 in the air, break up the rock-minerals. In a climate with dry seasons the dust may be swept away by the winds (deflation), leaving the larger pebbles. Stony deserts have thus been formed in Arizona and other parts of the world. The dust-charged winds can carve and wear down rock surfaces. Instances are common in the arid regions of the West and in the desert of Sahara.

The erosive action of water begins with the raindrop. If a piece of soft ground with small stones lying about be examined closely after a shower, it will be found that soil has been beaten down and washed away from the areas not protected by stones. This action sometimes takes place on a larger scale in semi-arid climates when rock-decay is slow, and curious pillars of earth or soft rock capped by protecting boulders are formed. Examples may be found in the Garden of the Gods, Colorado. When the raindrops unite to form tiny rivulets the process of river-erosion has begun. In fact, a patch of soft ground on a hillside during a shower shows many of the phenomena of stream-formation, as likewise does even a dust-covered street. The work of surface water is continuous. Some rock-constituents are dissolved and borne away in solution; other particles are carried away in suspension and, by abrasion on rocks below, help the stream carve its channel deeper. When the current slackens some of the waste from the higher lands may be deposited, the coarser materials first. Thus mountains are worn down and plains formed. The higher the mountains, the deeper the valleys can be carved; but even the highest mountains are ultimately deeply dissected, and finally worn down so that the current of the river may not be strong enough to transport the detritus. A country thus worn down is said to have reached a base-level of erosion, and its nearly level surface forms a peneplain. If such a region be uplifted, the streams will start work again vigorously, and a new cycle of erosion will begin. A region reduced to its base-level, if neither elevated nor depressed, can remain unchanged through millions of years.

The amount of waste brought down by some rivers is enormous. Thus the Po in flood carries one part sediment to every 300 parts of water; the Ganges one part sediment to 835 parts of water. These may seen small ratios of sediment, but the total amount of material discharged annually by the Ganges is calculated to be 378,100,000 tons, while the Nile annually brings down 150,000,000 tons. The Mississippi annually brings to the Gulf of Mexico 406,250,000 tons of material in suspension, enough to lower its whole basin one inch in 300 years. It is calculated that the average amount of material removed as sediment annually by streams over the whole land surface is 600 tons per square mile.

Marine erosion includes wave-action; great waves strike heavy blows against projecting headlands, and the surf on rocky beaches charged with boulders and stones is a never-ceasing mill. The undertow of waves sweeps out and rearranges the fine material ground from the rocks; tidal currents, often strong, may bear the waste long distances, or scour channels in soft formations. If a land surface be slowly sinking, the advancing ocean levels the rock ridges and hills. Submarine erosion, the work done by ocean currents, is of little importance, since these currents are seldom strong enough to abrade rocks. The erosive work of ice differs from that of running water in several particulars and is considered (see GLACIER) separately. Consult: Lyell, 'Principles of Geology' (1872); Geikie, 'Handbook of Geology' (1893); Dana, 'Manual of Geology' (1895); Gilbert, 'Geology of the Henry Mountains' (monograph U. S. Geological Survey 1877); Powell, 'Exploration of the Colorado River' (1875); Penck, 'Morphologie der Erdoberfläche' (1894); Davis, 'Physical Geography' (1901). See GEOLOGY; MOUNTAIN; PHYSICAL GEOGRAPHY; RIVER; SHORE.

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Eros'tratus, Ephesian incendiary. To perpetuate his name as the destroyer of one of the seven wonders of the world, he set fire to the magnificent temple of Artemis (Diana), at Ephesus, on the night Alexander the Great was born (356 B.C.). The indignant Ephesians decreed that whoever pronounced his name would be put to death, a sure means of insuring his fame.

Erot'ic (Greek *erōs*, love), relating to love. — Erotic poetry, amatory poetry.— The name of *erotic* writers has been applied to certain modern French fictionists, and in Greek literature, particularly to a class of romance writers, and to the writer of the 'Milesian Tales.' These writers belong to the later periods of Greek literature, and abound in sophistical subtleties and ornaments. The best of them are Achilles, Tatius, Heliodorus, Longus, Xenophon of Ephesus, and Chariton.

Erpenius, ėr-pē'nĭ-ŭs (Latinized from *Van Erpe*), **Thomas,** Dutch Orientalist: b. Gorkum, Holland, 11 Sept. 1584; d. Leyden 13 Nov. 1624. His fame rests principally on his acquaintance with the Oriental languages. To extend his knowledge of them he visited England, France, Italy, and Germany, and became acquainted with the most eminent scholars. He learned at the same time the Persian, Turkish, and Ethiopian languages. He returned, in 1612, to Leyden, and was appointed professor of Arabic and other Oriental languages. He established a press, at great expense, for the printing of works of Oriental literature. In 1619 a second Hebrew professorship was founded at Leyden, and committed to Erpenius. Soon after he received the office of Oriental interpreter to the States-General. The most learned Arabs admired the elegance with which he expressed himself in their language, so rich in delicate peculiarities. His reputation as a perfect master of the Arabic became universal, and he was repeatedly invited by the king of Spain to explain inscriptions on the Moorish buildings and monuments. The works of Erpenius (some of which were published after his death), are held in the highest estimation. Beside his 'Grammatica Arabica,' his 'Grammatica Hebraica,' and other grammatical works, his most valuable and celebrated publication is his 'Elmacini Historia Saracenica' (1625).

Errante, Vincenzo, vēn-chĕnd'sō ĕr-rän'te, Italian poet and statesman: b. Palermo 16 July 1813; d. Rome 29 April 1891. He was many years an exile for his share in Sicilian politics. His works are two volumes of 'Tragedies and

Lyrics' (1874); the dramas 'The Feast of St. Felix' and 'Suleiman the Great'; the poems 'The Ideal' and 'Liberty.' He wrote also a 'History of the Osmanli Empire from Osman to the Peace of Carlowitz' (1882-3).

Errantia, ĕ-răn'shĭ-a̤, an order of annelids of the sub-class Polychæta, characterized by their not dwelling in fixed tubes, but wandering about freely, seeking animal food. They have a well-developed head, with protrusible pharynx usually armed with chitinous jaws, and efficient locomotary organs. A typical genus is *Nereis,* with many familiar species.

Errard, Charles, shärl ăr-rär, French painter and architect: b. Nantes 1606; d. Rome 15 May 1689. He was instructed in painting by his father, and perfected his knowledge at Rome. On his return to France he gradually rose to eminence in his profession. In 1648 he became one of the 12 founders of the Academy of Painting. He was engaged in the decoration of the Palais Royal, Louvre, and other palaces. His chief claim to notice rests, however, upon his connection with the foundation of the French academy at Rome, which was projected by him and carried into effect in 1666, with 12 pupils.

Errata, ĕ-rā'ta (Latin, the plural form of *erratum,* an error), the list of errors and corrections placed at the end or at the beginning of a book. Before the invention of printing, and for a short time after, the errata were corrected on the page where they occurred, but this was found to be inconvenient when the art became a little more developed. The first known example occurs in an annotated edition of 'Juvenal,' published at Venice in 1478, which contains a list occupying two pages. 'The Vulgate,' published in 1590, at Rome, by Sixtus V., and of which the proofs were revised by that Pope himself, contains, instead of a table of errata, a bull which excommunicated those who would dare to make any alterations in the text. The book, however, was found to contain so many blunders that it was afterward suppressed, and the Papal bull had no other effect than that of amusing the learned and creating a demand for the copies still existing, some of which have been sold for about $200. See Bull; Mistake.

Errat'ics, or **Erratic Blocks,** in geology, boulders or large masses of angular rock which have been transported to a distance from their original mountains by the action of ice during the Glacial Period. Thus on the slopes of the Jura Mountains, in France, immense blocks of granite are found which have traveled 60 miles from their original situation. See Geology; Glacier.

Errera, Alberto, ăl-bĕr'tō ĕr-rā'rä, Italian political economist: b. Venice 21 April 1841. He was educated at Padua and has held the professorship of political economy and statistics in the schools of several Italian cities, including Venice, Milan and Naples, and also at the University of Naples. Among his works are: 'Storia e statistica delle industrie venete' (1870); 'Storia delle economia politica nei secoli XVII. e XVIII. negli stati della repubblica Veneta' (1877); 'Demographia' (1892); and 'Lezione di economia politica' (1892).

Er'rett, Isaac, American clergyman: b. New York 2 Jan. 1820; d. near Cincinnati, Ohio, 19 Dec. 1888. In 1840 he entered the ministry of the "Christian Church," a sect founded by Alexander Campbell, and held pastorates in Pennsylvania, Ohio, Michigan, and Chicago, Ill. For a time, he assisted Campbell in the editorship of the 'Millennial Harbinger,' in 1866 he established the 'Christian Standard,' and published it until his death. He was president of Alliance College 1868-9; filled many offices in his Church, and wrote: 'Brief View of Christian Missions' (1857); 'First Principles, or the Elements of the Gospel' (1867); 'Letters to a Young Christian' (1877); 'Evenings with the Bible' (1884-7); 'Our Position; the Plea Urged by the People Known as Disciples of Christ' (1885), etc.

Error, (1) In astronomy, errors or differences in calculations and observations, to correct which recourse is had to a system of reduction known as the method of least squares. (2) Clerical error, a mistake in writing, a slip of the pen. (3) Joiner in error, in law; the taking of issue on the suggestion of error. (4) Writ of error, in law, a process issued by a court of review, to an inferior court, suggesting that error has been committed and requiring the record to be sent up for examination; now commonly known as an appeal. (5) Court of error, a court exercising appellate jurisdiction by means of writs of error. (6) Assignment of error, in law, specification of the error suggested or objected to. For ordinary errors, see Bull; Mistake.

Error, Personal. See Equation, Personal.

Ersch, Johann Samuel, yō-hän sä'moo-ĕl ersh, German bibliographer: b. Grossglogau 23 June 1766; d. Halle 16 Jan. 1828. He was principal librarian and professor of geography and statistics at Halle. Among his publications are: a 'Dictionary of French Writers'; 'Manual of German Literature'; and, in connection with Gruber, the 'Universal Encyclopædia of Arts and Sciences' (1818).

Erse, ėrs, a corruption of the word Irish; a name applied to Irish Gælic people, and also to the lowlanders of Scotland. See Celtic Language and Literature.

Erse Language. See Celtic Language and Literature.

Erskine, ėrsk'ĭn, **Ebenezer,** Scottish clergyman, the founder of the Secession Church in Scotland; b. Scotland 22 June 1680; d. Stirling, Scotland, 2 June 1754. He was ordained minister of Portmoak, in Fife, in 1703, in which situation he continued for 28 years, when he removed to Stirling. His attitude toward patronage and other abuses in the Church led to his being deposed, when, in conjunction with his brother and others, he founded the Secession Church. He was the author of several volumes of sermons. See MacEwen, 'The Erskines' (1900).

Erskine, Henry, Scottish barrister: b. Edinburgh 1 Nov. 1746; d. Ammondell, West Lothia, 8 Oct. 1817. He twice held the office of lord-advocate, was for long the leader of the Scottish bar, and had a high reputation as a wit.

Erskine, John, of Carnock, afterward of Cardross, Scottish jurist: b. 1695; d. near Dumbarton 1 March 1768. He was called to the Scotch bar in 1719, and was author of 'Principles of the Law of Scotland,' and the 'Institute of the Law of Scotland,' both authorities.

Erskine, Ralph, Scottish clergyman: b. 15 March 1685; d. Dunfermline 6 Nov. 1752. He was a brother of Ebenezer Erskine (q.v.). He was ordained to the parish of Dunfermline in 1711, and in 1737 joined his brother, who had seceded from the Established Church. His 'Gospel Sonnets' and other religious works were once very popular.

Erskine, Thomas, Baron Erskine, Scottish jurist: b. Edinburgh 21 Jan. 1750; d. there 21 Jan. 1823. He became a noted forensic orator and jurist, attaining most of his renown as a pleader in support of the accusations of corruption made against Lord Sandwich; later he added to his success by his defense of Stockdale, Hardy, Thomas Paine, Horne Tooke and others. He was a member of the House of Commons in 1790–1806. He was created Baron Erskine of Restormel, on becoming lord chancellor.

Erup'tion, a term applied to a local disturbance in the skin characterized by the formation of redness or scaliness, blistering or pustulation. In one class of affections, known as the eruptive fevers, a characteristic form of skin-eruption is diagnostic. Thus the fine red rash of scarlet fever, the bluish red rash of measles, the irregular rash of chickenpox and the pustulate rash of smallpox are readily recognized. The popular notion that an eruption is an indication of something evil within the body finding its way out belongs to the mediæval days of superstition and ignorance, when disease was regarded as an evil spirit to be exorcised, and gave notice of its evacuation by means of an eruption on the skin. At the present time we know that most eruptions are either of purely local occurrence, due to localized irritants, as in the case of pimples, boils, etc., or that they represent a disturbance of the nerve-centres, whose end-filaments are distributed to the epithelial structures of the body. Thus in measles, not only the skin, but also the mucous membranes of the respiratory tract are affected, the poison affecting the nerve-structures being evidenced by nerve-irritation at the periphery of the body. The popular idea that it is necessary to bring an eruption out in acute infectious diseases such as measles, scarlet fever, etc., is a trustworthy one, but an interpretation is frequently given to it that is not sound. The presence of an eruption on the surface of the body in these affections is an indication of the protective energies of the human organism in its fight with the infection and poisoning. The inability of the body to counteract the poison of the disease may prevent the development of the eruption, and thus its bringing out, being the sign of the body's ability successfully to cope with the poison, is the warrant for the popular idea of the efficiency of the eruption. Many drugs locally applied, or taken internally, cause the formation of eruptions. These eruptions may be due to purely nervous influences, or they may be of local origin. Drug-eruptions following the use of the iodides and bromides are of this latter character. As the drug is eliminated through the skin, its passage there causes local irritation and the formation of an eruption. See Dermatitis; Measles; Skin.

Erup'tive Rocks. See Igneous Rocks.

Erwin von Steinbach, ĕr'vēn fōn stīn'baн, German architect: b. Steinbach, Baden; d. 17 Jan. 1318. The principal tower of the cathedral of Strasburg had been completed in the 7th century. It was partly built of wood, and was reduced to ruins by lightning and successive fires. The nave, begun in 1015, was only completed in 1275. Erwin was then requested to furnish designs for the decoration of the interior of the church, and for the construction of two new towers and a façade upon the site of the ruins of the old tower. The foundation stone of the new structure was laid 25 May 1277. The architect died when the work was only half finished; it was continued by his son Johannes (died 18 March 1339), and subsequently continued chiefly after his designs, still preserved at Strasburg. His daughter Sabina assisted him in the decoration of the interior of the church; and another of his sons, Winhing (d. 1330), was also an architect of some distinction. The remains of this family of architects are interred within the cathedral.

Eryman'thus, in ancient geography, a river and mountain of Arcadia, in Greece. The river, according to some the modern Dimitzana, rises on the frontiers of Arcadia and Elis, and flows into the Alpheus. The mountain, situated to the east of the river, formed the western point of the northern barrier of Arcadia, and was covered with forests. It was in this mountain that Hercules chased and killed the famous wild boar.

Eryngium, e-rĭn'jĭ-ŭm, a species of plants of the carrot family (*Umbelliferæ*). The generic name from the Greek refers to their thistle-like appearance. There are about 150 species in the genus, of which 22 are found in America. Rattlesnake-master, or button-snakewood (*E. aquaticum*) grows in wet soil and in the pine-barrens, from New Jersey south to Florida and west to Texas, Missouri, and Minnesota. Its common names are given to it because of its supposed efficacy as an antidote to the venom of snakes. A number of species are cultivated, both on account of the steel-blue color of the stem and branches, and of the unusual manner of growth. Eryngo (*E. maritimum*), sea-holly, is a native of England. It frequents sandy shores, and is distinguished from other plants of the order by its rigid, spiny, glaucous, veined leaves, and its dense heads of blue flowers. The roots are sometimes candied, and are reputed to be stimulating and restorative. Falstaff speaks of its use as a confection and its aphrodisiac qualities, either real or supposed, are mentioned by dramatists from Jonson to Prior.

Eryops, ĕr'ĭ-ops, a large fossil labyrinthodont amphibian, characteristic of the Permian Period in North America. The skull is 18 inches to 2 feet in length, very flat and broad.

Erysichthon, ĕr-ĭ-sĭk'thŏn, a legendary king of Thessaly, who, being guilty of sacrilege against Ceres, devoured his own flesh.

Erysimum, ĕ-rĭs'ĭ-mŭm, a genus of plants of the natural order *Cruciferæ*, chiefly biennials, with narrow entire leaves, and yellow, often fragrant, flowers. There are about 85 species, natives of northern temperate and cold countries. *E. cheiranthoides*, a native of Europe, with small yellow flowers, is found in waste places, along streams, and in fields from southern New England to Newfoundland, and westward to the

Pacific coast. The seeds of this plant were formerly employed as an anthelmintic, hence the name of wormseed. It is also called treacle-mustard, because used as an ingredient in the famous Venice treacle. The seeds of *E. perfoliatum* are used as a source of oil in Japan. Many of the plants formerly assigned to this species are now grouped in other genera, as *Sisymbrium*, etc.

Erysip'elas, an acute infectious disease of the skin and subcutaneous structures caused by a streptococcus. Whether the *Streptococcus erysipelatis* of Fehleisen, or the *Streptococcus pyogenes* is considered the causative factor or not, the fact remains that bacteriologically it is probable that these two forms of bacteria are identical. The reaction of the tissues to the streptococcus and its poisons causes the acute inflammation with redness, puffiness, and sometimes gangrene. This local swelling is attended with fever, headache, general constitutional symptoms, nausea, vomiting, and at times with toxic delirium. Occasionally the streptococcus wanders into the blood-stream, and general septicemia or pyemia results. At other times a streptococcic invasion of the joints produces an acute rheumatism with secondary heart complications. Erysipelas may affect any part of the body, but is very frequent over the face and head. It is extremely contagious, the organism finding entrance through minute wounds. Patients who have had recent erysipelas should on no account be allowed to come anywhere near women in childbirth, as puerperal fever may result. The treatment of erysipelas is by means of tonics — iron and quinine being favorites — nutritious and easily assimable diet, milk, cod-liver oil, and some form of alcohol. In those patients in whom abscess formation occurs, prompt surgical evacuation is imperative. Local treatment by ichthyol and similar antiseptics is widely employed with some benefit.

Erythe'ma. See DERMATITIS.

Erythræan (ĕr-ĭ-thrē'an) **Sea,** in ancient geography, a name given to what is now called the Indian Ocean, but including the Persian and Arabian gulfs. The name was latterly restricted to the Arabian Gulf.

Eryth'ric Acid is obtained from lichens by extracting with boiling water or milk of lime. It is a white, crystalline, tasteless, and odorless powder, readily soluble in alkalies, and alcohol. See CHEMISTRY.

Erythrina, ĕr-ĭ-thrī'na. See CORAL-TREE.

Erythrite, e-rith'rīt, or "cobalt bloom," a native hydrous cobalt arsenate, having the formula $Co_3As_2O_8 + 8H_2O$. It has a beautiful peach-blossom red color, whence its name from the Greek, *eruthros*, red. It occurs in monoclinic crystals, but more commonly in globular or stellate masses or earthy. It occurs at Schneeberg, Saxony; in Cornwall, England; in Chile, and in some parts of the United States.

Erythro'nium, a genus of small plants of the lily family, common in damp, shady woods, of which a well-known and widespread species (*E. americanum*) in the United States, is the "dog-tooth violet" or "adder's tongue" — both unfortunate names. It is among the earliest of spring flowers, appearing as two radical leaves, usually handsomely mottled, between which rises a slender, naked stem (scape) three to four inches high, bearing a single bell-shaped flower of six distinct lanceolate petals, pale yellow, often spotted near the base. Some eight other species are known in the United States, some bearing several flowers on the scape, and of various tints, as purple, rose-color or pinkish white.

Erythrophlœum, ĕ-rĭth-rō-flē'um, a genus of tropical trees, of the pea family, containing three species, two found in Africa, and the third in Australia. The *E. guineense* of Africa has a poisonous red juice, which is used by the natives as a test of innocence or guilt, and hence the name ordeal-tree. The natives of Guinea and the Gold Coast employ the same juice to poison the points of their arrows.

Erythroxylon, ĕ-rĭth-rŏk'ĭ-lŏn, a genus of plants of the natural order *Erythroxylaceæ*. The family contains 30 species, composed almost exclusively of trees and shrubs; growing in tropical South America. The flowers are small and lack color; the fruit is a drupe. The red dyewood of Brazil is *E. suberosum*, and the oil-wood of Mauritius is *E. hyperiifcolium*. The chief member of the genus and family is *E. coca*. See COCA.

Eryx, ē'rĭks, ancient name of a city and mountain in the west of Sicily, about six miles from Drepanum, and two from the seacoast. The mountain, now Monte San Giuliano, rises direct from the plain, unconnected with any other range, and hence possesses a much greater altitude in appearance than in reality, its height being only 2,184 feet. It was anciently believed to be the highest mountain in the island after Etna, and is frequently alluded to by Virgil and other poets. On the summit stood a celebrated temple of Venus, from which the goddess received the epithet of Venus Erycina. All traces of the ancient town of Eryx have now disappeared, and its site is occupied by the modern town of San Giuliano; but some remains of the temple still exist in part of the substructure of the castle.

Erzerum, ĕrz'room, **Erzeroum,** or **Erzeroom,** Turkey, a city of Armenia, and, since the annexation of Kars by Russia, the chief strategical centre and place of resistance to a Russian advance, about 100 miles southwest of Trebizond. Its fortifications have been repaired and much improved since 1864. The inhabitants consist of Turks, Armenians, and Persians, are very industrious; and, in addition to important manufactures, especially in copper and iron, carry on a very extensive trade. This is greatly favored by the position of the town, standing at the junction of several important roads leading from Transcaucasia by way of Trebizond, and communicating with different parts of Asia Minor, with Persia, Kurdistan, Mesopotamia, etc. The value of British goods imported into the town in 1898 was estimated at $244,000. Erzerum is a place of great antiquity. Anatolius, commander of the Emperor Theodosius II., here built the citadel of Theodosiopolis, northwest of the open Syro-Armenian trading town of Arsen. On the destruction of this town by the Seldjuks, in 1049, the inhabitants removed to Theodosiopolis, which received from them the name of Arsen-er-Rum, that is, Arsen of the Romans. Hence the modern name Erzerum. In 1241 it fell into the hands of the Mongols, and in 1517 into those of the Turks, notwithstanding whose mismanagement it continued to be the most important commercial emporium of the Armenian plateau, and had a population of 100.000. In 1829 it was taken by the Russians, but was restored to Turkey by the Peace of Adrianople. Many of the inhabitants, however, quitted the town and settled in the Russian territory. In the winter of 1877 it was besieged by the Russians, who reduced the defenders by famine, until in February 1878 it was surrendered, and held by the Russians for several months. It was again, however, restored to the Turks. Pop. (1901) 38,500.

Erzgebirge, ĕrts'gĕ-bĕr-gĕ, a range of low mountains about 100 miles long on the boundary between Saxony and Bohemia. The mountains, like the Blue Ridge Mountains in the United States and the Highlands of Scotland, are an ancient range, worn down and again uplifted. As the name (Ore Mountains) implies, the Erzgebirge contain valuable deposits of minerals and form an old mining region. Silver ores were mined there as long ago as 1150 and mines of lead, copper, tin, cobalt nickel and iron ore have also been sunk there.

Esarhaddon, ē-sär-hăd'ŏn, Assyrian ruler: d. about 667 B.C. He was the son of Sennacherib, one of the most powerful of the Assyrian monarchs. He extended the empire on all sides, and is the only Assyrian king who actually reigned at Babylon.

Esau, the eldest son of Isaac, and twin brother of Jacob (Gen. xxv. 24–6). His name (which signifies rough, hairy) was due to his singular appearance at birth, being "red, and all over like an hairy garment." The struggle for precedence between the brothers was foreshadowed the moment of their first appearance in the world. Esau, the father's favorite, became a cunning hunter; Jacob, the favorite of the mother, became a peaceful shepherd. One day, as Esau returned famished from the chase, he found his brother preparing some lentil pottage, and asked for a share of it. Jacob, taking advantage of his brother's distress, offered him the pottage if he would give up his birthright. Although this meant yielding up the headship of the tribe and the greater share of the family property, Esau nevertheless consented. He was named Edom (red) in consequence, from the color of the pottage; and the name was given to the land he settled in. The next episode in his history is when Jacob, instigated by his mother, personated Esau, and succeeded in getting his father's covenant blessing. The indignation of Esau at the base trick was natural; and Rebekah sent Jacob out of the way for a time, to escape his brother's vengeance. On his return from a protracted stay Jacob succeeded in mollifying Esau by presents and flattery. After a subsequent meeting of the brothers, on the death of their father, we hear no more of Esau.

Esbjerg, ĕs'byĕrg, Denmark, seaport, 56 miles west of Fredericia, with a large export trade in cattle, and dairy products, mostly to England. Its harbor, the only one of importance on the west coast of Jutland, was constructed by the state at great expense in 1868–74; and in 1887 an annual subsidy was granted by government for steam communication with Great Britain. Pop. (1901) 13,365.

Escalade, ĕs-kā-lād', in war, a furious attack of a wall or a rampart, carried on with ladders, to pass the ditch or mount the rampart, without proceeding in form, breaking ground, or carrying on regular works to secure the men. See WAR.

Escalator, the name applied to a continuous carrier designed for conveying passengers from one level to another within a limited time. The various units making up the escalator are so arranged that on the incline they present the familiar zigzag appearance of an ordinary stairway, and may be used as such. The escalator consists of an endless series of steps connected together by a heavy sprocket chain which, at the proper place, engages with the driving sprocket wheel. Each step is essentially a four-wheel truck, bolted to a shaft, which in turn, is connected to the links of the driving chain. There are two wheels at each end of the truck traveling on separate tracks, so placed that the steps remain horizontal at all points of the ascent. At the landing, at the top and the bottom of the escalator, the trucks travel in the same plane so that the steps there become a moving platform. Ample opportunity is thus given, even to the infirm, to board the device before the ascent begins and, at the top to step off again. A traveling hand-rail moving at the same speed as the steps further simplifies its use. Should a person fail for any reason to step off at the upper landing, a device called a shunt, removes him from it. This consists of a box-like affair, triangular in plan, placed about 10 feet from the top of the escalator with the apex pointing against the direction of the moving platform. In the lower part, set in a vertical position are two belts running backwards from the apex. Anything coming in contact with these belts is gently brushed to one side. Every part of the escalator is made to micrometer measurements to one thousandth of an inch by special machinery designed for the purpose. As a result of this unusual precision, the various steps fit together so nicely that a piece of paper cannot be forced between them. To secure practically noiseless operation, the wheels on which the trucks move are deadened, rawhide pinions are used in driving gear, and the tracks are built up of wood and steel. The links of the sprocket chain are made of two 18 inch cast steel shrouds, with 1½ inch steel pins between them at 3 inches between centres. The ends of the links are bushed with phosphor-bronze in which graphite is inlaid, thus providing lubrication of the bearing surfaces, and the wheels are similarly provided with a constant lubrication of graphite. The escalator is driven by an electric motor located within the structure of the upper landing and suitably geared to the large driving sprocket wheel by a combination of worm and spur gearing. All parts of the running gear are made of crucible cast steel, the axles and link pins being of cold drawn steel. Each casting is subjected to a test of many times the working-strain to come upon it.

While there are no mechanical limitations to the rate of speed with which the escalator may be driven, it has been found that a speed of about 100 feet per minute is satisfactory to the public. At this rate of driving, 4,000 steps per hour arrive at the landing and the maximum capacity of the machine depends upon the width of the steps used. The escalators which have been installed for railroad stations, large department stores and other localities where a large capacity is necessary, have been a little over five feet in width and as each step readily accommodates three people the maximum capacity of such a construction is 12,000 people per hour. For the smaller department stores and for use in railroad stations where the traffic is not heavy the escalator is made of such width as to accommodate one person on each step, and the capacity is therefore 4,000 per hour. It should be noted that the escalator is a perfectly reversible machine, operating equally well in either direction. In the «duplex» type, the steps during the descent are again guided into the familiar zigzag position by suitably placed tracks and thus the same machine serves to carry passengers both up and down. In a third modification of the device designed especially for the London underground railroads, where the difference between levels is considerable, the steps ascend in one spiral and descend in another spiral below the first.

Charles D. Seeberger.

Escanaba, ĕs-ka-nä'ba, Mich., city, county-seat of Delta County, on Little Bay de Nouquette, an inlet of Green Bay; on the Chicago & N. W., and the Chicago, M. & St. P. R.R.'s; 52 miles northeast of Marinette. It is the grain and vegetable raising and lumbering centre of the country and an important iron-shipping point; it has five docks for iron ore, and an excellent dock for the shipping of other products. It has a public high school, St. Joseph's high school, public library, daily and weekly newspapers, and a national bank. Pop. (1901) 9,549.

Escandon, Guillermo de Landa y, Mexican statesman: b. Mexico City. He was educated in Stonyhurst University, England; was several years a member of the national senate, representing the states of Chihuahua and Morelos; from 1900–02 was mayor of Mexico City; and became governor of the Federal District in 1903. Under his administration many very important reforms have been introduced and carried to successful results, among them the restriction or practical discontinuance of gambling; the improvement of the public carriage service; the enactment of rules restricting the speed of automobiles; the protection of the Peon or Indian class; the improvement of the prisons of the capital city and its suburbs, and also of the public buildings and military barracks; the bettering of the sanitary condition of the correctional schools, the theatres and other places of amusement, and of the entire city; the adoption of a system of street sweeping and sprinkling; the placing of proper restrictions on the sale of alcoholic beverages, etc.

Escape'ment, a part of the machinery in a watch or clock. See Clock; Watchmaking.

Escarp'ment, the abrupt descent, which may or may not be a cliff, from a plateau to lower land. See Mountain; Cliff.

Escars. See Eskers.

Eschaiot, esh-a-lŏt'. See Shallot.

Eschatology, ĕs-kā-tŏl'ō-jĭ (Gr. *eschatos*, «last,» and *logos*, «a discourse»), the doctrine of the last things, a theological term for what Scripture reveals and Christian speculation has concluded about a future state. But although the term is thus limited, an eschatology existed among all the great nations of antiquity, dark and ill defined as in the Greek, or elaborate as in the Egyptian religion. Together with it grows up more or less definitely the idea of retribution. See Theology.

Escheat', the reversion of property to the sovereign. The law considers that all property must have an owner; so if a person die intestate and without issue, the property, in England, escheats to the king, and in America to the State as sovereign. In some jurisdictions, before the sovereign receives title there is a certain kind of proceeding to determine whether or not there are any heirs, while in other jurisdictions the sovereign gets the title on the death of the owner; but even in these cases the sovereign's title is defeasible until there are proceedings to determine that the deceased had no heirs. When the sovereign obtains title by escheat it acquires all the rights and privileges of the last owner, and the statutory requirements must be strictly followed, both as to the disposal of the property and as to the use of the fund derived from the sale, in case a sale is necessary. In the United States the powers and duties of the sovereign in relation to escheated property are controlled by statute in the different states.

Eschenbach, Wolfram von, vōlf'räm fōn ĕsh'ĕn-bäн, German mediæval poet: b. Eschenbach, near Ansbach, Bavaria; d. about 1220. He was one of the most prominent minstrels at the court of Hermann, Landgraf of Thuringia; and his epics rank among the greatest German imaginative works. Besides several love songs he wrote 'Parzival'; 'Wilhelm von Orange,' and 'Titurel, or the Guardian of the Graal.'

Eschscholtz, Johann Friedrich, yō'hän frēd'rĭн ĕsh'shōlts, Russian naturalist: b. Dorpat, government of Riga, 12 Nov. 1793; d. there 19 May 1834. He studied medicine in his native city, and in 1819 became professor of anatomy and director of the zoological museum of the University of Dorpat. In 1815–18 and 1823–6 he accompanied Otto von Kotzebue in the latter's exploring tours around the world, collected a large number of natural history specimens, and made valuable scientific studies on the lower organisms of deep-sea life. The results of his studies were published in Kotzebue's account of the expedition (1821), and he presented his collections to the University of Dorpat 1826. His catalogue of over 2,000 animals was published in Kotzebue's 'Neue Reise um die Welt' (Vol. II. 1830). Adelbert von Chamisso, another member of these expeditions, named a botanical species *Eschscholtzia* in his honor, and Eschscholtz Bay, on the Alaska coast, is also named after him. He published: 'Ideen zur Aneinanderreihung der rückgrätigen Tiere' (1819); 'System der Akalephen' (1829); 'Zoologischer Atlas' (5 parts, 1829–33), containing plates and distributions of new species of animals.

Eschscholzia, ĕ-shōlt'sĭ-a, or **California Poppy,** a genus of annual and perennial herbs of the natural order *Papaveraceæ,* natives of the Pacific slope of the United States. The species, of which there are about a dozen, are distinguished by much dissected alternate leaves, yellow or white showy flowers (the sepals united to form a deciduous hood), and a long capsular fruit resembling a silique. The best-known species is probably *E. californica,* a perennial which is widely cultivated as an annual in flower gardens, and is a beautiful orange-colored flower, one of the most showy in the whole floral kingdom. It is gregarious in habit, and in California it covers large areas with an almost unbroken orange-yellow bloom of striking beauty when seen on the gray-green slope of a treeless hillside. It is easily raised, especially if the seed be sown soon after gathering in the fall, and the young plants protected in cold climates with a light mulch of straw or leaves. Spring-sown seed is usually less satisfactory since it is less viable. The name is erroneously spelled "Eschscholtzia."

Eschwege, ĕsh'vā-gĕ, Germany, a town of the Prussian province of Hessen-Nassau, on the Werra, 26 miles east-southeast of Cassel. It is a walled and well-built town, with a castle, long the residence of the landgraves of Hessen-Rotenberg, but now used as a public building. It has manufactures of woolen and linen cloth, several large tanneries and glue-works, oil and other mills, and a trade in meal, fruit, lard, ham, and sausages. Pop. 11,341.

Eschweiler, esh'vī-lĕr, Germany, town in the Prussian Rhine province, nine miles east-northeast of Aix-la-Chapelle, at the confluence of the Inde and Dente. It has manufactures of articles in iron and tin-plate, zinc and copper, machinery, boilers, railway plant, needles, wire, rolling-mills, smelting furnaces, etc. Calamine and lead, as well as productive coal-mines, are worked in the vicinity. Pop. 22,654.

Es'chynite. See ÆSCHYNITE.

Escobar y Mendoza, Antonio, än-tō'nē-ō ĕs-kō-bär' ē mĕn-dō'thä, Spanish casuist: b. Valladolid 1589; d. 4 July 1669. Entering the order of the Jesuits in 1604, he became celebrated as a preacher and writer. At his death he left more than 40 volumes in folio, mostly in theology and morality, the principal being the casuistical 'Liber Theologæ Moralis' (1646), which has several times been printed.

Escobedo, Mariano, mä-rē-ä'nō ĕs-kō-bā'-dō, Mexican soldier: b. Dos Arroyos, New Leon, 12 Jan. 1827; d. Tacubaya 22 May 1902. When the war between Mexico and the United States broke out he was a muleteer in charge of a string of pack mules belonging to his father. He converted his muleteers into a band of guerrillas, attacked small detachments of the American troops wherever he found them, and took part in the battles of Palo Alto and Resaca. Juarez commissioned him colonel in 1859. In 1861, upon the establishment of Juarez' government in the City of Mexico, Escobedo was made a brigadier-general and sent in pursuit of the Clerical forces under Marquez and Mejia, but was surprised, taken prisoner after an heroic defense, sentenced to be shot, but escaped and returned to Juarez. He took a prominent part in the engagements with the French which followed the intervention of Napoleon III. in Mexican affairs. He repulsed them at Puebla 5 May 1862, took part in the long siege of that place, and when it was captured by the French 17 May 1863, was taken prisoner, but succeeded in escaping. When Maximilian's empire was established, Escobedo took up his headquarters in Texas, secretly purchased arms and ammunition in New Orleans, 1865, organized and equipped a force of Mexican refugees, American negroes, and ex-Confederate soldiers, led them into Mexico, captured the imperial garrison at Monterey November 1865, and swept everything before him. Juarez appointed him commander-in-chief of the Army of the North; he continued his victorious course until all the chief cities were in the hands of the republicans, and finally besieged and defeated the emperor at Queretaro 15 May 1866. It is said that Maximilian offered his word of honor to Escobedo, on surrendering his sword, to leave the country at once if conducted to the nearest port; but Escobedo refused, ordered a court-martial to be instituted, and the emperor was condemned and executed. In 1874 he quelled an uprising against the government of Juarez, but was unsuccessful in putting down the revolution started by Gen. Diaz. He fled to Texas, issued a manifesto against Diaz, returned, was arrested and tried, and notwithstanding the government's efforts to convict him, was acquitted. To escape petty persecutions he went to New York 1879–80, but returned, and was appointed president of the supreme military court of justice 1882–3, when he retired at last to private life.

Esco'rial, or **Escu'rial,** a royal palace of Spain, distant from Madrid about 24 miles in a northwesterly direction, and situated on the acclivity of the Sierra Guadarrama, the range of mountains which divides New from Old Castile. The Escorial combines a monastery, a church, and a mausoleum with a royal palace. Everything about the Escorial — situation, plan, and purposes — bears the stamp of the singular and unpractical mind of its originator, Philip II. Not the least remarkable of its peculiarities is its site. Away from cities, amid the seclusion of mountain scenery, it stands at a height of 2,700 feet above the level of the sea. It was built in commemoration of the battle of St. Quentin, which was fought 10 Aug. 1557. The building is a rectangular parallelogram measuring 744 feet in length by 580 in breadth. The interior is divided into courts; while a projection 460 feet in length contains the chapel and the royal palace. The building was begun in 1563 by Juan Bautista de Toledo, a Toledan architect, and finished in 1584 by his pupil Juan de Herrera. It is irregular in its proportions, and thus loses much of the effect which, from its great magnitude, it ought to have. The innumerable windows (said to be 11,000 in honor of the Cologne virgins) give it the aspect of a large mill or barrack. The doors are also numerous. The material of the building is gray granite found in the neighborhood, which preserves its fresh and clean appearance. The church, situated immediately in front of the palace, is 320 feet long and 230 broad; and under it is the Pantheon or burying-place of the kings of Spain. Its interior is lined with dark marble beautifully veined. The monasterial part of the building contains a valuable library, especially rich in Greek and Arabic manuscripts, and there is a superb collection of pictures scattered through various parts of the building. Raffaele, Titiens, Rubens, Velasquez, Guido, and other great masters are here represented. During the French occupation the books, 30,000 in number, were removed to Madrid, but were sent back by Ferdinand minus 10,000 volumes. The Escorial was partly burned in 1671, when many MSS. were destroyed. It was pillaged by the French in 1808 (when the books were removed) and in 1813. It was restored by Ferdinand VII., but the monks, with their revenues which supported it, have long since disappeared, and the building, which from its situation requires to be kept in repair at considerable expense, has fallen into some decay, though repairs are executed from time to time. On 2 Oct. 1872 it was struck by lightning, and was in consequence seriously injured by fire. The monastery portion of it is now a seminary in which youths receive a secular education. The Escorial is 32 miles by railway from Madrid.

Escort, a guard, a body of armed men which attends an officer or baggage, provisions or munitions, conveyed by land from place to place, to protect them. This word is sometimes used for naval protectors; but the proper word in this case is convoy. In the United States escorts are of two kinds, funeral escorts and escorts of honor. The army regulations fix the character and size of escorts according to the military prominence or title of the individual.

Escosura, Patricio de la, pä-trē'thē-ō dā lä ĕs-kō-soo'rä, Spanish novelist and poet: b. Madrid 5 Nov. 1807; d. there 22 Jan. 1878. After various political and military ups and downs and being twice exiled, in 1855 he was sent as a special envoy to the Portuguese court, became under-secretary of state, minister of the interior, and afterward ambassador to Germany, 1872–4. He wrote the historical novels: 'The Count de Candespina' (1832); 'Neither King nor Pawn' (1835); and 'The Patriarch of the Valley'; the epics 'The Bust in Black Cloak' and 'Hernan Cortés at Cholula'; several dramas, the most successful of which was 'Hernan Cortés' Debaucheries'; and several historical works, among them a 'Constitutional History of England' (1859).

Escott, Thomas Hay Sweet, English journalist: educated at Queen's College, Oxford, and since 1865 actively connected with London journalism. He has been a leading article writer for the 'Standard' since 1866 and succeeded John Morley (q.v.) as editor of the 'Fortnightly Review.' He has published: 'England: Its People, Polity and Pursuits' (1897); and its sequel, 'Social Transformations of the Victorian Age' (1897); 'Politics and Letters' (1886); 'Lord Randolph Churchill: a Monograph' (1895); 'Personal Forces of the Period' (1898); 'A Trip to Paradoxia' (1899). He has also published an edition of 'Juvenal and Persius.'

Escuage, ĕs'kū-āj. See SCUTAGE.

Escuer'zo, a Spanish term for "toad," specifically applied in the valley of the La Plata to a large local toad-like frog (*Ceratophrys ornata*) noted for its varied colors, laid on like those of a Persian carpet. This patchwork thoroughly conceals them as they lie half-buried in the ground. "If there is not enough green vegetation," says Gadow, "they throw, with their feet, little lumps of earth upon their backs, the skin of which becomes at the same time more wrinkled and assumes duller tones. There the creature lies, perfectly concealed, betrayed only by the metallic, glittering eyes, waiting for some unfortunate creature to pass into the trap represented by the enormous mouth, which opens and shuts with lightning rapidity and an audible snap." These frogs are of the Cystignathine group (see FROG) and closely allied to the monstrous "horned toads" of Brazil. They live chiefly on frogs and are sometimes cannibals.

Escuintla, ĕs-kēn'tlä, Guatemala, one of the southern departments of that republic; population about 32,000. Its chief town, also called Escuintla, situated at an altitude of 1,269 feet above the level of the sea, on the line of the Central Railroad and half way between Guatemala city and the port of San José, has good hotels and apartment houses, and is a favorite winter resort. Pop. of Escuintla city about 12,350.

Es'culin, Es'culine. See ÆSCULIN.

Escutcheon, ĕs-kŭch'ȯn, in heraldry, is derived from the Old French *escusson,* French *écusson,* and that from the Latin *scutum,* a shield. It signifies the shield whereon coats of arms are represented. See HERALDRY.

Esdraelon, ĕs-drā-ē'lŏn or ĕs-drā'e-lŏn (Merdj-Ibn-Amer), the famous and beautiful plain in Palestine, situated between the mountains forming the western watershed of the Jordan and the Mediterranean Sea. Other names by which it is called in the Old Testament are Jezrael, valley of Megeddo, and the Great Plain. It is triangular in form, 36 miles in length, with an average width of 15 miles. On its boundary are: on the northeast Mount Tabor, the southeast Mount Gilboa, and on the southwest Mount Carmel. The principal streams are Nahr-el-Djalood, which flows into the Jordan, and the Kishon (Nahr-el-Moukataa) which flows into the Bay of Acre just north of Mount Carmel. Other streams traverse the plain, but are chiefly branches of the two streams mentioned. The soil is fertile and when cultivated with care yields good crops. When Esdraelon was traversed by caravans crossing Palestine from the rich countries east and west, grains, vegetables, and fruits were raised in abundance. Agriculture is again receiving attention. Some of the noted places on this plain are Djeneen (probably the old town of Engannin), at the entrance to the plain and 984 feet above the sea. Tradition says this is where the 10 lepers were cured (Luke xvii.); Zerlin, known by the residents as Zeraeen, called by the Crusaders Petit-Guérin, is now a large village. Near it is the fountain, Ain-Maeeteh, supposed to be where Saul camped when at war with the Philistines (1 Sam. xxxi). Ain-Djalood, said to be the place where Gideon selected the 300 men who fought and defeated the Midianites (Judge vii.). On the south side of the Kishor are the villages of Afooleh, El-Fooleh and Zerin. Afooleh is the old town of Aphec, one of the places where the Assyrians and Egyptians met in battle. At El-Fooleh was once a fortress built by the Templars, but destroyed by Saladin in 1187. Here was fought the battle between the French under

Napoleon, 4,000 in number, and the Mohammedans, 35,000 in number, in which the French were victorious. Ruins of the fort exist. For the ancient history of Esdraelon consult the Old Testament; many of the important places mentioned in the New Testament are in a good state of preservation. Nazareth, Nain, and all the surrounding section west of Mount Tabor, are usually included in the plain, and must be so considered if Mount Tabor is accepted as on the northeast boundary. Consult: Thomas, 'Two Years in Palestine'; Sayce, 'Patriarchal Palestine'; Costello, 'The Gospel Story'; Smith, 'Historical Geography of the Holy Land.'

Es'dras, Books of, two apocryphal books, which, in the Vulgate and other editions, are incorporated with the canonical books of Scripture. In the Vulgate the canonical books of Ezra and Nehemiah are called the first and second, and the apocryphal books the third and fourth books of Esdras. The Geneva Bible (1560) first adopted the present nomenclature, calling the two apocryphal books first and second Esdras. The subject of the first book of Esdras is the same as that of Ezra and Nehemiah, and in general it appears to be copied from the canonical Scriptures. The second book of Esdras is supposed to have been either of much later date, or to have been interpolated by Christian writers. This book takes its name from the supposed writer, a priest and doctor of the law, called Ezra by the Hebrews.

Es'erin, or **Physostigmin,** a drug obtained from Calabar-bean, the active principle of this plant, used as a remedy in cases of tetanus (lockjaw). A solution of eserin dropped in the eye causes contraction of the pupil, and hence its use in some eye ailments, as, for instance, glaucoma.

Esh'er, Reginald Baliol Brett, 2D VISCOUNT, English writer: b. London 30 June 1852. He was educated at Eton and Cambridge, and was private secretary to the Marquis of Hartington, then leader of the Liberal party, 1878–85. He was member of Parliament for Falmouth 1880–5, and in 1895 was appointed secretary to H. M. Office of Works, a post he retained until 1902. He succeeded his father as viscount in 1899. He has written: 'Footprints of Statesmen' (1892); 'The Yoke of Empire'; and many historical and political articles in the 'Fortnightly Review' and 'Nineteenth Century.'

Esh'er, England, village in Surrey, 15 miles southwest of London. Claremont Palace, where the Princess Charlotte resided and died, is in the neighborhood. Pop. 2,516.

Esk (Celtic for water), the name of two small rivers in England, one in Cumberland and one in Yorkshire; and of several in Scotland, the chief being the Esk in Dumfriesshire; the North Esk and South Esk in Forfarshire; and the North Esk and South Esk in Edinburghshire.

Es'kers, Eskars, or **Eschars,** deposits of gravel and sand evidently caused by the drift beneath the ice sheets of the Glacial periods. Such deposits are found in the northern part of North America, in Ireland where they are called escarks; in Scotland where they are known as kaims or kames; in Sweden as ösars. They sometimes consist of long ridges of sand and gravel, 40 and 50 feet high, and again are in large triangular masses, as in Sweden where the forms are very irregular. See GLACIER; GLACIAL PERIOD.

Eski-Sagra, ĕs'kĭ-sä'grä, or **Ezki Zaghra,** Rumelia, a town in the eastern part, on the south slope of the Balkans, about 100 miles northwest of Adrianople. It is near the chief passes of the Balkan Mountains, and its trade is increased because of its location. The mineral springs and extensive rose gardens nearby are sources of wealth for the town. Some of the manufactures are carpets, coarse linen, leather, and rose oil. It is one of the South Balkan strongholds which repelled the Russians in 1887. Pop. (1902) 19,521.

Eski-Shehr, ĕs'kĭ-shĕhr' (ancient DORYLÆUM), Turkey, a town 90 miles southeast of the Sea of Marmora. It has warm mineral springs, and manufactures of meerschaum pipes from the deposits of meerschaum in the neighborhood. The region of Asia Minor surrounding Eski-Shehr is noted for the quantity and quality of the meerschaum deposit. About two thirds of the people are Mohammedans and the remainder are Christians. Pop. 19,615.

Eskilstuna, ĕsk'il-stoo-nä, Sweden, city on the river of Eskilstuna, connecting Lake Maelar with Lake Hjelmar. It has daily communication with Stockholm, both by steamers and rail. On an island in the river is a large gun-factory, and its manufactures of iron and steel products are so great that it is called the "Sheffield of Sweden." The place takes its name from Saint Eskill, an English missionary of the 11th century, who, it is said, was martyred at a pagan assembly held where the city of Eskilstuna now stands.

Es'kimo Dog, the draft animal of the Arctic regions. It is a wolfish-looking dog, largely or sometimes wholly derived from the wolf, tinged with yellow or with a grayish color, having an outer coat of long hair, and an undercoat of soft wool. Its short pricked ears and bushy tail add to its wolf-like appearance. Its cry is not a bark, but a long melancholy wail. This dog is trained to hunt the polar bear and to drag the Eskimo's burdens over the rough ice, when harnessed in "trains" to sledges, and is highly prized in the frozen North.

Eskimos, or **Esquimaux,** es'ki-mō, the name of the inhabitants of the northern coast of the American continent down to lat. 60° N. on the west, and 55° on the east, and of the Arctic islands, Greenland, and about 400 miles of the nearest Asiatic coast. They have been met with as far as Arctic discoverers have hitherto advanced toward the pole. They prefer the vicinity of the seashore, from which they rarely withdraw more than 20, and hardly ever 80 miles. Their number scarcely amounts to 40,000. Nevertheless they are scattered as the sole native occupants of regions stretching 3,200 miles in a straight line east and west, to travel between the extreme points of which would necessitate a journey of no less than 5,000 miles. This distance, taken in connection with their homogeneous nature and manners, makes their small bands the most thinly scattered people of the globe. Their extraordinary persistency in maintaining their language and habits must be due to the difficulties they have had to face in procuring subsistence where no other nation can live. They call themselves ***Innuit*** ("the people").

Race.— They used to be classed among nations of the Mongolian stock; but now they are considered as akin to the American Indians. Their height nearly equals the average of the Indians. They appear comparatively taller sitting than standing. Their hands and feet are small, their faces oval, but rather broad in the lower part; their skin is only slightly brown; they have coarse black hair and very little beard. The skull is high.

Habits.— The Eskimos get their subsistence mostly from hunting by sea, using for this purpose skin boats where the sea is open, and dog sledges on the ice. From the skin, blubber, and flesh of the seal and the cetaceous animals, they procure clothes, fuel, light, and food. Their most interesting as well as important invention for hunting is the well-known small skin boat for one man, called a kayak. It is formed of a framework covered with skin, and, together with his waterproof jacket, it completely protects the man against the waves, so that he is able to rise unhurt by means of his paddle, even should he capsize. In winter the Eskimos are undoubtedly stationary. But during the summer, when sufficient open water is found, they roam about in their large skin boats. Their winter dwellings vary with regard to the materials of which they are built, as well as in their form. In the farthest west they are constructed mostly of planks, covered only with a layer of turf or sod; in Greenland the walls consist of stones and sod; in the central regions the houses are formed merely out of snow. In Alaska the interior is a square room, surrounded by the sleeping places, with the entrance on one side, while a hearth with wood as fuel occupies the middle of the floor. The number of inhabitants at an Eskimo station or village is generally under 40, but in rare cases more than 200 are found. A funnel-shaped, half-underground passage forms the entrance of the narrow dwellings.

Dress.— The dress of the Eskimos is almost the same for the women as for the men, consisting of trousers or breeches and a tunic or coat fitting close to the body, and covering also the head by a prolongation that forms the hood. For women with children to carry, this hood is widened so as to make it an excellent cradle, the amaut. Tattooing has been general among all the tribes. The ordinary materials of which clothes are made are the skins of seals, land animals, and birds.

Language.— The language is characterized by the power of expressing in one word a whole sentence in which are embodied a number of ideas which in other languages require separate words. The Greenland dictionary contains 1,370 radicals and about 200 affixes. A radical may be made the foundation of thousands of derivatives, and a word can be composed which expresses with perfect distinctness what in our civilized languages might require 20 words. In Greenland and Labrador the missionaries have adapted the Roman letters for reducing the native language to writing. The printed Greenland literature, including what has been published by the Moravian Brethren, amounts, with pamphlets and the like, to what might make 70 to 80 ordinary volumes.

Sociology.— It is doubtful whether an organization like that of the Indian "families" has been discovered among the Eskimos. But a division into tribes, each with their separate territories, actually exists. The tribe again is divided into groups constituting the inhabitants of the different wintering places. Finally, in the same station, the inhabitants of the same house are closely united with regard to common housekeeping.

Religion.— The inhabitants of Danish West Greenland, numbering about 10,000, the greater part of the Labradorians, and the southern Alaska Eskimos are Christianized. As for the rest, the religion of the Eskimos is what is generally designated as Shamanism.

The name Eskimo is said to be formed by corruption out of an Indian word signifying "eaters of raw meat." Their origin generally has been derived from Asia, but now they are believed by some to have come from the interior of America, and, following the river courses, to have arrived at the Arctic sea, where they have developed their abilities as an Arctic coast people. The Eskimos may be divided into the following groups: (1) The Western Eskimos, inhabiting the Alaska territory and the Asiatic side of Bering Strait; (2) the Mackenzie Eskimos, or Tchiglits, from Barter Island to Cape Bathurst; (3) the inhabitants of the central regions, including the Arctic Archipelago; (4) the Labradorians; (5) the Greenlanders. A side branch inhabits the Aleutian Islands.

The Christianized natives still preserve their ancient folklore. It represents at the same time their original poetry, religious ideas, and history, praising the deeds of their great men in braving the dangers to which their race has been continually subjected. The 'Tales and Traditions of the Eskimo' (1875) comprise a collection of 150 tales founded on versions supplied by about 50 narrators from different parts of Greenland, and a few from Labrador. A valuable collection has since been acquired from East Greenland, some tales from Baffin Land, and a number of the simplest fragments of the same from Bering Strait. See ALASKA; ARCTIC EXPLORATION; ETHNOLOGY; GREENLAND; LABRADOR.

Bibliography.— McLean, 'Notes on the Hudson Bay Territory' (1846); Hall, 'Life with the Eskimos' (1864); Rink, 'The Eskimo Tribes' (1887); Pilling, 'Bibliography of the Eskimo Language' (1888); Peary, 'My Arctic Journal' (1893); Nansen, 'Eskimo Life' (1894).

Es'ler, Erminda Rentoul, Irish novelist: b. Ireland. She married Robert Esler, M.D., in 1883. She has published: 'The Way of Transgression' (1890); 'The Way They Loved at Grimpat' (1894); 'A Maid of the Manse' (1895); 'Mid Green Pastures' (1895); 'The Wardlaws' (1896); 'Youth at the Prow' (1898); 'The Awakening of Helena Thorpe' (1901).

Esmann, ĕs'män, **Gustav Frederik,** Danish dramatist: b. Copenhagen 17 Aug. 1860. After a short period of legal study, he abandoned law for literature, and his first work was a volume containing two short stories, 'Gammel Gjaeld' (1885). Thereafter he devoted himself mainly to dramatic composition, and a notable series of plays, which have been acted with great success throughout the Scandinavian countries, have come from his pen. They are: 'I Stiftelsen' (1886); 'Enkemænd'; 'Før Bryllupet'; 'I Provinsen' (1890); 'Den Kære Familie' (1892); 'Magdalene' (1893); 'Den Store Maskerade'

(1895); 'Vaudrefalken' (1898); 'Det Gamle Hjem' (1899); 'Sangerinden' (1901).

Esmarch, Johannes Friedrich August, yō-hän'nĕs frēd'rĭh ow'goost ĕs'marh, German military surgeon: b. Tönning, Schleswig-Holstein, 9 Jan. 1823. He received his medical and surgical education in the universities of Kiel and Göttingen, and in 1860 was appointed professor and director of the Kiel Hospital. In 1870 he was a member of the hospital commission of the Prussian army and introduced a system of bloodless operations. In the autumn of 1888 he made a trip to the United States. He was an authority especially on gunshot wounds.

Esmeraldas, ĕs-mā-räl'däs, Ecuador, a province, etc. See ECUADOR.

Esneh, ĕs'nĕ, or **Esne,** a province in upper Egypt, situated on both banks of the Nile. The town of the same name, which is the capital of the province, stands about 30 miles above Thebes on the left bank of the river. It is a seat of manufactures, and produces blue cotton cloth and pottery, and is a depot of caravans from Abyssinia and Sennaar. The town was anciently called Latopolis; and was the centre of worship of the fish latus, a species of carp. Among the ruins of this once populous city is the temple, whose portico is in good preservation, having 24 beautiful columns, and a zodiac on the ceiling. Pop. 12,000.

Esocidæ, ĕ-sŏs'ĭ-dē. See LUCIDÆ.

E'sopus War, a long-continued and desultory conflict between the Dutch and the Indians at a place in Ulster County, N. Y., known to the Indians as Esopus, but now called Kingston. This series of skirmishes began in 1658, when the Dutch fired upon some Indian farm hands, who were drunk and riotous. Esopus, which the Dutch called Wiltwyck, was at last destroyed by the aborigines, who carried off 40 women and children, and killed 21 men. Gov. Stuyvesant sent out a strong force to punish the Indians, and in May 1664 a treaty of friendship was ratified.

Esoteric, ĕs-ō-tĕr'ĭk (Gr. *esōterikos*, "inner"), a term used in opposition to exoteric. In reference to the teaching of Pythagoras, Aristotle, and other ancient philosophers, it refers to those doctrines which they expounded to their select disciples, in contradistinction to those which they published to all the world (exoteric). The distinction does not necessarily imply that the esoteric doctrines were kept secret as a mystery, but only that they were of a higher and more difficult order. See ARISTOTLE; PYTHAGORAS.

Espalier, ĕs-păl'yėr, in gardening, a sort of trellis-work on which the branches of fruit-trees or bushes are extended horizontally, with the object of securing for the plant a freer circulation of air as well as a full exposure to the sun. Trees thus trained are not subjected to such marked nor so rapid variations of temperature as wall-trees. The term is most commonly used in France, where it is applied to a row of trees planted along a wall. See TRELLIS.

Espartero, Baldomero, băl'dō-mā'rō ĕs-pär-tā'rō, DUKE OF VITTORIA, Spanish statesman: b. Granatula 27 Feb. 1792; d. Logrono 9 Jan. 1879. The son of a wheelwright, he was educated for the priesthood, but joined the army as a volunteer in 1808. He took a leading part in the conflict with the Carlists, and was one of the most prominent men in Spain during several decades of the 19th century. He was regent of the kingdom in 1841–3, and again head of the government in 1854–6. In 1868 his name was put forward in the Cortes as a candidate for the throne, but the proposal was unsuccessful and the closing years of his life were spent in retirement.

Espar'to (Gr. *spartos;* Lat. *spartum*), a grass, the *Stipa* or *Macrochloa tenacissima*, growing native in Spain and Africa, known to the ancients, and applied by them to the manufacture of cordage, matting, etc., and still more extensively used at the present day. A few species of *Stipa* are found in dry woods from New England, south to Wisconsin. Esparto grows in tufts and bunches, like rushes, to a height of from two to four feet, and has a long, flat, lanceolated blade, which becomes cylindrical when the ripened plant begins to dry. It is pulled up by the roots, dried in the sun, and packed in bundles for exportation. Besides the various uses already indicated, esparto has for some time been applied to the manufacture of paper. Formerly the supply of esparto was almost wholly obtained from Spain, but a closely allied fibre called alfa (*Macrochloa arenaria*) is now obtained in still larger quantity from Algeria, while a third fibre, dis (*Festuca patula*), is imported for the same purpose from Tripoli and Tunis. See FEATHER BUNCH-GRASS; FIBRE.

Esperanto Language. "Esperanto," successor to "Volupuk" in the effort to establish an international language, has made considerable progress. The latest reports, which include a statement of events at the Congress of Esperantists held at Boulogne from 5–13 Aug. 1905, show that a substantial and probably lasting interest in this latest linguistic enterprise now exists in several of the larger European countries.

In 1887 Dr. Zamenhof, a Russian physician, issued his first pamphlet concerning a suggested new international language to be called "Esperanto." Only trifling progress was made during the first ten years of the movement. The idea first took root in the originator's native country. Russian educators and other men of culture looked upon the innovation with favor. After the lapse of a decade, a start was made to introduce the Zamenhof idea among the Norwegians and Swedes. They, too, showed a friendly attitude. Then France became interested, and the famous linguist, M. de Beaufront, who had himself previously devised a plan along similar lines, threw his own scheme aside and accepted that of Dr. Zamenhof as being better fitted for the purpose intended. The result of this vigorous and decisive movement in France by so distinguished a man as M. de Beaufront was that France almost immediately became prominent as a stronghold of Esperantism.

From France the movement extended to Germany, thence to Austria, Switzerland, Italy and England. In the latter country 30 societies of Esperantists were organized within a year of the system's introduction. During the past few months, active missionary work has been undertaken in the United States, looking toward the promulgation of the Zamenhof plan for use in commercial, educational and other fields. There is little doubt as to the success of the outcome, indorsed as it is by some of the greatest philologists in Germany, Austria, England and France.

Advocates of an international language have in the past, included numerous philosophers and scientists, including Roger Bacon, Descartes, Pascal, Leibnitz, Locke, Condillac, Voltaire, and Diderot. Only of late years have the linguistic theories of these famous thinkers been moulded into anything like practical shape.

Occasions Calling for the Use of an International Language.— One of the principal reasons for renewal of interest in the direction of one universal language is the necessity for producing a vehicle of common expression among delegates representing various countries at congresses and on similar occasions. It has been found difficult for individuals, acting for their respective nations, to keep in touch with the proceedings from day to day. The extended use of Esperanto and the widespread appreciation manifested in its development indicate that the method of Dr. Zamenhof offers a feasible solution of what has, hitherto, been an unsolved problem.

In addition to the advantages of having a common language for cosmopolitan assemblages, the transaction of voluminous mercantile affairs between nations and merchants of various nations require some such system to facilitate the making of purchases and adjustment of mercantile accounts.

For educational purposes, as in other ways, the availability of a means whereby educators can compare systems and processes without encountering the difficulties connected with proper and complete translation is very evident.

Present Uses of the Esperanto Language.— From a recently-published review it is learned that books on the Esperanto language are now being printed in more than twenty languages. The number of periodicals, including those strictly scientific, printed in the Esperanto language, is estimated at twenty-five. On the continent of Europe, representative daily and weekly newspapers, occasionally or regularly, publish articles in Esperanto. Esperantist clubs and societies are operating in many European cities and have large membership. Among the most important are those of Paris, with 3,000 members, Marseilles, Lyons, Bordeaux, Havre and Lille.

Several French publishers have undertaken, in an extensive way, to publish Esperanto works, conditional on the possession of exclusive rights. Quite a number of large commercial concerns are using the system for cable and telegraphic purposes. Courses of study in Esperanto form an attractive feature in commercial schools, clubs and public institutions, some of which make a special feature of teaching the blind to read by the new system. An Esperanto typewriting machine is one of the latest developments, and in that connection many stenographers are learning the use of the language for shorthand purposes.

In the colleges and schools, Esperanto is commanding considerable attention. One of the greatest Esperantist triumphs was the recent delivery of an address in the Esperanto language by Mr. Moch, the famous peace advocate, at the International Peace Congress, Luzerne. At the Boulogne congress, 1,200 delegates from 22 countries spoke the Esperanto language freely and understood each other thoroughly. A complete test was made by means of speeches, discussions, concerts, dramatic performances and religious services.

During the congress, the work of Dr. Zamenhof was officially noticed by the French government. The Minister of Public Instruction extended thanks in behalf of the President of the Republic and of the people of France. In the course of the proceedings a reception was tendered to the creator of Esperanto at the Hotel de Ville, Paris.

Method of the Esperanto Language.— In the general plan of Dr. Zamenhof the aim is to omit all accidental words in the language of each nation, retaining only such words as are common to all nations. Sounds peculiar to any one language are eliminated. The English *th* and *w*, appearing in English words, but not in those of the French or German languages, are, therefore, according to the rule of the originator of Esperanto, dropped. The French *u*, the German *u*, and the French nasals, not used in English, are left out, also the Spanish *n* and *j*, and the German *th*. The pursuance of this plan removes all difficulties as to pronunciation.

Phonetic spelling is the Esperanto rule, a certain letter having the same sound always. Mute and double letters are cut out. The letter *x* becomes *ks*, *ph* becomes *f*, *ch* becomes *k* for the guttural sound, and *ĉ*, *c* remaining for the ordinary sound in words like cigar. The g is used only for the guttural (gril, garb), and *ĝ* is used for the sibilant *aĝ* which is equal to *age*. New signs introduced are *ĉ* and *ĝ*. But these are for sounds already recognized. A third sign takes the place of a double letter, viz., *ŝ* for *sh* (*ŝip* equals ship and *ŝi* equals she). Further details regarding the vocabulary, prefixes and suffixes — in fact, the whole grammar — have been issued in separate form and can be readily obtained by students. It will suffice to say here that the Esperanto vocabulary is much smaller than that of any other language, being only about 2,000 words, exclusive of scientific and technical words, as compared with 32,000 in the French language, a considerably larger number in the German language, and over 100,000 in English. The simplicity of the Esperanto grammar is quite remarkable. The majority of those who undertake the study of Esperanto, diligently, under proper instruction, master it in a short time. See UNIVERSAL LANGUAGE; SCIENCE OF LANGUAGE; etc.

Espinas, Alfred Victor, äl-frā vēk-tōr ā-spē-nä, French sociologist: b. St. Florentin, Yonne, France, 23 May 1844. After teaching philosophy in the lycées of Bastia, Chaumont, Havre, and Dijon, he became successively professor of philosophy in the universities of Douai, Lille, and Bordeaux, and in the latter was dean of the faculty of letters 1887–90. Since 1894 he has been professor of the history of social economy, on the Chambrun foundation, in the faculty of letters of the University of Paris. Besides contributing largely to the 'Revue Philosophique,' he has translated (with Ribot) Herbert Spencer's 'Psychology' (1874), and written: 'Des Sociétés Animales' (1877–8); 'La Philosophie Expérimentale en Italie' (1880); 'Histoire des Doctrines Economiques' (1893); 'Les Origines de la Technologie' (1897); 'La Philosophie Sociale du XVIIIe Siècle et la Révolution' (1898).

Espirito-Santo, ĕs-pē'rē too-sän'tō, Brazil, a state bounded on the north by the state of Bahia, on the east by the Atlantic Ocean, on the south and west by the states of Rio de Janeiro and Minas Geraes. Area 17,307 square miles. Near the capital, Victoria, and the former capital, Villa Velha, are the small mountains Penha, Moreno, Frade Leonardo, and Mestre Alvares: the highest of these, Mestre Alvares, is one of the most conspicuous landmarks on the Brazilian coast. The state has immense forests, and is noted for the valuable woods found in them. The Doce River flows through some of the richest of the hinterlands, but is navigable only for very small craft. São Matheus, in the northern part of the state, is surrounded by coffee and mandioca plantations, the products of which are shipped from this port, officially known as Conceição da Barra. A number of small ports intervene between the Doce River and the spacious bay of Espirito-Santo, which has given its name to the state. Coffee, the chief agricultural product, is largely exported. Other exports are: tapioca, mandioca, cotton, cacao, hides and skins, and woods. A railway is being built to connect Ouro Preto, on the upper waters of the Doce, with the coast. Cotton goods are manufactured in the town of Pessanha. The population of the state, which was 135,997 in 1890, has increased to 382,137, this growth being due to European immigration. A few years ago the city of Victoria (pop. 8,000 in 1890, but 20,000 in 1901) had almost no maritime trade, as its port was too shallow to admit large vessels. Recently improvements have been made in the harbor, which now accommodates transatlantic steamers, and both trade and immigrants have sought it. Colonies of Germans, Poles, Swedes, Tyrolese, Portuguese, and Italians are established near Anchieta, Alfredo Chaves, Itapemirim, and Cachoeiro — chiefly in the southern part of the state. Some of these colonies are under government protection, receiving annual subsidies of seeds and cattle, but the majority of the colonists already own lands which they work without government aid.

Esplanade, ĕs-plā-nād', in fortification, the wide open space left between a citadel and the nearest houses of the city, to prevent an enemy from being able to assail it under cover of these houses. The term is also frequently applied to a kind of terrace, especially along the seaside, for public walks or drives.

Espou'sal (Sponsalia), or **Betrothal,** in the Roman Catholic Church consists of a deliberate mutual promise of marriage, expressed by outward signs, between two persons, both of whom may lawfully and validly enter into such an engagement. When such promise is made and accepted on both sides, neither party can lawfully withdraw from it without the other's consent or unless something occurs or some circumstance comes to light which, had it been known in time, would have hindered the engagement. Formerly such engagements used to be made with some solemnity *coram ecclesia* or at least in presence of witnesses; now they are usually made without ceremony or publicity.

Espronceda, José de, hō-sā' dā ĕs-prōn-thā'dä, Spanish poet: b. Almendralejo in Estremadura 1810; d. 23 May 1842. A precocious poet and revolutionist, he wrote the epic fragment 'Palayo' in confinement, and was repeatedly exiled. His most notable poems are: 'The Pirate'; 'The Beggar,' preaching socialism; 'The Headsman'; the grewsome 'Student of Salamanca'; 'The Clean Demon' (1841). The volume 'Forgotten Pages' was issued in 1874.

Es'py, James Pollard, American meteorologist: b. Washington County, Pa., 9 May 1785; d. Cincinnati 24 Jan. 1860. He was graduated at Transylvania University 1808. The name "storm-king" was given to him for his originating a theory of storms which involved him in much controversy. This he embodied systematically in his 'Philosophy of Storms' (1841). His meteorological doctrine on the point of how atmospheric disturbances commence was approved by the French Academy, but his views as to the mechanics of storm are contrary to received fact, and have been exploded. His principal contribution to practical meteorology was his institution of a system of telegraphic weather bulletins, which should converge at the capital and give daily intelligence of the weather in different widely separated points, and it may be justly claimed that he thus laid the foundation of all sound theory on the subject of weather prediction.

Esquimalt, ĕs-kwī'mält, Canada, seaport in British Columbia, on the southeast coast of Vancouver Island, and on the Strait of San Juan de Fuca; four miles from Victoria. The harbor is extensive and capable of receiving vessels of the greatest size, and is the British naval station for this part of the Pacific coast. It has a navy yard, marine hospital, a large dry dock built by the Dominion government in 1888, and a meteorological station. In 1894 the British government started work on the defenses of Esquimalt, consisting of earthworks, with disappearing guns, and two parapet forts on the hills for protection against a possible attack by land. The harbors of both Esquimalt and Victoria are kept thoroughly mined and wired, and constitute one of the best defended naval stations in the world. The population, exclusive of the British soldiers, officials and some of their families, is small, estimated in 1903, 2,000.

Esquimaux. See Eskimos.

Esquire, originally, a shield-bearer or armor-bearer, an attendant on a knight; hence, in modern times a title of dignity next in degree below a knight. In Great Britain this title is given properly to the younger sons of noblemen, to officers of the king's courts, and of the household, to counselors at law, justices of the peace while in commission, sheriffs, gentlemen who have held commissions in the army and navy, and in fact to anyone save tradesmen, mechanics, and peasants. It is usually given to all professional and literary men, both there and in the United States. In heraldry the helmet of an esquire is represented sideways with the visor closed.

Esquirol, Jean Etienne Dominique, zhŏṅ ā-tē-ĕn dō-mē-nēk ĕs-kē-rŏl, French physician: b. Toulouse 4 Jan. 1772; d. 12 Dec. 1840. His life was chiefly given to improving the methods of treating the insane, and he contributed greatly toward the abolition of the barbarous methods so long in vogue. In 1799 he founded a model asylum at Paris; visited all the asylums in France 1808; was appointed physician to the Saltpêtrière 1811; and in 1826 became head of the private asylum at Charenton, which he had largely planned. In 1817 his public revelations of the abuses current in French asylums led the government to appoint an investigating commission. His studies included the architecture and construction of asylums, and the best of the earlier 19th century buildings for the insane in France, such as those at Rouen, Nantes, and Montpellier, were built in accordance with his plans and instructions. He wrote: 'Des Illusions chez les Aliénes' (1832; Eng. tr. 1833); 'Des Maladies Mentales' (1838); and articles in 'Dictionnaire des Sciences Médicales,' and 'Encyclopédie des Gens du Monde.'

Esquiros, Henri François Alphonse, ŏṅ-rē fräṅ-swä äl-fōns ĕs-kē-rōs, French poet and miscellaneous writer: b. Paris 23 May 1814; d. Versailles 12 May 1876. His first work, a volume of poetry, 'Les Hirondelles,' appeared in 1834. This was followed by numerous romances, and a socialistic commentary on the life of Christ; 'L'Evangile du Peuple' (1840), for which he was prosecuted and imprisoned. He then published: 'Les Chants d'un Prisonnier' (1841), poems written in prison; 'Les Vierges Folles' (1842); 'Les Vierges Sages' (1842); 'L'Histoire des Montagnards' (1847); etc. Having to leave France in 1851, he resided for years in England, and wrote a series of essays for the 'Revue des Deux Mondes' on English life and character, which were translated under the title of 'The English at Home,' and were very popular. He also wrote a similar work on the Dutch. Other works of his are: 'Le Droit au Travail' (1849); 'Histoire des Martyrs de la Liberté' (1851); 'La Morale Universelle' (1859); 'Les Paysans' (1877); 'Le Château Enchanté' (1877), a novel.

Esquivel, Juan de, hoo-än' dā ĕs-kē-vĕl, Spanish soldier: b. 1470; d. 1519. He was the companion of Ovando when the latter went to Hispaniola to succeed Bobadilla as governor. In 1509 he conquered the island of Jamaica and settled it as a Spanish possession. The colony flourished under his administration, and he founded there the city of Sevilla Nueva.

Ess, Johann Heinrich van, yō-hän hīn'rĭн fän ĕs (better known by his Benedictine name «Leander»), German theologian: b. Warburg 15 Feb. 1772; d. Affolderbach in the Odenwald 13 Oct. 1847. He entered the Benedictine abbey of Marienmuster as a novice 1790; was pastor at Schwalenberg 1799–1812; and professor of theology at the seminary in Marburg 1812-22. In 1807, with his cousin Karl, he published a German translation of the New Testament, the circulation of which was forbidden by the Pope. The following year he published a defense of his views as to Bible reading by the people, a new edition of which was issued in 1816 entitled 'Gedanken über Bibel und Bibellehre.' After 1822 he gave his whole time to circulating his Bible versions among the people, to spreading his doctrines, and to the composition of a German version of the entire Scriptures, which he finished in 1840. Others of his publications are: 'Was War die Bibel den Ersten Christen?' (1816); 'Die Bibel Nicht ein Buch für Priester' (1818); an edition of the Vulgate (Tübingen 1822–4); of the Septuagint (1824; new ed. 1887); and of the Greek New Testament (1827).

Essay, a composition in which something is attempted to be briefly proved or illustrated. It is not easy to define the limits of the essay as a species of composition. In general it is understood of the briefer and less elaborate efforts of literary skill; but this distinction is not always maintained. Caution or modesty has induced many writers of note to give the title of essay to their most elaborate productions; thus we have Locke's 'Essay on the Human Understanding.' The subject of an essay may be any topic of human interest; it may be philosophical, scientific, logical, ethical, æsthetical, or humorous; and a series of essays may embrace connected, but so far independent views of the most extensive range of subjects. There is a class of English writers to whom the descriptive term essayist is applied. 'The Spectator,' 'The Tatler,' 'The Rambler,' and many other extensive collections, are among the works of this class of writers, the best of whom, from the variety which their works present in other particulars, can only be distinguished by excellence of style. In the United States Emerson is the most favorably known among essayists. From the brevity of the essay, considered in its ordinary sense, and the necessity of giving it some specific claim on the attention of cultivated readers, style may possibly be considered to have been, at least until recently, the distinctive characteristic of essay writers, and this form of composition may be supposed to have done some service in maintaining the standard of purity and excellence in the English language. See English Literature.

Essay on Criticism, An, a didactic poem by Pope (1711) in which he brilliantly explained and propounded the canons of verse structure and poetic taste. The poem abounds in striking passages which have become familiar quotations. See Pope, Alexander.

Essay on Man, An, a famous philosophical poem by Alexander Pope (q.v.), which appeared in four parts, 1732 to 1734. It was imitated by Voltaire and others. It contains many expressions which have become proverbial.

Essay on the Human Understanding, a famous philosophical work by John Locke (q.v.) (1690).

Es'sen, Germany, town of Rhenish Prussia, 18 miles northeast of Düsseldorf. It has recently greatly increased in population and manufactories. It is celebrated for the steel and iron works of the Krupps, the most extensive in Europe, employing about 28,000 workmen. This great establishment was started in 1827, with only two workmen. The rifled steel cannon made here are supplied to most of the armies of Europe. In the suburbs are the «colonies» — cottages, churches, schools, stores, libraries, places of amusement, homes for superannuated and disabled workmen, etc., established by the Krupps for their workmen. The town was founded in the 9th century, when the Benedictine abbey was established here, and for some time it was under the control of the Abbess of Essen. In the 10th century the Abbess Hagona gave the town municipal privileges. Pop. (1900) 118,863.

Essence, in metaphysics, originally the same as substance. Later, substance came to be used for the undetermined substratum of a thing, essence for the qualities expressed in the definition of a thing; or, as Locke put it, "Essence may be taken for the very being of a thing, whereby it is what it is." In chemistry, and in popular parlance, essences are solutions of the essential oils in alcohol, and may be prepared by adding rectified spirit to the odoriferous parts of plants, or to the essential oils, and distilling; or simply by adding the essential oil to the rectified spirit, and agitating till a uniform mixture is obtained. The term has, however, received a wider significance, and is applied to any liquid possessing the properties of the substance of which it professes to be the essence. Thus essences of coffee and beef, and rennet contain in a concentrated form the virtues of coffee, and beef, and in some circumstances may be substituted for them.

Essenes, ĕs-sēnz' (Εσσηνοι, Εσσαιοι, *Esseni*), a sect or society of Hyper-Pharisaic Jews which was already in existence 150 years B.C., and which existed till the 4th century; the remnant then returning to Pharisaic or orthodox Judaism or entering the Christian communion. Josephus the historian (1st century) describes their manner of life in some detail; Philo Judaeus has a notice of it, so too has Pliny in his 'Historia Naturalis.' Josephus was in his youth a probationer of the society, but lived among them only a short time and was unacquainted with the details of their system, which were strictly withheld from novices; but his narrative has the marks of authenticity. In essentials Josephus and Philo are in accord, and with them agrees Pliny in the one peculiarity of this society which he notices — their celibate life. The Essenes were stern ascetics and in that respect were the prototype of the Christian Solitaries, who in the 3d and 4th centuries peopled the Nubian deserts: withal, they were both in name and in deed Friends — for such was one of the appellations of the brethren. Among themselves they had all things in common, like the first Christians, and they were open-handed and hospitable to strangers. There were groups of Essenes in all the towns of Judea, but their institute had opportunity for full development only in their communal settlements on the western shore of the Dead Sea, where they devoted themselves to their peculiar religious observances and to agriculture and a few simple handicrafts. Their food was of the simplest, taken at the common board, their only drink, water; their attire was of the plainest, white linen material. None possessed more than one tunic or more than one pair of shoes. They rose at daybreak for prayer; after prayer and a hymn they went about their customary occupations. (Here we are reminded of what Pliny wrote to Hadrian concerning usages of the Christians in Bithynia: "They met on a stated day before daybreak and chanted a hymn to Christ as God.") At the 5th hour (11 A.M.) they again assembled in one place and bathed their faces in cold water, after which they put on pure white garments and repaired to the common simple meal, which was preceded by a blessing, a prayer and a hymn; and after the repast there was again prayer and a hymn. Then the brethren put off the ceremonial garb of white linen, put on their workday attire, and went back to their employments. No women were admitted to the order; like some of the modern Shakers they adopted young boys and brought them up in their own simple way of living; on attaining maturity they might, if willing, be admitted to membership after a term of probation; or they were free to return to the world. But they also received accessions of life-weary grown people. "Thus," says Pliny, "here is a people that never dies out (*æterna est*) yet in which there are no births: so fruitful for them is others' 'disgust of life'" (*Tam foecunda illis aliorum vitæ pœnitentia est*). Like the Society of Friends they forbade oaths; and they held that a man whose word needed to be confirmed by oath was not to be believed at all. Nevertheless the postulant for admission into the society was required to take "terrible oaths" that he would pay worship to God, be just to men, injure none, hate the unjust, be faithful and true to all, especially rulers, for none bears rule save by God's will. Pliny writes of a similar oath taken by the Christians.

There were four degrees of membership resembling in some respects the castes of the Hindus. If a person in a higher degree so much as touched one of a lower grade, he was thereby defiled and was bound to make himself clean in cold water. Their severely abstemious life, their contempt for riches and honors, their deep conviction of the immense superiority of their religion gave them all the heroic courage in face of persecution and torture which distinguished the Christians in the ages of martyrdom. So scrupulous were they in avoiding everything like idolatry, that some of them would never enter any city because of the images erected at the gates; nor would they touch a coin that bore the likeness of any ruler.

Consult: Pliny, 'Historia Naturalis'; the writings of Josephus and Philo Judacus; also *Philosophumena*, or 'Refutation of all Heresies,' written in Greek 230 A.D., author unknown.

Essential Oils. See OILS.

Essequibo, ĕs-sĕ-kē'bō, a river of British Guiana, which flows into the Atlantic by an estuary 20 miles in width. Its course is very irregular; its whole length is about 600 miles. It is navigable for some distance from the ocean. The district or division of Essequibo, which is in the basin of the Essequibo River, is well cultivated and extremely fertile, producing coffee, cotton, cocoa, and sugar. A portion of the basin of this river was included in the disputed territory claimed by the Venezuelan and the British governments in 1896. The claims were settled by treaty 2 Feb. 1897. Pop. 36,000.

Essex, Robert Devereux, 2D EARL OF, English courtier: b. Netherwood, Herefordshire, 10 Nov. 1567; d. London 26 Feb. 1601. He was educated at Trinity College, Cambridge, and appeared at court in 1577. On Leicester's death 1588, he became the chief favorite of Elizabeth. In 1590 he married the widow of Sir Philip Sidney, and in 1591 was sent to support Henry IV. against Spain, but the expedition effected nothing of importance. About this time Essex was on terms of close friendship with Francis Bacon, who assisted him greatly by advice on political and other matters. In 1596 he commanded an expedition to Spain, and greatly distinguished himself at the capture of Cadiz.

In 1597, after an unsuccessful expedition to the Azores, he, with Howard and Raleigh, made extensive captures of Spanish ships. Next year he quarreled with the queen, who struck him on the ear and bade him "go and be hanged." After some months a reconciliation took place, and he was appointed lord-lieutenant of Ireland (1599), then in a state of rebellion. He returned to England in September, having been entirely unsuccessful in his government; was made a prisoner in his own house, and was shortly afterward (June 1600) tried by a special court. The charges against him were that he had exceeded his instructions in the Irish campaign, and had deserted his post without leave; and he was deprived of all his offices, and sentenced to imprisonment, but not long afterward was set at liberty. He now conceived a deep resentment against the queen's councilors, particularly Cecil and Raleigh, who, he imagined, had biased her against him. Being summoned before the council, he assembled his friends in his house, and proceeding to the city, endeavored to enlist the citizens in his favor. After a skirmish with a party of soldiers he returned to his house, but after a short defense was compelled to surrender, and sent to the Tower. He was tried for treason on 19 February, and executed on 26 Feb. 1601. See Spedding, 'Bacon' (1881); Abbott, 'Bacon and Essex' (1877).

Essex, Robert Devereux, 3D EARL OF, English soldier: b. 1591; d. 14 Sept. 1646. When 11 years old he was restored by James I. to the rank and titles held by his father, the 2d earl. He served in the army of the elector palatine in Holland 1620–3, was vice-admiral of an unsuccessful naval expedition against Cadiz in 1625, and lieutenant-general of an army sent by King Charles against the Scotch Covenanters in 1639. Espousing the cause of the Parliament against the king, he was appointed to the command of the parliamentary army at the beginning of the civil war, was victorious over Charles at Edgehill in 1642, captured Reading in 1643, and relieved Gloucester, but lost the greater part of his army in 1644. He urged the impeachment of Cromwell before the House of Lords in 1645, and had to resign his commission. An annuity of £10,000 was settled on him for life.

Essex, England, a maritime county, on the southeastern coast; area, 1,533 square miles, of which 80 per cent is under cultivation. The chief towns are Chelmsford, the county town; Colchester, Maldon, and Harwich. Pop. (1901) 1,085,576.

Essex, The, an American 32-gun frigate built 1799 for the war with France. She was used as a Pacific convoy, and served later in the wars with the Barbary pirates. In 1812 Capt. David Porter did effective work with her: cutting out a brig with 197 soldiers from a British transport fleet; forcing the 16-gun sloop Alert to strike in eight minutes; and in a cruise on the west coast of South America, capturing the entire British whaling fleet and other prizes, they and those destroyed aggregating $2,500,000 in value. In February 1814 two British vessels, the 36-gun Phœbe and the 18-gun Cherub, blockaded her in the neutral harbor of Valparaiso; on 28 March he attempted an escape, but the vessel was disabled by a sudden gale, and in a fight of 2 hours and 20 minutes was cut to pieces, losing 58 killed and 66 wounded out of 255, and being left in a sinking condition. The battle was a mere massacre: the British had 38 long guns to the Americans' 6.

Essex Junto, a name applied about 1781 by John Hancock to the group of Massachusetts political leaders resident in or connected with Essex County, Mass.— the northeastern county, from just north of Boston to the New Hampshire boundary. Its coast was a line of commercial and fishing towns, and its interests therefore overwhelmingly in favor of a strong national government to protect them from foreign countries and their sister States. This made its leaders, whose great ability gave them powerful influence, the vanguard of the ultra Federalists, and adherents of Hamilton, whom they followed in his split with John Adams. The latter revived the old nickname, charged them with being a "British faction" and forcing on a war with France, and for years after his retirement assailed them in the press. When the embargo (q.v.) and the later war solidified all New England Federalism in a common self-defense, all the opposition and the suspected treason were attributed by outsiders to the Essex Junto. Its chief members were George Cabot, Timothy Pickering, Theophilus Parsons (State chief justice), the Lowell family, Stephen Higginson, and Benjamin Goodhue.

Esslingen, ĕs'ling-ĕn, Germany, town in Würtemberg; on the Neckar, seven miles east-southeast of Stuttgart. It was founded in the 8th century and was long a fortified, imperial free town. The old church, monastery, and town house are still extant. Originally Esslingen belonged to the duchy of Swabia, and the Swabian League of Swabian cities and governments was formed here in 1488. There are manufactories for machinery, articles of wood, gold, silver, and tin, and also for cutlery, dye-works, and paper. Pop. (1901) 27,643.

Essonite, or **Hessonite,** a variety of garnet (q.v.), also often called Cinnamon-stone (q.v.).

Estaing, ĕs-tăṅ, **Charles Hector,** COMTE D', French army and navy officer: b. Auvergne 1729; d. Paris 28 April 1794. He entered the French army as colonel of infantry; was promoted brigadier-general in 1757, and in 1777 became vice-admiral in the French navy. In 1778, in accordance with the treaty between France and the United States, France fitted out a fleet of 12 ships of the line and 4 frigates to aid the latter in the struggle against Great Britain, and Estaing was placed in command. He sailed 13 April, reached Delaware Bay in July, and proceeded to New York. He captured some prizes off the coast of New Jersey, agreed to assist in a land and sea attack on Newport to expel the British from Rhode Island; reached the harbor late in July; and hearing of the approach of a fleet, put to sea to meet it. He was overtaken by a severe storm, which caused him to put into Boston for repairs, and the projected attack failed. Subsequently he captured St. Vincent and Grenada, West Indies, and in 1779 co-operated with Gen. Lincoln in an ineffectual attempt to capture Savannah, Ga. He returned to France in 1780; commanded the allied fleets of France and Spain in 1783; was chosen admiral of the navy in 1792; and, despite his eminent military and naval services to

France, was condemned as a royalist and guillotined in 1794.

Estancia, ĕs-tän'thē-ä, Philippines, a pueblo of the province of Iloilo, situated on the eastern coast of the island of Panay, 66 miles north of the town of Iloilo. The main portion of Estancia is one mile inland, connected by a good road with the coast and anchorage ground. Pop. 12,700.

Estate, a term sometimes used to indicate property generally, whether personal or real. Sometimes it includes land alone. It signifies in law the interest which a person may have in property. It denotes the time during which ownership may exist, as for a year, for life, or forever. At common-law estates in land are divided, as regards the quantity of interest, into two kinds, (1) freehold estates, and (2) estates less than freehold. A freehold is an estate which may last for life or longer. An estate which is circumscribed within a certain number of years, or one in which the possessor has no fixed right of enjoyment, is less than freehold, and although in fact it may last longer than the life of its first possessor, still the law regards it as a lower estate than a freehold; it is personal property in the eye of the law, and does not descend to heirs, although it may pass to executors or administrators.

Freehold estates are divided into estates of inheritance, which pass to heirs, and estates not of inheritance; the former are again divided into estates in fee simple and estates in fee tail. An estate in fee simple is the estate which a man has where lands are given to him and his heirs absolutely without any end or limit put to his estate, and it is the most extensive and the highest interest a man can have in land. If not aliened or devised, it passes to heirs generally. On the other hand, a fee tail is an estate which is limited to certain particular heirs or to a certain class of heirs, to the exclusion of the others; as to the heirs of one's body, which excludes collateral heirs, or to the heirs male of one's body, which excludes females.

In the United States fee tails have had only a limited existence, and are now in general abolished. They were changed into estates in fee simple in New York as early as 1782. Freeholds not of inheritance are for life only, either for the life of the tenant or of some other person or persons; when the estate is called an estate *pour autre vie*. Life estates are created by operation of law, or by the act of the parties. An example of an estate created by act of the parties is where A conveys land to B for the term of his natural life, or where A conveys land to B without mentioning the duration of the term. Here under the common law B would take only a life estate; but by statute in many of the States — among them New York — a grant or devise of real estate possesses all of the interest of the grantor or testator, unless the intent to pass a less estate or interest appears by express terms or by necessary implication.

Dower and courtesy are estates created by operation of law. An estate by the courtesy is that estate to which a husband is entitled upon the death of his wife in the lands or tenements of which she was seized in possession in fee simple or fee tail, during their coverture, provided they have had lawful issue born alive, and possibly capable of inheriting her estate. An estate in dower is an estate which a widow has for her life in some portion of the lands of which her husband was seized at any time during coverture, and which her issue might have inherited if she had any, and which is to take effect in possession from the death of her husband.

Estates less than freehold are divided into estates for years, at will and by sufferance. An estate for years is an interest in lands by virtue of a contract for the possession of them for a definite and limited period of time. Such estates are ordinarily called terms. The length of time for which the estate is to endure is of no importance in ascertaining its character, unless otherwise declared by statute. An estate at will is where one man lets land to another to hold at his will, as well as that of the lessee. An estate of this kind is terminated by either party on notice. Out of estates at will a class of estates has grown up called estates from year to year, which can be terminated only by six months' notice, expiring at the end of the year. An important element in creating this estate is the payment of rent. An estate at sufferance is the interest of a tenant who has come rightfully into possession of lands by permission of the owner, and continues to occupy the same after the period for which he is entitled to hold by such permission. This estate is not of frequent occurrence, but is recognized as so far an estate that the landlord must enter before he can bring ejectment against the tenant. If the tenant has personally left the house, the landlord may break in the doors, and the modern rule seems to be that the landlord may use force to regain possession, subject only to indictment if any injury is committed against the public peace.

Estates may depend upon condition; that is, their existence may depend on the happening or not happening of some event whereby the estate may be created, enlarged, or defeated. A term for years, a freehold, or a fee may thus be upon condition. The condition must either be precedent, that is, must happen before the estate can vest or be enlarged; or must be subsequent, when it will defeat an estate already vested.

Estates may also be divided into estates which are legal and those which are equitable. Estates are termed equitable when the formal ownership is in one person, while the beneficial ownership is in another. In another form of expression it may be said that a trust is created. The nature of the estate is not affected by this distinction. For example, a trust estate may be an estate for life or a fee, and in the latter case is transmissible to heirs as though it were a legal estate.

Estates are divided into estates in possession and estates in expectancy, in regard to the time of enjoyment. An estate in possession is one in which there is a present right of enjoyment. Estates in expectancy are those which give either a vested or contingent right of future enjoyment. Estates are also divided, in regard to the number of owners, into estates in severalty; in joint tenancy, in common and in coparcenary. An estate in severalty is one which has only a single owner. An estate in joint tenancy is an estate owned jointly by two or more persons, whose title is created by the same instrument. The right of survivorship is the distinguishing characteristic. When a tenant dies his interest is extinguished, and the estate goes to the survivors. Where an estate is conveyed to two or more persons, at common law, without indicating how it is to be held, it is construed to be in joint tenancy. In most of the United States, however, this rule has been changed by statute, and persons to whom an estate is conveyed or given take as tenants in common, unless they hold as trustees. An estate in common is an estate held in joint possession by two or more owners at the same time by several and distinct titles. An estate in coparcenary is an estate which several persons hold as one heir, whether male or female. This estate has the three unities of time, title, and possession. The interests, however, of the coparceners may be unequal. In the United States this estate is essentially extinguished, and heirs take as tenants in common.

Este, ĕs-tā, the name of an illustrious and ancient Italian family. Albert Azzo II. is considered the founder of the greatness of his house. He inherited or acquired Este, Rovigo, Montagnana, Casal Maggiore, and other places in Italy; and was made governor of Milan by Henry III. in 1045. One of his sons became duke of Bavaria in 1071, by the title of Welf I. He was the ancestor of the German branch of the house of Este, the dukes of Brunswick and Hanover. Albert Azzo died 1097, having previously resigned his Italian possessions to his son Fulk, and retired to Burgundy. Fulk I. was attacked by his brother Welf, who compelled him to become tributary to him to the extent of a third of his revenues. He was succeeded (1137) by his son, Obizzo I., who joined the Lombard league against Frederick Barbarossa in 1167. He d. 1193, and was succeeded by his son, who in the annals of the family is called Azzo V. Either he or Oberto acquired by marriage Ferrara, with its dependencies in Romagna, and with a feud which became hereditary with the house of Torello, for a member of which house the bride, violently carried away by the Estes, was intended. The house of Este thus became vassals of the Church as well as of the empire. He was succeeded by Azzo VI. (d. 1212). He was constantly engaged in war with the Torelli, by whom he was thrice driven from Ferrara. Aldobrandino, his son, died young, and was succeeded by his brother Azzo VII., a minor, in 1215. He was engaged in protracted wars with the Ghibelline party. Honorius VII. invested him with the marquisate of Ancona. He d. 1264, and was succeeded by his grandson, Obizzo II., who was chosen Lord of Modena and Reggio. We may pass over his successors to Niccolo III., who succeeded in 1393 at the age of nine. During his reign, and those of some of his predecessors, the house of Este became patrons of literature. He died at Milan 26 Dec. 1441. Lionel, his son (1441–50), receives a high character from Muratori for justice and piety, and for his patronage of letters. He mediated a peace in 1450 between the Venetians and Alfonso, king of Sicily; and died in November of the same year. He was succeeded by his brother, Borso (d. 20 Aug. 1471), who received new accessions of dignity from the emperor, and was created Duke of Ferrara by Pope Paul II. His reign was peaceable and prosperous. Ercole I., his brother (d. 25 Jan. 1505), succeeded, to the prejudice of his son Niccolo. His usurpation caused a war, which was unsuccessful in deposing him. He had Milan and Florence for allies, the Pope and Venice for adversaries. After the conclusion of peace in 1484 he maintained neutrality in his estates for the remainder of his reign, while the rest of Italy was convulsed with wars and revolutions. He had for his minister Boiardo, the famous author of the 'Orlando Innamorato'; and Ariosto, born near the commencement of his reign, grew up under his patronage. Alfonso I., his son, d. 31 Oct. 1534. His reign was a contrast to the peaceable one of his father. In 1509 he joined the League of Cambray, and commanded the Papal army as gonfalonier. While conducting the operations of the allies elsewhere, his estates were ravaged by the mercenary troops of Venice, whose atrocities are described in the 36th canto of the 'Orlando Furioso.' Alfonso continued in the French alliance after the Pope had joined the Venetians. He assisted in the battle of Ravenna, and took prisoner Fabrizio Colonna, the general of the Pope. After the French had been driven from Italy he endeavored to make peace with the Pope; but Julius continued implacable. Leo X. restored him to his possessions, with the exception of Modena and Reggio, but afterward excommunicated him. He joined in the wars between Francis I. and Charles V. on the side of the French king, but was afterward reconciled with the emperor, who confirmed him in his possessions, against Pope Clement VII. (1530). He married as his second wife the famous Lucrezia Borgia. His brother, the Cardinal Ippolito, was the patron of Ariosto. Alfonso was succeeded by his son, Ercole II., who died 3 Oct. 1559. He married Renée of France (daughter of Louis XII.) in 1528. She favored the Reformation, and made the court of Ferrara the resort of the few advocates of that cause in Italy. Calvin visited it in 1535. Ercole at first adhered to the imperial party, but in 1556 joined the league of Paul IV. and Henry II. of France against Spain, and was made general of the allied forces; but did not push the war with vigor, and made peace with Spain in 1558. Leonora, his daughter by Renée, was the object of the unfortunate attachment of Tasso. He was succeeded by his son, Alfonso II., the patron and persecutor of Tasso, who died 27 Oct. 1597. He was succeeded by his cousin Cesare (d. 11 Dec. 1628), whom by his testament he had made his heir; but this disposition was annulled by the Pope, Clement VIII., who excommunicated Cesare and deprived him of Ferrara, with the dependencies of the Church. Cesare was obliged to content himself with Modena and Reggio, which depended on the empire. From this period the political importance of the house of Este greatly diminishes. The last sovereign of the house was Francesco V., who succeeded in 1846. In 1859, the dynasty was deposed by the National Assembly, the duchy was annexed to Sardinia by the Treaty of Zürich 10 Nov. 1859, and has consequently been incorporated with the kingdom of Italy.

Este, Italy, a town in the province of Padua, 17 miles southwest of Padua; the ancient Adeste. Pop. about 6,000. The leaning tower, or campanile, is an interesting feature of the town, as is the battlemented mediæval fortress, known as the Rocca. Here once ruled the Este family, one of the most ancient and illustrious families of Italy. In the 11th century the house of Este became connected by marriage with the German Welfs, or Guelphs, and founded the German branch of the house of Este, the dukes of Brunswick and Hanover. The sovereigns of Ferrara and Modena were of this family, several of them being famous as patrons of letters. The lives of Boiardo, the author of 'Orlando Innamorato'; Ariosto, and Tasso were closely connected with members of this house. The last male representative of the Estes died in 1798. His daughter married a son of the Emperor Francis I. of Austria, who founded the Austrian branch of the house of Este, of which the male line became extinct in 1875.

Esters (an arbitrary modification of "ether"), COMPOUND ETHERS, OR ETHEREAL SALTS, are compounds in which one or more alcohol or basic radicals are united to one or more acid radicals. They are analogous to the salts of the metals. Thus $CH_3COO.H$ is acetic acid, and if the typical hydrogen of this acid is replaced by the monad radical "ethyl," the resulting compound, $CH_3COO.C_2H_6$, is known as "ethyl-acetic ester." Chemically, this substance is analogous to potassium acetate, $CH_3COO.K$, obtained by replacing the hydrogen of the acetic acid by potassium. The word "ester" was originally applied by Gmelin to compounds of the alcoholic radicals with oxygenated acids; but it has now been extended so as to include all the salts of the alcoholic radicals. Ethyl bromide, $C_2H_5.Br$, for example, is now included among the esters. Some of the esters are prepared by the direct action of the acid upon the alcohol. In other cases a mixture of the acid and the alcohol is distilled with the addition of sulphuric acid, zinc chloride, or other dehydrating agent. The esters may also be prepared by treating the iodide of the alcohol radical with the silver salt of the acid, the iodine and silver combining to form iodide of silver, while the liberated alcoholic and acid radicals combine to produce the desired ester. The esters of the organic acids occur in fruits and flowers, and are also prepared artificially for flavoring purposes, and for improving the bouquet of wines. The fats and oils which contain glycerine in combination with oleic, margaric and other acids may be regarded as esters, since glycerine is a triatomic alcohol. Much attention has been paid to the esters in connection with theoretical chemistry, since they are well adapted for the study of the laws of mass-action. See EQUILIBRIUM, CHEMICAL; ETHER.

Es'terhazy. See ESZTERHAZY.

Esther, or **Hadassal** (Heb. "myrtle"), the name of a Jewish maiden, chosen by Xerxes to be his queen. She was one of the heroines of Hebrew history and maintained the rights of her nation at the court of the king of Persia. See ESTHER, BOOK OF.

Esther, Apocryphal Books of. See APOCRYPHA.

Esther, The Book of, relates how a Jewish virgin, who was a foster-daughter of Mordecai, was chosen by the king of Persia, Ashauerus (Xerxes), as his wife in room of the disobedient and disgraced queen Vashti, and brought about the great deliverance of her people which is commemorated in the Feast of Purim ("lots"). Haman, the king's prime minister, had issued a decree for the extirpation of all the Jews, and had prepared to hang Mordecai; but Mordecai, who had formerly detected a conspiracy against the king's life, was raised to great honor, and Haman was hanged on the gallows 50 cubits high that he had prepared for Mordecai. After this Esther, at Mordecai's instance, revealed her Hebrew lineage, and prevailed upon the king to counteract the former edict by another permitting the Jews everywhere to destroy their enemies. The 'Book of Esther' stands conspicuous among the Hebrew scriptures as an expression of the uncompromising spirit of Hebrew nationality, containing hardly a trace of religious feeling. The name of God is not once mentioned, while the great king of Persia is referred to nearly 200 times. A possible explanation is the fact that the book was meant to be read at the merry revels of the Purim festival. It has continued in constant use and favor among the Jews, and of the five Hagiographical rolls it is called emphatically 'The Roll' (*Megillah*). The author is quite unknown, and the date is probably the latest Persian or the earliest Greek period.

Esthonia, ĕs-thō'nĭ-a̤, Russia, a maritime government, bordering on the Gulf of Finland and the Baltic. It includes several islands, of which the most important are Dagoe and Oesel; area, about 7,818 square miles. The peasantry are almost all of Finnish origin, and speak a Finnish dialect. In the 10th and 12th centuries it belonged to Denmark; it was afterward annexed by Sweden, and in 1710 was seized by Russia. Reval is the capital. (See REVAL.) Pop. 416,580. Consult: Vincent, 'Norsk, Lapp, and Finn'; Jordan, 'Beiträge zur Geographie und Statistik Esthlands.'

Estienne, ā-tē-ĕn, or **Etienne** (Lat. STEPHANUS), **Henri,** ŏṅ-rē, French painter and scholar: b. Paris 1528; d. Lyons March 1598. He was a son of Robert Estienne (q.v.) and continued his work. Beside compiling the noted 'Thesaurus linguæ Græcæ' (1572), he wrote 'Apologie pour Hérodote' (1566); 'Traité de la conformite du Français avec le Grec'; etc.

Estienne, or **Etienne** (Lat. STEPHANUS), **Robert,** rō-bār, French printer and scholar: b. Paris 1503; d. Geneva 7 Sept. 1559. In 1526 he established a printing house in Paris and in 1539 was appointed royal printer to Francis I. He removed to Geneva about 1552. He published many editions of the Greek and Latin classics and compiled numerous other works. His son HENRI took up his father's work on the death of the latter and was also a writer of note. He died in Lyons in 1598.

Estiva'tion, the dormancy or "summer-sleep," induced in some of the lower plants and animals by heat and drought, and the means by which in summer they resist these unfavorable conditions, as they do others in winter by hibernation. The two states are comparable, though induced by opposite conditions. In summer the principal danger to which such organisms are exposed is the deprivation of water. Some of the lowest are able to endure this to an extreme degree. Certain bacteria and other low plants, and various animalcules will survive prolonged baking, and may blow about in the dust of dried-up ponds for a long period, ready to revive when dampened. Among land-snails estivation is a common phenomenon, the snails protecting themselves from excessive loss of moisture, not only by burrowing into the ground, but by throwing one or several epiphragms of hardened, sometimes chalky, mucus across the aperture of the shell, thus shutting themselves into an air-tight case, where they remain inactive until better conditions arrive. In a similar manner certain fishes and amphibians bury themselves in the muddy bottom of ponds or river-pools evaporated by drought, where they preserve sufficient dampness about them to keep alive. Turtles, on the other hand, are often compelled to leave their pools in the tropics, because the water becomes so hot and full of fermentation, and seek cool spots under rocks, and the like, where they sleep torpidly until autumn. Even a few mammals of extremely hot regions, such as the deserts of Australia, go into a summer-sleep during the height of the hot season, substantially as their congeners hibernate in the midwinter of northern climates. Compare: HIBERNATION.

Estop'pel, the preclusion of a person from asserting a fact by previous conduct, inconsistent therewith, on his own part or the part of those under whom he claims, or by an adjudication upon his rights which he cannot be allowed to call in question; a preclusion, in law, which prevents a man from alleging or denying a fact, in consequence of his own previous act, allegation or denial of a contrary tenor; a plea which neither admits nor denies the facts alleged by the plaintiff, but denies his right to allege them. According to Blackstone, it is a special plea in bar, which happens where a man has done some act or executed some deed which precludes him from averring anything to the contrary. Where a fact has been asserted or admitted for the purpose of influencing the conduct or deriving a benefit from another, so that it cannot be denied without a breach of good faith, the law enforces the rule of good morals as a rule of policy, and precludes the party from repudiating his representations or denying his admissions. (Rawle, Cor. 407.)

This doctrine of law gives rise to a kind of pleading that is neither by way of traverse nor of confession and avoidance; that is, a pleading which, waiving any question of fact, relies merely upon the estoppel, and, after stating the previous act, allegation, or denial of the opposite party, prays judgment if he shall be received or admitted to aver contrary to what he before said or did. This pleading is called a pleading by way of estoppel. Until a recent period questions regarding estoppel arose almost entirely in relation to transfers of real estate, and the rules in regard to one kind of estoppel were quite fully elaborated. The principle is now applied to all cases where one by words or conduct wilfully causes another to believe in the existence of a certain state of things, and induces him to act on that belief or to change his own previous situation.

Estoppels operate not only on present interests, but on rights subsequently acquired. They operate, however, only between parties and privies, and the party who pleads the estoppel must be one who was adversely affected by the act which constitutes the estoppel. An estoppel may be by record, and by record in this connection is meant the record of a tribunal of a judicial character. An admission made in a pleading in a judicial proceeding cannot be contradicted by the person making it. So, ordinarily, the judgment of a court of competent jurisdiction cannot be impeached. If it determines the status of a person or thing, it is binding on all persons, whether rendered by a domestic or a foreign court. Judgments of this character are judgments *in rem.* If the judgment is *in personam,* it is conclusive if rendered by a domestic tribunal, and is conclusive in some instances if rendered by a foreign tribunal. Legislature records also import absolute verity. (Bigelow on Estop. 33.)

An estoppel by deed is such as arises from the provisions of a deed. It is a general rule that a party to a deed is estopped to deny anything stated therein which has operated upon the other party, as the inducement to accept and act under such deed, including a deed made with covenant of warranty, which estops even as to a subsequently acquired title. The deed must be good and valid in its form and execution to create an estoppel, and must convey no title upon which the warranty can operate in case of a covenant.

Estoppels must be reciprocal. An estoppel *in pais,* or equitable estoppel, occurs when a party to an action has by his act or declaration induced the other party to do some act or acts which otherwise would not have been done, or to omit to do some act or acts which he would have done, and by means of which he has been injured. The principle underlying such estoppels is, that it would be a fraud in a party to assert what his previous conduct and admission have denied, when, on the faith of that denial, others have changed their situation. There must, however, as a rule, be some intended deception in the conduct or declarations of the party to be estopped, or such gross negligence on his part as to amount to constructive fraud, by which another has been misled to his injury.

Estotiland, a mythical land, placed by the old geographers where is now portions of Newfoundland, Labrador, and that part of British America bordering on Hudson Bay. It was said to have been discovered by two Friesland fishermen driven out of their course by a storm, two centuries before the time of Columbus. In 1497 the Cabots set sail from England for Estotiland, but discovered instead Newfoundland.

Estremadura, ĕsh-tra-mä-doo'rä, Portugal, a maritime province divided by the Tagus into two nearly equal parts, of which the north is the more mountainous. Wines and olives are the principal produce. The chief city is Lisbon. Area, 6,876 square miles; pop. (1900) 1,232,593.

Estremadura, ā-strā-mä-doo'rä, a division of Spain, in the southwest, consisting of two provinces, Badajoz and Caceres. The northern part has large forests, and in the central and southern parts are some good agricultural lands. Deposits of coal, copper, and silver are found in the mountains; but the mines are not well developed. Area, 16,700 square miles; pop. 845,873.

Es'tuary. Where a shore-line is sinking or has been recently depressed, the rivers, unless large and heavily charged with sediments, have their valleys drained by the encroaching sea, forming roughly funnel-shaped bays. Such bays are called estuaries, and are common along the sinking Atlantic coast of North America. Illustrations are seen in Passamaquoddy and Narragansett bays, the mouth of the Hudson River, Delaware and Chesapeake bays. Owing to their shape, estuaries frequently have strong tidal currents, due to the height of the tides, and the rising tide rushes in as waves, the most remarkable examples of such surf-like tidal waves, or bores, being found in the Bay of Fundy. The rivers entering estuaries drop much of their fine sediment there because of the checking of their currents and the precipitating effect of salt water. The strong tidal currents sweep away and rearrange these sediments. Hence conditions on the bottoms of estuaries are often unfavorable for the growth of organisms, and the estuary deposits of past ages are seldom rich in fossils, but may contain remains of land organisms brought down by the old river; and the tidal mud-flats have preserved the prints of raindrops, the traces of worms, and the tracks of birds and reptiles. See River.

Eszterhazy, ās-tār-ä-zē, or ĕs'tĕr-hä-zī, **Marie Charles Ferdinand Walsin,** forger: b. Austria 16 Dec. 1847. He served in a regiment of Papal Zouaves during the latter part of the French empire; was promoted commander, a rank equivalent to major in other armies, in 1892. In the early part of 1897 he was retired from the army. He became known throughout the civilized world through his connection with the trial of Capt. Alfred Dreyfus (q.v.), whom he accused as being the writer of the famous "bordereau," alleged to have been sent to certain German military officers revealing French military secrets. In December, 1894, Dreyfus was tried by court-martial and convicted as the author of the document, and on 5 Jan. 1895 was publicly degraded and a little later sent as a prisoner to Devil's Island. In 1896, Col. Picquart, the head of the intelligence bureau of the war office, made certain discoveries which pointed to Maj. Eszterhazy as the author of the "bordereau." These discoveries led to further investigation and Dreyfus was brought from his prison and given a new trial in 1899, but was again convicted, although much of the evidence gathered pointed to Eszterhazy as the forger of Dreyfus' handwriting and as the real traitor. So strong did this opinion become that Eszterhazy was compelled to leave France.

Eszterhazy von Galantha, ĕs'tĕr-hä-zī fōn gä-län'tä, a family of Hungarian magnates, afterward princes of the German empire, whose authentic genealogy goes back to the first half of the 13th century. They were zealous partisans of the house of Hapsburg, to whom, during the reigns of Frederick II. and Leopold I., they lent a powerful support. In 1238 Peter and Elias, sons of Salomon von Estoras, divided their father's inheritance. The former obtained Zerhaz, the latter Illyeshaza, and thus became the founders of two principal lines, the latter of which became extinct in the male line in 1838, with Count Stephen Illeshazy. Peter's descendants took from their domain the name of Zerhasy, till Francis Zerhazy (b. 1563; d. 1595), vice-regent of the county of Presburg, changed this name into Eszterhazy in 1584, on the occasion of his being named Lord of Galantha. Among noted modern inheritors of the name are Paul IV., Prince Eszterhazy, a general and literary savant (1635–1713). His grandson, Nicholas Joseph, a great patron of arts and music, founder of the school in which Haydn and Pleyel, among others, were formed (1714–90). Nicholas, Prince Eszterhazy, distinguished as a field marshal and foreign ambassador (1765–1833). Prince Paul Anthony, a distinguished and able diplomatist (1786–1866), successively Austrian ambassador at Dresden, Rome, and Britain, and a supporter of the National Hungarian movement.

Eszek, es'sĕk, or **Esseg,** Austria-Hungary, a royal free city in Croatia and Slavonia, capital of the county of Veröcze, on the Drave, about 63 miles west-northwest of Peterwardein. It consists of the town proper, partially fortified, and three suburbs, and is the seat of an appeal court for three countries. It has a normal school for the training of teachers. The manufactures are not extensive; but the four annual fairs, chiefly for corn, cattle, and hides, are important. As a Roman colony, founded by the Emperor Adrian, under the name of Mursia, it became the capital of Lower Pannonia, and in 335 was made a bishop's see by Constantine. Pop. 23,216.

Etampes, Anne de Pisseleu, än dė pēs-sē-lė ā-täṅp, Duchesse d', French royal favorite: b. about 1508; d. about 1576. She became the mistress of Francis I., but to save appearances he gave her for a nominal husband Jean de Brosse, afterward Duke d'Etampes. The new duchess wielded a paramount influence in the affairs of the nation. Upon the fine arts and in some other directions she exerted a good influence, but the jealousy between her and Diana of Poitiers, the mistress of the Dauphin Henry, became a source of calamity for France. It was chiefly under the influence of this feeling that she betrayed to Charles V. the movements of the French army; and the disadvantageous treaty of Crécy in 1544 was due to the intrigues of Anne and of Diana.

Etampes (ancient Stampæ), France, a town in the department of the Seine-et-Oise, at the confluence of the Etampes and Juine, southwest of Paris. It has four Gothic churches, one of them a remarkable structure of the 13th century; tanneries and bleacheries, and a considerable trade in corn, flour, and prepared wool. Pop. 9,310.

Etang, ā-täṅ, is a French geographical term applied to the remarkable salt lagoons and marshes on the south and west coasts of France. The stagnant seawater is generally utilized, as in Brittany and in the department of Bouches-de-Rhone, for the manufacture of salt. The principal lagoons of this character in France are the Etangs de Berre, de Sigean, de la Palme, and de Leucate on the south, and de Heurtin, de Cazan and de Parentes on the west coast.

Etawah, ĕ tä'wä, India, a town in the northwest provinces, 70 miles southeast of Agra, capital of the district of Etawah, situated on the Jamna River. It was once the residence of many of the Mogul grandees, and it is now an important trade centre. Pop. (1891) 38,793.

Etching, the art of producing designs on a plate of steel or copper by means of lines drawn with an etching needle (a fine-pointed steel tool), the lines being drawn through a coating or varnish (the ground), and bitten in by some strong acid which can only affect the plate where the varnish has been removed. See ENGRAVING.

Eteocles, ĕ-tē'ō-klēz, and **Polynices,** pŏl-ī-nī'sēz, two heroes of ancient Greek legend, sons of Œdipus, king of Thebes. After their father's banishment from Thebes, Eteocles usurped the throne to the exclusion of his brother, an act which led to what was known as "The Expedition of the Seven Against Thebes," Polynices being one of the seven leaders. The two brothers fell by each other's hand. The interment of Polynices was forbidden under penalty of death but Antigone (q.v.), his sister, braved the doom decreed. Racine has dramatized this story with some poetical variations in his 'Frères Ennemis.' See ADRASTUS.

Eternal City, The, Rome, the capital of Italy. Legend states that it was raised by or under the immediate supervision of the immortal gods. The term is frequently to be met in classic literature. 'Ave, Roma Immortalis' is the title of a historical work on the Italian capital, by Francis Marion Crawford. 'The Eternal City' is the title of a novel by Hall Caine, published in 1901, the scene of which is laid in Rome. It was dramatized and produced simultaneously in England and in the United States in 1902.

Ete'sian Winds, winds blowing at stated times of the year; applied especially to north and northeast winds which prevail at certain seasons in the Mediterranean regions.

Etex, Antoine, äṅ-twän ā'tĕks, French sculptor, painter, architect, engraver and writer: b. Paris 20 March 1808; d. Chaville 16 July 1888. He took the second grand prize of Rome (1829) with his 'Dying Hyacinthe'; and became a member of the Legion of Honor (1841). Among his other works in sculpture are: 'Cain and His Cursed Race' (1833); 'Resistance of France to Coalition of 1814'; and 'Peace,' for the Arc de l'Etoile; group, 'City of Paris Imploring God for Victims of Cholera'; 'Charlemagne'; equestrian statue of Charles I. Among his paintings are: 'Romeo and Juliet'; 'Faust and Marguerite'; 'Allegorical Glory of the United States,' for City Hall, New York (1853). Among his literary works are: 'Notes on Paul Delaroche' (1857); 'Study of Life and Works of Ary Schæffer' (1859); 'Textbook for the Polytechnical Association, for Students and Workmen' (1861).

Ethane, C_2H_6, a gaseous hydrocarbon belonging to the paraffin series and constituting its second member (the first being methane, or marsh-gas). It occur in the gases that are given off by crude petroleum, and it may be prepared by heating methyl iodide with metallic zinc in closed tubes at 300° F.; the iodide of methyl that is required being obtained by acting upon methyl alcohol (see ALCOHOL) with iodine, in the presence of phosphorus. Ethane is also liberated at the anode, together with carbon dioxide in the electrolysis of a concentrated solution of sodium acetate. It is a colorless gas, which burns with a pale flame, and combines with water, under pressure, to form a crystalline hydrate. At a temperature of 39° F. it may be liquefied by a pressure of 47 atmospheres. Chlorine combines with ethane rapidly, in diffuse daylight, with the formation of ethyl chlorid, C_2H_5Cl; but if excess of chlorine is present, higher substitution products are also formed, terminating with hexachlorethane, C_2Cl_6. Ethane is also known as "ethyl hydrid."

Eth'elbald, king of Wessex: d. 860. He was a son of Ethelwulf, king of the Anglo-Saxons, and obtained the throne of Wessex in 856. While Ethelwulf was making a journey to Rome, Ethelbald formed the project of seizing the throne. A civil war was prevented only by the moderation of Ethelwulf, who resigned to his son the dominion of Wessex, and confirmed that portion of the kingdom to him in his will. The reign of Ethelbald was peaceful, but he excited general disapprobation by marrying, contrary to the canonical law, his stepmother Judith. Ecclesiastical and popular displeasure forced him at length to a separation, and Judith returning to France, eloped from a convent with Baldwin, afterward count of Flanders. From this union descended Matilda, wife of William the Conqueror, and through her the race of English sovereigns.

Eth'elbert, king of Kent: b. about 552; d. 616. He married Bertha, the daughter of Charibert, king of the Franks, and a Christian princess, who, stipulating for free exercise of her religion, brought over with her a Frankish bishop. Her conduct was so exemplary as to prepossess the king and his court in favor of the Christian religion. In consequence, Pope Gregory the Great sent a mission of 40 monks, headed by Augustine, to preach the gospel to the Saxons (597). They were well received, and numbers were converted; and the king himself at length submitted to be baptized. Civilization and knowledge followed Christianity, and Ethelbert, about 600, enacted a body of laws, which was the first written code promulgated by the northern conquerors. At the time of the landing of Augustine, he had acquired a supremacy over all the English south of the Humber. Ethelbert founded the see of Rochester in 604, and afterward that of London. He was succeeded by his son, Eadbald.

Ethelbert, king of Kent and Wessex: d. 866. He was the third son of Ethelwulf, and succeeded to the government of Kent about 855; and in 860, on the death of his brother Ethelbald, became king of Wessex. His reign was much disturbed by the inroads of the Danes, whom he repulsed with vigor, but without permanent success, as, whenever they were driven from one part of the country, they ravaged another.

Eth'elred I., king of England: d. 871. He was the fourth son of Ethelwulf, and succeeded his brother Ethelbert in 866. Assisted by his brother Alfred, Ethelred drove the Danes from the centre of Mercia, where they had penetrated; but, the Mercians refusing to act with him, he was obliged to trust to the West Saxons alone, his hereditary subjects. Notwithstanding various successes, especially a great victory at Ashdown, the invaders continually increased in numbers. Ethelred died, in consequence of a wound received in an action with them, and was succeeded by Alfred.

Ethelred II., king of England: b. 968; d. London 23 April 1016. He succeeded his brother, Edward the Martyr, in 978, and, for want of sound judgment and sagacity, was surnamed the "UNREADY" (without *rede* or counsel). About 981 the Danes, who had for some time ceased their inroads, renewed them with great fury. In his reign began the practice of buying them off by presents of money. After repeated payments of tribute (see DANEGELD) he effected, in 1002, a general massacre of the Danes in England. Such revenge only rendered his enemies more violent; and in 1003 Sweyn and his Danes carried fire and sword through the country. They were again bribed to depart; but, upon a new invasion, Sweyn obliged the nobles to swear allegiance to him as king of England; while Ethelred, in 1013, fled to Normandy with his family. On the death of Sweyn, in 1013, he was invited by the national council to resume the government. Ethelred, in 1002, married, as his second wife, Emma, sister of the Norman Duke Richard II.

Ethelre'da, Saint, East Anglian princess: d. Exning, Suffolk; d. Ely 23 June 679. Although twice married she made and kept the monastic vow of chastity and continence. She finally became abbess of Ely, and the county fair which was held all over the land on her day, after her canonization as Saint Ethelreda or Audrey, gave rise to the expression "tawdry," as indicating something cheap and fine, such as would be offered for sale in a village booth.

Eth'elwulf, king of England: d. 858. He succeded his father, Egbert, in 839, and soon after his accession associated his son Athelstan with him, giving him the sovereignty over Essex, Kent, and Sussex. In 851 the Danes poured into the country in such numbers that they threatened to subdue it; and though opposed with great vigor by Athelstan, they fixed their winter quarters in England, and next year burned Canterbury and London. After inflicting a great defeat on the Danes at Ockley, he went on a pilgrimage to Rome, and on his return found his son Ethelbald in revolt against him. In order to avoid a civil war, he gave up the western division of the kingdom to his son, retaining Kent for himself. Before going to Rome, Ethelwulf had made certain grants, which used to be regarded as the first payment of tithes in England; but modern authorities reject this view.

Ethendun, Battle of, the victory which Alfred the Great gained over the Danes (878), and which led to the treaty with Guthrum, the Danish king of East England. The locality where the battle was fought is supposed to be at Edington, in Wiltshire.

E'ther, in chemistry, any compound which may be regarded as derived from water by the replacement of each of the hydrogen atoms by a basic or alcoholic radical. The ether is "simple" if the basic radicals that are so substituted are alike, and it is "mixed" if they are unlike. The formation of a simple ether may be conveniently illustrated by the case of common, or "diethyl" ether, $(C_2H_5)_2O$. This may be prepared in various ways, but the sulphuric-acid method will serve best to illustrate the nature of the compound. When alcohol, $C_2H_5.OH$, is heated to 285° F. with sulphuric acid, H_2SO_4, one of the hydrogen atoms of the acid is replaced by the alcohol radical ethyl C_2H_5, according to the equation $C_2H_5.OH + H_2SO_4 = (C_2H_5)HSO_4 + H_2O$, the compound $(C_2H_5)HSO_4$ being known as hydrogenethyl-sulphate, or "sulphovinic acid." When the hydrogen-ethyl-sulphate comes in contact with another molecule of the alcohol, it undergoes a second transformation, by which another ethyl radical is taken up, and a molecule of sulphuric acid again set free, as indicated by the equation. $(C_2H_5)\ HSO_4 + C_2H_5.OH = (C_2H_5)_2O + H_2SO_4$. It will be seen that although a molecule of sulphuric acid is used up in the first part of the process, it is regenerated in the second part, so that on the whole there has been no change in the quantity of acid present. The water produced in the first stage, and the ether, $(C_2H_5)_2O$, produced in the second stage, pass off in the state of vapor, and the apparatus is ready for the admission of a new supply of alcohol. The process by which an ether is formed, as here illustrated, is called etherification; and the etherification is said to be "continuous" if it can go on, as in this case, by merely passing a stream of the alcohol into one end of the apparatus, and withdrawing the vapor of ether and water at the other end. Methyl ether, for example, can be formed by the action of sulphuric acid upon methyl alcohol in a manner precisely analogous to that explained above. The equations in this case are $CH_3.OH + H_2SO_4 = H_2O + (CH_3)\ HSO_4$; $(CH_3)HSO_4 + CH_3OH = H_2SO_4 + (CH_3)_2O$; where $CH_3.OH$ is methyl alcohol, $(CH_3)_2O$ is methyl ether, and $(CH_3)HSO_4$ is hydrogen-methyl-sulphate.

As an illustration of a mixed ether, the case of methyl-ethyl ether may be cited. If ethyl alcohol be heated with iodine in the presence of phosphorus, a substance known as ethyl iodide is formed. Thus: $5C_2H_5.OH + 5I + P = 5C_2H_5.I + H_3PO_4 + H_2O$. On the right of this equation, H_3PO_4, is phosphoric acid, and $C_2H_5.I$ is ethyl iodide, which is a liquid boiling at 152° F., readily separable from the phosphoric acid by distillation. Now if ethyl iodide be mixed with potassium ethylate (obtained by dissolving metallic potassium in absolute ethyl alcohol), the following reaction occurs, and ethyl ether is formed: $C_2H_5.I + C_2H_5.OK = KI + (C_2H_5)_2O$. But if the ethyl iodide is mixed with potassium *methylate*, $CH_3.OK$, which is obtained by dissolving metallic potassium in absolute methyl alcohol, then the ether that is formed contains the radical methyl, CH_3, and also the radical ethyl C_2H_5, and hence is a mixed ether; $C_2H_5.I + CH_3.OK = KI + C_2H_5.O.CH_3$. The mixed ether, $C_2H_5.O.CH_3$, is known as methyl-ethyl ether. The reactions that have here been given at some length are typical of similar ones that hold true very generally of the alcohols and ethers. In all the more familiar cases the iodide of a given alcohol radical can be prepared by treating the corresponding alcohol with iodine and phosphorus; and a potassium "alcoholate" can be formed by dissolving metallic potassium in the corresponding (anhydrous) alcohol. Then if we wish to prepare a proposed mixed ether, we have only to treat the iodide of one of its radicals with the potassium compound of the other one, as indicated above. The commoner ethers, both simple and mixed, strongly resemble one another in their general properties. Thus they will not mix with water, nor combine with ammonia nor other alkalis, nor with metallic sodium, nor with dilute acids. The resemblance is also close in other respects. (For "compound ethers" see ESTERS.)

Ethyl Ether, Diethyl Ether, or Sulphuric Ether.— When the term ether is used without qualification, diethyl ether, $(C_2H_5)_2O$, is universally understood to be meant, just as ethyl alcohol is understood, when alcohol is mentioned without qualification. The preparation of diethyl ether, by the action of sulphuric acid upon alcohol, has already been described. The substance so obtained is a mobile, colorless, inflammable and very volatile liquid, with a specific gravity of about 0.72 at ordinary temperatures. It will not mix with water to any great extent, but will mix readily with many organic fluids, and also with liquid carbon dioxide. It dissolves resins and fats, and many of the alkaloids. It boils at 95° F., under a pressure of one atmosphere, and at 200° F. below zero it freezes into a crystalline solid, which melts again at about 180° F. below zero.

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Ether, in physics, a hypothetical substance, probably devoid of weight, which is supposed to fill all space, and to penetrate freely among the ultimate particles of which matter is composed. It is not in any way related to the substance known as "ether" to the chemist, and the identity in name is unfortunate. The physicist has the advantage of priority, however, and cannot be expected to change the name because the chemist subsequently appropriated it for something else. Although we know very little about the precise properties of the ether of physics, the admission of its existence is almost a necessity of thought. For we know that light is some kind of a periodic disturbance, and we know that it travels through interstellar space with a definite, finite speed. It would manifestly be absurd to suppose that a motion of any kind could take place in a void, in which there was nothing to be moved; and hence, as has been said, it appears to be a logical necessity to admit the existence of some kind of a luminiferous (light-bearing) ether throughout space. As soon as we begin to inquire closely into its nature, however, we encounter difficulties that have thus far proved insuperable. Obviously our conclusions in this respect will depend to a large extent upon a study of the phenomena of light, and of the kind of motion that would be competent to produce those phenomena. Naturally the assumption was first made that the ether, when submitted to stress, conforms to the same laws of elasticity that hold true in ordinary matter. (See ELASTICITY.) In that case the full mathematical theory of the motion of the ether would involve no less than 21 numerical coefficients, if the ether were anisotropic. But there is every reason to believe that, whatever its nature may be, it is the same in all its parts, and that its properties, whatever they may be, are the same in all directions. If these two facts are admitted — that is, if the ether be admitted to be isotropic — then the number of constants involved in the theory reduces to two. These, as is explained in the article ELASTICITY, are (1) the modulus of compressibility, and (2) the modulus of rigidity. If the ether were analogous to a liquid or a gas, its modulus of rigidity would be zero. It is found, however, that the equations of motion that are obtained by making the modulus of rigidity zero are not at all competent to explain the actual phenomena of light; for in this case the ether-waves would be merely waves of alternate compression and rarefaction, like those of sound in the air, and there could be no such phenomenon as polarization. It must therefore be admitted that the modulus of rigidity of the ether has a definite, finite value, if the ether itself is to be regarded as analogous to other kinds of matter, so far as its general mechanical deportment is concerned. If it be also admitted that the modulus of compressibility of the ether has a definite, finite value, the conclusion is reached that the ether can transmit two essentially different kinds of waves, one of which involves distortions of its parts, while the other involves changes in its density. Of these the first would admit of polarization, while the second would not. Moreover, the two kinds of waves would have, in general, different velocities of propagation; and the fact that all ether-disturbances appear to be propagated at the same speed indicates that only one kind exists, and that we must therefore make one of the three following assumptions with regard to the compressibility of the ether: (1) The modulus of compressibility of the ether is infinite; or (2) it is zero; or (3) the circumstances under which the atoms (or their component electrons) impress their motions upon the ether are such that the modulus of compressibility is not involved in any way. The first of these alternatives implies that the ether is absolutely incompressible, and this is the one that has been most favorably regarded by physicists in general. The second implies that the ether yields indefinitely, even to the smallest compressive forces, so that it is essentially unstable. This view has been developed in recent years by Lord Kelvin, but it is hard to regard it as more than a mathematical possibility. The mind almost refuses to admit that it corresponds to the actual state of affairs in space. The third of the suggested alternatives must also be regarded as improbable, although perhaps we can hardly pronounce it impossible. On the whole, therefore, it is plain that if the elastic behavior of the ether is analogous to that of ordinary bodies, we have to admit (tentatively, at least) that so far as elastic properties are concerned, the ether resembles an absolutely incompressible solid. In the article 'Ether,' in the 'Encyclopædia Britannica,' Maxwell gave estimates of the density and modulus of rigidity of the ether, and these estimates have been widely copied in works on physics, without question, although the computation upon which they are based contains several arithmetic errors. Correcting these, his estimate of the density of the ether becomes 106×10^{-20}, that of water being unity; and his estimate of the modulus of rigidity becomes (when expressed in C. G. S. units) 955, the modulus of rigidity of glass, in the same units, being 24×10^{10}. Roughly, therefore, the calculation may be said to indicate that the ether is about one 1,000,000,000,000,000th as dense as air, and about one 240,000,000th as rigid as glass. Maxwell's computation, however, assumes that the amplitude of an ether-wave is one $\frac{1}{100}$ of its length, and this is a subject upon which we can hardly form an intelligent guess. There does not appear to be any sufficient reason why he could not equally well have taken the amplitude equal to the 100,000th of the wave-length; and if he had done this, he would have concluded the density of the ether to be one 1,000,000,000th of that of air, and its rigidity to be one 240th of that of glass. These numerical estimates are therefore of no particular value. It is not likely, however, that the amplitude of an ether-wave is greater than the value that Maxwell assumes, and hence his results may be taken as minimum limits to the values of both the density and the rigidity of the ether, on the supposition that the assumed analogy of the ether to an incompressible elastic solid is defensible.

According to the elastic-solid theory of the ether, light consists of a periodic or wave-like disturbance in a jelly-like medium, the waves traveling in straight lines with a uniform velocity of about 186,000 miles per second, and the direction of oscillation of the ether being at right angles to the direction in which the wave progresses, just as the direction of oscillation of the various points of a rope along which a wave is passing is at right angles to the rope. This view of the case accords very well with most of the observed phenomena, but there are some that do not appear to be reconcilable with it. We believe that the ether penetrates all bodies, and fills up the spaces between their molecules (or electrons); and as the phenomena of refraction show that the velocity of light is less in a transparent solid (say in glass) than it is in a vacuum, it follows that the ether in the glass has either a greater density or a less rigidity than it has in free space. Either of these suppositions will fit this simple case equally well; but there are other phenomena that will not be satisfied so easily, and it has been found to be impossible to make any single set of consistent assumptions which shall reconcile the "elastic-solid" theory of the ether with all the known facts. For example, when we come to investigate certain problems in partial reflection from transparent media, and others relating to diffraction from small particles, we are obliged to conclude that it is the density of the ether that varies, the rigidity remaining practically constant. On the other hand, the phenomena of double refraction require us to admit that the rigidity of the ether in a doubly refracting body is different in different directions; and hence we conclude that the rigidity of the ether is modified by the presence of molecules of matter — a conclusion at variance with that previously reached by considering the phenomena of diffraction and partial reflection. Other difficulties have been encountered in the application of the elastic-solid theory of the ether to the phenomena of light, and although reference to it is common, because it is definite enough to present a clear image to the mind, and so is helpful in many ways, the general opinion among physicists of the present day is that it is no longer tenable as an accurate description of the real properties of the ether. It has been abandoned in favor of the "electro-magnetic" theory of Maxwell, and in abandoning it we also abandon the method of estimating the density and rigidity of the ether to which reference has been made, above.

Faraday was convinced, many years ago, that there is some mechanism by which magnetic and electric forces are enabled to make themselves felt through a space apparently vacuous. "Such an action," he said, "may be a function of the ether; for it is not unlikely that, if there be an ether, it should have other uses than simply the conveyance of radiation." Maxwell, after reading Faraday's writings, became so impressed by the ideas which they advanced that he applied his own ingenious and powerful mind to the problems whose solution Faraday had dimly glimpsed, and succeeded in completely revolutionizing our ideas with regard to light and the ether. His now famous "electro-magnetic theory" is given in his masterly but exceedingly difficult 'Treatise on Electricity and Magnetism,' and a popularized account of it may be found in Oliver J. Lodge's 'Modern Views of Electricity.' He agrees with previous writers that light is some sort of a periodic disturbance in some sort of an ether, and that the displacements that occur are indeed perpendicular to the direction in which the light-wave travels; but he teaches us that these displacements are not analogous to those that are produced in an elastic solid when that solid is deformed. He considers that they are of an electrical nature, and that we must learn about them not by observing the behavior of elastic bodies under stress, but by observing the phenomena exhibited by electrified bodies. Maxwell has given us the fundamental equations that must be satisfied when an electrical disturbance is propagated through the ether, and by means of these equations the entire theory of light can be constructed on the new basis. The theory thus constructed agrees well with the facts of observation, and it is free from the objections that beset the old elastic-solid theory. Moreover, it successfully withstood the searching experimental tests devised and executed by Hertz and his followers, whose labors have shown us that electrical radiations are propagated with the same speed as light, and that they can be reflected, refracted, diffracted, polarized, and made to interfere; so that we are now quite ready to admit that light consists in a rapid succession of such radiations. It is not at all essential to Maxwell's theory that we should know precisely what an "electrical displacement" really is, and hence it does not teach us so much about the nature of the ether as we might expect. It does teach that the elastic-solid analogy is probably not correct, and it strongly suggests that the ether is incompressible, and that there is some kind of an ethereal rotation going on in a magnetic field; but it has not yet been made to furnish a means of estimating the density of the ether, nor of obtaining any of its other constants.

We do not even certainly know whether the ether is continuous, or whether it is molecular in structure. Some writers find it difficult to think of a displacement of any kind, in a space that is entirely filled with matter, especially if the matter is incompressible. Others hold that this objection is without weight.

Faraday's idea that magnetic and electric induction are propagated by the same medium as light proved to be exceedingly fruitful, and it is by no means unlikely that the ether possesses still other functions, which will throw further light upon its nature, when they are understood. The various kinds of radiations that have been discovered in recent years ("cathode rays," "Becquerel rays," "X-rays," and the like) were at first believed by many authorities to consist in ethereal motions different from those constituting light, and it was even thought that some of them might correspond to the waves of ethereal compression that had been so earnestly sought. Some of these radiations, however, are now believed to be nothing but ordinary light of exceedingly short wave-length, and others are believed, at least tentatively, to consist in the actual emission of storms of corpuscles, or «electrons,» from the bodies from which they proceed. (See ELECTRON; RADIUM; RADIATION.) Gravitative action has also been attributed to ether stresses, and it is indeed probable that this is its real nature. No mechanical explanation of gravitation, as an ether-phenomenon, has yet been offered, however, to which serious objections cannot be urged. In Maxwell's theory of gravitation it is assumed that bodies produce a stress in the ether about them, of such a nature that there is a pressure along the lines of gravitative force, combined with an equal tension in all directions at right angles to those lines. «Such a state of stress,» says Maxwell, «would no doubt account for the observed effects of gravitation. We have not, however, been able, hitherto, to imagine any physical cause for such a state of stress.» He calculates that to produce the actual effects of gravity, as observed at the surface of the earth, the ether would have to be subject to a pressure of 37,000 tons per square inch in a vertical direction, and a tension of the same numerical magnitude in all horizontal directions.

One of the most obvious difficulties in the way of the ether-theory is that the planets, and even the atoms, move through space as though it were absolutely empty. According to modern notions, however, the atom may be only an aggregate of still smaller «electrons,» each of which may transpire to be nothing but a state of strain in the ether; and if this proves to be the case, we are certainly not in position at present to say that the ether would oppose in the slightest degree the transmission of such a state of strain through its own substance. The difficulty with the theory of aberration is more formidable. If a shower of rain is falling vertically, the drops will appear to an observer to descend vertically so long as he remains stationary. If he moves forward, however, the drops will strike him in the face, and will therefore appear, to him, to come from some point slightly in advance of the zenith, rather than from the zenith itself. A similar phenomenon is observed in connection with light, and is known as aberration. Every star is seen in its true position when the earth is moving directly toward it; but three months later, when the earth is moving at right angles to this direction, the observer's telescope will have to be inclined slightly toward the direction in which the earth is moving, in order that the light from the star may come down through the instrument centrally. The maximum displacement that a star can have, from this cause, is known by observation to be about 20.47 seconds of arc on the heavens. If the ether were motionless, the analogy with the rain-drops would be perfect, and the «constant of aberration,» whose value has just been given, could be calculated from the known velocity of light, and the known velocity of the earth's orbital motion. It is found, however, that the theory of aberration is exceedingly complicated when the possibility of currents in the ether is admitted, and hence physicists have been much concerned to know whether or not the earth drags the adjacent ether along with it, in its motion around the sun. As long ago as 1859 Fizeau showed, by a justly celebrated experiment, that the ether is apparently dragged along by a current of water flowing through a tube; and Michelson and Morley have since shown, by an even more ingenious experiment, that there is evidence that the ether in the immediate vicinity of the earth participates in the earth's motion to such an extent that any difference that may exist does not amount to the twentieth part of the whole motion. Lodge, on the other hand, found no evidence of any "ether drag" in the space between two rapidly whirled steel plates that were separated by an interval of one inch. (See Preston, 'Theory of Light.') The whole subject of the "drag" of the ether is still unsettled; but the observed value of the constant of aberration appears to require that the ether is not disturbed by the motion of the earth through it.

The most noteworthy book on the ether, in recent times, is Larmor's 'Æther and Matter,' which (like all other advanced works on the same subject) is difficult reading. Consult, also, Drude, 'Physik des Æthers.'

Etherege, ĕth'ėr-ej, SIR **George,** English dramatist: b. about 1635; d. 1691. In 1664 appeared his first comedy, 'The Comical Revenge, or Love in a Tub'; an incongruous mixture of prose and verse, but suited to the taste of the times, and well received. The author was immediately enrolled among the courtly wits of the day, and in 1668 brought out 'She Would if She Could,' which was very coarse and licentious. In 1676 he produced his third and last comedy, entitled 'The Man of the Mode, or Sir Fopling Flutter.' This performance was still more applauded than the preceding, and the Sir Fopling was, for a long time, deemed the ideal of the superlative beau or coxcomb of the age. Etherege's plays are little more than lively conversation pieces, with a great paucity of genuine humor or felicitous plot.

Ethical Movement and Ethical Societies in America and Abroad. The first Ethical Society was established and the Ethical Movement inaugurated in 1876 in New York by Felix Adler, then a lecturer at Cornell University. In response to a call, several hundred persons met in May at Standard Hall, and at the conclusion of Prof. Adler's address, outlining the purpose and spirit of the proposed organization, the Society for Ethical Culture of New York was constituted. In this address he appealed to his auditors to unfurl a new flag of peace and conciliation over the bloody battlegrounds where religions had fought in the past; he laid stress upon the urgent need of a higher and sterner morality to cope with the moral perils of the hour, especially noting the growing laxity that accompanied the decline of discredited forms of religious belief; and he placed peculiar emphasis upon the duty of caring for the moral education of the young. The society thus initiated grew rapidly, and soon gave practical effect to his programme. Within a few years it had established a free kindergarten for the children of the poor, the first of its kind in New York; and this developed into a workingman's school, based upon the Froebelian pedagogy, which was the first school to introduce manual training and systematic ethical instruction into the curriculum. It also inaugurated a system of trained nurses for the poor, which has since become an adjunct of dispensary out-door relief in the city. Nor were the larger social and political applications of morality to contemporary life neglected: its leader devoting special attention in his platform utterances to the labor problem and specific social reforms, as being at bottom great moral issues. His vigorous exposure of the evils of the tenement houses bore fruit in the creation of the Tenement House Commission of 1884, of which he was appointed a member. He also was among the first advocates of small parks in the congested districts, of public playgrounds and public baths; and, above all, of greater justice and humanity in the relations between labor and capital, employer and employed. The Labor party here found a new type of advocate; and reformers and politicians a platform from which the issues of the hour were brought to the touchstone of ethical first-principles.

Meanwhile, the society filled more and more the place of a church in the lives of its hitherto unchurched members. It did not neglect the problems of the personal life; but aimed to illuminate and inspire its members in their dealings with the problems of the home and the vocation, family relations, marriage, the training of the young, etc. Its position as a distinctive religious organization became better understood and its religious appeal more forcibly felt, while its practical educational and philanthropic activities continued to multiply. Its schools, testifying to its conviction that moral improvement must begin with the care and education of the young, expanded until kindergarten, normal and high school departments were added. These have for some time been inadequately housed. The Sunday audiences, too, have twice outgrown their accommodations. To meet its requirements, the Society is erecting at Central Park West and 63d Street, a thoroughly modernized school building, next to which an appropriately dignified meeting place and society-house will later on be added. The very thoroughly equipped schoolhouse will enable the society, in greater measure even than in the past, to fulfil its cherished aim of having a model and experimental school, standing for the highest ideals of non-sectarian education and the most efficient pedagogical methods of realizing them. What distinguishes these from many other similar schools is their democratic organization and spirit: like the public schools, they educate children both of the well-to-do and of the poor, that is, an equal proportion of pay pupils and pupils admitted under a system of free scholarships endowed by the Society.

To give further effect to its conception of a religious society as a body of workers, bent upon learning by doing and promoting piety by service, the society opens to its members many other fields of education and philanthropic activity. Here the women of the society take a prominent part. Most of the philanthropies are affiliated under a general representative body known as the Women's Conference, through whose recent initiative and effort the Manhattan Trade School for Girls was established. Fortunate in drawing an unusual number of young men to its ranks, the Society has a strong Young Men's Union which contributes largely to the support of two neighborhood houses: the Hudson Guild on the West Side, of which Dr. John Lovejoy Elliott, one of Prof. Adler's associate lecturers, is the head worker; and the Down-Town Ethical Society, on the lower East Side. The Union also owns and supports a summer home on its farm of 70 acres at Mountainville, N. Y., where a farm school is held, and a summer holiday is given to groups of the boys and girls who belong to the Neighborhood clubs. The larger policies and relations of all the working bodies of the society are considered and shaped by a Council of Fifty, composed of representatives from all of them. One other event in the history of the society that calls for mention is the recent appointment of Prof. Adler to the newly created chair of political and social ethics at Columbia University. As the chair was endowed with a view to Prof. Adler's tenure of it at the instigation of some members of the well-known Committee of Fifteen appointed by the Chamber of Commerce to deal with the social evil in New York, of which committee Prof. Adler was an active member, this appointment is a remarkable public tribute to the large public place which the founder of the ethical movement has won for himself and for it.

Early in the history of the society, a number of young men were attracted to it, and, after a period of apprenticeship in New York, went forth to found societies in Chicago, Philadelphia, and St. Louis, and across the seas in London. These American societies are under the leadership respectively of William M. Salter, S. Burns Weston and Walter L. Sheldon; and, while loosely federated in a union, they maintain an individuality of their own, and have developed different forms of activity according to local needs and circumstances. They all hold Sunday exercises, which consist for the most part of music, readings, and an address. All admit to membership on a simple declaration of devotion to the ethical ends set up. All attach great importance to the moral and religious education of the young, and maintain well-organized Sunday schools and associations and clubs of young men and young women devoted to the same end and to various kinds of practical work. From the publishing and literary headquarters of the Ethical Union in Philadelphia (S. Burns Weston, 1305 Arch Street) is issued monthly 'Ethical Addresses,' containing the more important lectures of the leaders; and the 'International Journal of Ethics,' under a committee of ethical specialists in America and Europe with Mr. Weston as managing editor. The New York society publishes bi-monthly the 'Ethical Record,' a journal of practical ethics, edited by Percival Chubb, also one of Prof. Adler's associate lecturers. Among the literary products of the American societies are Prof. Adler's 'Creed and Deed,' 'Moral Instruction of Children,' and 'Life and Destiny'; Mr. Salter's 'Ethical Religion'; Mr. Sheldon's 'An Ethical Movement,' 'An Ethical Sunday School,' and 'Old Testament Bible Stories as a Basis for Ethical Instruction of the Young.'

That the movement initiated in America expressed no merely local phase of religious development is evident by its still more rapid spread in Europe. American influences led to the establishment in 1886 of the London Ethical Society with which Profs. Muirhead, Bosanquet, Bonar, and others, upon whom the ethical influence of Thomas Hill Green of Oxford had been profound, were identified; and under its auspices lectures were given at Toynbee Hall and elsewhere by many men at the universities and in public life who felt the importance of the new ethical propaganda, such as Seeley, Caird, Leslie Stephen, etc. About the same time Dr. Stanton Coit went over from New York to assume (*vice* Mr. Moncure D. Conway) the leadership of the congregation at South Place Chapel, then renamed the South Place Ethical Society, which, after a brief pastorate, he resigned to push the ethical cause in other ways. Under his energetic leadership, the ethical societies have multiplied rapidly in London and in the provinces, where also several of the Labor Churches have affiliated themselves with the ethical movement. A Union of Ethical Societies (14 or more), and a Moral Instruction League (to introduce systematic non-theological, moral instruction into all schools) are in vigorous activity; a weekly paper, 'Ethics,' has been maintained for several years; and there has been a considerable output of literature, including Dr. Coit's anthology, 'The Message of Man,' a 'Collection of Ethical Songs,' and, edited by him for the Society of Ethical Propagandists, a volume of essays by different writers, entitled 'Ethical Democracy'; Quilter's 'Upward and Onward,' a book for boys and girls; Sander's 'Reorganization of the People'; McCabe's 'Discipline in the Roman Church.' In London there is also an independent Ethical Religion Society, founded and led by Dr. Washington Sullivan. Ireland, likewise, has been reached, where there is an ethical society at Belfast. At Leicester, Eng., F. J. Gould, the leader of the Secularist Society there, has advanced the ethical instruction of the young by his 'Children's Books of Moral Lessons' (two series), and by his effective advocacy of the cause on the Leicester School Board, which he has forced to take an advanced position on the subject of moral instruction in the board schools.

The new movement was finding, meanwhile, favorable soil on the Continent. A centre of activity was established at Berlin, where Prof. Gizycki, Prof. William Foerster, and others identified themselves with the cause. Societies were in time established at Munich, Dresden, Danzig, Freyburg, Stuttgart, Breslau, Frankfort, Jena, Magdeburg, Strassburg, Ulm, Königsberg; and in Austria at Vienna, in Italy at Venice and Rome, in Switzerland at Zürich and Lausanne; and in France through the Union pour L'Action Morale (1891) which found spokesmen in M. Emil Desjardins (notably in his stirring brochure 'Le Devoir Present'), and in other well-known writers. Among the latest additions to the ethical societies is one at Tokyo in Japan. The German societies support a weekly paper, 'Ethische Kultur,' published at Berlin; and the Parisian society a monthly, entitled 'La Coöpération des Idées.'

The increasing activity in these European centres led to the establishment of an international organization with a central station at Zürich, and Prof. F. W. Foerster as secretary and organizer. Here in September 1896 an International Congress was held which issued a representative manifesto. It is largely colored by a continental sense of the urgency of applying ethical principles in the domain of social and political affairs. It announced its sympathy with the efforts of the populace to obtain a more human existence; but recognized as an evil hardly less serious than the material need of the poor, the moral need which exists among the wealthy, whose integrity is often deeply imperilled by the discords in which the defects of the present industrial system involve them. It demanded that the social conflict should be carried on within the lines prescribed by morality, in the interest of society as a whole, and with a view to the final establishment of social peace. It appealed to the ethical societies to provide the intellectual armor for this struggle, and to all their members to promote the progressive social movement by simplicity in the conduct of life and the display of an active social spirit. It declared (in view, doubtless, of prevailing scepticism and license) the pricelessness and indispensableness of the institution of pure monogamic marriage; demanded opportunity for the fullest development for women; advocated the improvement of the lot of female wage-earners in industrial establishments; and made a strong plea for the restoration of lost unity in the educational system by setting up a common ethical purpose as the aim of all culture. It declared for universal peace, and against militarism and the national egotism and jealousy which precipitate war. Finally, it urged upon all ethical societies not simply to concern themselves with these practical issues, but to devote their utmost energy to the building up of a new ideal of life in harmony with the demands of modern enlightenment. This manifesto represents most, but not all, of the leading interests of ethical societies. It expresses their almost universal interest in the social question, and their desire to bring theories, policies and measures of reform to the test of ethical principle; it expresses also their interest in promoting peace and an education animated and unified by an ethical purpose. It does not, however, lay stress upon the relation of the movement to modern liberalism, its frank acceptance of the spirit and results of modern science, and its repudiation of the supernatural, miraculous, and priestly elements in religion; nor does it voice the deeper religious seriousness and spirituality of the movement. By some of the leaders this latter is very strongly emphasized; and some of the ethical societies are primarily churches for inspiration and guidance in the difficult effort to lead the good life.

While the inception of the ethical movement was due to the insight and prevision of Felix Adler, and its first powerful impact due to his attractive eloquence and personal power, its rapid growth to international dimensions is clear evidence that it met a deep and widespread need. It was fitly born on American soil; for a new ethical religion and ethical church for America had been definitely prophesied and sketched by Emerson in his later essays on 'Worship' and 'The Sovereignty of Ethics.' He had said: "The progress of religion is steadily to its identity with morals. . . . It accuses us that pure ethics is not now formulated and concreted into a cultus, a fraternity with assemblings and holy days, with song and book, with brick and stone. . . . America shall introduce a pure religion. . . . There will be a new Church founded on moral science; at first cold and naked, a babe in a manger again, the algebra and mathematics of ethical law, the church of men to come, without shawms, or psaltery, or sackbut; but it will have heaven and earth for its beams and rafters, science for symbol and illustration; it will fast enough gather beauty, music, picture, poetry." The development of advanced Unitarianism through Channing and Parker had been in this direction. It had two practical outcomes — the Free Religious Association, which still holds annual sessions; and the Ethical Movement. As distinguished from the Free Religious Association, which expressed vaguely the libertarian tendencies of Emerson's thought, the Ethical Movement gave effect to the positive and constructive tendency which found clear utterance in his prophecy. Although this positive spirit was present in the religious society conducted in New York by Octavius B. Frothingham—who was wont to say, after he had retired and it had disbanded, that its legitimate successor was the Society for Ethical Culture—it was not until Felix Adler brought to the new movement at once an ethical outlook and philosophy learned chiefly in the school of Kant, an impassioned Hebraic sense of religion as righteousness of life, and a practical sense of the urgency and ethical import of the great impending moral issues in the social, industrial, and political world, that conditions existed for the full birth of the new ethical religion.

The most distinctive feature of this new phase of religious development was that it did not propose to add to the religions of the past, in the way in which these had multiplied, namely, on the basis of differences of speculative belief. Instead, it announced the basic importance and the priority of the ethical factor in religion. It approached religion, not from the credal, but from the practical moral standpoint; and it saw, in a common affirmation of this priority and supremacy of virtue and the good life, a ground of union for people of varying philosophical convictions, or none. Following Emerson, it asserted that character and conduct condition creed and thought; and that it is only by sowing a worthy character that men can reap a vital and meaningful creed. It contended that no certain and lasting basis of union can be found in anything so variable and personal as one's philosophical view of the world; and that no one should pledge his intellectual future by subscribing to-day to a creed which to-morrow he may outgrow. What a man thinks is the result of what he is,— the outcome, therefore, of his action, his experience, his effort and his love, far more than it is the outcome of his deliberate thought and accumulated knowledge. This position differed from that of the Comtian Positivists because theirs assumed a final, definite, and in some respects, very negative philosophy. The new movement allowed for the greatest individual differences in men's philosophical interpretation of life, save in the one tenet that all must acknowledge the sacred obligation imposed by man's moral nature to live the good life and to follow without swerving the dictates of duty according to the best light that is in each.

On the basis of this moral earnestness and this attitude of moral resolve men may safely and hopefully work backward into a philosophy and forward into a faith. Their philosophy and their theory of moral sanction may be what it will, theistic or pantheistic, materialistic or idealistic; it may or may not issue in a faith in immortality, conditional or absolute. This is a personal concern, and the statements on such matters frequently made by the leaders of ethical societies who differ much in their philosophies, are merely expressions of personal conviction, and not made as in any way committing the societies. This is to make a clear distinction between the private and the public factors of religious belief; and to find as the only possible basis for religious union, for those who would jealously guard their intellectual integrity, a moral aim by which any man should be ashamed not to be bound.

The ethical movement has been criticized, notably of late by Charles Booth, in his concluding volume reporting the life of the poor in London, as lacking in imaginative color and appeal, and therefore unlikely to spread among the masses of the people. Perhaps Emerson was right in emphasizing the austerities of the new religion in its early protestant phases. But at heart it is genial and passionately human. It has nothing sensationally novel to offer; it does not compete with picturesque claimants like Theosophy, Christian Science, Vedantism, etc., and it may be a fact that "plain goodness," "mere morality," "the beauty of holiness," will not yet draw many with their old-new evangel. And yet one finds among its adherents nothing less than a new type of the religious temperament, voicing a new imaginative sense of the hidden mysteries and wonders of the moral personality, the new unrevealed heights and depths of the moral life, the unrealized joyousness of devotion to duty and to service.

PERCIVAL CHUBB,
Editor the 'Ethical Record.'

Ethics (from Gr. ἠθικά, having to do with conduct, from ἦθος, character, lengthened form of ἔθος, custom, manners; *cf.* morals, from Latin, *mos, mores,* customs), that branch of the theory of conduct which is concerned with the formation and use of judgments of right and wrong, and with intellectual, emotional, and executive, or overt, phenomena, which are associated with such judgments, either as antecedents or consequents. As a branch of the theory of conduct, it is generically akin to the sciences of jurisprudence, politics and economics; but it is marked off from such sciences in that it considers the common subject-matter of human conduct from the standpoint of rightness and wrongness. Such terms as good and evil, the dutiful or obligatory, might be used in the definition as substitutes for the terms "right" and "wrong," but good and evil are somewhat too wide in scope, including, for instance, economic utilities, commodities and satisfactions; while duty is somewhat too narrow an idea, emphasizing the notion of control at the expense of the idea of the good and desirable. "Right" and "wrong" designate exactly those phases of good and evil to which the idea of the obligatory is also applicable. The terms moral philosophy, moral science, and morals have also been used to designate the same subject of inquiry.

In its historical development, ethics has been regarded as a branch of philosophy, as a science, and as an art — often as a composite of two or all of these in varying proportions. As a branch of philosophy, it is the business of ethics to investigate the nature and reality of certain conceptions in connection with fundamental theories of the universe. It is the theory of reality in its moral aspect. The term good is taken to denote or describe a property of ultimate and absolute being. As such, it is usually co-ordinated with two other fundamental properties of reality, the true and the beautiful; and the three philosophic disciplines are defined as ethics, logic, and æsthetics. Even when so much emphasis is not thrown upon the place of the good in the general scheme of the universe, ethics may still be regarded as a branch of philosophy, because concerned with the ideal, with what ought to be, or with what is absolutely desirable, as distinct from the actual, the existent, the phenomenal. From this point of view, ethics is regarded as *normative* in character, that is, concerned with establishing and justifying certain ultimate norms, standards, and rules of action.

In contrast with such functions, ethics as a science is concerned with collecting, describing, explaining and classifying the facts of experience in which judgments of right and wrong are actually embodied or to which they apply. It is subdivided into social, or sociological, ethics, and individual, or psychological, ethics. (*a*) The former deals with the habits, practices, ideas, beliefs, expectations, institutions, etc., actually found in history or in contemporary life, in different races, peoples, grades of culture, etc., which are outgrowths of judgments of the moral worth of actions or which operate as causes in developing such judgments. Up to the present, social ethics has been developed mainly in connection, (1) with discussion of the evolution of morality, either by itself or in connection with institutions of law and judicial procedure, or of religious cult and rite; or (2) with problems of contemporary social life, particularly with questions of philanthropy, penology, legislation, regarding divorce, the family and industrial reform — such as child-labor, etc. In both aspects it is closely connected with the science of sociology. It is sometimes called inductive, or in its second aspect, applied ethics. (*b*) Psychological ethics is concerned with tracing in the individual the origin and growth of the moral consciousness, that is, of judgments of right and wrong, feelings of obligation, emotions of remorse, shame, of desire for approbation; of the various habits of action which are in accord with the judgment of right, or the virtues; with the possibility and nature, from the standpoint of the psychical structure of the individual, of free, or voluntary, action. It gathers and organizes psychological data bearing upon the nature of intention, and motive; desire, effort and choice; judgments of approbation and disapprobation; emotions of sympathy, pity in relation to the impulse of self-preservation and the formation and reformation of habit in its effect upon character, etc. In other words, it treats behavior as an expression of certain psychical elements and groupings, or associations: psychological analysis.

Ethics as an art is concerned with discovering and formulating rules of acting in accordance with which men may attain their end. These rules may be considered as of the nature either of injunctions or commands, which prescribe as well as instruct; or as technical formulæ which indicate to the individual the best way of proceeding toward a desired result, thus not different in kind from rules of painting, or of carpentry. Which view is taken depends usually upon the kind of philosophy with which ethics as an art is associated. Ethics as an art may also be an outgrowth of either a general philosophy of conduct, or of a scientific analysis of it. Thus, from the philosophic point of view, a recent writer, Sorley, in the Dictionary of Philosophy and Psychology (Vol. I., p. 346, 1902), says of ethics: "It has to do not merely with actual conduct, but with right or good conduct, and accordingly with an ideal from which rules may be laid down for actual conduct." It is clear that the philosophical establishment of the ideal is considered to terminate in rules for its attainment. On the other hand, Jeremy Bentham in his 'Principles of Legislation' (1789), having before insisted that ethics is a science whose truths are to be discovered "only by investigations as severe as mathematical ones, and beyond all comparison more intricate and extensive," goes on to define ethics "as the art of directing men's actions to the production of the greatest possible quantity of happiness," and says it is the business of private ethics "*to instruct* each individual in what manner to govern his own conduct in the details of life." Thus as an art ethics may be grounded upon either a philosophy or a science.

As may readily be inferred from the above account, some of the most serious problems of ethics at present are concerned with defining and delimiting its own scope, basis and aims. From a purely abstract point of view, all three conceptions can exist harmoniously side by side. It is possible theoretically to regard certain topics as assigned to ethics as a branch of philosophy, others to its scientific phase, and others to the practical, or to ethics as an art. But no consensus as to these various possible assignments exists. Usually those who insist that ethics is a branch of philosophy deny that it can be anything else; they deny that any descriptive and explanatory account of *actual*, as distinct from ideal, conduct, deserves the name of ethics. What we have above treated as belonging to the science of ethics is by them treated as really a matter of history, sociology and psychology, not of ethics proper at all. Thus Green, 'Prolegomena to Ethics' (1883), begins by attempting to prove that a natural science of ethics is inherently impossible, because moral conduct by its nature implies an ideal that transcends actual conduct which alone can be made a matter of observation and experiment, and sets up an obligation which in its absoluteness transcends all the sanctions of experience. On the other hand, those who have occupied themselves with the scientific analysis of moral behavior and character, have usually denied the legitimacy of the philosophic aspect. Thus Bentham expressly regards all philosophical inquiries as doomed to result in sterility, in mere dogmatic personal assertions, or, as he calls them, "*ipse dixits*." A more recent writer, Leslie Stephen, 'Science of Ethics' (1882), without absolutely denying the possibility in the remote future of a metaphysics of conduct, says that the metaphysical view is entirely irrelevant to a scientific treatment. Along with this uncertainty as to the defining aim and characteristic methods of ethics, are naturally found a large number of subordinate and secondary controversies and divisions of opinion.

As a matter of fact, however, in every historical period there have been found in ethical theories some connection with general philosophic thought, and with the data of behavior exhibited in experience (or the scientific aspect) and with the further direction and conduct of life — the practical aspect. Historically, ethics has passed through three epochs: (1) the Græco-Roman; (2) the Patristic-Mediæval; (3) the Early Modern; terminating with say the French Revolution, and may now be regarded as having entered upon a fourth stage. In each period, a certain practical interest is uppermost in social life, and this interest serves to concentrate and direct attention toward certain relevant theoretic problems. An adequate account of ethical thought accordingly is possible only in connection with the larger civilization and culture of which it is a part. Brief characterizations of the main problem of each epoch in its wider social tendencies will serve, however, to point out (*a*) the philosophic, (*b*) the scientific, (*c*) the practical centre of ethics in each period.

The Græco-Roman period was characterized by the disintegration of local custom, tradition and institution, civil and religious, coincident with the spread of cosmopolitan learning and the formation of an inclusive political organization taking effect in both legislation and administration — Greek culture and the Roman empire. With the disintegration of the habits and modes of life which had previously defined the sphere of legitimate individual satisfaction, and which supplied the sanctions of the moral life, there was necessarily coincident an inquiry which attempted to establish through reflection adequate substitutes for the waning institutional modes of control. One of the results of modern historical science is the proof of the extent and stringency of the force of custom in early life. It is custom which defines the morally right and obligatory, and it is custom which enforces its own demands. In it are bound together morals, law, and religion, and all are bound into the very life of the people, emotional and intellectual, as well as practical. Where custom rules, moral theory is unnecessary and indeed impossible. In the 6th and 5th centuries before Christ, this régime of custom was irretrievably shaken in the Greek world, and with a twofold result upon morals. Many thought that all sanctions for morality had disappeared, or at least lost validity, and that pure individualism in thought and conduct — tempered at best only by some judicious regard to consequences — was the proper outcome. Others, prevented by what they regarded as the low moral standards of customary morality from coming to its defense were also shocked by the demoralization attendant upon ethical individualism, and set to work to discover a universal and unassailable basis for a higher type of ideal morality. In this conflict, ethical theory was born.

The Græco-Roman Period (6th century B.C. to 5th A.D.) — The controversy originated in a discussion as to whether morality exists by convention (νόμῳ), by arbitrary enactment (θέσει), or in reality, that is (in the terminology of the time), "by nature," (φύσει), or in the nature of things. Some of the Sophists taught that morality was a creature of the efforts of the rulers of a community, being a device on their part to keep others in subjection for the better indulgence of their own desires — much as many of the "free-thinkers" of the 18th century (in many respects the modern congeners of the Sophists) taught that religion was an invention of state-craft and priest-craft. Others taught that it was a product of social agreement or institution. Some of the nobler Sophists (like Protagoras, see the Platonic dialogue of the same name) interpreted this as praise of the state of civilization and culture as against the raw, crude state of nature; while others taught that it was merely a conventional means to personal satisfaction, and hence had no binding force when short-cuts to happiness were available. In the meantime, the actual moral discipline of the Greek city-state was much relaxed, partly because of the interminable dissensions of party strife; and partly because the religious beliefs which were the foundation of civic life were fast becoming incredible. Socrates (about 470 B.C.–399 B.C.) was apparently the first to undertake a positive and constructive analysis of moral ideas. He made the following contributions: (1) All things have to be considered with reference to their end, which indeed constitutes their real "nature"; the end of each thing is its good. Man must therefore have his own end, or good; this is real and inherent, not conventional nor the product of law. (2) To know is to grasp the essential, real being of a thing — its "nature," or end; "know thyself" is the essence of morality; it means that man must base his activity upon comprehension of the true end of his own being. All evil is really involuntary, based on ignorance, or misconception of man's true good. To be ignorant of the good is the one disgrace. If a man does not know it — and Socrates professed that he did not — he can at least devote himself seriously to inquiring, to the effort to learn. If not wise (a sophist) he can at least be a lover of wisdom (a philosopher). And until he attains knowledge, the individual will be loyal to the responsibilities of his own civic life.

The two conceptions of the good as somehow the fulfilment of man's true nature or reality, and as attainable only under conditions of rational insight are the bases of all later Greek thought. Opinions differed to what man's end is, and as to the character of true knowledge of it. The extreme division was between the Cynic school, the forerunner of the Stoics, founded by Antisthenes (about 444 B.C.–369 B.C.), and the Cyrenaic (the precursor of Epicureanism), founded by Aristippus (about 435 B.C.–360 B.C.). The former taught that virtue, manifested in temperance or self-control, is the one and only good, pleasure as an end being evil, and that it is known by pure reason. The latter taught that pleasure, known only in feeling (the sensation of a gentle and continuous change) is the good. The wise man of Socrates is he who knows this moderate and enduring pleasure and is not captured by sudden and violent passion. Both schools take a somewhat antagonistic attitude toward the state; the Cynic emphasizing the superiority of the sage to government and authority, well illustrated in the anecdotes of Diogenes and Alexander the Great; the Cyrenaic holding that the pleasures of friendship and social companionship of the congenial are superior to those of participation in public life. These schools thus set two of the fundamental problems of subsequent ethical theory, namely, the nature of the good, and the nature of knowledge of it; and supplied the framework of later schools of thought. Those who hold that pleasure is the good are termed Hedonists (Gr. ἡδονή, pleasure) those who held to its residence in the virtuous will Perfectionists, or (with certain qualifications added) Rigorists. Those who hold that it is known through reason are Intuitionalists, the other school, Sensationalists or Empiricists.

Plato (q.v.) (about 427 B.C.–347 B.C.) attempted a synthesis of the conceptions of the two schools just referred to, with a constructive programme of social, political and educational reform, and with a reinterpretation of earlier philosophic theories of the universe and of knowledge. His most characteristic doctrines are (1) the generalization of the Socratic conception of the good as constituting the true essence or nature of man. Under the influence of philosophic concepts derived from a variety of sources, Plato conceived man as essentially a microcosm; as the universe in miniature. He is composed of a certain arrangement of the elements of reality itself; hence he can be truly known only as the real nature of the universal reality which constitutes him is known; his good is ultimately one with the final cause or good of the universe. Thus Plato goes even farther than Socrates in asserting that morality is by nature — it is by the nature not only of man but of absolute reality itself, which is thus given an ethical or spiritual interpretation. Thus he grounded ethics on general philosophic conceptions and has been the model for all since who have distinctly conceived ethics to be a branch of philosophy. Moreover, since he regards the ultimate good of the universe as one with God and as the animating purpose in the creation of physical nature, he brings ethics into connection with religion, and with man's relations to the world about him. (2) Plato regarded the state in its true or ideal form as the best embodiment or expression of the essential nature of individual man; as indeed more truly man than any one individual. In its true organization, it reflects or images the constitution of the ultimate good. Thus Plato brings ethics back into connection with politics as the theory of ideal social organization. Practically, he delineates this state in outline (especially in his Republic, and, with greater attention to feasible detail in his Laws), and proposes in view of this ideal a specific reform of the existing order, instead of disregard of it as with Cynic and Cyrenaic. (3) He sets forth a scheme of the good as realizable in human nature, which endeavors to combine the one-sided extremes of mere pleasure, and mere virtue. He conceives the good to be the fulfilment of all the capacities, faculties or functions of human nature, the fulfilment of each power being accompanied with its own appropriate pleasure, and all being ordered and bound together in a harmonious whole by a law of measure or proportion which assigns to each its proper place; at the head, the pleasure of pure knowledge; at the bottom, the appetites; between, the pleasures of the nobler senses (sight and hearing), and of the higher impulses— ambition, honor, etc. The right functioning of each is virtue; its product is pleasure. The system of pleasures according to virtue is the good. Moreover, he specifies four cardinal virtues which result — wisdom, the knowledge of the good or organized whole; justice, the law of proportion or measure; courage, the assertion of the higher tendencies against the pleasures and pains arising from the contemplation or imagination of the lower; temperance, the law of subordination in accordance with which each lower function is restrained from usurping the place of the higher. Plato's system of ethics remains the standard of ethical theories of the "self-realization" type.

Aristotle (q.v.) (384 B.C.–322 B.C.) gave the philosophic considerations of Plato a more scientific and empirical turn — a contrast, however, which is often exaggerated. He protested against the identification by Plato of human end or good with that of the universe, and consequently attached less importance to knowledge in the form of philosophic insight, and more to practical insight or wisdom. But, in the main assuming the Platonic basis, he carried into detail the analysis of human faculties or functions involved in conduct, giving a careful analysis of desire, pleasure and pain, of the various modes of knowledge, of voluntary action, and making a remarkable analysis of the various forms of virtue and vice actually current. In a word, he emphasized in detail psychological and social aspects, merely sketched by Plato. On the social side, it had become obvious that the comprehensive scheme of reform entertained by Plato was impossible; and here, also, Aristotle is free to undertake a more empirical description and analysis of various forms of government and organization in their moral bases and bearings. When, in the 12th and 13th centuries A.D. the works of Aristotle were again made known to the European world, first through translations from the Arabic and then from the Greek, Aristotle's ethics became embodied in the official philosophy of the Roman Catholic Church, especially in the writings of St. Thomas Aquinas (1225–74), and found literary expression in the Divine Comedy of Dante. His ethical writings have more profoundly affected common speech and thought than those of any other writer, and to a large extent have become a part of the moral common-sense of civilized humanity.

The details of later ethical philosophy in Greece and Rome form an interesting part of the history of ethics, but, with one exception, supply no new idea of sufficient importance to need mention here. The exception is the Stoic conception of virtue as "living in accordance with nature," and the conception of the "law with nature" which grew out of this. This idea, under the form of *jus naturale*, was taken up into Roman jurisprudence, and became the ideal of a common moral law which underlies all differences of positive, municipal law, and which, accordingly, forms an ethical standard by which positive law can be tried, and its diversities reduced to a common denominator. It reappeared in the Middle Ages in the form of the natural law (as distinct from revealed or supernatural law), written on the "fleshly tablets of the heart," and was thus indirectly influential in forming the still current notion of *conscience* as a moral legislative force. It came out in continental ethical thought of the 17th and 18th centuries in the conception of moral law as something analogous to a system of mathematical axioms, definitions and demonstrations, discoverable by reason, and forming the framework of both individual and political ethics.

Patristic Mediæval Period (5th to 15th centuries A.D.)— The second period of ethical history is characterized by the subordination of ethics, as a branch of philosophy, to theology. The distinctive features contributed in this period to subsequent ethics are the emphasis laid upon ideas of law, authority, obligation or duty, and merit or demerit, namely, the good as religious salvation involving a knowledge and love of God as supreme perfection, possible only in the next world; and evil as sin, guilt also needing supernatural expiation. Because of the emphasis upon law and authority, moral ideas are largely assimilated to forensic and juridical conceptions. Most significant, however, for ethical theory is the transfer of theoretical interest from the conception of the good, the central idea of ancient ethics, to that of obligation. Not the natural end of man, but the duty of absolute submission of will to transcendent moral authority was the keynote. And even when ethics was freed from subservience to theology, it still remained easier for the modern mind to conceive of morality in terms of the nature and authority of duty than as the process of realizing the good. On the more concrete, empirical side, the great contribution of mediæval theory was in depicting the moral drama, the struggle of good and evil, as it goes on in the individual soul. The fact that this was fraught with significance for an endless future life made it a subject of anxious and minute attention; and here, too, even when the moral region was later marked off more or less definitely from the religious, modern thought owes its consciousness of the subtle perplexities, temptations and shades of moral effort and issue to mediæval rather than to ancient ethics.

Early Modern Period (The Reformation to the French Revolution).—The complexity and variety of moral theory and inquiry since the 15th century, as well as its relative nearness, make it difficult to secure the perspective necessary to its proper characterization. It is all more or less connected, however, with the struggle toward greater individual freedom, and with the problem of maintaining a stable associated and institutional life, on the basis of recognition of individuality — the democratic movement. In its earliest period, modern ethics was largely characterized by reaction against scholasticism; it was an effort to secure a basis for ethics free from subordination to theology and to mediæval philosophy, and the schoolmen's versions of Aristotle. Moreover so much of energy was expended in the practical effort to get freedom of thought, of political action, of religious creed, of commercial life, that moral theory turned largely upon detailed questions arising out of the practical struggle. This accounts to a considerable extent for the scattered, fragmentary condition of modern ethics as compared with the systematic character of either Greek or mediæval thought. Moreover, the very gaining of intellectual freedom of inquiry opened up countless fields of interest. Ethical problems sprang into existence at every turn; every new movement in industry, in politics, national and international, and in art, brought with it a new ethical problem. Social life was itself undergoing such rapid change, and in such tentative, uncertain ways, that each of these problems had to be attacked independently. The result is a critical, controversial and individualistic, rather than a constructive and systematized ethics — with the advantage, however, of remarkable richness in detail.

Continental ethics followed the prevailing philosophic method of rationalism: the attempt to build up a theory of conduct, individual and social, on the basis of pure reason, independent of revelation of ecclesiastic authority, or positive institutions. While the method was *a priori* in name, as matter of fact it drew largely upon the inheritance of generalized Roman law, attempting to harmonize and purify it in accordance with ideals of unity and comprehensiveness which were supposed to represent the demands of reason. Grotius (1583–1645) was the founder of this movement, and, in his *De Jure Belli et Pacis,* used the idea of law which is founded upon man's rational nature, which in turn is inherently social, to place international relations of comity, commerce and war upon a more humane and enlightened basis. His German successors, Puffendorf (1632–94), Leibnitz (1646–1716), Thomasius (1655–1728), Wolff (1679–1754), carried on with greater critical acumen and more adequate philosophic instruments, the same work, and finally developed a complete system of rights and duties (called *Naturrecht* after *Jus Naturale*) applicable to all spheres of private, domestic, civil, political and international life — a *code* of morals, positive in effect, but supposed all to be drawn deductively from rational first principles. Upon the whole, the influence of German ethical rationalism was conservative; the result in fundamentals was the justification of the existing social order, purged of inconsistencies and reformed of abuses in detail. French rationalism took a different turn. It attempted a synthesis of the more basal notions of the newly arisen physical science with psychological ideas borrowed from Locke and his English successors. It was rationalistic not so much in attempting to deduce an ethical system from the conceptions of reason, as in subjecting the existing order of belief and institutions to unsparing criticism as anti-scientific. In its extreme forms it seemed to demand an abrogation of existing institutions, the erection of the same *tabula rasa* in social matters, that Descartes had postulated in intellectual, and a creation, *de novo*, by sheer voluntary action, of a new social order, aiming at universal happiness. Reason gives an ideal of society in which all men shall be free and equal, and in which economic want and misery shall be abolished, and a widely diffused intelligence and wealth shall be instituted. Pessimistic to the extreme as regards the existing order, it was equally optimistic as to the possibilities of social organization, culminating in the conception of the infinitely progressive perfectibility of human nature; thus Helvetius, 1715–1771 (De l'esprit, 1758; De l'Homme, published 1773); Diderot (1713–1784); Condillac (1715–1780); D'Holbach (1723–1789), especially 'Système Social' (1773); Condorcet (1743–1794). While German ethics had emphasized the conception of natural law which is social in nature, French thought culminated in a deification of natural rights which are individual in their import and location. Certain characteristic features of not only the French Revolution but of the thought of American publicists in the latter half of the 18th century are directly traceable to this influence.

English ethical theory received its impetus from Hobbes (1588–1679). He begins with an analysis of the make-up of the individual, and resolves the latter into a bundle of egotistic impulses, all aiming at unrestricted satisfaction. He denies the existence of any inherent social tendency, or of anything "rational" in the individual save as deliberation may be involved in the individual's efforts after satisfaction. The social counterpart of this unlimited individualism is chaos, anarchy, conflict — the war of all against all. Hence the individual's quest for happiness is self-contradictory. It is possible of fruition only within the state of absolute power which prescribes to each individual the proper sphere of the exercise of his powers. The state is thus the author and sanction of all moral distinctions and obligations. The authority of this state with respect to individuals is absolute; since the source of moral law, it cannot be subject to anything beyond itself. There are thus three strains in Hobbes' teaching. The psychological, which teaches pure egotism and hedonism; the ethical, which makes the state the source of moral values and relations; the political, which makes its authority unlimited. Each strain evoked profound and instant reaction. John Locke (1632–1704) taught that the individual has a natural right to a life of personal security, possession of property and social activity, subject only to limits of the similar rights of others, and that the state comes into existence to protect and secure these rights by settling cases of dispute or aggression, and hence is null and void when it goes beyond this province, and encroaches upon individual rights. A succession of writers, notably Shaftesbury (1671–1713); Hutcheson (1694–1747); Butler (1692–1752); Adam Smith (1723–1790), undertook a re-analysis of human nature, and endeavored to justify the presence of disinterested, benevolent impulses, of tendencies to regard the welfare of others. Cudworth (1617–1688); More (1614–1687); Cumberland (1632–1718); Clarke (1675–1729); Price (1723–1791), took up the question of the origin of moral distinctions, and tried to show that they were based not in the state but in immutable laws of reason, or upon a science as abstract and certain as mathematics; or else were made known in intuition, etc. But during these inquiries, new problems came to light, and led to a rearrangement of forces. These problems were: (1) the relation of happiness — the expression of the self-seeking tendencies of man — to virtue, the expression of his benevolent tendencies; (2) the nature of the test or standard of right and wrong; (3) the nature of moral knowledge. The first problem led in Butler to the attempt to introduce "conscience" as a third and balancing authoritative factor in human nature; and in Smith and Hume (1711–1776) to a peculiarly rich and significant theory of sympathy as a central principle through which distinctively moral sentiments are generated and whose exercise is intimately bound up with individual happiness. The second and third problems taken together lead to the conflict of utilitarianism and intuitionalism, the former holding that conduciveness to the maximum of possible happiness is the standard of right, the basis of obligation, and the source of all moral rules; this conduciveness to be determined by actual experience; the latter holding that there are moral values, which are inherently and absolutely such, without reference to consequences. Each school has a theological and a non-theological variety. Among theological utilitarians are prominent Gay (1686–1761), and Paley (1743–1805); among the non-theological Jeremy Bentham (1748–1842) outranks all the others. Without adding much that is fundamentally new to the theoretical analysis, he makes an analysis of happiness in connection with a discussion of the various impulses (or motives as he termed them) of human nature the basis of a thorough-going scheme of judicial and penal reform. Through him utilitarianism became the most potent instrument of the first half of the 19th century of social reform; conduciveness to general and equally distributed happiness being the test by which all customs, traditions and institutions were tried — and by which most of them in their existent forms were condemned.

Recent Modern. (From the French Revolution.)—The last 20 years of the 18th century signalize a turning point in the history of thought. Bentham's and Kant's chief works are dated in this period. The French Revolution, carrying into effect the naturalistic rationalism and its optimistic faith in the possibilities of the individual, compelled a reconsideration of the intellectual premises from which it set forth. The problem of 19th century ethics was to get back from the individual to the social whole which includes him and within which he functions; but to do this in a way which should take due account of the deepened significance given to individual initiative and freedom — without, that is, a return to pure institutionalism, or to arbitrary external authority. The following schools or main tendencies are easily distinguishable:

(*a*) *English Liberalism.*— In Bentham, utilitarianism, as we have seen, became a programme of social reform. The attempt to stretch an individualistic hedonism which taught that the end of desire is always the agent's own pleasure into a theory which taught that the individual should always judge his motives and acts from the standpoint of their bearing upon the happiness of all beings, brought out all the weaknesses of the theory. James Mill (q.v.) (1773–1836) strove valiantly to overcome these weaknesses by a systematic use of the principle of association, in virtue of which individual states become indissolubly connected, through punishment or commerce, with the welfare of others — the theory of "enlightened selfishness," for which Hartley (1705–1757) had previously provided the psychological machinery. His son, John Stuart Mill (1806–1873) while extending the same idea, introduced into utilitarianism two innovations, which were seized upon by his intuitional opponents as virtual abandonments of the entire hedonistic position. These were that quality of pleasure is more important than quantity, and that the individual is naturally social and so instinctively judges his own welfare from the standpoint of society, instead of *vice versa*. J. S. Mill also severely criticised the other utilitarians for their neglect of the ideal elements in education, and for neglect of the culture element in historical development. Without abandoning the individualistic basis he was much influenced by schools (*b*) and (*c*) below.

From (*b*) came the influence of Coleridge (1772–1834); Maurice (1805–1872), and Sterling (1806–1843). Bain (1818—) belongs to the same empirical and utilitarian school. Sidgwick (1838–1900) in his 'Methods of Ethics' attempted a fusion of the utilitarian standard with an intuitional basis and method.

(*b*) German rationalism culminated in Kant (1724–1804), who reduced the function of moral reason in man to a single principle; the consciousness of the moral law as the sole and sufficing principle of action. Since the claims of this principle are opposed by those of self-love — the desire for personal happiness — the presence of moral reason in us takes the form of a "categorical imperative," or the demand that duty alone, without any influence from inclination, desire or affection, be the motive of conduct. Upon the consciousness of duty are built the ideas of freedom, God and immortality — that is, by moral action is opened to us a sphere of reasonable faith in transcendental realities which are shut to scientific and philosophic cognition. Kant brought rationalism to a turn much as Bentham had affected empiricism. Subsequent German thought attempted to overcome the formalism of Kant's bare reason making itself known only in a consciousness of obligation. Hegel (1770–1831) attempted a synthesis of the Kantian idealism with the ideas of Schiller, of Spinoza (especially through the medium of Goethe), and of the rising historical school founded by Savigny. He endeavored to show that the social order is itself an objective embodiment of will and reason, and that the regions of civil law, of family life, social and commercial intercourse and above all the state, constitute an ethical world (as real as the physical) from which the individual must take his cue. He anticipated in many particulars from the standpoint of a different method and terminology, doctrines of recent anthropology and social psychology. German moral influence has been felt in English thought chiefly through Coleridge, Carlyle (who was mainly affected by Kant's successor, Fichte, 1762–1814), and more recently, T. H. Green (1836–1882). The New England Transcendentalists were also affected by this school of thought, Ralph Waldo Emerson (q.v.) (1803–1882) giving a highly original version of it, blending it with factors of his own personality and with ideas drawn from Puritanism.

(*c*) In France, the reaction from the individualism of the Revolution was most marked. At the head of the reaction stands Comte (1798–1857), who attempted to build up a theory of ethics upon an organized social basis, similar in many respects to that of Hegel, but relying upon a systematization of sciences rather than upon philosophy, for method, his system accordingly being termed positivism. Comte sought to show how such an ethical-social science could replace metaphysics and theology, the latter in the form of a religion of humanity. He influenced G. H. Lewes and the latter's wife, George Eliot, and also John Stuart Mill.

(*d*) In the latter half of the 19th century the theory of evolution has been dominant in ethical as well as in other forms of philosophic and scientific thought. Herbert Spencer's application is the best known to English readers. It is, however, generally recognized that his fundamental ethical conceptions were worked out before he became an evolutionist, and that the attachments between his ethics and the theory of evolution are of a somewhat external character. Indeed, it is now clear that the further development of the science of ethics waits upon the more thorough clearing up of the evolutionary ideas themselves, and upon more complete application to biology, psychology and sociology (including anthropology and certain phases of the history of man) in order to supply the auxiliary sciences necessary for ethical science. Through the conception of evolution it is probable that ethics will be emancipated from the survival of the idea that it is an art whose business is to lay down rules. The practical aspect of the theory of ethics will necessarily remain (since it is theory of practice or conduct), but it will take the form of providing *methods* for analyzing and resolving concrete individual and social situations, rather than of furnishing injunctions and precepts. The coincidence of the evolutionary tendency with the growth of democracy will relieve ethics in its philosophic aspects from its dependence upon fixed values, ideals, standards and laws, and constitute ethics more and more a working method for the self-regulation of the individual and of society.

Every period of ethical theory has been associated, as we have seen, with some corresponding epoch of human development, having its own characteristic problem. Upon the whole, however, ethics has not as yet adequately outgrown the conditions of its origin, and the supposed necessity they imposed of finding something as fixed and unchanging as custom. Consequently, philosophic inquiry has been devoted to finding *the* good, *the* law of duty, etc.; that is, something unchanging, all inclusive. Even the empirical school, in its emphasis upon pleasure, has tried to find something free from conditions of development, something fixed in the sense of being everywhere and at all times the same single unchanging standard and end. Even Spencer distinguishes present ethical codes as merely relative, and anticipates a period in which evolution will reach its goal — a period in which an unchanging set of rules shall be uniformly binding. But as ethical writers become more habituated to evolutionary ideas, they will cease setting up ideals of a Utopian millennium, with only one end and law; and will devote themselves to studying the conditions and effects of the changing situations in which men actually live. Consult: Humphrey, 'Conscience and Law, or Principles of Human Conduct'; Rickaby, 'Ethics and the Natural Law' (1900); Ming, 'Data of Modern Ethics Examined' (1901). JOHN DEWEY,
Columbia University.

Ethio'pia (Gr. αἴθω, to burn, and ὄψ, countenance), the biblical CUSH, in ancient geography, the name originally given by the Greeks to the southern parts of the known world. It is divided in the poems of Homer into eastern and western Ethiopia, and this distinction is repeated by Herodotus, and by the later Greek and Roman geographers. Homer gives the southern limit of Ethiopia as the northern boundary of the Southern Sea. Some ancient writers give the boundaries of the three Ethiopian kingdoms, Meroë, Aksum, and

Napata. Eastern Ethiopia appears to have included southern India, whose inhabitants were called Ethiopians from their color. There were also other Asiatic Ethiopians, an equestrian race, of a darker color than their neighbors, who wore crests made of the hides and manes of horses, and are supposed to have been a Mongolian tribe which had wandered into the steppes of Koordistan. The name Ethiopia was more usually and definitely applied to the country south of Libya and Egypt, between the Red Sea on the east and the desert of Sahara on the west, and embracing the modern regions of Nubia, Sennaar, Kordofan, and Abyssinia. In a still narrower sense, the designation was restricted to the province or kingdom of Meroë, which was also called the civilized Ethiopia. African Ethiopia, which is called in the Bible the land of Cush, embraced, according to Pliny, 45 distinct kingdoms; yet as neither the Greeks nor Romans ever penetrated beyond Napata, in lat. 19° N., we are indebted for most accounts of it to Greek imagination. Meroë, between the Nile and the Astaboras, formed the most powerful kingdom, and had a theocratic constitution. The other principal divisions were the Blemmyes, whose aspect was hideous; the Troglodytæ, who lived in caverns; the Macrobii, or long-lived men; the Ichthyophagi, or fish eaters; and the Creophagi, Chelonophagi, Elephantophagi, Struthophagi, and Ophiophagi, respectively the eaters of flesh, tortoises, elephants, ostriches, and serpents. Fable placed also in this region the race of pygmies. Some parts of Ethiopia were named from their productions; as the land of cinnamon, and of myrrh, and the Jews and Phœnicians went thither to obtain aromatics and ivory. The Ethiopian kings seem to have been chosen from among the priests, and the order of succession gave the crown to the nephew of the king, the son of his sister; and in default of an heir, an election was made. The people practised circumcison, and embalmed their dead in a manner similar to that of the Egyptians. They were of an intrepid, impetuous, and violent character, and yet are represented as loving and practising justice. Homer makes Jupiter visit them, and sit at their feasts. There were many Ethiopian queens named Candace, one of whom became subject to the Emperor Augustus. Under the Romans the population of Ethiopia became almost wholly Arabian, and so continued after the introduction of Christianity in the 4th century. When the followers of Mohammed overran the entire region some centuries later, the Arabic element gained complete predominance in it. During the Middle Ages the Christians and clergy of Abyssinia were designated as the Ethiopian Church.

Language and Literature.— Of the different dialects spoken in modern Abyssinia, the Amharic and the Tigré are the most remarkable. The former of these shows little affinity with the ancient language of the country, the Geez, or the Ethiopic properly so called, which since the beginning of the 14th century, when a dynastic change made the Amharic the language of the court, has ceased to be the vernacular, and is used only by people of education and learning, in religious and civil documents. This ancient language, which has its name from the inhabitants calling it *lesana geez,* that is, language of science, as it is also called language of books, is of Semitic origin, resembling in roots, structure, and grammatical forms, the ancient South Arabian dialect of the Himyarites, which since Mohammed has disappeared from the peninsula. This favors the hypothesis of some historians, who suppose the Ethiopians to have been a colony from Arabia. The alphabet also of the Geez greatly resembles that of the Himyarites, as found in their remaining inscriptions. It consists of 26 consonants and 7 vowels, which are small marks inseparably connected with the former, thus forming a peculiar syllabic mode of writing, analogous to the Devanagari and some other Indian alphabets. Few of these letters show a resemblance to the Phœnician alphabet, while 24 of them may be traced in the Arabic. There are no diacritical marks; the single words are separated by two dots; the accent is difficult; the mode of writing is from left to right, the reverse having been the practice before the introduction of Christianity into Abyssinia. In roots, and forms of expression and construction, the Geez is poorer than the Arabic. According to Gesenius, one third of all the roots can be traced distinctly in the Arabic, and many other words may be presumed to be of the same origin, while the roots of others can be found in the Hebrew, Syriac, or Chaldaic, some being native African, a few of Greek, scarcely any of Coptic derivation. The Geez has 10 conjugations, 8 of which answer to those of the Arabic, the 5th and the 6th being peculiar. A double infinitive is used substantively, this mood having both an absolute and constructive form. There is no participle. The dual is unknown both in verbs and nouns; the difference of masculine and feminine is observed throughout in the second and third persons. The relation of the genitive is expressed by an inflection, causing some changes in the terminations, or through the relative pronoun; the dative by prepositions; the comparative and superlative degrees by particles. The plural is formed by affixed syllables, *ân* in masculine, *ât* in feminine nouns, on the principle common to the Hebrew, Arabic, and Aramaic, or by changes in the radical letters, after the manner of the so-called broken plural in Arabic. In the formation of nouns the Geez most resembles the Hebrew, but it has superfluous final vowels, modified in certain cases, in which it is analogous to the Arabic in its nunnation. Beside a few fragments in inscriptions, there are no remnants of the ancient Ethiopian literature of a period preceding the introduction of Christianity under Constantine the Great, but of works composed since that time about 200 are known to European scholars. The Old Testament, translated from the Septuagint by unknown Christian writers in the 4th century, is extant in manuscripts in Europe, but only a part of it has been printed The Psalms were published in Ethiopic and Latin by Ludolf (Frankfort 1701), and in Ethiopic alone (London 1815). The version of the New Testament appeared at Rome in 1548, and in the London polyglot Bible. Of versions of apocryphal books, in which the Ethiopic is particularly rich, several have been published, as the 'Book of Enoch,' translated by Richard Laurence into English (2d edition, London 1833), and by Hoffmann into German (Jena 1838), in *Vatis,* translated by Laurence into Latin, and published in both languages (Oxford 1819). Geez in 1840 (London), and

Ascensio Isaiæ. The 'Didascalia, or Apostolical Constitution of the Abyssinian Church,' was published in Ethiopic and English by Platt (London 1834). The *Synaxar* contains lives of saints, martyrologies, and the hymns of the Ethiopian Church, in rude rhythmical form, every three or five lines often ending in the same consonant, which forms a kind of rhyme. The profane literature of the Ethiopian language is comparatively poor, consisting chiefly of chronicles, which appear to be of considerable interest, but have not yet been generally accessible. Of these the most remarkable are the 'Keber za Nageste,' containing the traditional and legendary history of the once mighty kingdom of Aksum, a copy of which was brought to Europe by Bruce, and a translation of it appended to his travels; and the 'Tarek Nagushti,' or chronicle of kings. In Europe the Ethiopian language was almost unknown until the time of Job Ludolf, who, being assisted by an excellent native scholar, Abbas Gregorius, made himself master of it, and published an admirable dictionary and grammar (2d improved and enlarged edition, Frankfort, 1702). Manuscripts written in the Ethiopian language are in possession of Abyssinian monks and in libraries in Europe. Their knowledge of music may be inferred from their musical notation which has been published. After a long interval the interest in this language and literature has been revived by the works of Platt, Laurence, Gesenius, Hupfeld, Hoffmann, Rödiger, Ewald, and others, as well as by the contributions of Isenberg, Blumberg, and D'Abbadie. Consult: Hoskins, 'Travels in Ethiopia'; Bruce, 'Travels in Abyssinia'; Bosset, 'Etudes sur l'histoire d'Ethopie'; Bent, 'The Sacred City of the Ethiopians.'

Ethiopian Church. See ABYSSINIAN CHURCH.

Ethiopian Region. See ZOÖGEOGRAPHY.

Ethiopic Writing. See ETHIOPIA.

E'thiops Mineral, a name formerly given by chemists to the black sulphide of mercury, prepared by rubbing mercury and sulphur together, either hot or cold. *Æthiops martis,* or ethiops of iron, was the black oxide got by exposing iron-filings and water to the air. Vegetable ethiops is the plant bladder-wrack, heated until it becomes black, a remedy for scrofula.

Eth'moid Bone, The (so called from *ēthmos,* «a sieve»), is one of the eight bones which collectively form the cranial box. It is of a somewhat cubical form, and enters into the formation of the cranium, the orbits, and the nasal fossæ. Its upper surface is perforated by a number of small openings (whence its name). See NOSE.

Ethnog'raphy, a branch of ethnology, the vast science which treats of mankind as a whole, their origin and their development in language, art, religion, and political ideas, from barbarism into civilization. The German scientists class ethnology as a science standing midway between natural history and philosophy. As natural history, in the ordinary sense of the term, is a classification and description of the lower animals, ethnology may fairly be considered as a classification of the various families of the human race, based on the observation of their physical characters, and geographical distribution. From the earliest records and monuments of mankind we find traces of various types of humanity. The statues and paintings of ancient Egypt represent several racial types including the negro, the Berber, and the Asiatic. In the first book of Moses, mankind are divided according to their descent from one of the three sons of Noah, Shem's progeny occupying Western Asia, while to the posterity of Ham and Japhet fell North Africa, and Southern Europe, respectively. Some recognition of the superficial physical differences observable in variously distributed races may also be found in Greek and Roman writers. In the Middle Ages little progress was made in ethnography. The discovery of America, with its revelation of new human types, seems to have given the first genuine stimulus to this study, and the word ethnography was first used in a book published at Nuremberg in 1791, and entitled 'An Ethnographical Picture Gallery.' In his great work, 'Systema Naturæ,' Linnæus classes mankind (*Homo sapiens*) together with the apes under the order of *Primates,* and divides them into four groups, as American, European, Asiatic, and African. Buffon in his 'Variétés dans l'espèce humaine' distinguishes the races according to their geographical distribution, though he makes some reference to physical variations. Blumenbach was the first to classify the races of men according to the shape of their skull. The Caucasian, whose skull was symmetrical, he set, as the normal type, midway between the Mongolian with the square skull, and the negro with his prognathous skull, while the American was ranged between the Mongolian and the Caucasian, and the Malayan between the Caucasian and the negro. In each of these types he distinguished and recognized as important the character of the hair, the setting of the eyes, and the form of the mouth.

The modern science of ethnography dates from the year 1829 when Milne-Edwards wrote to Thierry, with the result that the Société Ethnologique was founded. The founding of an ethnographic museum was suggested by Jomard in 1843, and built some years later in Paris. Since that time the study has been thoroughly systematized all over the world. While of all ethnographical classifications the most obvious is the enumeration of the white, yellow, red, and black-skinned races, as together making up mankind, this is clearly insufficient, as it would be likely to confound widely different types. Many attempts at a more scientific classification have been made. Oscar Pechsel recognized seven races of men: (1) the Australian; (2) the Papuan, including the Melanesian, the Negrito, etc.; (3) the Mongolian, including the Polynesian, the Malay, the Eskimo, and the American Indian; (4) the Dravidian (southern India and Ceylon); (5) the Hottentot and Bushman; (6) the negro; (7) the Mediterranean races, or Caucasian, which include the Hamitic, Semitic, and Indo-European.

It will be seen that these divisions are based upon other considerations than those of physical character, for it is merely because of their geographical proximity that the Hamitic, which includes the inhabitants of North Africa, can be placed in one category with the Caucasian. Among the most recent systems of ethnographical classification is that of Haeckel who has divided the human family into races in accordance with the variations of a single physical character, that namely of the hair. According to his authority there are two main species and four sub-species of hair found among mankind, who may be broadly separated into the woolly-haired (Ulotriches), and the straight-haired (Lissotriches). The woolly-haired consist (1) of the crested-haired (Lophocomi) subdivision, represented by the Hottentot, and the Papuan; and (2) of the fleecy-haired (Eriocomi) which includes the negro and the Kaffir. The straight-haired are sub-divided into the streaming-haired, and the curly-haired. To the former belong the Australian, the Arctic dwellers, the American Indian, Malay, and Mongolian; to the latter the Dravidian, the Mediterranean races, and the Nubian.

Ethnology, that branch of the science of anthropology which treats of the races of mankind and seeks to explain their origin and development.

Anthropology is the science which treats of man in relation to himself, to other men and to all nature. It is subdivided into several branches, each of which treats of some special phase of man's natural history. There is a difference in the meaning given by students to the names employed to designate the divisions of the study of man. Ethnology, ethnography, and anthropology have been to some extent interchangeable terms. Each of these branches of knowledge has a special meaning given it in different countries. However, there is becoming a more general acceptance of a definite meaning for these topics. The comprehensive term anthropology is recognized in its general sense to include all others (Keane, Tylor, Mason). The meaning herein given to Ethnology is widely recognized (Keene, Brinton.) The use of the term anthropology, to designate societies for the study of man and for sections in national scientific bodies on both sides of the Atlantic, indicates a general tendency to accept the proper meaning of the word.

Etnnology differs from ethnography, which deals chiefly with the collection of facts regarding the families, tribes and races of mankind, in seeking to explain the significance of the information obtained. Ethnography (from *ἔθνος*, a people, *γράφειν*, to write) is a writing about, a description of, peoples. Ethnology (from *ἔσνος* a people, *λόγος*, a discourse), attempts to interpret the facts gathered, to explain the causes for the conditions and the relationships of different peoples. Ethnography and ethnology occupy a relation to each other somewhat akin to that of geography and geology. One deals chiefly with existing facts; the other attempts to interpret the history which brought them forth.

Broca says ethnography studies peoples, ethnology races. The following seems a convenient scheme for grouping the branches of anthropology. Substantially it is as follows: Archæology, Biology, Psychology, Ethnology, Ethnography, Philology, Technology, Sociology, and Religion (Mason).

The unity of the race is now generally accepted. From the researches of the physiologist, the anatomist, the philologist and the psychologist we obtain the same testimony as to the specific unity of our race. The place of origin or centre of dispersal is not fixed. From the studies of eminent specialists, it would seem that the land about the shores of the Mediterranean, or the region farther eastward toward India, may claim to be the home of primitive man. About the Mediterranean they settled down like frogs about a pond (Plato).

For classification, mankind is divided into groups. On account of their distribution, these are sometimes named for geographical divisions. They are also distinguished as families, clans, tribes, nations, peoples and races. In the naming of the latter, family relationships form a prominent factor. It is with both of these lines of classification and the distribution of those discussed under them that ethnology has to do.

In these efforts at classification, different schemes have been tried. It is generally accepted that there are two groups of elements of characterization, which are sometimes called criteria. These are physical elements and psychical elements.

The principal physical elements are the bones, the shape of the skull, the facial angle, the color of the skin, color, shape and texture of the hair. Of these, color, probably because the most conspicuous feature, was the first to be considered and formed the basis of all the early classifications. The craniological school founded by the elder Retzius (1796–1860), made the shape of the head the basis of classification, and introduced exact methods into this branch of the subject. This was based on the relative length and breadth of the skull, and accordingly mankind was divided into long-skulled, and short, broad-skulled races. Later developments in craniology introduced a third class, representing a mean between the other two. Craniology alone cannot be depended upon to supply sufficient or trustworthy materials for the proper classification of mankind. Nevertheless it has thrown much light upon the subject. Of late years the color, shape and texture of the hair have steadily risen in the estimation of naturalists as a racial test. The hair is now regarded as the most constant of all the physical features, and has been made the foundation of their groupings by some of the most eminent anthropologists.

The other physical ethnical elements are of little value separately, but are often useful aids in combination with others. Such are stature; the shape, color and position of the eye; the size and form of the brain; the shape of the nose and mouth; the superciliary and zygomatic arches, and all such other elements as collectively constitute the broad, flat features of the lower, the oval and regular faces of the higher races.

The psychical elements are less conspicuous, and have but recently been taken into account in classification. It has been said that "Love and hunger rule the world." The former relates to the perpetuation of kind, the latter to self preservation. Around these two may be grouped the other factors of this class. The following are the principal psychical elements:

(1) Preservative instinct, food, clothing, shelter; (2) Perpetuating instinct; (3) Language; (4) Religion; (5) Government; (6) The Arts.

Food, clothing and shelter are the imperative needs of the human species at all ages and under all conditions. Among the prominent topics considered under the sexual impulse are the

RACES OF MANKIND

BUSHMAN: 1. Bushman (after *Fritsch*).—2. Namaque woman (after photograph, *Fabri*). NEGROES: 3. Loango woman (after Doctor *von Falkenstein*).—4. Man from Darfur (after photograph, *Hagenbeck*). NEGRITOS: 5. Man from the New Hebrides (after *Godeffroy*). 6. Woman from Tasmania (from a photograph, *von Bulow*). BLACK-HAIRED RACES: 7. Italian woman (from life). 8. Italian (from life). AUSTRALOIDS: 9. Man from Southwestern Australia (after photograph, *von Bulow*).—10. Nubian woman (after photograph, *Hagenbeck*). BLOND RACES: 11. Danish Girl (from a photograph).—12. South Russian (from a photograph). POLYNESIANS. 13. Girl from the Tonga Islands (after *Godeffroy*).—14. Dyak from Borneo (after *Dammann*). MONGOLOIDS: A. 15. Tarantsha-Mongol (after *Prschewalskij*).—16. Kalkas-Mongol woman (after *Prschewalskij*).—B. 17. Chinaman (after portrait, Museum of Ethnology, Berlin).—18. Yakut woman from the Cheta (after *Middendorf*). C. 19. North Am. Indian (after photo).—20. South Am. Indian (after *Kohde*). ESKIMO: 21. Koriak woman (from "Peoples of Russia").—22. Eskimo from Greenland (after photograph, *Hagenbeck*).

position of woman, the marriage relation and the line of descent. Language is the chief of the psychical elements. Some perhaps, with Horatio Hale, would make it the sole test of race. The power of religion, both as a constructive and dispersive force, is the repeated testimony of history. The organization and administration of government, whether in its primitive form or in the more enlightened stage, is of deepest interest. The arts of life find their origin in the rude homes of early man, and have steadily been influential in all human progress. For these have lives been lost, tribes been destroyed, nations been formed, battles been won. They have been the motive power in every effort, the impulse behind every forward movement of mankind from the earliest days to now.

There have been so many changes in this world of ours and so many mixtures of ancestral strains that it is impossible to determine certainly to which race certain peoples belong. After successive efforts by able students to classify mankind upon this or that character or group of characters, the tendency now seems to be to return to the earlier classification. To recur to the three greater subdivisions — white, black and yellow; or, Caucasian, Negro, Mongolian.

With all the data gathered and the characters used in succeeding classifications, the original color plan in a general way is as good as we know. Popularly, too, this seems to have struck the fancy. Without thought we speak of a person as white, black or red, as he is a Caucasian, Negro or an American Indian.

Dall divides man into three groups: white, black, and yellow. Flower and Lydekker also assign all representatives of mankind to three primary divisions. The status of the American aborigines is left unsettled. Keane gives to these a place among the races, making four. Linnæus in his day adopted four primary divisions. He, however, recognized man as a distinct genus, *homo*, having four species: *Homospæthiopicus*, *Homospmongolicus*, *Homospamericanus*, *Homospcaucasicus*. Gerland divides mankind into six races, separating the Dravidians from the other groups. To-day man is considered a single species, having several varieties or races. Blumenbach gives five groups, classified according to the color of the skin. Prof. Huxley also designated five groups along somewhat similar lines. Morton used the skull as a basis of

GENERAL ETHNOGRAPHIC SCHEME.

Race	Traits	Branches	Stocks	Groups or Peoples
European	Color white Hair wavy Nose narrow	I South Mediterranean	1. Hamitic	1. Libyan 2. Egyptian 3. East African
			2. Semitic	1. Arabian 2. Abyssinian 3. Chaldæan
		II North Mediterranean	1. Euskaric	Euskarian
			2. Aryac	Indo-Germanic or Celtindic peoples
			3. Caucasic	Peoples of the Caucasus
African or Negro	Color black or dark Hair frizzly Nose broad	I Negrillo	1. Central African 2. South African	Dwarfs of the Congo Bushmen, Hottentots
		II Negro	1. Nilotic 2. Sudanese 3. Senegambian 4. Guinean	Nubian
		III Negroid	1. Bantu	Kaffirs and Congo tribes
Asiatic or Mongolian	Color yellow or olive Hair straight Nose medium	I Sinitic	1. Chinese 2. Tibetan 3. Indo-Chinese	Chinese Natives of Tibet Burmese, Siamese
		II Sibiric	1. Tungusic 2. Mongolic 3. Tartaric 4. Finnic 5. Arctic 6. Japanic	Manchus, Tungus Mongols, Kalmucks Turks, Cossacks Finns, Magyars Chukchis, Ainos Japanese, Koreans
American	Color coppery Hair straight or wavy Nose medium	I Northern	1. Arctic 2. Atlantic 3. Pacific	Eskimos Tinneh, Algonkins, Iroquois Chinooks, Kolosh, etc.
		II Central	1. Mexican 2. Isthmian	Nahuas, Tarascos Mayas, Chapanecs
		III Southern	1. Atlantic 2. Pacific	Caribs, Arawaks, Tupis Chibehas, Quichuas
Oceanic	Color dark Hair wavy or frizzly Nose medium or narrow	I Negritic	1. Negrito 2. Papuan 3. Melanesian	Mincopies, Aetas New Guineans Feejeeans, etc.
		II Malayic	1. Malayan 2. Polynesian	Malays, Tagalas Pacific Islanders
		III Australic	1. Australian 2. Dravidian	Australians Dravidas, Mundas

classification; Haeckel and Broca the hair; and Hale language.

To one who carefully goes over the different schemes of classifying man, it is apparent that none is wholly satisfactory. Each in some direction overlaps some other. It is by taking all these race criteria so far as they are of value that the most reliable conclusions may be drawn as to the proper classification of mankind. No one set of standards will properly answer. That classification will be most satisfactory which obtains the most help from all the elements. All that we can aim to do is to group under some general and loose fitting subdivisions those members of the species which display the greatest number of similarities. (Brinton.) Perhaps it will be as satisfactory to follow the plan of Linnæus and classify the races of men according to geographical areas. Under such a plan we speak of the European race, which in ancient times was confined to Europe and adjacent parts of Asia and Africa; the African race, whose natural home is Africa; the Asiatic race, which is chiefly confined to Asia; the American race, composed of those occupying the western continent before its occupation by Europeans; and, the Oceanic or Australian race, comprising the tribes of Polynesia, Australia and the many groups of islands sometimes included in Oceanica. We can use Blumenbach's scheme of dividing them according to the color of the skin. Under it, they are grouped as follows:

1, Caucasian, or white; 2, Ethiopian, or black; 3, Mongolian, or yellow; 4, American, or red; 5, Malay, or brown. Dr. D. G. Brinton enumerated five races of mankind. Their chief characteristics may be summed up substantially as follows: I. The European Race — Traits — Color white, hair wavy, nose narrow, jaws straight, skull variable, languages inflectional, religions ideal. II. The African, or Negro Race — Traits — Color black, hair woolly, nose flat, jaws protruding, skull long, language agglutinative, religions material. III. The Asiatic, or Mongolian Race.— Traits — Color yellowish or brownish, hair straight, nose flat or medium, jaws straight, skull broad and high, languages isolating or agglutinative, religions material. IV. The American Race — Traits — Color coppery, hair straight, nose narrow, jaws straight, skull variable, language incorporating, religions ideal. V. The Oceanic Race — Traits — Color dark, hair lank or wavy, languages agglutinative.

Classified in this manner, the human species presents the subdivisions shown in the scheme on the opposite page.

Of the South Mediterranean branch of the European race there are given two divisions, the Hamitic and the Semitic. The former is divided into three groups, the Libyan, Egyptian and East African. The Libyan group extends over northern Africa from the Atlantic Ocean to the Nile. Some of these tribes are very dark and have been termed "Black Caucasians." Nevertheless, except for color, they are fine representatives of the white race. The Egyptian group is represented by the ancient Egyptians and their descendants, the modern Fellah of the Nile valley and the Copts. These two groups of this branch of the European race have been potent factors in the world's history. The development of the earliest seats of culture, the organization of government, and the establishment of high degrees of civilization have been the work of their representatives. On the contrary the East African group is represented by a number of tribes who are chiefly nomadic and occupy the territory south of the Egyptian group and extending from the Nile to the Indian Ocean. They include the Gallis, Somalis and Agaas.

The Semitic stocks are made up of three groups — the Arabian, Abyssinian and Chaldæan. The most prominent of the first group are the Arabians; the existing tribes best known are the Ishmaelites and Bedouin. They have occupied at different times parts of the Arabian peninsula and now practically cover it all.

The Abyssinian group is supposed to have originated in the region last mentioned and to have been dispersed over Abyssinia and adjacent parts of Africa. They have become mixed with adjoining tribes and a corrupt form of Christianity exists among them. The Abyssinians, Tigre and Amhara are prominent nations. The former is best known.

The third group of Semitic peoples has been called the Chaldæan. This includes the Syrians, Israelites, Samaritans, Babylonians and Jews. They also originated in Arabia and spread out into other lands. The Jew has become worldwide in his dispersal. From these peoples great nations were developed and from them two great religious leaders, Jesus Christ and Mohammed, have sprung.

The North Mediterranean branch is divided into three divisions. They are the Euskaric, Aryac and Caucasic stocks. The only surviving remnant of the Euskaric stock is the Basques of Spain. That they formerly were more widely distributed is generally believed. Their relationship with other peoples is not satisfactorily determined. The most extended and most important of these race stocks is the Aryac. The origin of the Aryans has been a fruitful theme of discussion in recent years. While there is still a difference of opinion on this subject, the majority of writers have accepted the theory of their European origin. The Aryac or Indo-Germanic stock is divided by Brinton into eight groups: Celtic, Italic, Illyric, Hellenic, Lettic, Teutonic, Slavonic and Indo-Iranic groups.

The Lettic or Lithuanian peoples, while comparatively inconspicuous, are in some respects the most interesting of their fellows. They are thought by some students to be the remnant of the original stock and that which most resembles it. They are located along the Baltic Sea in Prussia and Russia.

The Indo-Iranic group is of special interest because it has the farthest eastern range and for the reason that it is nearest the region which those who believe in the Asiatic origin of the race think was its primitive home. The term Iranic is derived from the plateau of Iran, which has been thought by some to be the area of dispersal of the race. The group divides into two divisions, the Iranic, whose old representatives were the Bactrians and Persians. To-day it includes the modern Persians, the Parsees, generally known as fire-worshippers, and the tribes of Beluchistan, Afghanistan and neighboring regions. The Indic branch comprises the peoples occupying India. The most prominent of these are the Hindus, Rajpoots and Djats. The typical Brahmins probably are the best representatives of the stock.

The Teutonic group includes the Germans, English, Norwegians, Swedes and Danes, and their ancestors, the Goths, Vandals, Angles, Saxons, Norsemen. These independent, aggressive, progressive races have been conspicuous in the history of the past and the activities of the present. They have spread throughout the world as missionaries of business, education or religion. They are the forces which operate in all progressive government and are destined to sway the world.

East of these is the Slavonic group. It is represented to-day by the Russians, Poles, Czechs, Bulgarians, and other tribes of the Danube region. Of their ancestors known in history are the Scythians and Massagetæ. The Slavonic tribes to the east, in one direction, came in contact with the Indo-Iranians and, in another, with some of the branches of the Mongolians. Within comparatively recent times some of them have made remarkable progress in civilization. Russia now ranks as one of the great world powers.

The Hellenic group comprised the ancient Greeks and their relatives. They occupied at an early date the peninsulas of Asia Minor, Greece, the southern part of Italy and contiguous territory. The progress of Greek culture is familiar. Greek language, literature and art form the basis of education everywhere. Their dominion was one of the world's greatest confederacies. Overthrown by the Romans and subsequently by the Mohammedans, they were for generations hidden from the view of the progressive world. The Illyric stock is situated near the Greeks in Turkey. It is represented by the Albanians. The Italic stock covered most of the Italian peninsula. The Umbrians, Etruscans, Oscans and Latins were the principal older representatives. They developed the Roman empire and in the organization and conduct of government and the framing of laws they achieved a front place in the history of the world.

The Celtic group, originally spread over western Europe, has largely disappeared. Certain parts of the British Isles and the north of France contain the surviving members. These are the Irish, Welsh, Scotch, Manx and the people of Brittany.

The Caucasic stock is represented by four groups: Lesghic, Circassic, Kistic and Georgic. They occupy the Caucasus Mountain region.

The African race occupies Africa south of the Sahara desert and of the Nile valley. It is classified in three groups: the Negrillos, Negroes and Negroids. Under Negrillos (little Negroes) are grouped the Akkas and other pygmies of the interior region, and the small-sized Bushmen and Hottentots farther south. The characters of some of these tribes are faithfully preserved in figures upon the Egyptian monuments. The most striking of these physical features is the peculiar growth and development about the pelvic region. The clicks of the Hottentot and Bushman languages find no counterpart in any other tongue. The Negroes are confined chiefly to western and central Africa, ranging east into Nubia. They comprise four subdivisions: the Nilotic, Sudanese, Senegambian and Guinean. The first is confined to the upper Nile valley. The Sudanese group is represented by tribes in Sudan and westward. The western coast south of the Senegal River is the territory of the Senegambians. Farther south toward the Niger River are the tribes of the Guinea group. This region was the chief source of the slave trade. The descendants of the Guinea negroes found throughout the United States are living witnesses of the slavery which existed there but a generation ago.

The Negroids approach the Negroes, but are in some ways quite different from them. Their color is brown rather than black; their hair is "kinky" but not woolly; the nose is straight and not short and flat. They are of two groups — the Nubian and Bantu. The former are found in Nubia and the upper Nile valley. The latter occupies practically all of southern Africa except the region of the Hottentots and Bushmen. Among the better known tribes are the Kaffirs, Bechuanas and Zulus. The African race occupies a low stage in culture. It has developed in the restricted area south of the Sahara basin. Probably it reached its typical development in the Niger valley.

The Asian, or Mongolian race is made up of two divisions — the Sinitic and Sibiric. The Sinitic branch includes the Chinese, Tibetans and the inhabitants of Anam, Siam, Burma and Cochin China. The Chinese have occupied their territory from quite early times. They have developed a peculiar civilization and in some particulars reached quite a high stage of culture. While there is considerable difference of opinion whether the arts of ancient China developed there or were acquired from the Aryans to the westward, it seems probable that in a great measure at least, they were indigenous.

The Sibiric branch of this race is largely located north of the mountains of Central Asia, ranging with the Arctic Circle from the Pacific to the Atlantic Ocean. The six groups are the Tungusic, reaching from northern China toward the Arctic Ocean and to Kamchatka. The Mongolic occupying the vast highlands west of Manchuria. Genghis-Khan and later Tamerlane established two of the wide extended Mongol empires. The Tartaric, another highland group, has spread from Turkestan in several directions. The Turk is the most conspicuous representative, though much mixed with other races. The Finnic is a group of Mongols occupying northern Europe. It is represented there by the Finns and Lapps and farther south by the Magyars. From there it extends east to the Volga River. The rude tribes fringing the Arctic Ocean in eastern Siberia and reaching to the Pacific are grouped under the name Arctic. The Chukchis and Kamchatkans are of their number. The Japanese and Koreans constitute the Japanese group. The Japanese are the most progressive and advanced of the Asiatic race.

The Oceanic race may be divided into three stocks — Negritic, Malayic and Australic. It occupies Australia, the islands of the South Pacific and Indian oceans, and the adjacent shores of Asia. In their migrations, whether along the shores or over the seas, they have so intermingled that their relationships are puzzling. The Negritic stock is represented by the Negritos, including such small peoples as the Mincopies of the Andaman Islands, the Papuans of New Guinea and other islands, and the Melanesians. The Malayic stock is the most conspicuous and energetic of the ocean peoples. Its representatives are found extending almost two thirds around the world, reaching from Easter Island to Madagascar. The most typical Malays are found in Malacca, Sumatra and Java, while others less marked extend from the Celebes to the Philippines. The Malays farther to the eastward are often called Polynesians. From their traditions it has been possible to obtain a fairly good idea of their successive migrations and of the comparative time of the settlement of the different island groups. They extend from New Guinea to New Zealand, Easter and the Sandwich islands. The Australic stock includes the different tribes of Australia, the extinct Tasmanians, and, according to some authorities, the primitive peoples of the peninsula of Hindustan. The Australians are very low in culture, nomadic, lacking government and wear little or no clothing. "The life of these savages proves to be of undeveloped type, alike in arts and institutions, so much so, that the distinction of being the lowest of normal tribes may be claimed for them."—(E. B. Tylor.)

The American race includes those peoples occupying the western continent at the time of its discovery by white men. For the purpose of study they may be divided into seven groups: Arctic, North Atlantic, North Pacific, Mexican, Inter-Isthmian, South Atlantic, South Pacific.

The Arctic group includes the Eskimo and Aleutian peoples. They occupy the shores of the oceans in Arctic America, and extend from Labrador to Greenland. In the North Atlantic group are some Indians of wide range. The Athabascans extend from the valleys of the Yukon and lower Mackenzie, to Arizona, while farther to the southward reaching into Mexico, the warlike Apaches are of this group. The Algonkins ranged from Newfoundland to the Rocky Mountains and from the Churchill River valley and Hudson Bay southward throughout the Ohio and Mississippi valleys to the Tennessee River. These included most of the Indians encountered by the early settlers. Their names are more or less familiar to us from history. The intelligent Iroquois, the formidable Dakotas (Sioux), the southern Indians, some of whom built mounds within historic times, and the tribes of the interior plains also belong to this division. The North Pacific group includes a number of tribes west of the Rocky Mountains, many of which are small and represent distinct linguistic stocks. Several of these tribes have the head artificially deformed. These include the Flatheads and Nez Percés (Pierced Noses). The Cliff-dwellers and Pueblo tribes of the arid regions of the southwestern United States are placed here. The Mexican group is notable because of the state of civilization attained by the Aztecs, its best known tribe. The organization developed, government established, education acquired, buildings constructed and arts pursued were unequaled by any tribe of the American race. The Mayas were the most important tribe of the Inter-Isthmian group. They were builders of note, elaborate decorators of stone, and mural artists. The South Atlantic group occupied the Atlantic coast of South America. They were chiefly wandering tribes without settled habitations. The Quichuas of Peru are the best known tribe of the South Pacific group. They attained higher civilization than any other South American tribe. They developed agriculture, domesticated animals, constructed large buildings of stone, were expert workers in metals, and devised a method of record keeping by means of strings and knots called quippus. See Keane, 'Ethnology'; Brinton, 'Races and Peoples'; 'The American Race'; Gerland, 'Ethnography'; Tylor, 'Anthropology.'

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Ethyl, the organic radical C_2H_5, which occurs in many carbon compounds, but which cannot exist in the free state. Its most important compound is ethyl hydrate, or ethyl alcohol (see ALCOHOL); but the iodide, C_2H_5I, which is formed by acting upon ethyl alcohol with iodine in the presence of phosphorus, is also of much importance in synthetic chemistry.

Eth'ylam'ine, an amine (q.v.) in which one or more of the hydrogen atoms of ammonia, NH_3, is replaced by the radical ethyl, C_2H_5. Three compounds of this sort are possible, and all have been actually prepared. When only one of the hydrogen atoms of the ammonia has been replaced, the resulting compound, $NH_2.C_2H_5$, is known as mono-ethylamine, or ethyl monamine; and it is this substance which is understood when the word ethylamine is used without qualification. $NH.(C_2H_5)_2$ is known as diethylamine, and $N.(C_2H_5)_3$ is called triethylamine. All three are formed when absolute alcohol is heated with zinc chloride, in closed tubes, to 500° F.; and they may then be separated by the crystallization of their picrates. Ethylamine (that is, the mono-amine) may also be prepared by boiling cyanic ether with an aqueous solution of caustic potash, absorbing the liberated gas by passing it through hydrochloric acid, and finally drying the ethylamine hydrochloride that is so formed, and distilling it with quicklime. All three of the ethylamines are alkaline, all smell of ammonia, and all combine with acids to form salts. The mono-amine is a colorless, inflammable liquid, having a specific gravity of 0.70, boiling at 68° F., and not solidifying at 220° below zero, F. Diethylamine (which may be prepared by heating the mono-amine with ethyl bromide) is also volatile, colorless, and inflammable, with a specific gravity of 0.72, and boils at 133° F., under ordinary atmospheric pressure. Triethylamine is very similar to the other two in general character. It has a specific gravity of 0.73, boils at 194° F., and its critical temperature (according to Pawlewski) is 513° F. (See CRITICAL POINT.) Triethylamine is but slightly soluble in water; diethylamine dissolves in water freely; mono-ethylamine mixes with water with a considerable rise of temperature, and the probable formation of a hydrate; though it is entirely expelled again, upon boiling.

Eth'ylene, a gaseous hydrocarbon having the formula C_2H_4, and constituting the first member of the olefine series. It is formed in the dry distillation of numerous organic bodies, but is most conveniently prepared for laboratory purposes by mixing 1 part of alcohol with 4 parts of sulphuric acid, adding enough sand to form a paste, and heating the mass over a flame. The sand takes no part in the chemistry of the process, but merely serves to regulate the action. The sulphuric acid, owing to its affinity for water, removes the elements of water from the alcohol, and thereby liberates the ethylene, $C_2H_5.OH = H_2O + C_2H_4$. Ethylene is a colorless gas, which burns with a bright flame, a five-foot burner, using the pure gas, yielding a light of 68 candle-power. It may be condensed to a transparent liquid which boils, under ordinary atmospheric pressure, at 153° F. below zero, and freezes at 272° F. below zero. Ethylene is an unsaturated compound, and combines directly with hydrogen when mixed with that gas and led over platinum black; the product of the combination being ethane, C_2H_6. Mixed with three times its own volume of oxygen, and fired by a spark, ethylene explodes with great violence. When it is mixed with chlorine in the dark, combination takes place according to the formula $C_2H_4 + 2Cl = C_2H_4Cl_2$, the new substance being an oily fluid, known as ethylene dichloride, or «Dutch liquid.» It is on account of this reaction that ethylene was formerly called «olefiant» (or «oil-forming») gas. It will be observed that the foregoing reaction is an additive one. In diffuse daylight chlorine attacks the dichloride of ethylene, with the formation of more highly chlorinated substitution products, of which the highest is C_2Cl_6.

Etienne, Charles Guillaume, shärl gē yōm ā-tē-ĕn, French dramatist: b. Chamouilly 6 Jan. 1778; d. Paris 13 March 1845. Under the first empire he was censor, editor-in-chief of the ‹Journal of the Empire,› and a member of the Academy; at the Restoration he was expelled from the Academy, and thereafter as editor of the «Constitutional» was a power on the side of the opposition. His comedies give proof of brilliant fancy, elegant style, and great constructive skill; ‹The Two Sons-in-Law› is the best comedy of the Imperial Era, and not unworthy of Molière. He composed many farces, vaudevilles, operettas, and spectacular pieces, which had unbounded success; and his operas, ‹Cinderella› and ‹Joconde,› were the delight of Paris. He wrote a ‹History of the French Theatre.›

Etienne du Mont, ā-tē-ĕn dü môṅ (Fr. «Saint Stephen of the Mount»), a fine church of mediæval Paris. It was founded in 1220; its completion and restoration were begun in 1517, and the building reached its present perfection in 1626. The shrine of Saint Genevieve, heroine and patron saint of Paris, is its principal point of antiquarian interest, but it is also the burial-place of Pascal and Racine.

Etiolation, ē″tĭ-ō-lā′shŏn, the alteration in the color and the structure of plants due to the absence of light during growth. The most noticeable changes are paleness and elongation of the stems. The elongation is due to the extension of the cells, and the paleness to the non-development, arrested development or destruction of the chlorophyll or green coloring matter of the plant. Other phenomena are imperfect development of leaves, altered method of branching, and various modifications of tissues, especially in the imperfect development of the cell-walls, which do not attain normal thickness. Agriculturally, etiolation is either a fault to be shunned or a useful process. In the first case it is often responsible for the «lodging» of wheat and other grain-crops sown too thickly, the bases of the stems being shaded so much that the cells fail to develop normal strength, and when the heads form the wind easily beats down the plants. The sprouting of potatoes, turnips, etc., is also undesirable. But etiolation is utilized in the blanching of various plants, such as asparagus and sea-kale, and especially salads such as celery, endive, and chicory. The process involves the exclusion of light by means of earth banked around the stems, by boards, paper, etc., or by tying the outer leaves loosely over the inner ones as with endive or with cauliflower. Rhubarb is often grown in darkness. In general, tenderness and modifications in flavor are the chief ends sought in the process.

Etiquette, ĕt′ĭ kĕt, a collective term for the established ceremonies and usages of society. Among courts the Byzantine and Spanish courts, and the French court under Louis XIV. and Louis XV., were noted for the strictness of their etiquette. Social etiquette consists in so many minute observances that a tolerable familiarity with it can be acquired only by a considerable intercourse with polite society. Quickness of sympathy and a certain fineness of observation are more needed for proficiency in this sphere than mere power of intellect.

Etive, ĕt′ĭv, **Loch,** an inlet from the Firth of Lorne, on the west coast of Scotland. The scenery of its shores is very beautiful. About three miles from the sea, at Connel Ferry, a ridge of sunken rocks crossing it causes a turbulent rapid, which at half-tide forms a sort of waterfall. Salmon and other fish are plentiful.

Etlar, Carit, pseudonym of Karl Brosböll, Danish realistic novelist: b. Friderica 7 April 1816. His first story was ‹The Smuggler's Son› (1839); of his later writings, the historical tale of ‹The Queen's Captain of the Guard› and the realistic story ‹The People in Need› (1878) are the most popular; his verse also has merit. An edition of his collected works was published 1859–68; with an additional collection in 1873–9; a new edition appeared in 1888.

Et′na, or **Ætna,** a volcano in the eastern part of the province of Catania, on the island of Sicily, and the largest active volcano in Europe. Directly north is the valley of Alcantara, on the west and south, the valley of Simeto, and on the east, the Ionian Sea. From the waters on the east Etna rises cone-like to a height of about 10,875 feet; but on the south and west it seems formed of superimposed mountains, the terminal being surrounded by a number of cones, all of volcanic origin, about 100 of which are of considerable size. The circumference at the base is about 100 miles. Around the mountain and on the lower slope are a number of villages, cultivated fields, groves of olive-, orange-, fig-, and date-trees; and a little higher up is a belt of forest with oak, birch, beech, and coniferæ. Above 7,000 feet vegetation is scanty, the cone is almost bare; rocky precipices, lava beds, masses of ashes and scoriæ are visible at its summit except where covered by snow. A deep depression, Val de Bove, on the eastern side, was once the principal crater; and frequently lava has issued out of the sides of the mountain, thus forming small cones and craters, about 200 of which are now distinctly marked. From the summit may be seen the whole of the island of Sicily, the Lipari Islands, Malta, and Calabria. The eruptions of Etna have been numerous and many of them destructive: more than 80 have been recorded, 11 of which occurred before the Christian Era. That of 1169 A.D. overwhelmed Catania and buried 15,000 persons in the ruins. In 1669 the lava spread over the country for 40 days, and 10,000 persons are estimated to have perished. In 1693 there was an earthquake during the eruption, when over 60,000 lives were lost. One eruption was in 1755, the year of the Lisbon earthquake. Among more recent eruptions are those of 1852, 1865, 1874, 1879, 1886, 1892. An eruption is ordinarily preceded by premonitory symptoms of longer or shorter duration. In Greek mythology there are found frequent allusions to Etna, especially in the legends of Enceladus and Hiphæstus. Consult: Dana, 'Characteristics of Volcanoes'; Kneeland, 'Volcanoes.'

Etna, Pa., borough in Allegheny County, on the Allegheny River, the Pittsburg & W., the Etna & M., and a branch of the Pennsylvania R.R.'s. It is really a suburb of Pittsburg, with only the Allegheny River between. The chief industries are in connection with the iron and steel products for which this part of the State is so famous. Pop. 5,482.

E'ton, England, town, in the county of Buckingham, on the Thames, 22 miles west of London. It consists principally of one narrow street, which has of late years been much improved. An iron bridge across the Thames connects Eton with Windsor, from which it is separated only by the river. Eton derives its celebrity from its college. Pop. 3,309.

Eton College is one of the famous English public schools, and was founded by Henry VI. in 1440, under the name of "The College of the Blessed Virgin Mary Beside Windsor." The present collegiate edifice was begun in 1441 and the whole of the original structure was completed about 1523. Important additions were made in 1846, and also in 1889. This school was intended originally for the benefit of the sons of worthy but poor parents, and also for the support of 25 poor infirm men; and was to be maintained out of the incomes from the royal demesne lands. Now the students admitted are the sons of the gentry and nobility, and so numerous are the applicants that it is usual to enter the names at birth. The scholarships are open to all British subjects; but candidates must be 12 years or over and not more than 14 years, and must pass an examination. A certain number of the students, not under 17 years, are elected each year to scholarships at King's College, Cambridge. The number of pupils on the foundation is limited to 70, but the number outside, called oppidans, who board and lodge in the houses of the masters, is about 1,000. The course of instruction is mainly classical, but the modern languages, mathematics, and the natural sciences are given now a due share of attention. Consult: Cust, 'Eton College'; Lyte, 'History of Eton College' (1440–1898).

Etorofu, ā'tō-rō-foo, or **Iturup,** ē-too-roop', (1) an island; (2) a strait; in the most northerly part of Japan. The island belongs to the Kurile group.

Etruria, ē-troo'rĭ-a (Greek *Tyrrhenia*), the name anciently given to that part of Italy which corresponded nearly with the modern Tuscany, and was bounded by the Mediterranean, the Apennines, the river Magra, and the Tiber. The name Tuscia, for the country, came into use in late times, while Tusci, as well as Etrusci, was used by the Romans as the appellation of the people from an early period. The oldest inhabitants of the country belonged, according to the accounts of the ancients, to the Umbrian stock, and were dispossessed by the Tyrrhenians or Tyrsenians, a people who came by sea, and who were generally believed to be Lydians. These again were in early times subjected by another race who called themselves Rasena, and who finally became incorporated with the Tyrrhenians proper, the whole nation then being called Tuscans or Etruscans. These Rasena, by ancient writers usually confounded with the Tyrrhenians, entered Italy at a very early period from the north, and gradually took possession of the whole country from the Alps, Ticino, and lower Adige on the south.

To what race the Etruscans belonged is unknown, and our ignorance is equally great with regard to their language, remains of which still exist in numerous inscriptions mostly on tombs. It appears to have been quite distinct from the languages of the rest of Italy, but attempts to connect it with the Greek, Celtic, Germanic, or Semitic languages have had little or no success. The characters used are essentially the ancient Greek, and were either introduced from Magna Græcia or possibly from Corinth. Etruria was very early a confederation under the rulers of the 12 principal cities, each of which formed a republic by itself. The chiefs of these republics were styled *lucumones*, who were also the priests and generals, and held their meetings in the temple of Voltumna, where they deliberated together on the general affairs of the country. In all the cities there appears to have been an aristocracy, toward which the mass of the common people stood in the relation of clients, though there would no doubt be a body of entirely free men resembling the plebeians at Rome. The religion of the Etruscans offers a subject of great difficulty, but it is at least certain that it had many points in common with the religious systems of the Sabines and Latins, while in some respects it shows evidences of an Eastern origin. Among the deities may be mentioned Tina or Tinia, corresponding to the Latin Jupiter; Cupra, corresponding to Juno; Menerfa (Minerva); Sethlans (Vulcan); Turms (Mercury); and Aplu or Apulu (Apollo).

The chief occupations of the Etruscans were agriculture and commerce, both maritime and overland. Grain, wine, timber, cattle, and wool seem to have been the principal articles of trade. The staple food of the common people was pulse, but the upper classes were notorious for extravagance in their diet as well as in dress and in furniture. Their knowledge of the arts and sciences is said to have been derived mainly from Greece, and in a less degree from Egypt. The iron mines and copper mines in the interior of Etruria were worked at a very remote period, and the metallurgical skill shown by the Etruscans was obviously connected with their proficiency in the art of working in bronze, silver, gold, etc. Of Etruscan architecture our knowledge is limited. The so-called Tuscan order seems to be little else than a modification of the Doric. Of their temples there exist no traces; the theatres have been more fortunate, that at Fiesole showing how much in this form of construction they owed to the Greeks. The sepulchres, which were always subterranean, but frequently having superstructures of an architectural character surmounting them, present many varieties of construction.

For articles in terra-cotta the Etruscans were especially celebrated. These were not restricted to small objects, but embraced statues and figures of large size, with which the exteriors and interiors of their temples were adorned. Closely related to this branch of art was the Etruscan pottery, in the manufacture of which they excelled: but the only extant productions of this class that can be said to be genuine are the red ware of Arretium and the black ware of Clusium ornamented with figures in relief, many of them of a grotesque and strongly marked Oriental character. On the other hand, numbers of the painted vases popularly known as Etruscan vases, are undoubtedly productions of Greek workmen, the subjects, the style, and the inscriptions being all Greek. The skill of the Etruscans in works of bronze is attested by many ancient writers, and also by numerous extant specimens. The style of art characteristic of these works is stiff and archaic, having some resemblance to the early Greek, though some of the existing specimens exhibit more freedom of design and great beauty of execution. The bronze candelabra, of which many examples have been preserved, were eagerly sought after both in Greece and Rome. Another branch of art which seems to have been peculiar to this people was that of the engraved bronze mirrors, a considerable number of which has been discovered, some quite recently. These mirrors were polished on one side, and have on the other an engraved design, taken in most cases from Greek legend or mythology. Consult Dennis, 'The Cities and Cemeteries of Etruria' (1892).

Etruria, Kingdom of, the name given to the province of Tuscany, in Italy, when, in 1801, Napoleon formed of it a kingdom, and made Florence the capital. In 1808 he incorporated it with the French empire, and in 1809 his sister, Elise Bacciocchi, was made grand duchess of Tuscany. The country came under the control of Ferdinand III., when Napoleon became an exile in 1815.

Etruscan Vases, a class of beautiful ancient painted vases made in Etruria, but not strictly speaking a product of Etruscan art, since they were really the productions of a ripe age of Greek art, the workmanship, subjects, style, and inscriptions being all Greek. They are elegant in form and enriched with bands of beautiful foliage and other ornaments, figures and similar subjects of a highly artistic character. One class has black figures and ornaments on a red ground — the natural color of the clay; another has the figures left of the natural color and the ground painted black. The former class belong to a date about 600 B.C., the latter date about a century later, and extend over a period of about 350 years, when the manufacture seems to have ceased. The subjects represented on these vases frequently relate to heroic personages of the Greek mythology, but many scenes of an ordinary and even of a domestic character are depicted. The figures are usually in profile.

Ettlingen, ĕt'lĭng-ĕn, Germany, town in the grand duchy of Baden, on the Alb, five miles south of Carlsruhe. It is an ancient place, containing some Roman remains; is entered by three gates, and has an old castle with gardens, town-house, hospital, normal and other schools, manufactures of linen and cotton goods, starch, leather, and paper. Pop. 8,156.

Ettmüller, Ernst Moritz Ludwig, lood'vĭg ĕt'mül-lĕr, German philologist and historian: b. Gersdorf, Saxony, 5 Oct. 1802; d. Zürich 15 April 1877. He made extensive researches in German mediæval literature and was author of 'German Dynasty Founders' (1844); and other epic poems, besides the 'Anglo-Saxon Lexicon' (1852).

Ettrick, ĕt'rĭk, a district of Scotland, in Selkirk, through which the Ettrick water runs. It is now a sheep pasture, denuded of wood, but in ancient times it formed part of Ettrick Forest, which included the whole county as well as parts of Peebles and Edinburghshire. The "Ettrick Shepherd," James Hogg, was a native of this district.

Ettrick Shepherd, The. See Hogg, James.

Ettwein, ĕt'vīn, **John,** American Moravian bishop: b. Trendenstadt, Würtemberg, 29 June 1721; d. Bethlehem, Pa., 2 Jan. 1802. He came to America in 1754, and for nearly 50 years worked among the Moravians as evangelist, pastor, and bishop. He traveled thousands of miles, oftentimes on foot, preaching in 11 of the 13 colonies and in what is now the State of Ohio, "in cities, in villages, in homesteads, from pulpits, in the open air, in court-houses and barns, to many and very different classes of men," as he himself wrote. Among the Indians, too, he worked with great success. In 1776–7 he rendered noble service to the sick and wounded of the American army in the general hospital at Bethlehem, Pa. Elected bishop in 1784, he presided over his church for nearly 17 years, displaying the soundest judgment in matters of polity, and a fine personal heroism in critical circumstances. In 1787 he founded the Society for Propagating the Gospel Among the Heathen, which still exists, richly endowed, and is the bulwark of the extensive Moravian mission work. He became proficient in the language of the Delaware Indians, prepared a dictionary and phrase book of it, and in 1788 compiled an account of the language with a vocabulary, which has since been published by the Pennsylvania Historical Society. Old age compelled his retirement from active service in 1801.

Et'ty, William, English painter: b. York 10 March 1787; d. there 13 Nov. 1849. He worked long without much recognition, but at length in 1820 won public notice by his 'Coral Finders.' In 1828 he was elected an academician. Among his works, which were greatly admired, are a series of three pictures (1827–31) illustrating the 'Deliverance of Bethulia by Judith'; 'Benaiah one of David's Mighty Men'; 'Women Interceding for the Vanquished.' All these are very large pictures, and are now in the National Gallery of Scotland. Others of note are: 'The Judgment of Paris'; 'The Rape of Proserpine'; 'Youth at the Prow';

and 'Pleasure at the Helm.' In coloring and the representation of the nude he displayed high ability.

Etymologicum Magnum (Gr. «the great etymological glossary, or dictionary»), the sole lexicon of size surviving from the Byzantine age of Greek learning. It is evidently a compilation from other works of the same class, and bears no author's name. The book may be attributed to the 10th century. It consists of a number of quotations from the works of ancient grammarians, arranged alphabetically. It may have received its name from its first critical editor, Sylburg, or from its printer, Calliergus. The book is of high philological value, although many of the derivations of words contained in it are fanciful and utterly unscientific.

Etymology (Gr.), the investigation of the origin or derivation and of the original signification of words. It forms a subsidiary part of the science of comparative philology, and, though it has occupied the attention of the learned and the curious in every age, it is only within the 19th century that its study has been pursued on really scientific principles. Ignorance, or what is still more dangerous, half-knowledge, has often suggested false etymologies, and many more have sprung from that excess of confident and self-sufficient ingenuity which will not take plain words like *beef-eater* and *welsh-rabbit* for what they are. Folk-etymology properly so called, has played an important role in the development of languages. The words that the people have known from infancy are for them things, but it is quite different with the new terms they meet. These arrest their curiosity, and, as they believe that every word has its signification, they seek for this, guided by resemblances of sound with words already known, and consequently reach conclusions often hopelessly distorted by false analogies. We see the same illogical process in the Old Testament interpretation of personal names, applied conveniently after the fact; in the Homeric explanation of the names of gods and men; in the quaint etymologies so common in the mediæval writers, and in such moderns as Thomas Fuller; in the vagaries of Celtic topographers; and even in the pages of some modern dictionaries it is possible to find such a statement as that the English word *news* is derived from a certain conjunction of the points of the compass, north, east, west, and south. These whimsical etymologies were laughed at by Dean Swift, whose *ostler* = *oatstealer*, was a stroke of genius, but have not yet disappeared; and, indeed, the modern ideas of method in etymology are hardly at all beyond the point attained by the grammarians of Alexandria and by Varro among the Romans. It was the birth of philology and the study of the languages of the East that made a scientific etymology possible. It no longer sought the relations of the words of a single language exclusively within itself, but extended its view to the whole group of cognate tongues, or, wider still, to a whole family, and became a new science under the name of Comparative Grammar. Grimm's Law was the first finger-post that pointed out the path; among his greatest successors are Curtius and Fick. The Teutonic revival in England in the 19th century commenced the history of English upon an historical method, from which has grown a really scientific English etymology, as seen in the dictionaries of Prof. Skeat and Dr. Murray. No more useful chart of warning could be given than the former's canons for etymology: «Before attempting an etymology, ascertain the earliest form and use of the word, and observe chronology. If the word be of native origin, we should next trace its history in cognate languages. If the word be borrowed, we must observe geography and the history of events, remembering that borrowings are due to actual contact.» See Curtius, 'Grundzüge der Griechischen Etymologie' (1879); Fick, 'Vergleichendes Wörterbuch der Indo-germanischen Sprachen' (1874–6); Palmer, 'Folk-Etymology' (1882); also see SCIENCE OF LANGUAGE.

Eu, ė (Lat. *Auga*), France, town in the department of Seine-Inférieure, two miles above the mouth of the Bresle; 17 miles northeast of Dieppe. It was in the castle belonging to this place that William the Conqueror married Maud of Flanders. The town was burned to the ground in 1475, by order of Louis XI., to prevent it from falling into the hands of the English. It has several small manufacturing establishments. Pop. 5,412.

Eua, ā-oo'ä, a small island belonging to the Friendly Islands, owned by Great Britain; area, about 125 square miles. The climate of all the islands of the Tonga group, to which the Friendly Islands belong, is but slightly higher than that of the Samoan Islands, just north.

Eubœa, ū-bē'a, formerly called NEGROPONT, a Greek island, the second largest island of the Ægean Sea. It is 90 miles long, 30 in greatest breadth, reduced at one point to four miles. It is separated from the mainland of Greece by the narrow channels of Egripo and Talanta, and is connected with the Bœotian shore by a bridge. There are several mountain peaks, one over 7,000 feet. The island is well wooded and remarkably fertile. Wine is a staple product, and cotton, wool, pitch, and turpentine are exported. The chief towns are Chalcis and Karysto. The island was anciently divided among seven independent cities, the most important of which were Chalcis and Eretria, and its history is for the most part identical with that of those two cities. With some small islands it forms a modern nomarchy, with a population of 103,442 in 1901.

Eubulides (ū-bū'lĭ-dēz) **of Miletus,** Greek philosopher: the best known of the disciples of Euclid of Megara, flourished about the middle of the 4th century B.C. His life was a struggle against Aristotle, in which by a captious logic he sought to prevail against good sense. A partisan of the Megaric principle, that there is nothing real but what is always one, simple, and identical, he immediately found an adversary in the founder of the great contemporary school which made experience the condition of science. He attacked the peripatetic doctrine, like Zeno of Elea, by striving to show that there is none of our experimental notions which does not give place to insolvable difficulties.

Eubulus, ū-bū'lŭs, Greek comic writer: fl. at Athens about 375 B.C. His subjects were chiefly mythological, and many of his plays contained parodies of the tragic poets, especially Euripides.

Forest Cover for Parks, Los Angeles, California.

Avenue Shade Trees, near Santa Monica, California.

Eucaine. See COCAINE.

Eucalyptus, ū-ka-lĭp'tŭs, a genus of trees and a few shrubs of the natural order *Myrtaceæ.* The species, of which there are about 140, are characterized by simple unsymmetrical leaves, whose edges usually turn toward the sun; generally white, bell-shaped flowers, sometimes solitary, but commonly in terminal or axillary umbels near the ends of the twigs; calyx-lobes joined to form a lid, which falls off when the flower opens (from this feature the genus is named); numerous stamens; and many-seeded, angular fruit-capsules. With the exception of about half a dozen species which are natives of the East Indies and the Malay Peninsula, the members of the genus are indigenous to Australasia, where they are among the most common forest trees. The various species are highly valued for planting in parks and along avenues; for the gum-resin which oozes from their trunks; for the volatile oil contained in their leaves; for the tannin obtained from their bark; for the fibre of their inner bark; and for their powers of transpiring immense quantities of water, a quality made use of in swampy districts to get rid of excessive moisture, especially when such cannot be readily removed by drainage. They have been widely distributed by man in warm climates, particularly in the British possessions. But above all these things they are valued for their timber, which is extensively used for wharf, ship, bridge, and house building, telegraph poles, railroad ties, implements, furniture, etc. To obtain it the trees are frequently ring-barked about the beginning of the warm season so as to exhaust the sap as much as possible. After standing until the end of the dry season they are felled. Some of the species are among the largest living trees of the world. Specimens exceeding 450 feet in height and with a girth of 50 feet are occasionally reported, and trees of 400 feet in height are often found.

Few species are hardy, but many are cultivated for ornament where they can be given shelter from cold winds, or where, like other tender ornamental plants, they can be removed to a house during the winter. In California a majority of the species thrive in the open air, and are valued for their striking habits of growth, their foliage, etc. They are readily propagated from seeds sown in light, sandy soil. The seedlings should be transplanted when about four inches tall, and again at rather frequent intervals, to insure the formation of fibrous roots near the surface, thus to secure them a good start when transplanted to final quarters. Transplanting should always be done in cool, moist, cloudy weather. When once established they demand no further attention than ordinary pruning and training.

Among the best known species are the following: *Eucalyptus globulus,* the blue-gum, which often exceeds 300 feet in height, has bluish or grayish smooth bark, except at the base. It is noted for its rapid growth, the unpleasantly flavored nectar of its blossoms, which are very attractive to bees, and its ability to withstand long periods of drought. It is the most frequently planted species in California, where it is also becoming naturalized by means of its seeds. It is also planted to some extent in Florida and other Gulf States, and is said to survive a temperature as low as 20° F. It is one of the most valuable of timber trees and is one of the chief sources of oil of eucalyptus. A somewhat hardier species (*E. viminalis*), popularly known as manna gum, attains about the same size, but has either dark-colored persistent bark or light-colored deciduous bark. In California, where it is also spreading like the former, it has withstood lower temperatures and made phenomenal growths, in some instances exceeding 70 feet in height and 3 feet in girth in 12 years. It is valuable for its nectar, of which bees are very fond, but its timber is less valuable than that of the preceding species, being less strong. It is frequently used for fencing, shingles, and other purposes where strain is not expected. Perhaps the most valued is *E. marginata,* the jarrah tree or wood, which often attains heights exceeding 70 feet without the development of any limbs, and at that height often has a girth of 15 feet. It is not hardy. Its wood is especially valued for wharf and ship building, since it is not attacked by the teredo or shipworm. It is also highly esteemed for underground work, such as ties and telegraph poles, and, being easily worked and polished, is popular for house finishing and furniture. The largest species is probably *E. amygdalina,* the peppermint-tree, which is also noted for its abundant yield of oil. Its timber is not strong, but is largely used for staves, shingles, building, etc. *E. robusta,* the swamp-mahogany gum, is perhaps the species most frequently planted in swampy places. Its timber is remarkably durable and is used, like that of *E. marginata,* but is somewhat less esteemed. It is one of the finest of avenue trees, and one of the best for bees because of its abundant nectar and profuse bloom.

In medicine the oil of eucalyptus is used for its antiseptic and stimulating properties. It is very widely used in affections of the nose, mouth, and bronchi, and in diseases of the bladder and urethra. It makes a very agreeable and efficient drug to add to antiseptic mouthwashes, and is useful internally as an intestinal antifermentative. Trees of eucalyptus have been planted, especially in low marshy places, with a belief in their beneficial effects against malaria. It is frequently asserted that they have a direct action on malaria. By the aid they furnish in converting marshes into dry land they also help to prevent the development of mosquitoes, some forms of which are known to be the chief agents in the spread of malarial disease. (See MALARIA; VOLATILE OILS.) Consult: Bailey 'Cyclopedia of American Gardening' (1900–2); Mueller, 'Eucalyptographia'; Bentham, 'Flora Australiensis,' Vol. III.; Pepper, 'Eucalyptus in Algeria and Tunisia, from an Hygienic and Climatological Point of View' (Proceedings of the American Philosophical Society, Vol. 35, pp. 39–56); Cooper, 'Forest Culture and Eucalyptus Trees.'

Eucharis, ū'ka-rĭs, a genus of plants of the natural order *Amaryllidaceæ,* the species which, mostly natives of Colombia, are perennial herbs with perennial bulb-like rootstocks, broadly ovate leaves, and very showy white flowers in umbels upon long, strong scapes. They are very popular hot-house plants because of their beauty and the prolificacy of their long-lasting flowers. They are easily grown in coarse fibrous soil which will permit of abundant watering without danger of stagnation. Partial shade and rather high temperature are also needed. The best-known species is probably *E. grandiflora*, which is popularly known as star-of-Bethlehem and Amazon lily. The flowers of this species are borne upon a scape often exceeding 18 inches in height and bearing two to four star-like and very fragrant flowers, often four inches in diameter.

Eucharist, ū'kā-rĭst, in the Roman Catholic Church, the sacrament of the body and blood of Jesus Christ, and also the Christian covenant sacrifice. Regarding the Eucharist as a sacrament the Roman Catholic Church teaches that it is the true body and blood of Jesus Christ under the "species" or appearances or physical properties of bread and wine. The institution of this sacrament by Christ is recorded in the three synoptic gospels and in St. Paul's first letter to the Corinthians. The name given to the sacrament comes from the expression in the original Greek text of Luke xxii. 19, ἐυχαριστησας (eucharistesas), "having given thanks." The words of institution, as given by the same evangelist, are: "This is my body which is given for you. . . . This is the chalice, the new testament in my blood, which shall be shed for you." The perpetuation of this sacrament is commanded in the words, "This do for a commemoration of me" (1 Cor. xi. 24). A year before the institution of the sacrament Jesus Christ in a discourse at Capernaum, spoke of his flesh being "meat indeed" and his blood "drink indeed"; and it is important to note the circumstances in which he employed those extraordinary expressions. He had already said: "I am the bread of life," at which the Jews murmured. Thereupon Jesus, instead of modifying the expression which offended them, re-enforced it, saying: "The bread which I will give is my flesh for the life of the world." At this the Jews again murmured, but Christ does but emphasize the doctrine in the words already quoted. And not only the Jews were scandalized by these speeches: many of his disciples even would no longer listen to him; they "went back and walked no more with him." Would the apostles also desert him? and he elicited from them a profession of implicit faith in his words, however "hard" his sayings might be.

And that attitude of the apostles is the attitude of the Roman Catholic Church. Those words of her Founder and the many other announcements he made touching this sacramental mystery, the Roman Catholic Church from apostolic times has received in their plain literal interpretation — the interpretation put upon them by all who heard them, Jews, disciples, apostles, and by Jesus Christ himself: the Roman Catholic Church teaches that in the Eucharist is contained "truly, really, and substantially" the body and blood of Jesus Christ, together with his soul and divinity. Here nothing is added to, nothing taken away from, the words of Christ, and nothing explained away in those "words of eternal life." And when in the 11th century the Church's reading of those words as denoting a "true, real and substantial" change of the bread and wine into Christ's body and blood was challenged by Berengarius, who, more "spiritually-minded" than the apostles of Jesus Christ, would fain see in Christ's words only a figurative, symbolical presence of his body and blood in the sacrament, the Roman Catholic Church adopted the fittest possible word to express the change wrought in the bread and wine — the word Transubstantiation: in the Eucharist the substance of bread and wine remain no longer underlying the outward appearances, "species" of bread and wine: what underlies them now is the body and blood of Christ. Such is the teaching of the Roman Catholic Church with regard to the real presence of Jesus Christ in the Eucharist.

But the Eucharist is not only a sacrament: it is also the perpetual New Covenant sacrifice, believed to have been foretold by the prophet Malachi, as rendered in the Vulgate, which differs slightly from the authorized Anglican version: "From the rising of the sun even tc the going down thereof, my name is great among the Gentiles, and in every place there is sacrifice, and there is offered to my name a clean oblation" (Mal. i. 10–11). And the Roman Catholic Church teaches concerning the Eucharistic sacrifice or the Mass that "it is one and the same sacrifice with that of the cross: the victim is one and the same, Jesus Christ, who offered himself, once only, a bloody sacrifice on the altar of the cross. The bloody and unbloody victim is still one and the same, and the offering upon the cross is daily renewed in the Eucharistic sacrifice, in obedience to the command of our Lord, 'Do this in remembrance of Me.' "— *Catech. Conc. Trid., cap. de Eucharistiæ Sacr.*

Euchlo'rine, a name given by Sir Humphry Davy to the yellow gas obtained by acting upon potassium chlorate with hydrochloric acid. Davy believed it to be a new oxide of chlorine; but it is now known to be a mixture of chlorine and chlorine peroxide, ClO_2. It has powerful bleaching and disinfecting properties, but it is frightfully explosive, and should never be prepared nor handled save by an expert chemist, provided with proper safeguards, and with a full previous knowledge of its properties.

Euchre, ū'kėr, a game of cards, said to be of German origin, the most generally played parlor game after whist in the United States. The pack of cards consists of 24, being an ordinary "deck," minus the deuce, trey, four, five, six, seven, and eight spots of each suit. The game is usually played by two, three, or four persons, the most interesting party being four, two playing on each side as partners. When choice of partners and first dealer shall have been decided five cards are dealt, usually two at once, then three, or the contrary. In throwing around for partners and dealers the holder of the best card deals. The cards rank in value as follows: The best euchre card is the knave of trumps; the second best is the knave of the suit of the same color as the trump. The former card is called the "right bower," the latter the "left bower." After the right and left bowers the cards rank as at whist, the knaves of the color not turned as trumps falling into their regular place as at whist. The object of the game is to take tricks. The score is five points, unless otherwise agreed. The non-dealer may "pass," or "order up" the trump. Should he pass, then the dealer may take up the trump and discard. In that case the dealer must make three tricks or be "euchred," which counts two points for the adversary, but if he makes the three tricks (or four), he counts one point. Should he make all five tricks, it is termed "a march," and counts him two on the score. The non-dealer has the first lead, after which he who takes the trick leads. Should the non-dealer "order up" the trump he must make three tricks or be "euchred," which counts two for his opponent, if he win three tricks (or four), having ordered up the trump, he scores one point. Should he make "a march," he scores two. If both players pass (the dealer turning down the trump), and then both decline to make a trump, there must be a new deal. Either party naming a new suit for trump must make the three tricks or be "euchred." In four-handed euchre the same counts are made and the same rules practised as in the two-handed game, together with the following: The opportunity to "pass," "order up," "assist," or "play alone" goes around in rotation, beginning with the player on the left of the dealer. "To assist" is for the partner of the dealer to say "I assist," which has the same effect as ordering up the trump, and is subject to the penalty of two points to the adversary, should three tricks not be secured by the party "assisting" and his partner. Either partner ordering up a trump or making a trump may "play alone," that is, play his hand singly against the other two, his partner not playing his hand that round at all. "Progressive euchre" is played by a number of participants at separate tables, the successful players moving up in a regular order. A prize is generally awarded to the two winners.

Euchologion, ū-kō-lō'jĭ-ŏn, the liturgical and ritual book of the Greek Church, answering to the Missal, which is the Pontifical and Ritual of the Latin Church. The Uniate Greek Church, or Church of the Greek Rite in communion with the See of Rome, has a separate Euchologion.

Euclase, ū'klās, a rare gem mineral, a basic silicate of glucinum and aluminum, HBe Al SiO_5. It occurs in Brazil, Siberia, and Austria, in brilliant, transparent, colorless to pale-green or blue crystals of monoclinic forms, and has a hardness of 7.5.

Euclid (ū'klĭd) **of Megara**, Greek philosopher, the founder of the Megaric school of philosophy. He was a pupil of Socrates, after whose death, 399 B.C., he retired to Megara (most probably his native city) and set up a school of philosophy, in which he blended the doctrines of the Eleatic school with those of his master. He adopted the Eleatic notion of one universal unchangeable existence, and upon this he engrafted the ethical views of Socrates. From its subtlety and disputativeness, the school of Euclid was sometimes called the Dialectic or Eristic. Nothing has survived of Euclid's work and the date of his death is unknown.

Euclid of Alexandria, Greek mathematician: fl. about 277 B.C., and taught geometry at Alexandria in the reign of Ptolemy Soter, and extended the boundaries of mathematical science. The severity and accuracy of his method have never been surpassed. His 'Elements,' in 13 books, still form the most usual introduction to the study of geometry. See GEOMETRY, ELEMENTARY PURE; MATHEMATICS.

Eudæmonism, the doctrine that happiness (Gr. *eudaimonia*) is the chief good. Happiness, according to Aristotle, is the activity of soul in accordance with virtue, virtue being the mean between excess and defect as determined by reason. See ETHICS.

Eudialyte, ū-dī'a-līt, a rhombohedral red mineral of vitreous lustre, translucent or nearly so; its hardness, 5.5; specific gravity, 2.90 to 3.01. It consists principally of silicates of iron, zirconia and lime. There are two varieties, eudialyte proper, of which the double refraction is positive, and eucolite, in which it is negative. It is found in North Greenland, Norway, and Arkansas.

Eudiom'eter, an instrument employed in the analysis of gaseous mixtures. It was originally designed for ascertaining the quantity of oxygen contained in any given bulk of elastic fluid. The first instrument of this kind was constructed by Priestley. In one form of eudiometer two platinum wires are inserted near the top of a graduated glass tube open at the bottom. An electric spark is introduced by these wires. The process involves the explosion and combustion of one of the constituents to be determined. The operation may be conducted in a trough of mercury or over water. See GASOMETRIC ANALYSIS.

Eudists, ū'dĭsts, a congregation or society of secular priests founded in the 17th century by a priest named Eudes; for the purpose of conducting ecclesiastical seminaries and giving "missions" in parish churches, for the revival of religious zeal and the conversion of sinners. The members of the society take no religious vows, but they live in common and are voluntarily subject to the orders of their superior. They do not wear any habit to distinguish them from the rest of the secular clergy. Their first house was established at Caen in Normandy 1643; the membership at that time consisted of Eudes and eight other priests. In his time Eudes conducted 110 missions in various places in the kingdom. The institute never spread to other countries. Eight or more Eudists were among the priests who were butchered in the wholesale slaughter of priests, monks and bishops at the Carmes, Paris, September 1792. The society was broken up during the French Revolution, many of the members seeking refuge in England. In 1826 the apostolate was revived and resumed with ardor and great success.

Eudocia, ū-dō'shĭ-a, Roman empress: b. Athens about 393; d. Jerusalem about 460. She was a daughter of Leontius the philosophical sophist. After the death of her father, who left nearly all his property to his two sons, she went to Constantinople for the purpose of complaining of this injustice to the emperor, Theodosius II. There she embraced the Christian religion, was baptized as Eudocia and became empress 421 A.D. She was afterward divorced and spent the remainder of her life in Jerusalem, engaged in acts of devotion. She is said to have written some Greek poems and also a life of Christ.

Eudoxia, ū-dŏk'sĭ-a, Byzantine empress: wife of Arcadius, emperor of the West: d. 409. She was the daughter of Banto, a Frankish general of Theodosius; and Eutropius, the eunuch, intriguing against Rufinus, chief minister of Arcadius, induced the emperor to take her to wife, instead of marrying the daughter of Rufinus, as the latter had designed. Eutropius soon after this union caused Rufinus to be put to death and succeeded him. Eudoxia, if we may believe John Chrysostom, was an infamous creature, although at one time winning his admiration and profuse acknowledgments by an open profession of religious earnestness. She was a woman of strong passions and resolute will, and when Eutropius insulted her by saying that as he had raised her so he could debase her, she appealed to the weak Arcadius, who at once degraded Eutropius from all his honors, and ordered his statue in the market place of Constantinople to be destroyed. Chrysostom so vehemently inveighed against the court life of Eudoxia that she caused him to be banished in 403, but popular clamor, added to the panic caused by an earthquake, induced her to recall him. But her enmity caused his second exile in 404. She survived this persecuted prelate only two years, and if she were too impatient under the almost Aristophanic invective of a bishop who was more a monk than a courtier, she was probably sincere in her anxiety to rescue the feeble Arcadius from the dominion of a minister like Eutropius, and the best act she ever did in her life was to bring this monster of profligacy and corruption to the end of his career.

Eudoxia, Roman empress. She was the daughter of Theodosius II.; b. Constantinople 422; d. about 463. She was married to her cousin Valentinian III., emperor of the West, after whose death, by the hands of emissaries of the senator Maximus, she was constrained to espouse the latter. Maximus subsequently had the folly to reveal to her the part which he had taken in the murder of Valentinian, and when the time for vengeance seemed to her to have come she invited to Italy Genseric, king of the Vandals, at whose approach Maximus was murdered. Genseric delivered Rome to pillage, and bore away with him to Africa Eudoxia and her two daughters.

Eudoxians, ū'dŏk'sĭ-a̤nz, followers of Eudoxius, who from 356 A.D. was bishop of Antioch, in Syria, and from 360 to his death in 370 bishop and patriarch of Constantinople. He was successively an Arian, a Semi-Arian and an Aëtian. Respecting the Trinity, he believed the will of the Son to be differently affected from that of the Father.

Eudoxus (ū-dŏk'sŭs) **of Cnidos,** Greek astronomer, lived about 370 B.C., was the scholar and friend of Plato. All his works are lost, but the poem of Aratus on astronomy makes us acquainted with the extent of his astronomical knowledge. Eudoxus seems to have been the first to introduce an astronomical globe into Greece, and this may account for the great reputation which he acquired and long continued to enjoy.

Eufaula, ū-fâ'la̤, Ala., city in Barbour County, on the Chattahoochee River, and on the Central Georgia Railroad; 80 miles southeast of Montgomery. It is at the head of steamboat navigation on the river; is the trade centre of a large manufacturing and agricultural district; and carries on an extensive cotton-shipping trade, exporting over 30,000 bales annually. It has gas and electric lights, waterworks plant erected by the city in 1897 at a cost of $60,000, public parks, Union Female College, public high school, and three national banks. Pop. (1900) 4,532.

Euganean (ū-gā'nē-a̤n) **Hills,** a range of well-wooded hills, lying southwest of Padua, in northern Italy. They owe their origin to eruptions of trachyte during the Jurassic Period. The highest point, Monte Venda, reaches about 1,895 feet. On their slopes stand several villas, among them Petrarch's house at Arquà. Valuable building stone and mineral springs abound.

Eugène, ė-zhān, **Prince** (François Eugène de Savoie-Carignan), Austrian general: b. Paris 18 Oct. 1663; d. Vienna 21 April 1736. Among all the generals and statesmen of Austria, none has rendered more numerous and important services than Eugène. He was great alike in the field and the cabinet. He petitioned Louis XIV. for a company of dragoons, but was refused on account of the opposition of Louvois, minister of war, who hated the family of Eugène. Indignant at this repulse Eugène, in 1683, entered the Austrian service. The distinction he earned at the siege of Belgrade in 1688, at that of Mayence in 1689, and elsewhere, procured for him rapid promotion. War having broken out between France and Austria, he prevailed upon the Duke of Savoy to enter into an alliance with the emperor, and in 1690 received the command of the imperial forces sent to Piedmont to act in conjunction with the troops of the Duke of Savoy. He defeated the Turks at the battle of Zenta (11 Sept. 1697), and obtained on that occasion the applause of Europe. The loss of the Turks at Zenta obliged them to accede to the Peace of Carlowitz 1699, which was the first symptom of their decline. In 1703 he received the command of the army in Germany; and his efficient co-operation with Marlborough frustrated the plans of France and her allies. In the battle of Höchstädt (Blenheim) 13 Aug. 1704, the two heroes gained a decisive victory over the French and Bavarian army, commanded by the Prince of Bavaria and Marshal Tallard, the latter of whom was made prisoner. In 1705 Eugène returned to Italy, where he hastened to the relief of Turin, stormed the French lines, forced them to raise the siege, and in one month drove them out of Italy. In 1707 he entered France, and laid siege to Toulon; but the immense superiority of the enemy obliged him to retire into Italy. During the following years he fought on the Rhine, took Lille, and, in conjunction with Marlborough, defeated the French at Oudenarde (1708), and Malplaquet (1709). After the recall of Marlborough and the defection of England from the alliance against France, his farther progress was in a great measure checked. The Peace of Rastadt, the consequence of the Treaty of Utrecht, was concluded between Eugène and Villars in 1714. In the war with Turkey, in 1716, Eugène defeated two superior armies at Peterwardein and Temesvar, and, in 1717, took Belgrade, after having gained a decisive victory over a third army that came to its relief. The Treaty of Passarovitz (concluded in 1718) was the result of this success. During 15 years which followed, Austria enjoyed peace, and Eugène was as active in the cabinet as he had

Courtesy of the Booklovers Magazine. From the painting by Winterhalter.

EUGENIE.

been in the field. Consult Malleson, 'Prince Eugène of Savoy' (1888).

Eugene, ū-jēn', Ore., city, county-seat of Lane County; on the Willamette River, the Southern P. and the O. R. & N. C. R.R.'s; 105 miles west by south of Portland, and 52 miles from the Pacific Ocean. The University of Oregon, established here in 1876, had in 1903 about 500 students. The manufactures are chiefly flour, lumber, and bricks, and some articles for home consumption. The city was settled in 1854. Pop. 3,561.

Eugene Aram, a novel by Bulwer-Lytton, published 1832. It was founded on the career of an English scholar, Eugene Aram: b. 1704; executed for the murder of one Clark in 1759. The character of the murderer and the circumstances of his life made the case one of the most interesting from a psychological point of view, in the criminal annals of England. Aram was a scholar of unusual ability, who, self-taught, had acquired a considerable knowledge of languages, and was even credited with certain original discoveries in the domain of philology. Of a mild and refined disposition, his act of murder seemed a complete contradiction of all his habits and ideals of life.

'Eugene Aram' is an unusually successful study in fiction of a complex psychological case. At the time of its publication, it caused a great stir in England, many attacks being made upon it on the ground of its false morality. To the present generation its romance is of more interest perhaps than its psychology. Thomas Hood's poem on the same theme is entitled, 'The Dream of Eugene Aram'; W. G. Wills' play, 'Eugene Ara[illegible]' was produced in 1873 by Henry Irving.

[illegible]ène de Beauharnais, ė-zhān dė bō-är-[illegible] [illegible]e BEAUHARNAIS, EUGÈNE DE.

Eu[illegible]énie, ė-zhā-nē (EUGÉNIE MARIE DE M[illegible] ODE GUZMAN Y DE PORTO-CARRERO), [illegible]press of the French: b. Granada, [illegible]pain, 5 May 1826. Her father, the Count [illegible] Montijo, was of a noble Spanish fam-[illegible] [illegible]er mother was of Scotch extraction, maiden name Kirkpatrick. On 29 Jan. 1853 she became the wife of Napoleon III. and empress of the French. On 16 March 1856, a son was born of the marriage. When the war broke out with Germany she was appointed regent (27 July 1870) during the absence of the emperor, but on 4 September the revolution forced her to flee from France. She went to England, where she was joined by the prince imperial and afterward by the emperor. Camden House, Chiselhurst, became the residence of the imperial exiles. On 9 Jan. 1873, the emperor died, and six years later the prince imperial was slain while with the English army in the Zulu war. In 1881 the empress transferred her residence to Farnborough in Hampshire. She has published 'Some Recollections from My Life' (1885).

Eugénie Grandet, ė-zhā-nē grän-dā, a novel by Honoré de Balzac. It appeared in 1833, and is included among the 'Scenes of Provincial Life.' In it, the great French master of realism depicts with his accustomed brilliant precision the life of a country girl, the only child of a rich miser.

Eugenius, ū-jē'nĭ-ŭs, the name of four popes. The first, Saint Eugenius, was elected 654; d. 657. EUGENIUS II. occupied the Roman See from 824 to 827. His election was contested by a powerful faction in the city who favored Cincinnus (Zinzinnus); and Lothaire, son of Louis le Débonnaire, who shared the empire with his father, came to Rome to quell the disturbance. On this occasion the people and clergy of Rome took the oath of fidelity to the two emperors, and promised that thereafter whenever a new pope succeeded he should, before his consecration, take oath in presence of the people and the emperor's representative to honor the emperor as the protector of the Church. The Pope was the first to take this oath; its terms were complied with at the two papal elections next following, for example, of Valentinus who filled the see three months and of Gregory IV. EUGENIUS III.: b. Pisa; d. Tivoli 7 June 1153. He was a Cistercian abbot and a close friend of Saint Bernard of Clairvaux and was elected 1145. Before his consecration the populace of Rome, led by Arnold of Brescia, effected a revolution and overturned the papal government; during a reign of a little more than eight years Eugenius was most of the time in exile, living at Viterbo, Siena, and other places in Italy and in France. EUGENIUS IV.: b. Venice 1838; d. Rome 23 Feb. 1447. He was a Celestine monk, cardinal, and bishop of Siena when he was elected successor to Martin V. 1431. On 23 July 1431 was opened the Council of Basel, convoked by his predecessor; but not one bishop was present for the opening, only theologians, abbots and canons. On 12 November the Pope ordered the council to be dissolved and convoked another council to be held in 1433 at Bologna; but the fathers of the council of Basel continued to hold their sessions; throughout his reign the Pope was in conflict with the council. From first to last the council sought primarily and almost exclusively to curb the authority of the Roman See, and in consequence there passed between Rome and Basel a succession of bulls ordering the dissolution of the council, annulling its acts, anathematizing its members; and from the other side decrees of the council declaring that general assembly of the Church to be superior in authority to the Pope, and finally a decree proclaiming Eugenius deposed and setting up as Pope Amedeo, Duke of Savoy, who assumed the style Felix V. This was the act of the council in its 35th session held 8 July 1439. At the same date there was assembled at Florence, at the call of Eugenius, a council attended by 160 Latin and some 20 Greek bishops, with the Emperor John Palæologus; at this council a reconciliation was effected between the eastern and western churches; but it stood only till its terms and conditions became known in the East, when it was repudiated by the Greek Church. The cause of the rival Pope Felix was at this time fatally weakened by the withdrawal by the emperor Sigismund of his support and by his declaring for Eugenius.

Eugenol, or **Eugenic** (ū-jĕn'ĭk) **Acid** ($C_{10}H_{12}O_2$), a substance occurring in oil of cloves, as well as in the oil obtained from the fruit of *Myrtus Pimenta*, and several others. It is a colorless, oily, aromatic liquid, resembling the phenols. See THYME.

Eugubine (ū'gū-bīn) **Tables,** the name given to seven bronze tables found in 1444 at the town of Gubbio, the ancient Iguvium or Eugubium, now in the Italian province of

Perugia, bearing inscriptions in a language decided to be that of the ancient Umbrians. These tables are the most important monument of the language in which they are written. Four are inscribed in Umbrian characters, two in Latin, and the remaining one partly in Umbrian and partly in Latin. The contents of the tables refer to the ritual of the priests of the Temple of Jupiter. Photographic reproductions of the inscriptions, with translations, are given in Bréal's 'Les Tables Eugubines' (1875–8).

Euhemerism (ū-hē'mĕ rĭzm), or **Euemerism.** See MYTHOLOGY.

Eukairite, ū-kā'rīt, a rare mineral of a shining lead-gray color and granular structure, consisting chiefly of selenium, copper, and silver. Its name is derived from the Greek word meaning *opportune,* and was given to it by Berzelius because found soon after the discovery of selenium.

Eulachon, ū'lă-kŏn, or **Candle-fish.** See CANDLE-FISH.

Eulalia, ū-lā'lĭ-a, Spanish virgin martyr: b. Merida, Estremadura; d. 12 Feb. 308 A.D. When she was only 12 years old, the great persecution of Diocletian was set on foot, whereupon the young girl left her maternal home, and, in the presence of the Roman judge, cast down the idols he had set up. She was martyred by torture.

Eulalia, a popular name for certain species of tall perennial ornamental grasses of the genus *Miscanthus* (natural order *Gramineæ*). They are natives of eastern and southern Asia. The best-known species is probably *M. sinensis,* which has developed several well-marked horticultural varieties characterized by green, mottled or striped foliage and large terminal fan-like panicles of flowers, which, after shedding their deciduous parts, are still attractive because of their persistent silky hairs, which give the panicle a delicate, fluffy appearance for which they are valued as house decorations and for everlasting bouquets. Because of their beauty, their perfect hardiness, and the ease with which they can be propagated by means of seeds or division of the roots, these plants are universal favorites, especially for bedding purposes.

Eulenburg, oi'lĕn-boorg, **Botho,** German statesman: b. 31 July 1831. In 1867 he was elected to the North German Reichstag as a Conservative; became minister of the interior in 1878 and as such formulated the famous Socialist law of October 1878. Differences with Bismarck led to his resignation of this office 1881. In 1892 he succeeded Count Caprivi as president of the Prussian ministry, but owing to controversies between Eulenburg and Caprivi over the bill for an amendment to the criminal code, the emperor dismissed them both in October 1894. In 1899 Eulenburg took his seat in the Herrenhaus, or Prussian House of Lords.

Eulenspiegel, oi'lĕn-spē-gĕl, a typical character associated in Germany with all sorts of frolics and fooling. The type originated in Till or Tyll Eulenspiegel, a German clown who lived probably in the first half of the 14th century, and became celebrated for the wild pranks and escapades that he practised in all parts of Germany, and in some of the neighboring countries. According to popular account he was born at the village of Kneitlingen, near Brunswick, and died at Mölln, near Lübeck. The tricks and frolics currently attributed to Eulenspiegel first appear in a Low Saxon account written in 1483; the earliest edition, in High German, was published at Strasburg in 1519 by Thomas Murner. This work became very popular, and was translated into nearly every European language. In English it first appeared as a miracle-play, with the title 'A Merry Feast of a Man that was called Howleglas' (Eulenspiegel meaning literally "owl-glass"). An edition of Murner's original collection was published by J. M. Lappenberg at Leipsic in 1854, and English translations and editions appeared in 1860 and 1890.

Euler, oi'lĕr, **Leonard,** Swiss mathematician: b. Basel 15 April 1707; d. St. Petersburg 7 Sept. 1783. In his 19th year he gained the *accessit* of the prize offered by the Paris Academy of Sciences for the best treatise on the masting of vessels. In 1733 he became professor of mathematics in the Academy of St. Petersburg, where he labored with astonishing industry. He composed more than half of the treatises in this branch of science contained in the 46 quarto volumes published by the St. Petersburg Academy 1727–83; and at his death left about 100 unpublished dissertations, subsequently printed by the society. In 1741 he accepted an invitation from Frederick the Great to become professor of mathematics in the Berlin Academy, but in 1766 returned to St. Petersburg. He first gave the example of those long processes in which the conditions of the problem are first expressed by algebraic symbols, and then pure calculation resolves all the difficulties. He applied the analytic method to mechanics, and enlarged the boundaries of this science. He greatly improved the integral and differential calculus, of which he afterward published a complete course, which surpassed everything then extant on this subject. An extensive optical treatise, 'Sur la Perfection des Verres object. des Lunettes,' in the Mémoires de Berlin (1747), was the result of his inquiries into the means of improving spectacles. The share which he contributed by this work toward the discovery of achromatic telescopes is sufficient to distinguish his name in this department also. He also employed himself in metaphysical and philosophical speculations. He attempted to prove the immateriality of the soul, and to defend revelation against freethinkers. In his well-known 'Lettres à une Princesse d'Allemagne, sur Divers Sujets de Physique et de Philosophie' (1768–72), he attacks the Leibnitzian system of monads and pre-established harmony. Among his numerous writings may be mentioned here his 'Theoria Motuum Planetarum et Cometarum'; 'Introductio in Analysin Infinitorum,' which has always been regarded as his greatest production; 'Institutiones Calculi Differentialis'; 'Institutiones Calculi Integralis'; 'Introduction to Algebra'; his 'Dioptrica'; 'Opuscula Analytica.'

Eumenides, ū-mĕn'ĭ-dēz. See FURIES.

Eumol'pus, a mythical personage of ancient times, celebrated as a poet, warrior, hierophant, and legislator, according to the common tradition a Thracian, the son of Poseidon and Chione, the daughter of Boreas. He is said to have been driven from Thrace, but to have afterward returned. The accounts of his subsequent career vary. According to one tradition he was the founder of the Eleusinian mysteries, in which he was instructed by Demeter. The sacerdotal family of the Eumolpides at Athens claimed to be descended from this Eumolpus.

Euno'mians, the extreme faction of the Arian sect in the 4th century, so called from the name of their leader, Eunomius, who was made bishop of Cyzicus in Mœria 360, but who was deposed the following year. For 30 years thereafter he was the foremost champion of Anomœanism, or the doctrine that Jesus Christ the son of God is of different nature (or substance) from the Father (ἀνόμοιος κατ'οὐσίαν καὶ κατά παντα : unlike in substance and everything): thus his doctrine was that of Unitarianism. The doctrine of the Roman Catholic Church, declared in the Council of Nicæa, was that of ὁμοούσιαὰ consubstantiality; that of the Semi-Arians was that the Son is of like or similar substance, ὁμοιούσιος and hence they are called homœusians, while the orthodox took the name of homousians (both words usually written homoiousians, homoousians). To give solemn expression to their distinctive tenet the Eunomians changed the baptismal formula, "I baptize thee in the name of the Father," etc., to this: "I baptize thee in the name of God, the Creator, into the death of Christ."

Euno'mius, Arian bishop: b. Dacora, Cappadocia; d. there 392. In the controversy which gave rise to Arianism, Eunomius was an ardent disciple of Arius. So extreme were his views that he and his followers were looked upon as members of a party within the Arian ranks, and were called Eunomians. He was made bishop of Cyzicus in 360, and remained at the head of this see for some years. He lived the life of an exile after this on account of his views, but finally returned to his birthplace.

Eunuch, the keeper of a harem, generally a castrated man. Eunuchism is of prehistoric origin and prevails among all nations and peoples. Eunuchs were common in biblical times.

Euonymus, ū-ŏn'ĭ-mŭs, a genus of the staff-tree family (*Celastraceæ*), comprising upward of 65 species of shrubs, natives of the north temperate zone. Six species are found in America. The best known are the strawberry bush (*E. americanus*), the burning-bush or wahoo (*E. atropurpureus*) and the spindle-tree (*E. europeus*). (See SPINDLE-TREE.) From the bark of the wahoo or burning-bush, an extract known in medicine as euonymin, is obtained. It is used as a cholagogue, tonic and diuretic, and for its stimulant action on the liver.

Euornithes, ū-ôr'nĭ-thēz, a grand division of birds, which, according to some authors, includes all living birds except the ostriches and their allies and the penguins; and according to others includes all birds, modern and extinct, except Archæopteryx. In this sense it is equivalent to the preferable term *Neornithes* (q.v.).

Eupata'ria, or **Eupatoria,** Russia, seaport, in the government of Taurida, on the Black Sea, 40 miles northwest of Simferopol. Having long been possessed by the Tartars of the Crimea (who gave it the name of Kosloff or Kesloff), it is more Asiatic than European in its aspect. The salt lake of Sakè is a bathing resort. It was here that the allied forces landed at the commencement of the Crimean war (14–18 Sept. 1854). It was unsuccessfully attacked by the Russians 17 Feb. 1855. Pop. 17,757.

Eupato'rium, a genus of composite plants including many (about 400) species, especially characteristic of America, where several are well known. Among the most prominent are boneset or thoroughwort (*E. perfoliatum*), a native of low grounds distinguished by the fact that its opposite leaves are joined around the stem; and the joe-pyr-weed, or gravel-root (*E. purpureum*), whose purplish rosy flowers become conspicuous in late summer in wet meadows borne on stems often 12 feet high. The hemp-agrimony is a well-known British medicinal herb. The flower-heads in this genus are corymbs, all the florets tubular. Several of these plants have enjoyed from time immemorial a reputation in folk-medicine as remedies for the breaking up of fevers. Popular tradition has it that eupatorium is good for broken bones, the common name boneset preserving this notion. It has no such action. By reason of a certain amount of volatile and fixed oil which eupatorium contains it makes a fair diaphoretic mixture, and in the form of "boneset tea" it is of service in causing profuse sweating. This may be of service in the treatment of congestions in different parts of the body. See DIAPHORETICS.

Eupat'rides (Gr. εὐπατρίδαι, *eupatridai*, well-born), the aristocracy, or land-owning class of ancient Athens, distinguished from the *geomiroi*, or peasants, and the *demiourgoi*, or artisans.

Eupen, oi'pĕn (Fr. *Néaux*), Germany, town in Rhenish Prussia, on the Wenze, near the frontiers of Holland, 10 miles south-southwest of Aix-la-Chapelle. Its manufactures are numerous and varied. Eupen owes its manufacturing prosperity to the French refugees, who settled here while the town formed part of the duchy of Limburg, under Austrian rule. After the Peace of Lunéville, when this duchy was ceded to France, Eupen belonged to the department of Ourthe until the Peace of Paris in 1814, when this town, with other portions of Limburg, was ceded to Prussia. Pop. 15,587.

Eu'phemism, a figure of speech by which one avoids the use of words directly expressing anything improper, disagreeable, or painful, by the employment of phrases that suggest in a more delicate manner or under a more cheerful aspect the idea to be conveyed. Thus the Greeks, in speaking of the Erinyes or Furies, came to call them the Eumenides, or well-disposed, gracious goddesses, and sometimes *semnai theai*, "the august goddesses." Nearly all languages have some euphemism for death, or to express the fact that one has died, as when we speak of the "departed." In the Bible we have the phrases "he was gathered to his fathers," "he has fallen asleep," etc.; the Romans, with the same intention, said "he has lived" (*vixit*); the Germans say "he is ascended" (*er ist hinaufgegangen*), or "he has been made immortal" (*er ist verewigt worden*).

Euphorbiaceæ, ū-fôr-bĭ-ā'se-ē (the *Spurge* family), a natural order of plants, consisting of more than 4,000 species of herbs, shrubs and trees arranged in 220 genera, some of which are well known for their ornamental and economic uses. They are, with few exceptions, natives of warm climates, especially of tropical America, and nearly every species has an acrid juice, usually poisonous, but sometimes made bland when heated. Among the members of the family are many species of commercial importance. Thus the juice of some species and the roots of others are used in medicine, for in plants of this kind are found croton oil, castor oil, etc. A few of the Euphorbiaceæ yield fragrant balsamic products; a few, although their juice is poisonous, yield a wholesome starch in considerable abundance (see MANIOC); a few are cultivated and used as pot-herbs, particularly species of *Plukenetia* in the East Indies; a few yield wholesome and agreeable sub-acid fruits, as *Cicca disticha* and *C. racemosa* in the East Indies; the seeds of some are edible, as those of the candle-nut (q.v.), etc.; the oil of the seeds is also in some cases used for food, like other bland oils, but more frequently for burning, as castor-oil, candle-nut oil, the oil of *Elæococca verrucosa* in Japan and Mauritius, and the solid oil of *Stillingia sebifera*, which is used in China for making candles, and in medical preparations as a substitute for lard. From *Hevea* is derived the highest grade of rubber produced in South America. Others yield dye-stuffs. The timber of some of the Euphorbiaceæ is valuable — for example, African teak. Of the 210 genera, 10 are represented in the American flora, the most important being Croton, Ricinus (castor-oil plants), and the Euphorbia or spurge proper. This genus numbers about 700 species, most abundant in the warm parts of the north temperate zone, more than 125 of them being found in America. They are all known as «spurge,» and are more or less poisonous. Some one species is found in every part of America, those not native having escaped from cultivation. Some of the species are imposing ornamental plants and are much used in landscape gardening, and in greenhouses, usually for their curious forms of growth, rather than for their beauty.

Plants of this family, although of widely differing forms of growth and foliage, are characterized by unisexual, monœcious or diœcious flowers often brilliantly colored and often inconspicuous, in the latter case sometimes subtended by brilliantly colored bracts; the usually three-lobed fruits split elastically when ripe and throw the seeds to greater or less distances.

Euphor'bium. See GUMS.

Euphor'bus, in Greek mythology, the son of Panthous, slain by Menelaus in the Trojan war.

Euphrasia, a genus of plants of the figwort family (*Scrophulariaceæ*). It comprises about 110 species, natives of temperate and cold regions of both hemispheres, four of them occurring in North America. They are annual or perennial low-branched herbs, with small, blue, yellow or white flowers, generally known by the name eyebright. The principal American species are: *E. latifolia*, glandular eyebright; *E. americana*, hairy eyebright, the most widely distributed, and *E. oakesii*, oakes eyebright, found only in the White Mountains. The common English eyebright, *E. officinalis* is not known in America. This is a very pretty little plant, the flowers white streaked with purple, and a yellow spot on the lip. It grows so abundantly in some places, as to give the ground an appearance of being covered with snow, during the time of its flowering, from May to September. The whole plant is slightly aromatic. It has been used with success in catarrhal inflammations of the eye, in cough, hoarseness, earache, or headache which follow after catarrhs.

Euphrates, ū-frā'tēz, a celebrated river in Asiatic Turkey, having its sources in Central Armenia, at no great distance from the shores of the Euxine, and its mouth in the Persian Gulf; length, including windings, 1,716 miles. It is formed by the junction of two large streams, called the Kara-Su and the Mourad-Chai. These two head streams unite near Kaban Maden, about lat. 38° 58′ N.; lon. 38° 30′ E.; from which point the river holds in the main a southeasterly course, until it falls into the Persian Gulf. At Korna, about 100 miles from its mouth, it is joined by the Tigris, and the united streams take the name of the Shatt-el-Arab. In point of current the Euphrates is for the most part a sluggish stream, except in the height of the flooded season. The Shatt-el-Arab has a depth of from 3 to 5 fathoms, and presents banks covered with villages and cultivation. The most important town on the Shatt-el-Arab is Bassora or Basra. The melting of the snow in the mountains along the upper part of the river's course causes the Euphrates to rise. This takes place about the beginning of March, and it increases gradually up to the end of May. The river continues high for 30 or 40 days; but afterward there is a daily decrease. From the middle of September to the middle of October the river is at the lowest. The Euphrates is navigable for a long distance from the sea, but there are numerous rapids. Steamers navigate the Shatt-el-Arab. Between the Euphrates and the Tigris lies the celebrated region Mesopotamia.

Euphrates Valley Railway, a projected road from the Mediterranean coast of Asiatic Turkey to the Euphrates valley and Persian Gulf. Projects for shortening the journey to India by the construction of a railway in the Euphrates valley have been repeatedly discussed, and some such expeditious method of reinforcing the British troops in India has been regarded as highly desirable. The schemes spoken of have been various, but the original project was to connect the Bosphorus with the Persian Gulf. In 1901 an agreement was made between the Turkish government and the German company controlling the Anatolian Railway from the Bosphorus to Konia, whereby this railway is to be continued to Bagdad and Bassorah. There is already a line from Smyrna joining the line to Konia, and this would furnish a shorter through route.

Euphrosyne, ū-frŏs'ĭ-nē (Lat., from Gr. Εὐφροσύνη, the personification of joy, from εὔφρων, *euphron*, joyous), in Greek mythology, one of the three Graces (q.v.).

Euphues (ū'fū-ēz), **or the Anatomy of Wit,** and **Euphues and His England,** a book and its sequel, by John Lyly, published respectively in 1578 and 1580, when the author was a young courtier. They constitute the first and second part of a work which can only loosely be called fiction in the modern sense. Perhaps the word «romance» best expresses its nature. For a dozen years the work was fashionable in the polite circles of England; and the word "euphuism" survives in the language to designate the stilted, far-fetched, ornate style of writing introduced and made popular by Lyly. Although Lyly's style had in it too much of the affected to give it long life, he undoubtedly did something toward making the 16th century speech refined, musical, and choice. It is this rather than any attraction of story that makes the 'Euphues' interesting to the modern student of literature.

Eu'phuism, an affected style of speech which distinguished the conversation and writings of many of the wits of the court of Queen Elizabeth. The name and the style were derived from 'Euphues, or the Anatomy of Wit' (about 1579), and the 'Euphues and His England' (about 1581), of John Lyly. These books, which became the model of the wits and gallants of the time, and an acquaintance with which was regarded as a test of courtly breeding were characterized by smoothness and verbal elegance, but chiefly by fantastic similes and illustrations. Sir Walter Scott draws the portrait of a euphuist in the character of Sir Piercie Shafton, in 'The Monastery.'

Eupion, ū'pĭ-ŏn, or Eupione, Reichenbach's name for a fragrant colorless liquid produced in the destructive distillation of various animal and vegetable substances. It is highly volatile and inflammable; it is insoluble in water, but mixes with oils, and acts as a solvent for fats and resins. It is not readily acted on by ordinary chemical reagents.

Eura'sians (syncopated from Europe-Asians), a name given to the "half-castes" of India, the offspring of European fathers and Hindu mothers. They are particularly common in the three presidential capitals — Calcutta, Madras, and Bombay. They usually receive a European education, and speak English with grammatical correctness, although with an accent not altogether agreeable to English ears. The girls, in spite of their dark tint, are generally very pretty, and often become the wives of young officers or civil officials. The sons usually receive appointments in the civil service, or become clerks in merchants' offices. They are also often spoken of as East Indians. The word Eurasian is often extended to include all persons of mixed European and Asiatic descent.

Eure, ėr, France, a department in the northwest forming part of Normandy; area 2,300 square miles. The chief river which flows through it is the Seine. The mining and manufacturing industries are extensive. Pop. (1901) 331,184.

Eure, a river of France, which has given its name to two departments — that of the Eure, and that of the Eure-et-Loir. The river rises in the department of the Orne, and flows into the Seine, near Pont-de-l'Arche, after a course of 124 miles, being navigable for about half the distance.

Eure-et-Loir, ėr-ā-lwär, France, a department in the northwest, forming part of the old provinces of Orléannais and Ile-de-France; area, 2,267 square miles. The department is essentially agricultural, and has few manufactures. The capital is Chartres. Pop. (1901) 272,624.

Eureka, ū-rē'ka, a Greek word meaning "I have found it"; used as an expression of triumph at a discovery. See ARCHIMEDES.

Eureka, Cal., city, county-seat of Humboldt County; on Humboldt Bay, the Eel River, and the San Francisco & N. W., the California N., the Eureka & K. R. R.R.'s; 225 miles northwest of San Francisco. It has a fine harbor, which has been improved by the United States government on the jetty plan. The city is situated in the famous redwood region, and has large lumber interests. Sequoia Park, a tract of 40 acres of redwood forest, is near the city. The city has gas and electric lights, high schools, daily and weekly newspapers, and five banks. Pop. (1904) 11,111.

Eureka, Ill., city, county-seat of Woodford County; on the Atchison, T. & S. F. and the Toledo, P. & W. R.R.'s; 20 miles east of Peoria. Eureka College, under the auspices of the Christian Church, was established in 1855. The city is a trade centre for the surrounding agricultural college. Pop. 2,200.

Eureka, Kan., city, county-seat of Greenwood County; on Fall River; and on the Atchison, T. & S. F. and the Missouri P. R.R.'s; about 58 miles northeast of Wichita. It is the seat of the Southern Kansas Academy, under the auspices of the Congregational Church. The city is a trade centre for the surrounding rich agricultural region. Pop. 2,236.

Eureka, Nev., town, county-seat of Eureka County; on the Southern P. R.R. Some of the richest mines of the State are near, lead, gold, and silver; and many other valuable minerals are found in Eureka and adjoining counties. The town has numerous and important smelting and refining works. Because of severe fires, destroying a large portion of the place, the population decreased from in 1880, 5,000, to in 1901, 2,000.

Eureka College, a coeducational institution in Eureka, Ill.; founded in 1855 under the auspices of the Christian Church; reported at the close of 1900: Professors and instructors, 16; students, 225; and volumes in the library, 6,500.

Eureka Springs, Ark., city and county-seat of Carroll County; situated in the Ozark Mountains in the northwestern part of the State, and on the Eureka Springs R.R., 18 miles southeast of Seligman, Mo. The city is chiefly noted for its medicinal springs and its healthful climate, and very little manufacturing is carried on. Onyx of a fine grade is found in the vicinity. The city has a high school and three graded public schools; there are two banks, with a combined capital of $50,000, and 10 church edifices. The city is lighted by gas, owns and operates its waterworks and has an electric railway system. The affairs of the community are administered by a mayor and council of six members elected every two years. It was first settled in 1879 and became a city in 1880. The population are mainly Americans. Pop. (1900) 3,572.

E. M. BARE,
Secretary Commercial Club.

Euripides, ū-rĭp'ĭ-dēz, Greek tragic poet: b. Salamis, probably 23 Sept. 480 B.C., d. 406 B.C. The date given for his birth by the Arundel marbles is 485 B.C.; and Müller upholds the date

481 B.C., on the ground that Eratosthenes states him to have been 75 at his death. The usual account, however, places it on the day of the battle of Salamis. Euripides is said to have begun to write tragedies at the age of 18, but no play was exhibited by him until 455 B.C., the year in which he exhibited the 'Peliades.' He was not successful in gaining the first prize till the year 441 B.C., and he continued to exhibit till 408 B.C., when he exhibited the 'Orestes.' Most of the short remainder of his life was passed at the court of Archelaus, king of Macedonia, where he was held in the highest honor. The honor paid to Euripides by Archelaus is not the only proof of the estimation in which he was held by foreigners. Plutarch records in his 'Nicias' that on the occasion of the destruction of the Athenian army in Sicily, under Demosthenes and Nicias, by the Syracusans (413 B.C.), many of those who survived, and were made prisoners, obtained their liberty by reciting to their masters some of the verses of Euripides, and he adds that numbers of them on their return home visited the poet to express their thanks to him. The Athenians themselves did not neglect to do honor to their great poet after his death, for Pausanias makes mention of a statue to him that stood in the theatre of Athens.

Euripides made it a chief aim to awaken the tender emotions. "He knew," says one critic, "the nature of the passions, and had the art of inventing situations in which they could have their full play. Most of his characters were once in the enjoyment of distinguished prosperity, and the retrospect, in their present situation, checks the violence of the passions, and lowers them to the tone of lamentation. For this reason, in his tragedies the passions are breathed forth in soft complaints, rather than raised to a lofty height; for the same reason he is so rich in moral sentences and philosophical declamations, as his personages have always coolness enough to reflect on their situation. Euripides knew well what was suited to produce an effect at the moment. The times of boldness, when Æschylus wrote, were past, and the power of the state was beginning gradually to sink. The pathetic manner of Euripides then became popular." Various faults may be found with his loose plan, his often unintelligible changes of character, his superfluous choruses, and sometimes, too, his subject; but he stands pre-eminent in true, natural expression of the passions, in interesting situations, original groupings of character and varied knowledge of human nature. He is a master, too, in the art of managing the dialogue, in adapting the speeches and answers to the character, the sex, and station, the known or private views, the present disposition of the speaker, and the necessity of the moment, in short, to all that gives distinctness and individuality to a person. There is, too, a certain tenderness and softness diffused over his writings, which cannot fail to please the mind. He has been often called the woman-hater; but this seems to be rather a random charge, and was made probably on account of his many severe strictures on the follies of the female sex.

The number of tragedies composed by Euripides is stated by one authority to be 75, of which only 5 are said to have gained him the prize; according to another authority the total number of his tragedies reached 92, 15 of which gained him the prize. His extant plays amount to 18, or 19 if the 'Rhesus' be included in the number, as it is by some scholars, although others reject it as spurious. The following are the extant plays of Euripides: 'Alcestis'; 'Medea'; 'Hippolytus Coronifer'; 'Hecuba'; 'Heracleidæ'; 'Supplices'; 'Ion'; 'Hercules Furens'; 'Andromache'; 'Troades'; 'Electra'; 'Helena'; 'Iphigenia in Tauride'; 'Orestes'; Phœnissæ'; 'Bacchæ'; 'Iphigenia in Aulide'; and 'Cyclops.' The works of Euripides have been translated into verse by Way (1894–8); and into prose by E. P. Coleridge (1885). See Mahaffy, 'Introduction to the Study of Euripides' (1879); Lawton, 'Three Dramas of Euripides' (1889); Decharme, 'Euripide et l'esprit de son théâtre' (1893); Verrall, 'Euripides the Rationalist' (1895); Haigh, 'Tragic Drama of the Greeks' (1876); England, 'Euripides and the Attic Oration' (1898); Nestle, 'Euripides, der Dichter der griechischen Aufklärung' (1901).

Euripus, ū-rī'pŭs, in ancient geography, the strait between the island of Eubœa and the mainland, Bœotia in Greece. At Chalcis, the width at the narrowest part was 120 feet.

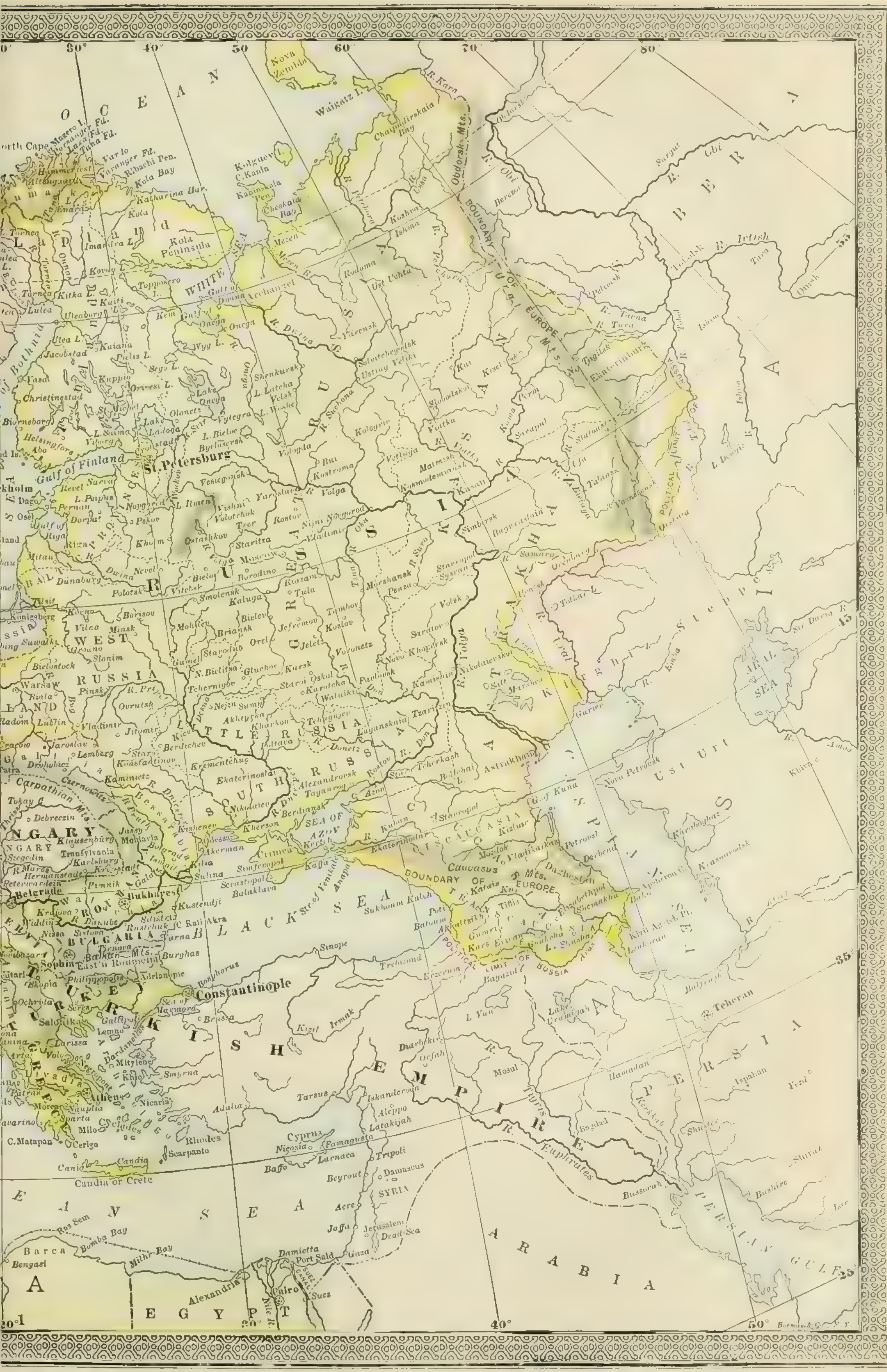
Euroclydon, ū-rŏk'lĭ-dŏn, a tempestuous wind that frequently blows in the Levant, and which was the occasion of the disastrous shipwreck of the vessel in which St. Paul sailed, as narrated in Acts xxvii. 14–44. In the form in which the word is found in the revised version it must be taken as made up of the two Greek words, *euros*, the east or rather southeast wind, and *klydōn*, a wave. But the word used for it in the Vulgate is *Euro-aquilo*, a Latin compound signifying a northeast wind; and some of the best MSS. have the reading *Eurakylōn* instead of *Euroclydon*, which is accepted by some scholars as the preferable reading. Whatever may have been the true form of the word, it was applied to a northeast or north-northeast, and not an east or southeast wind, as the course taken by the vessel referred to indicates. Exactly such a wind is described by sailors of the present day as prevalent at certain seasons (especially in early spring) in the Mediterranean. The name by which the wind is now known is *Gregalia*.

Europa, ū-rō'pa, in Greek mythology, the daughter of Agenor, king of the Phœnicians, and the sister of Cadmus. The fable relates that she was abducted by Jupiter, who assumed the form of a bull, and swam with his prize to the island of Crete. Here Europa bore to him Minos, Sarpedon, and Rhadamanthus.

Europe, the smallest of the great continents but the most important, distinguished above the others by the character of its population, the superior cultivation of the soil, and the flourishing condition of arts, sciences, industry and commerce.

Topography.— Europe forms a huge peninsula projecting from Asia, and is bounded on the north by the Arctic Ocean; on the west by the Atlantic Ocean; on the south by the Mediterranean, the Black Sea, and the Caucasus range; on the east by the Caspian Sea, the Ural River, and the Ural Mountains. The most northerly point on the mainland is Cape Nordkyn, in Lapland, in lat 71° 6′ N.; the most southerly

EUROPE.
SCALE OF MILES
Telegraph Cables
Capitals indicated thus
Cities with 1,000,000 or over, by type.. London
Cities with 500,000 to 1,000,000 thus
ARCTIC CIRCLE
ATLANTIC OCEAN
NORTH SEA
BAY OF BISCAY
MEDIT
TYRRHENIAN SEA
ICELAND
BRITISH ISLES
SCOTLAND
IRELAND
London
Paris
FRANCE
SPAIN
PORTUGAL
GERMANY
Berlin
DENMARK
Copenhagen
SWITZERLAND
AUSTRIA
ITALY
Rome
Corsica
Sardinia
Sicily
Malta
MOROCCO
ALGERIA
Algiers
TUNIS
Tunis
Tripoli
AFRI
TRIPO
Copyright, 1903, by The The Americana Company
Longitude West
Longitude 10° East from Greenwich


O C E A N
Nova Zembla
Waigatz I.
R. Kara
Obdorsk Mts.
Obdorsk
North Cape
Hammerfest
Varanger Fd.
Kola Bay
Kolguev I.
Kola Peninsula
WHITE
Gulf of Dwina
Archangel
Onega
Mezen
Kem
Ulea
Ulea L.
Jacobstad
Vasa
Christinestad
Biorneborg
Helsingfors
Abo
Viborg
Lake Ladoga
Lake Onega
Vytegra
L. Bieloe
Byeloserek
Gulf of Finland
St. Petersburg
Cronstadt
Narva
Revel
L. Peipus
Pernau
Dorpat
Gulf of Riga
Riga
Novgorod
L. Ilmen
Pskov
Mitau
Dunaburg
Vitebsk
Polotsk
Kovno
Konigsberg
Vilna
Minsk
Grodno
Slonim
Bielostock
WEST RUSSIA
Warsaw
Lublin
Pinsk
Jitomir
Kiev
Berdichev
Smolensk
Kaluga
Moscow
Borodino
Tula
Orel
Kursk
Tver
Torjok
Volotchok
Ostashkov
Staritza
Rostov
Yaroslav
Vologda
Kostroma
Nijni Novgorod
Vladimir
Riazan
Tambov
Voronetz
Penza
Morshansk
Simbirsk
Samara
Syzran
Saratov
Volsk
Kazan
Viatka
Perm
Ufa
Orenburg
Ekaterinburg
BOUNDARY OF EUROPE
Ural Mts.
R. Volga
R. Ural
Uralsk
Astrakhan
Tzaritzin
Kamishin
Kharkov
Poltava
Ekaterinoslav
Kherson
Nikolaiev
Odessa
Kishenev
Akerman
Crimea
Sevastopol
Simferopol
Balaklava
Kertch
SEA OF AZOV
Taganrog
Rostov
Novo Tcherkask
Stavropol
CIS CAUCASIA
Ekaterinodar
Kizliar
Vladikavkas
Petrovsk
Derbend
Daghestan
Caucasus Mts.
BOUNDARY OF EUROPE
TRANS CAUCASIA
Tiflis
Kutais
Poti
Batoum
Baku
Shemakha
Elizabethpol
Erivan
Kars
Gumri
Lenkoran
Erzerum
POLITICAL LIMIT OF RUSSIA
Trebizond
Sinope
B L A C K S E A
Sukhoum Kaleh
Anapa
Kaffa
Kustendji
Bukharest
Galatz
Sulina
Kilia
Jassy
Moldavia
Bessarabia
Czernowitz
Lemberg
Carpathian Mts.
Debreczin
HUNGARY
Klausenburg
Transylvania
Karlsburg
Kronstadt
Szegedin
Temesvar
Hermanstadt
Peterwardein
Belgrade
Widdin
R. Danube
Rustchuk
Silistria
Varna
BULGARIA
Sofia
Sistova
Tirnova
Balkan Mts.
East'n Roumelia
Philippopolis
Adrianople
Burghas
Bosphorus
Constantinople
Sea of Marmora
Brussa
Gallipoli
Dardanelles
Salonika
Larissa
Mitylene
Smyrna
Athens
Nauplia
Sparta
Patras
Milo
Cerigo
C. Matapan
Candia
Candia or Crete
Scarpanto
Rhodes
Nicaria
T U R K I S H E M P I R E
Kizil Irmak
Tarsus
Adana
Iskanderoon
Aleppo
Latakiyah
Cyprus
Famagusta
Nicosia
Larnaca
Baffo
Tripoli
Beyrout
Damascus
SYRIA
Acre
Jaffa
Jerusalem
Dead Sea
Gaza
Damietta
Port Said
Suez Canal
Suez
Cairo
Alexandria
Nile R.
E G Y P T
Barca
Bengasi
Bomba Bay
Milhr Bay
Ras Sem
S E A
A R A B I A
Diarbekir
Orfah
Mosul
Tigris
Euphrates
Bagdad
Bussorah
L. Van
Lake Urumiyah
Bayazid
Tabreez
Teheran
P E R S I A
Hamadan
Ispahan
Yezd
Shuster
Shiraz
Bushire
Kerkah
PERSIAN GULF
Balfrush
Astrabad
Krasnovodsk
Apsheron C.
Kara Boghaz
Ust Urt
Novo Petrovsk
Gulf Kuna
ARAL SEA
Khiva
Syr Daria R.
Kirghiz Steppe
Gurief
Irgiz
Turgai
R. Irtish
Obi
Tobolsk
Tiumen
Tara
Omsk
Ishim
L. Dengiz
POLITICAL LIMIT OF RUSSIA
SIBERIA
Berezov
Petchora
Ishma
Ust Ishma
Solvytchegodsk
Ustiug Veliki
Yarensk
Totma
Kirillov
Rybinsk
Vetluga
Kotelnich
Vyatka
Glazov
Sarapul
Malmysh
Zlatoust
Troitsk
Chelyabinsk
Shadrinsk
Kolyvan
Ekaterinburg
Tobol
R. Tara
R. Tavda
Pelimsk
10°
20°
30°
40°
50°
60°
70°
80°
25°
35°
45°
55°

points are Punta da Tarifa, lat. 36° N., in the Strait of Gibraltar, and Cape Matapan, lat. 36° 17′, which terminates Greece. The most westerly point is Cape Roca in Portugal, in lon. 9° 28′ W., while Ekaterinburg is in lon. 60° 36′ E. From Cape Matapan to North Cape is a direct distance of 2,400 miles, from Cape St. Vincent to Ekaterinburg, northeast by east, 3,400 miles; area of the continent, about 3,800,000 square miles. Great Britain and Ireland, Iceland, Nova Zembla, Corsica, Sardinia, Sicily, Malta, Crete, the Ionian and the Balearic Islands are the chief islands of Europe. The shores are very much indented, giving Europe an immense length of coast line (estimated at nearly 50,000 miles). The chief seas or arms of the sea are: the White Sea on the north; the North Sea, or German Ocean, on the west, from which branches off the great gulf or inland sea known as the Baltic; the English Channel, between England and France; the Mediterranean, communicating with the Atlantic by the Strait of Gibraltar (at one point only 19 miles wide); the Adriatic and Aegean seas, branching off from the Mediterranean, and the Black Sea, connected with the Aegean Sea through the Hellespont, Sea of Marmora, and Bosporus.

The mountains form several distinct groups or systems of very different geological dates, the loftiest mountain masses being in the south central region. The Scandinavian mountains in the northwest, to which the great northern peninsula owes its form, extend above 900 miles from the Polar Sea to the southern point of Norway. The highest summits are about 8,000 feet. The Alps, the highest mountains in Europe (unless Mount Elbruz in the Caucasus is claimed as European), extend from the Mediterranean first in a northerly and then in an easterly direction, and attain their greatest elevation in Mont Blanc (15,781 feet), Monte Rosa, and other summits. Branching off from the Alps, though not geologically connected with them, are the Apennines, which run southeast, through Italy, constituting the central ridge of the peninsula. The highest summit is Monte Corno (9,541 feet). Mount Vesuvius, the celebrated volcano in the south of the peninsula, is quite distinct from the Apennines. By southeastern extensions the Alps are connected with the Balkan and the Despoto-Dagh of the southeastern peninsula of Europe. Among the mountains of southwestern Europe are several massive chains, the loftiest summits being in the Pyrenees, and in the Sierra Nevada in the south of the Iberian Peninsula. The highest point in the former, La Maladetta or Mont Maudit, has an elevation of 11,165 feet; Mulahacen, in the latter, is 11,703 feet, and capped by perpetual snow. West and northwest of the Alps are the Cévennes, Jura, and Vosges; north and northeast, the Harz, the Thüringerwald Mountains, the Fichtelgebirge, the Erzgebirge and Böhmerwaldgebirge. Farther to the east the Carpathian chain encloses the great plain of Hungary, attaining an elevation of 8,000 or 8,500 feet. The Ural Mountains between Europe and Asia reach the height of 5,540 feet. Besides Vesuvius two other volcanoes are Etna in Sicily, and Hecla in Iceland. A great part of northern and eastern Europe is level. The «great plain» of north Europe occupies part of France, western and northern Belgium, Holland, the northern provinces of Germany, and the greater part of Russia. A large portion of this plain, extending through Holland and north Germany, is a low sandy level not infrequently protected from inroads of the sea only by means of strong dykes. The other great plains of Europe are the plain of Lombardy (the most fertile district in Europe) and the plain of Hungary. Part of southern and southeastern Russia consists of steppes.

Rivers and Lakes.— The main European watershed runs in a winding direction from southwest to northeast, at its northeastern extremity being of very slight elevation. From the Alps descend some of the largest of the European rivers, the Rhine, the Rhône, and the Po, while the Danube, a still greater stream, rises in the Black Forest north of the Alps. The Volga, which enters the Caspian Sea, an inland sheet without outlet, is the longest of European rivers, having a direct length of nearly 1,700 miles, including windings of 2,400 miles. Into the Mediterranean flow the Ebro, the Rhône, and the Po; into the Black Sea, the Danube, Dnieper, Dniester, and Don (through the Sea of Azov); into the Atlantic, the Guadalquivir, the Guadiana, the Tagus, and Loire; into the English Channel, the Seine; into the North Sea, the Rhine, Elbe; into the Baltic, the Oder, the Vistula, and the Duna; into the Arctic Ocean, the Dwina. The lakes of Europe may be divided into two groups, the southern and the northern. The former run along both sides of the Alps, and among them, on the north side, are the lakes of Geneva, Neuchâtel, Thun, Lucerne, Zürich, and Constance; on the south side, Lago Maggiore, and the lakes of Como, Lugano, Iseo, and Garda. The northern lakes extend across Sweden from west to east, and on the east side of the Baltic a number of lakes, stretching in the same direction across Finland on the borders of Russia, mark the continuation of the line of depression. It is in Russia that the largest European lakes are found — Lakes Ladoga and Onega.

Geology.— The geological features of Europe are exceedingly varied. The older formations prevail in the northern part as compared with the southern half and the middle region. North of the latitude of Edinburgh and Moscow there is very little of the surface of more recent origin than the strata of the upper Jura belonging to the Mesozoic Period, and there are vast tracts occupied either by eruptive rocks or one or other of the older sedimentary formations. Denmark and the portions of Germany adjoining belong to the Cretaceous Period, as does also a large part of Russia between the Volga and the basin of the Dnieper. Middle and eastern Germany with Poland and the valley of the Dnieper present on the surface Eocene formations of the Tertiary Period. The remainder of Europe is remarkable for the great diversity of its superficial structure, rocks and deposits belonging to all periods being found within it, and having for the most part no great superficial extent. Europe possesses abundant stores of those minerals which are of most importance to man, such as coal and iron, Great Britain being particularly favored in this respect. Coal and iron are also obtained in France, Belgium, and Germany. Gold is found to an unimportant extent, and silver is widely spread in small quantities. The richest silver ores are in Norway, Spain, the Erzgebirge, and the Harz Mountains. Spain is also rich in quicksilver. Copper ores are abundant in the Ural Mountains, Thuringia, Cornwall, and Spain. Tin ores are found in Cornwall, the Erzgebirge, and Brittany.

Climate.— Several circumstances concur to give Europe a climate peculiarly genial, such as its position almost wholly within the temperate zone, and the great extent of its maritime boundaries. Much benefit is also derived from the fact that its shores are exposed to the warm marine currents and warm winds from the southwest, which prevent the formation of ice on most of its northern shores. The eastern portion has a less favorable climate than the western. The extremes of temperature are greater, the summer being hotter and the winter colder, while the lines of equal mean temperature decline south as we go east. The same advantages of mild and genial temperature which western has over eastern Europe, the continent collectively has over the rest of the Old World. The diminution of mean temperature, as well as the intensity of the opposite seasons, increases as we go east. Peking, in lat. 40° N., has as severe a winter as St. Petersburg in lat. 60°.

Botany.— With respect to the vegetable kingdom Europe may be divided into four zones. The first, or most northern, is that of fir and birch. The birch reaches almost to North Cape; the fir ceases a degree farther south. The cultivation of grain extends farther north than might be supposed. Barley ripens even under the 70th parallel of north latitude; wheat ceases at 64° in Norway to lat. 62° in Sweden. Within this zone, the southern limit of which extends from lat. 64° in Norway to lat. 62° Russia, agriculture has little importance, its inhabitants being chiefly occupied with the care of reindeer or cattle, and in fishing. The next zone, which may be called that of the oak and beech, and cereal produce, extends from the limit above mentioned to the 48th parallel. The Alps, though beyond the limit, by reason of their elevation belong to this zone, in the moister parts of which cattle husbandry has been brought to perfection. Next we find the zone of the chestnut and vine, occupying the space between the 48th parallel and the mountain chains of southern Europe. Here the oak still flourishes, but the pine species become rarer. Rye, which characterizes the preceding zone on the continent, gives way to wheat, and in the southern portion of it to maize also. The fourth zone, comprehending the southern peninsula, is that of the olive and evergreen woods. The orange, lemon, and olive flourish in the southern portion of it, and rice is cultivated in a few spots in Italy and Spain.

Zoology.— As regards animals the reindeer and polar bears are peculiar to the north. In the forests of Poland and Lithuania the urus, a species of wild ox, is still occasionally met with. Bears and wolves still inhabit the forests and mountains; but, in general, cultivation and population have expelled wild animals. The domesticated animals are nearly the same throughout. The ass and mule lose their size and beauty north of the Pyrenees and Alps. The Mediterranean Sea has many species of fish, but no great fishery; the northern seas, on the other hand, are annually filled with countless shoals of a few species, chiefly the herring, mackerel, cod, and salmon.

Inhabitants.— Europe is occupied by several different peoples or races, in many parts now greatly intermingled. The Celts once possessed the west of Europe from the Alps to the British Islands. But the Celtic nationalities were broken by the wave of Roman conquest, and the succeeding invasions of the Germanic tribes completed their political ruin. At the present day the Celtic language is spoken only in the Scotch highlands (Gaelic), in some parts of Ireland (Irish), in Wales (Cymric), and in Brittany (Armorican). Next to the Celtic comes the Teutonic race, comprehending the Germanic and Scandinavian branches. The former includes the Germans, the Dutch, and the English. The Scandinavians are divided into Danes, Swedes, and Norwegians. To the east, in general, of the Teutonic race, though sometimes mixed with it, come the Slavonians, that is, the Russians, the Poles, the Czechs or Bohemians, the Servians, Croatians, etc. In the south and southeast of Europe are the Greek and Latin peoples, the latter comprising the Italians, French, Spanish and Portuguese. All these peoples are regarded as belonging to the Indo-European or Aryan stock. To the Mongolian stock belong the Turks, Finns, Lapps, and Magyars or Hungarians, all immigrants into Europe in comparatively recent times. The Basques at the western extremity of the Pyrenees are a people whose affinities have not yet been determined. The total population of Europe is about 394,000,000; nine tenths speak the languages of the Indo-European family, the Teutonic group numbering about 108,000,000, the Slavonic and Latin over 95,000,000 each. The prevailing religion is the Christian, embracing the Roman Catholic Church, the various sects of Protestants (Lutheran, Calvinistic, Anglican, Baptists, Methodists, etc.), and the Greek Church. A part of the inhabitants profess the Jewish, a part the Mohammedan religion.

Political Divisions.— The states of Europe, with their respective areas and populations, are as shown below. In addition to those given in the table, there are also the insignificant states of Andorra, Monaco, and San Marino, which still maintain a kind of precarious independence.

Area and Population.— The following table shows the countries with their government, area, and population according to the last official reports:

Countries	Government	Area in Eng. Sq. M.	Population
Andorra	Republic	175	6,000
Austria-Hungary	Empire	201,591	47,102,000
Belgium	Kingdom	11,373	6,069,321
Bulgaria	Principality	37,860	3,154,375
Denmark	Kingdom	14,789	2,417,441
France	Republic	204,092	38,641,333
Germany	Empire	208,830	56,357,178
Great Britain and Ireland	Kingdom	120,979	41,607,542


EUROPE
(Physical)
SCALE
170 Statute Miles to one inch
EXPLANATION
ARCTIC OCEAN
ATLANTIC OCEAN
NORTH SEA
BALTIC SEA
MEDITERRANEAN SEA
BLACK SEA
CASPIAN SEA
KARA SEA
WHITE SEA
ADRIATIC SEA
AEGEAN SEA
BAY OF BISCAY
GULF OF BOTHNIA
English Channel
Isotherm of 32°
ARCTIC CIRCLE
ICELAND
Mt. Hecla
FAROE Is.
SHETLAND Is.
ORKNEY Is.
HEBRIDES
BRITISH ISLES
GRAMPIANS
PENNINE RANGE
CENTRAL PLAIN
IRISH SEA
LOFOTEN Is.
NORTH CAPE
Varanger Fjord
SCANDINAVIAN PENINSULA
SCANDINAVIAN HIGHLANDS
DOVREFJELD
KOLA PENINSULA
Lake Onega
Lake Ladoga
NOVAYA ZEMLYA
TIMAN MOUNTAINS
URAL MOUNTAINS
Tundras
Petchora R.
Northern Dvina R.
Kama R.
Oka R.
Volga River
Don River
Dnieper R.
Dniester R.
Prut R.
Dvina R.
Vistula R.
Oder R.
Elbe R.
Rhine
Seine R.
Loire R.
Rhone R.
Po R.
Danube R.
Drainage Divide
VALDAI PLATEAU
GREAT LOWLAND PLAIN
Marshes of the Pripet
STEPPES
Caspian Depression below Ocean Level
PLAIN OF FRANCE
PLAIN OF BOHEMIA
ERZGEBIRGE
CARPATHIANS
HUNGARIAN PLAIN
WALLACHIAN PLAIN
THE ALPS
Monte Rosa
Mt. Blanc
PLAIN OF LOMBARDY
APENNINES
ITALIAN PEN.
Mt. Vesuvius
Strait of Messina
Mt. Etna
SICILY
MALTA
CORSICA
SARDINIA
BALEARIC Is.
PYRENEES
Pic de Nethou
CANTABRIAN MTS.
IBERIAN PENINSULA
SPANISH PLATEAU
SIERRA MORENA
SIERRA NEVADA
Mulhacen
Tagus R.
Douro R.
C. FINISTERRE
C. ST. VINCENT
Strait of Gibraltar
JUTLAND PEN.
LANDS END
Strait of Dover
CRIMEA
Sea of Azov
CAUCASUS MOUNTAINS
Mt. Elbruz
Mt. Ararat
BALKAN PENINSULA
BALKAN MTS.
GRECIAN PEN.
MOREA PEN.
Bosporus
Dardanelles
Sea of Marmora
CRETE
CYPRUS
ASIA
AFRICA
6500 ft.
13000 ft.
Latitude North
Longitude West from Greenwich
Longitude East from Greenwich
Copyright, 1903, by Rand, McNally & Company

Countries	Government	Area in Eng. Sq. M.	Population
Greece	Kingdom	25,014	2,433,806
Italy	Kingdom	110,410	34,970,785
Lichtenstein	Principality	65	9,434
Luxemburg	Grand Duchy	998	236,543
Monaco	Principality	8	15,180
Montenegro	Principality	3,630	228,000
Netherlands	Kingdom	12,648	5,074,632
Norway	Kingdom	124,445	2,209,880
Portugal	Kingdom	36,038	5,428,659
Rumania	Kingdom	46,314	5,800,000
Russia (European)	Empire	2,095,504	106,264,136
San Marino	Republic	38	11,002
Servia	Kingdom	18,757	2,312,484
Spain	Kingdom	197,670	17,565,632
Sweden	Kingdom	172,876	5,136,441
Switzerland	Republic	15,976	3,119,635
Turkey	Empire	62,744	5,711,000
Bosnia, Herzegovina, and Novibazar, occupied by Austria-Hungary	Belongs to Turkey.	23,262	1,568,092
Total		3,748,036	393,851,531

History.— Europe was probably first peopled from Asia, but at what date we know not. The first authentic history begins in Greece at about 776 B.C. Greek civilization was at its most flourishing period about 430 B.C. After Greece came Rome, which, by the early part of the Christian era, had conquered Spain, Greece, Gaul, Helvetia, Germany between the Danube and the Alps, Illyria, Dacia, etc. Improved laws and superior arts of life spread with the Roman empire throughout Europe, and the unity of government was also extremely favorable to the extension of Christianity.

With the decline of the Roman empire a great change in the political constitution of Europe was produced by the universal migration of the northern nations. The Ostrogoths and Lombards settled in Italy, the Franks in France, the Visigoths in Spain, and the Anglo-Saxons in South Britain, reducing the inhabitants to subjection or becoming incorporated with them. Under Charlemagne (771–814) a great Germanic empire was established, so extensive that the kingdoms of France, Germany, Italy, Burgundy, Lorraine, and Navarre were afterward formed out of it. About this time the northern and eastern nations of Europe began to exert an influence in the affairs of Europe. The Slavs, or Slavonians, founded kingdoms in Bohemia, Poland, Russia, and the north of Germany; the Magyars appeared in Hungary, and the Normans agitated all Europe, founding kingdoms and principalities in England, France, Sicily, and the East. The Crusades and the growth of the Ottoman power are among the principal events which influenced Europe from the 12th to the 15th century.

The conquest of Constantinople by the Turks (1453), by driving the learned Greeks from this city, gave a new impulse to letters in western Europe, which was carried onward by the invention of printing and the development of national life in the European states. The discovery of America was followed by the temporary preponderance of Spain in Europe, and next of France. Subsequently Prussia and Russia gradually increased in territory and strength. The French Revolution (1789) and the Napoleonic wars had a profound effect on Europe, the dissolution of the old German empire being one of the results. Since then the most important events in European history have been the separation of Belgium from Holland, and the establishment of the independence of Greece, both in 1830; the disappearance of Poland as a separate state; the Crimean war of 1854–56 in which Great Britain, France, and Sardinia maintained the integrity of Turkey against Russia; the unification of Italy under Victor Emmanuel; the Franco-German war, resulting in the consolidation of Germany into an empire under the leadership of Prussia, and the establishment of the Third Republic in France; the attempt of Russia in 1877 to again sweep Turkey from her rank as a European nation; the partial dismemberment of the Turkish empire, including the loss of Crete and the unsuccessful war of the Greeks against the Turks in 1897.

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European Saratoga, The, Baden-Baden, famous for its medicinal waters and as a resort of fashion. Similarly, Saratoga has been named the «American Baden-Baden.»

Eurotas, ū-rō'tas, or **Iri,** a river of southern Greece (Peloponnesus), at one time called the Iris and Niris in the upper, and the Basilipotamo (King's River) in the lower part of its course, flows in a southerly direction through the valley between the ranges of Taygetus and Parnon, and enters the Gulf of Kolokytha.

Euro'tia, a genus of the goosefoot family (*Chenopodiaceæ*), which comprises two species, one of which, *E. lanata*, is found in America, and is generally known as American Eurotia or white sage. It is a many-branched herb, from one to three feet high, the flowers densely covered with long silky hairs. It is found from June to September in dry soils in the northwest Territories, from western Nebraska to New Mexico, Nevada and California. It is also called winter fat, being gathered and used as a winter forage; it has been successfully employed as a remedy for intermittent fevers.

Euryale, ū-rī'a-lē, a genus of the water lily family (*Nymphæaceæ*). It has but one species, *Euryale ferox,* a native of China and southeastern Asia. The plant is covered with spines; the flowers are small, red, or purplish, and the leaves very large, sometimes four feet in diameter. The seeds are rich in starch, and in the native countries of the plant, are an article of commerce, being roasted and eaten, or used in soups. The root is also eaten. The plant is hardy and will grow out of doors in America and reproduce itself as far north as Baltimore. In some instances it has grown for a number of years even farther north, but an unusually severe winter will kill it, unless protected.

Eurydice, ū-rid'ĭ-sē, in Greek mythology, the wife of Orpheus, who died by the bite of a serpent. Her husband, inconsolable for her loss, descended to the lower world, and, by the charms of his lyre, moved the infernal deities to grant him permission to bring her back. This they granted, on condition that he would not look back upon her till he had reached the upper world. Forgetting his promise, he looked and lost her forever. This story has often formed a subject for poets — as for Virgil in the Georgics (book iv.), and for Pope in his 'Ode on St. Cecilia's Day.' One of the first modern operas was the 'Eurydice' (Euridice) of Coccini and Peri. It was first produced at Florence in 1600. The name Eurydice was borne by certain Macedonian princesses.

Euryl'ochus. See CIRCE.

Eurymone, ū-rĭm'ō-nē, an infernal deity, who gnawed the dead to the bones, and was always grinding her teeth. Also a daughter of Apollo.

Eurynome, ū-rĭn'ō-mē, in Greek mythology, the daughter of Oceanus and mother of the Graces.

Eurypterus, ū-rĭp'tē-rŭs, a remarkable fossil arthropod related to the horseshoe crab (*Limulus*), many genera and species of which occur in Palæozoic rocks of western Europe and eastern North America. They include the largest arthropods known, and form the family *Eurypteridæ* and order *Eurypterida* of the subclass *Merostomata* (q.v.). They resembled the modern horseshoe crabs in structure, but had elongated, often scorpion-like bodies, terminating in a hinged, spike-like or flattened tail or telson. The most remarkable feature, however, is the great size they attained, some exceeding six feet long, so that they were well named by Haeckel *Gigantosraca.* The surface was formed by a thin chitinous epidermal skeleton, ornamented by fine scale-like markings, and bearing upon the head-shield two large lateral faceted eyes and a pair of median ocelli. Beneath the cephalo-thorax are six pairs of legs, the foremost preoral, the basal joints of which serve as jaws. The last pair is greatly enlarged, somewhat flattened and terminated by an oval plate, which suggests that these limbs served as paddles in swimming, but they may have been otherwise useful. In *Pterygotus* and some allied genera the preoral limbs are modified into more or less antennæ-like organs terminating in toothed pincers (chelæ), no doubt for seizing prey, etc. The ventral segments are 13, of which the first 2 bear the genital organs, and the remainder leaf-like structures regarded as respiratory and equivalent to the "bookgills" of *Limulus.* These extraordinary crustaceans are found associated with graptolites, cephalopods, and trilobites in the Ordovician; with marine crustacea in the Silurian; with oceanic fishes in the Devonian, and with land and fresh-water plants and animals in the coal measures. Their structure shows that they must have been aquatic (marine) and good swimmers; but toward the end of their race they became gradually adapted to brackish and even fresh water. The latest review of the group is in Eastman's American edition of Zittell's 'Text-book of Palæontology' (1900), which contains a full bibliography. See MEROSTOMATA.

Eurysthenes (ū-rĭs'the-nēz) **and Procles,** prō'clēz, the twin sons of Aristodemus, and the progenitors of the two royal lines of Sparta.

Eurystheus, ū-rĭs'thūs, the son of Sthenelus, and king of Mycenæ, who, at Juno's instigation, ordered Hercules to perform "the twelve labors." Hyllus, the son of Hercules, afterward killed him.

Eusden, ūs'dĕn, **Laurence,** English poet: b. Spofforth, Yorkshire (?), 1688; d. Coningsby, Lincolnshire, 27 Sept. 1730. He attracted much attention by his 'Original Poems' (1714); 'Ode for the New Year' (1720), and other poems, resulting in his appointment as poet laureate in 1718.

Eusebius (ū-sē'bĭ-ŭs) **of Caesare'a,** surnamed Pamphili, Church historian: b. probably, Cæsarea, Palestine, 264 A.D.; d. there about 349. He is known as Eusebius Cæsariensis and Eusebius Pamphili, that is, Pamphilus's Eusebius — a style assumed after the martyrdom of his instructor, Saint Pamphilus. He was chosen bishop of Cæsarea 314. Though he never subscribed to the views held by Arius and the Arians regarding the Godhead of Christ, he was always friendly toward them and thus incurred censure as being at best a Semi-Arian. Before the rise of Arianism he wrote a spirited defense of the Christian faith in refutation of a book by one Hierocles, who contended that the noted impostor, Apollonius of Tyana, was superior to Jesus Christ in sanctity and in miraculous powers. Eusebius wrote two treatises which have come down to our time: (1) the 'Preparation,' and (2) the 'Demonstration of the Gospel,' usually designated by their Latin titles, 'Præparatio Evangelica,' 'Demonstratio Evangelica.' The argument of the former is the groundlessness of idolatry, the impostures of the oracles, the monstrous impieties of the heathen mythology and theology; and the author shows that the doctrine of the unity of the Godhead, and the truth of his revealed religion is as ancient as the world. In the 'Demonstratio', the argument is that the law and the prophecies of the Jewish scriptures clearly foreshow Jesus Christ and the Gospel. Of his other works extant the chief is his 'History of the Church, from the Time of Its Founder to the year 323.' See Schöne, 'Die Weltchronik des Eusebius in ihrer Bearbeitung durch Hieronymus' (1900).

Eusebius of Em'esa, Greek ecclesiastic: b. Edessa; d. Antioch about 360. He studied under Eusebius of Cæsarea, and at Alexandria and Antioch. Averse to all theological controversies, he declined the bishopric of Alexandria vacant by the deposition of Athanasius. He was afterward, however, appointed bishop of Emesa, in Syria, but was twice driven away by his flock, who accused him of sorcery on account of his astronomical studies. The homilies extant under his name are probably spurious.

Eusebius of Nicome'dia, Arian bishop: d. Constantinople 342. He was appointed bishop of Beryta (Beirut) in Syria, and afterward of Nicomedia. He appeared as the defender of Arius at the Council of Nice, and afterward placed himself at the head of the Arian party. He baptized the Emperor Constantine in 337, and became patriarch of Constantinople in 339.

Eustachian (ū-stā'kĭ-an) **Tube,** in anatomy, a canal leading from the pharynx to the tympanum of the ear; named for the Italian anatomist, Eustachio. See EAR.

Eustachio, Bartolommeo, bär-tō-lŏm-mā'ō ā-oos-tä'kē-ō, Italian physician and anatomist: b. San Severino, Italy, soon after 1500; d. August 1574. He devoted himself to medical science and in particular to anatomy, which he much enriched by his researches. Among his discoveries were the Eustachian tube and the Eustachian valve of the heat. His 'Tabulæ Anatomicæ' was published 1714.

Eustathius (ūs-tā'thĭ-ŭs) **of Thessalonica,** Greek scholar: b. Constantinople; d. Thessalonica 1198. He was at first a monk, then a deacon and teacher of rhetoric in his native city; he was archbishop of Thessalonica from 1160, and of Myra from 1174, and died at an advanced age. Eustathius was profoundly versed in the ancient classic authors. His most important work is his commentary on Homer (1st ed. 1542–50). His commentary on Dionysius was first printed at Paris (1547). Of his commentary on Pindar, only the 'Proœmium' has come down to us; a part of his theological and historical treatises, letters, etc., was published by Tafel in 1832.

Eusta'tius, Saint, one of the Leeward Islands. See SAINT EUSTATIUS.

Eus'tis, James Biddle, American diplomatist: b. New Orleans, La., 27 Aug. 1834; d. Newport, R. I., 9 Sept. 1899. He was admitted to the bar in 1856 and practised in New Orleans till the Civil War broke out. He then entered the Confederate army and served as judge-advocate on the staffs of Gens. Magruder and J. E. Johnston till the close of the war. He was elected United States senator in 1876, but not given his seat till late in 1877; and was professor of civil law in the University of Louisiana in 1879–84, when he was again elected senator. In March 1893, he was appointed United States minister to France, and on the expiration of his term, in 1897, resumed practice in New York. He translated into English the 'Institutes of Justinian,' and Guizot's 'History of Civilization.'

Eustis, William, American physician and politician: b. Cambridge, Mass., 10 June 1753; d. Boston 6 Feb. 1825. He served as a surgeon in the American army during the Revolution, and subsequently practised medicine in Boston. He was a member of Congress 1801–5 and 1820–3; was secretary of war 1809–13; and governor of Massachusetts in 1823–5.

Eusto'ma, a genus of herbs of the gentian family, which comprises two species, natives of the Southern States, Mexico and the West Indies. The most common species is Russell's Eustoma (*E. russellianum*), which grows on the prairies from Nebraska to Louisiana, Texas and Mexico. The flowers are purple, bell-shaped, sometimes three inches in diameter.

Eutaw, ū'tâ, Ala., town, county-seat of Greene County; on the Alabama G. S. R.R.; about 95 miles southwest of Birmingham. It was settled in 1838, named in honor of the battle of Eutaw Springs, S. C. (1781), where the American forces, commanded by Gen. Greene, gained a victory. It is in a rich agricultural region. Pop. 1,008.

Eutaw Springs, a small tributary of the Santee River in Charleston County, S. C. It is noted for the battle fought on its banks in 1781. See EUTAW SPRINGS, BATTLE OF

Eutaw Springs, Battle of, 8 Sept. 1781, in the Revolution. Tactically a drawn battle, in results it was an important American victory, winning the object of Greene's campaign; as the British shortly abandoned interior South Carolina, retiring to Charleston. Greene, having captured 96, stole on the British at Eutaw, some 2,300, under Gen. Stuart, and attacked suddenly at 4 A.M. He had about 2,000 men, part militia, but with Marion and Pickens for commanders; while the regulars were the famous Marylanders under Howard and Hardman, Virginians under Campbell, North Carolinians under Sumner, and the remnant of the brave Delaware men; with William Washington, R. H. Lee, and Pleasant Henderson for cavalry leaders. The British had one line; the right on Eutaw Creek, the left in the air. The Americans had two, besides the reserves; the militia in front, who fought desperately and fired in some cases 17 rounds before giving way. Then the regulars rushed forward and swept the British line off the field; but gaining their camp, stopped to plunder it, and though rallied, could not drive the British from the strong positions they had taken. In assailing a brick house, Greene's guns were captured and he lost many of his best men; and a charge of Col. Washington's was repulsed and himself taken prisoner. Greene was obliged to retreat; but Stuart decamped in the night. The American loss was 408 regulars killed and wounded, militia probably at least 150; British, 453 killed and wounded, 257 missing.

Euterpe, ū-tėr'pē, one of the Muses, considered as presiding over lyric poetry. The invention of the flute is ascribed to her. She is usually represented as a virgin crowned with flowers, having a flute in her hand, or with various instruments about her. As her name denotes, she is the inspirer of pleasure. (See MUSES). In botany, *Euterpe* is a genus of palms found in South America and the West Indies, and embracing seven or eight species. Some specimens attain a height of nearly 100 feet. The wood of *E. oleracea* is used for flooring. Its fruit, as also that of *E. edulis,* is edible; and the latter species furnishes assai (q.v.). Euterpe in astronomy is an asteroid (No. 27), discovered by Hind in 1853.

Eutha'mia, a genus of *Compositæ,* which includes some of the golden-rods (q.v.).

Euthanasia, ū-tha-nā'sĭ-a, means, in Greek, being happy or opportune in the time of one's death. The correlative adjective is applied in Greek literature to a man who died for his country, and it has been translated by the Latin historian "felix opportunitate mortis." The term euthanasia has recently been employed by some scientific men in advocating the reasonableness of relieving the sufferings of those afflicted with incurable diseases by administering to them anæsthetics or narcotics in sufficient doses to prove fatal.

Eutro'pius, Flavius, Latin historian, who, as he himself informs us, bore arms under the Emperor Julian. The place of his birth and his history are unknown to us. He flourished about 360 A.D. His abridgment of the history of Rome 'Breviarium Historiæ Romanæ,' written in a perspicuous style, reaches from the foundation of the city to the time of the Emperor Valens, to whom it is dedicated. The best editions are those of Droysen (1878), Rühl (1887).

Eutyches, ū'tĭ-kēz, heresiarch of the Eastern Church, who flourished in the 5th century. He was a priest and archimandrite or prior of a monastery in Constantinople; was the founder of the religious sect called after him Eutychians, but also Monophysites, as believing that in Jesus Christ was but one nature, and that the Divine: μόνος, *singularis,* single, φύσις, nature. The Council of Ephesus (431) having declared that in Jesus Christ were united the divine and human nature, Eutyches was condemned as a heretic by a synod of bishops held in Constantinople 448, but the next year the "Robber Synod" of Ephesus, controlled by Dioscorus, patriarch of Alexandria, reversed that judgment. In 451 the General Council of Chalcedon annulled the decrees of the Robber Synod, excommunicated Eutyches and formulated the Catholic doctrine regarding the hipostatic union of the divine and human natures in Christ. Eutyches died in exile. His doctrine took fast root in Syria, Armenia, Mesopotamia, Egypt and Ethiopia, and in those countries the Monophysite Churches are strong to this day. See MONOPHYSITES.

Euxanthic (ūk-săn'thĭk) **Acid** ($C_{21}H_{18}O_{11}$), called also **Purreic Acid,** an acid obtained from purree, or Indian yellow. With the alkalies and earths, it forms soluble yellow compounds.

Euxenite, ūk'sē-nīt, a rare Norwegian mineral, essentially a niobate and titanate of yttria, erbia, ceria, and uranium. It sometimes contains iron calcium, and germanium, while water is always present. It occurs in orthorhombic crystals, but usually it is massive. It has a hardness of 5.5, a specific gravity of 4.6 to 5.1, a brilliant metallic-vitreous lustre, and a brownish-black color, showing a reddish-brown translucence in thin slivers.

Euxine, ūk'sĭn, the ancient name for the Black Sea.

Eva, Little, a beautiful child, who becomes the friend and consoler of Uncle Tom in Harriet Beecher Stowe's novel 'Uncle Tom's Cabin.' Her early death forms one of the climaxes in that affecting story.

Evadne, e-văd'nē, in Greek fable, the daughter of Mars and Thebe, who threw herself into the funeral pile of her husband, Cateneus.

Evagoras, e-văg'ō-ras, king of Salamis in Cyprus, flourished about the beginning of the 4th century B.C. His family had been expelled by a Phœnician exile. Evagoras recovered the kingdom in 410 B.C., and endeavored to restore in it the Hellenic customs and civilization. He was friendly with the Athenians, and in return for his services a statue was erected to him at Athens. His increasing power attracted the jealousy of the Persian king, Artaxerxes II., who declared war against him and besieged Evagoras in his capital. He was saved only by the dissensions of his enemies, and was able to conclude in 385 a peace by which the sovereignty of Salamis was secured to him.

Evagrius (e-văg'rĭ-ŭs) **Scholas'ticus,** Syrian Church historian: b. Epiphonia about 536; d. after 594. He wrote the history of the Church in continuation of the ecclesiastical histories of Eusebius, Socrates, Theodoret and Sozomen from 431, the date of the Council of Ephesus, to 594. His surname, Scholasticus, indicates that he was by profession (probably at Antioch) an advocate, for such at that time was a usual meaning of the word: he was legal adviser to Gregory, patriarch of Antioch, who commended him for his fidelity and learning to the emperor, Tiberius Absimarus, and obtained his promotion to a judicial office. In recognition of his eminent integrity as an official of the empire his second marriage was made the occasion of a public festival; which, however, had a disastrous ending, for it was interrupted by a violent earthquake, which caused the loss of thousands of lives.

Evan'der, in classical legend, the civilizer of Latium, the son, according to one account, of Hermes and an Arcadian nymph. About 60 years before the Trojan war he established himself in Latium, and built, at the foot of the Palatine Hill, on the banks of the Tiber, a town, to which he gave the name of Pallantium. The Roman legends represent him as teaching the Latins the use of the alphabet, and the arts of agriculture and music, softening their fierce manners by the introduction of more humane laws, and introducing among them the worship of the Lycæan Pan, Heracles, Demeter, etc. In the Æneid Virgil brings his hero Æneas into connection with Evander, who gives him a favorable reception, and becomes his ally against the Latins. Divine honors were paid to Evander by the inhabitants of Pallantium in Arcadia.

Evald, ā'vält. See EWALD.

Evangel'ical, a word literally signifying "pertaining to the gospel," and used in different senses. In one of its senses it is a term used to qualify certain doctrinal opinions, especially strong views on the question of the atonement, justification by faith, and allied doctrines. In this sense the word, when applied to a whole church, is in Scotland almost synonymous with orthodox; and in the United States it has much the same significance, in contrast to the words "liberal" and "rationalistic." In England the Evangelical or Low Church party is looked upon as extreme in its views, and is distinguished from the orthodox party, which holds the doctrines above specified in a more moderate form. When used in a less general sense something more is implied in the word. It indicates peculiar attachment to sound doctrine and peculiar fervency in advocating it. In another sense the term is applied in Germany to Protestants as distinguished from Roman Catholics, inasmuch as the former recognize no standard of faith except the writings of the evangelists and the other books of the Bible, and more especially to the national Protestant Church, formed in Prussia in 1817, by a union of the Lutheran and Calvinistic churches.

Evangelical Alliance, an association of members of the different sections of the Christian Church, organized in London 19–23 Aug. 1846. At this meeting was adopted a doctrinal basis, which is, in effect, the recognition by the members of the divine inspiration, authority, and sufficiency of the Holy Scriptures; the right of private judgment in their interpretation; the unity of the Godhead, and the Trinity of persons therein; the doctrine of human depravity in consequence of the fall; the incarnation, atonement, intercession, and mediatorial reign of the Son of God; justification by faith alone; the work of the Holy Spirit in conversion and sanctification; the immortality of the soul, the resurrection of the body, and the final judgment of the world resulting in the eternal blessedness of the righteous, and the eternal punishment of the wicked; the divine institution of the Christian ministry; and the obligation and perpetuation of the ordinances of baptism and the Lord's Supper. The American branch of the alliance was organized in 1867. Conferences of the entire alliance have been held in 1851, 1855, 1857, 1861, 1867, 1873, 1879, 1885, 1891, that of 1873 having met in New York. The American branch held a conference at Chicago in October 1893. The alliance has aided largely in the promotion of religious liberty in Europe and the East.

Evangelical Association, a religious denomination founded in Pennsylvania about the beginning of the 19th century by Jacob Albright, a member of the Methodist Episcopal Church, who was born in Pennsylvania 1759, and from about 1790 traveled among the German population as an evangelist. Albright founded a society of converts in 1800, which so increased in numbers that it was finally organized in 1807 as the Evangelical Association of North America with Albright as bishop. The theology of the association as defined in its 21 articles closely resembles that of the Methodist Episcopal Church, from which, also, it differs little in government and form of worship. The Church was divided in 1891, when a minority, numbering 40,000, organized the United Evangelical Church. In 1901 the association had 27 annual conferences, including 1 in Japan, 1 in Switzerland, and 2 in Germany; 476 local and 1,088 itinerant preachers, and property valued at $6,125,430. Consult: Orwig, 'History of the Evangelical Association' (1858).

Evangelical Counsels, in Catholic theology, are distinguished from divine commandments in this, that the commandments are of universal obligation for whoever would be saved, while the Evangelical Counsels point to the readiest and surest means of attaining that end. When a certain ruler put to Jesus Christ the question: "What good thing shall I do that I may inherit life?" and received the answer: "If thou wilt enter into life, keep the commandments," he was taught the condition of salvation which applies to all mankind. But he wanted to know whether there is not a more excellent way: he had "observed all those things from his youth up"; was there not some other "good thing" for him to do? Then Jesus prescribed to him the perfect way: "Sell all that thou hast and distribute unto the poor," giving him one of the Evangelical Counsels, the counsel of voluntary poverty. The celibate life is commended by St. Paul as more favorable to entire devotion to the service of God than the state of marriage: that Evangelical Counsel is the principal topic of the epistle of 1 Corinthians. Finally, entire obedience is the third of those counsels — renunciation of self-will, cheerful submission to the rule of superiors. Members of the religious orders of the Catholic Church bind themselves by solemn vows to practise the three Evangelical Counsels: poverty, chastity, and obedience.

Evangelical Union, the name of a religious body, also familiarly known as the Morisonians, from the Rev. James Morison, of Kilmarnock, by whom, with three other clergymen, it was founded in Scotland in 1843. The Morisonians maintain the universality of the atonement, combining with this the doctrine of eternal personal and unconditional election. In point of church government the members of the Evangelical Union are independent. The body had in 1899 between 90 and 100 congregations, chiefly in Scotland, and 712 ministers. Consult: Ferguson, 'History of the Evangelical Union' (1876).

Evangeline, e-văn'jĕ-lĭn, the heroine of one of Longfellow's earlier narrative poems, to which her name is given. It is written in English hexameters, and describes, although with little real topographical delineation of scenery, the deportation of the Acadians by the English government in 1775.

Evangelical Christian Science. See Sabin, Oliver C.

Evan'gelist (a bringer of good tidings), in the New Testament, a preacher of the gospel, distinguished (Eph. iv. 11) from the apostles, prophets, pastors, and teachers. The term came ultimately to refer to only the authors of the four Gospels, but in modern times has been extended to indicate also an unattached preacher whose specific work is the arousing of personal interest in matters of religion.

Evans, Arthur John, English archæologist: b. Nash Mills, Hertfordshire, 1851. He is a son of Sir John Evans (q.v.). He was educated at Harrow, Oxford, and Göttingen, and has been keeper of the Ashmolean Museum, Oxford, from 1884. Since 1893 he has superintended archæological researches in Crete, excavating in 1900–2 the pre-historic palace of Knossos. He has published: 'Through Bosnia' (1895); 'Illyrian Letters'; 'Antiquarian Researches in Illyricum' (1883–5); 'Cretan Pictographs and Pre-Phœnician Script' (1898); 'The Mycenæan Tree and Pillar Cult' (1901); etc.

Evans, Augusta Jane. See Wilson, Augusta Jane Evans.

Evans, Clement Anselm, American lawyer: b. Stewart County, Ga., 25 Feb. 1833. He was graduated at the Augusta, Ga., Law School 1852; established himself in practice; was county judge 1854–5, and State senator 1859–60. During the Civil War he served in the Confederate army as acting major-general in the Army of Northern Virginia. After Gen. Lee's surrender he entered the Methodist Episcopal ministry, and served until 1890. He has written a 'Military History of Georgia'; and edited the 'Confederate Military History' (12 vols.).

Evans, Edward Payson, American author: b. Remsen, N. Y., 8 Dec. 1833. He has made a special study of Oriental languages; in 1884 became connected with the 'Allgemeine Zeitung,' of Munich in Europe, to which he contributed many articles on the literary, artistic, and intellectual life of the United States. He has published 'Summary of the History of German Literature' (1869); 'Progressive German Reader' (1870); 'Animal Symbolism in Ecclesiastical Architecture' (1896) 'Evolutional Ethics and Animal Psychology' (1898); etc.

Evans, Elizabeth Edson Gibson, American prose writer: b. Newport, N. H., 8 March 1833. She was married to Edward Payson Evans (q.v.) 1868. She has published: 'The Abuse of Maternity' (1875); 'Laura, an American Girl' (1884); 'A History of Religions' (1892); 'Story of Kasper Hauser' (1892); 'The Story of Louis XVII. of France' (1893); 'Transplanted Manners' (1895); 'Confession' (1895); 'Ferdinand Lassalle and Helen von Dönninger' (1897); 'The Christ Myth' (1901).

Evans, Frederick William, American writer: b. Bromyard or Leominster, England, 9 June 1808; d. Mount Lebanon, N. Y., 6 March 1893. He removed to the United States in 1820; joined the United Society of Believers (Shakers) at Mount Lebanon, N. Y., in 1830, and became an elder in that society. The best known of his works are: 'Compendium of the Origin, History, and Doctrines of the Shakers' (1859); 'Autobiography of a Shaker' (1869); 'Shaker Communism' (1871); 'The Second Appearing of Christ' (1873).

Evans, Sir **George De Lacy,** British general: b. Moig, Ireland, 1787; d. London 9 Jan. 1870. He entered the army in 1806, and in the beginning of 1814 was sent to America, and at the battle of Bladensburg (24 Aug. 1814) had two horses shot under him. At the head of 100 men he forced the capitol at Washington. He was twice wounded before New Orleans in December 1814, and was on that account sent home to England, where he recovered just in time to be able to join Wellington at Quatre-Bras and Waterloo. In 1846 he was raised to the rank of major-general. At the outbreak of the Crimean war he was appointed to the command of the second division of the British army, and distinguished himself at the battle of the Alma, the siege of Sebastopol, and the battle of Inkermann. For his services he received the thanks of the House of Commons, the Grand Cross of the Bath, and had the cross of a grand officer of the Legion of Honor conferred on him by Napoleon III.

Evans, Henry Clay, American politician: b. Juniata County, Pa., 18 June 1834. He served in the 51st Wisconsin Infantry, enlisting 1864, and subsequently settled in Chattanooga, Tenn., as an iron and railway-car manufacturer, and was mayor of Chattanooga for two terms. He sat in Congress in 1889–91, and was assistant postmaster-general 1889–93. His election as governor of Tennessee 1894 was disputed and the opposing Democratic candidate was seated. He stood second in the vote for vice-president at the National Republican convention 1896, was appointed United States commissioner of pensions in 1897, and became consul-general in London 1902.

Evans, Hugh Davy, American author: b Baltimore, Md., 26 April 1792; d. there 16 July 1868. He studied law, began practice in Baltimore in 1815; and became eminent as a jurist. He was editor of 'The True Catholic' 1843–56; was connected with various other papers. He was a prominent member of the Maryland Colonization Society, and prepared a code of laws for the Maryland colony in Liberia; and in 1862–64 lectured on civil and ecclesiastical law. Among his writings are: 'Essays on Pleading' (1827); 'Maryland Common-Law Practice' (1837); 'Theophilus Anglicanus' (1851); 'Essays on the Episcopate of the Protestant Episcopal Church in the United States' (1855); 'Treatise on the Christian Doctrine of Marriage' (1870).

Evans, John, American geologist: b. Portsmouth, N. H., 14 Feb. 1812; d. Washington, D. C., 13 April 1861. He served on several State and Territorial geological surveys; and discovered remarkable fossil deposits in the Bad Lands of Nebraska. He was afterward commissioned by the United States government to carry on the geological surveys of Washington and Oregon.

Evans, John, American philanthropist: b. Waynesville, Ohio, 9 March 1814; d. Denver, Col., 3 July 1897. He was graduated at the medical department of Cincinnati College in 1838; in 1848 became a professor in the Rush Medical College of Chicago, in which city he accumulated a large fortune by investments in real estate. Much of this he gave to philanthropic objects. He established the Northwestern University, and endowed two chairs in it with $50,000 each. In 1862 he was appointed governor of the Colorado Territory. Later he established the University of Denver, to the construction of which he gave $200,000 and a large endowment. He gave largely for the erection of the Grace Methodist Episcopal Church in Denver, and aided almost every educational institution and Methodist Episcopal Church in the State.

Evans, Sir **John,** English archæologist: b. Britwell Court 17 Nov. 1823. His publications include: 'The Coins of Ancient Britons' (1864, supplement 1890); 'The Ancient Stone Implements, Weapons, and Ornaments of Great Britain and Ireland' (1872, 2d and enlarged edition 1897); 'Ancient Bronze Implements, Weapons, and Ornaments of Great Britain and Ireland' (1881). From 1878 till 1896 Sir John Evans was treasurer of the Royal Society, and he presided over the Toronto meeting of the British Association in 1897. He has also been president of the Geological Society (1874–6), of the Numismatic Society (1874–96), and of the Society of Antiquaries (1885–92), and he is a corresponding member of the Institute of France. His great work on stone implements received a prize from the French Academy, and both it and his other work on bronze implements were translated and published in Paris shortly after they appeared in England.

Evans, Mary Ann, or **Marian.** See Eliot, George.

Evans, Oliver, American inventor: b. Newport, Del., 1755; d. New York 25 April 1819. In 1777 he invented a machine for making card-teeth. Two years later he entered into business with his brothers, who were millers, and in a short time invented the elevator, the conveyor, the drill, the hopper-boy, and the descender, the application of which to mills worked by water-power effected a revolution in the manufacture of flour. For some years after these improvements were perfected, the inventor found much difficulty in bringing them into use, although in his own mill the economy of time and labor which they effected was very manifest. About 1799 or 1800 he set about the construction of a steam-carriage; but finding that his steam-engine differed in form as well as in principle from those in use, it occurred to him that it could be patented and applied to mills more profitably than to carriages; and in this he was completely successful. This was the first steam-engine constructed on the high-pressure principle; and to Evans, who had conceived the idea of it in early life, and in 1787 and again in 1794-5 had sent to England drawings and specifications, the merit of the invention belongs, although it has been common to assign it to Vivian and Trevethick, who had had access to Evans' plans. In 1803-4, by order of the board of health of Philadelphia, he constructed the first steam dredging machine used in America, consisting of a flat scow with a small engine to work the machinery for raising the mud. Evans also invented the boiler known as the "Cornish boiler." He wrote: 'The Young Engineer's Guide'; and 'Miller and Millwright's Guide.' See Thurston, 'Growth of the Steam-engine' (1878).

Evans, Robley Dunglison, American naval officer: b. Floyd Court House, Floyd County, Va., 18 Aug. 1846. He was appointed to the United States Naval Academy from Utah in 1860, was promoted ensign in 1863, and in 1864-5 was on board the Powhatan of the North Atlantic blockading squadron. He participated in both attacks on Fort Fisher, in 1868 was commissioned lieutenant-commander, in 1870-1 was on duty at the navy yard, Washington, in 1871-2 at the Naval Academy. Having served in 1873-6 successively on the Shenandoah and the Congress, of the European station, he was made commander in 1878; in 1891-2 was in command of the Yorktown at Valparaiso, Chile, and in 1893 became captain. During the Spanish-American war he was in command of the Iowa, and at the naval battle of Santiago he took an important part in the destruction of Cervera's fleet. In 1901 he was commissioned rear-admiral, and in 1902 was made commander of the Asiatic fleet, with the flagship Kentucky. He published 'A Sailor's Log' (1901).

Evans, Thomas Williams, American dentist: b. Philadelphia 23 Dec. 1823; d. Paris 14 Nov. 1896. He studied dentistry and practised in Maryland and later in Lancaster, Pa., and made a specialty of saving teeth by filling. In seeking a substitute for gold foil he mixed rubber and sulphur, which made a black substance instead of a white one. Because of the unfavorable color he laid the substance aside and gave it no more thought till his mixture was used by others for producing commercial gutta-percha, which he declared he had discovered. In 1848 he went by invitation to Paris as the most skilful American dentist, to attend to the teeth of President Louis Napoleon. During his career in Paris he accumulated a very large fortune. He also won an international reputation as an expert in military sanitation, and was one of the founders of the Red Cross Society. His home was the refuge of the Empress Eugénie from the mob on the night of 4 Sept. 1870. Dressed in his wife's clothes, she was taken by him to the Normandy coast, where he secured her escape to England. He bequeathed all of his fortune, estimated at from $8,000,000 to $12,000,000, excepting $250,000, to establish a museum and institute in Philadelphia.

Evans, William, Canadian agriculturist and author: b. Cavan, Ireland, 1786; d. Montreal, Canada, 1857. He emigrated from Ireland to Canada in 1819, became secretary of the first agricultural society in Montreal, in 1837 contributed a series of letters on agriculture to the *Courier,* and subsequently established the 'Canadian Quarterly' and the 'Agriculturist and Industrial Magazine.' In 1842 he edited in Toronto the 'British American Cultivator,' and in 1843 founded the 'Canadian Agricultural Journal' at Montreal. He became secretary and treasurer of the board of agriculture, Lower Canada, in 1853. His writings further include 'The Theory and Practice of Agriculture' (1835).

Ev'anston, Ill., city in Cook County, on Lake Michigan, and on the Chicago & N. W., and the Chicago, M. & St. P. R.R.'s; 12 miles north of Chicago. It includes the villages of Rogers Park and South Evanston; is delightfully laid out; and has gas and electric light plants; electric and elevated railroads to Chicago; Holly system of waterworks, weekly newspapers, and a national bank. It is the seat of Northwestern University (M. E.) founded in 1854, largely endowed and of high repute, with a library of 25,000 volumes and a museum. It is the seat also of the Garrett Biblical Institute, Winchell Academy, of the Evanston College for Women, founded in 1871, and the Visitation Academy. The Dearborn Observatory was transferred here from Chicago in 1888, and dedicated the following year as a department of Northwestern University. Evanston was the home of Frances Willard (q.v.). It is really a residential suburb of Chicago. Pop. (1900) 19,259.

Evanston, Wyo., city and county-seat of Uinta County, 76 miles east of Ogden; on the Bear River and the Union Pacific railway. There are valuable coal mines in the vicinity, and the surrounding region is also largely devoted to stock-farming and agriculture. Oil has been discovered in the neighborhood. Among the local industries are a large flouring-mill and railway repair shops. The State Asylum for the Insane is situated here. Pop. (1890) 1,995; (1900) 2,110.

Evansville, Ind., a city and port of entry of Vanderburg County, of which it is the county-seat, about 185 miles west of Louisville, 192 miles northeast of Cairo, and 180 miles southwest of Indianapolis; on the Ohio River, and the Louisville, E. & St. L., the Louisville & N., the Evansville & T. H., and other railways. It is pleasantly located on a high bank of the river.

Industries, etc. Evansville is the chief shipping point for southwestern Indiana, and ranks highly among the commercial centres of the State. According to the government census for 1900 there were in that year 705 establishments representing manufacturing and mechanical industries, with a capital of $10,059,375 and buildings valued at $1,913,592, employing the average number of 7,279 wage-earners with total wages of $2,883,975. The cost of materials used was $7,504,660, and the value of products $14,193,320. The neighboring region abounds in coal and the local coal trade is a large one. There is also an important trade in flour, pork, tobacco, grain, and timber. There are machine-shops and foundries, plow-works, furniture factories, flouring-mills, and manufactures of cottons and woolens, brick and tile, pottery, terra-cotta and fire-clay products, malt liquors, and saddlery and harness. The wharfage and shipping facilities are excellent.

Public Institutions, Buildings, etc.— The prominent buildings include the United States custom-house, the court-house, the city-hall, the Willard Library, the State Hospital for the Insane, Evans Temperance Hall, and the United States Marine Hospital. There are also three parks. Daily and weekly newspapers are published.

History, Government, etc.— Evansville was founded by Gen. R. M. Evans in 1816, became the county-seat of Vanderburg County in 1819, and was incorporated in 1847. The government is administered by a charter of 3 March 1893, with amendments of 11 March 1895. This instrument provides for a mayor, elected for four years, and a common council, one member from each ward for one year and four councilmen at large for two years. The annual expenditure of the municipality is about $700,000, the annual income about $940,000. The municipality owns the waterworks, which are operated at a yearly expense of about $30,000. Pop. (1890) 50,750; (1900) 59,007; (1903 est.) 61,482.

Evansville, Wis., a village of Rock County, 17 miles northwest of Janesville and 22 miles south by east of Madison; on the Chicago & Northwestern railway. Among its industries are an extensive wind-mill factory, an iron-foundry, and two large tobacco warehouses. Pop. (1890) 1,523; (1900) 1,864.

Evapora'tion (Lat. *evaporatio,* from *evaporare,* to emit vapor), the formation of vapor at the free surface of a liquid. In evaporation a portion of the liquid escapes in the gaseous form from the general mass, and, rising into the space, spreads through it according to the laws of diffusion of gases. Supposing the temperature of the space above the liquid to be uniform, the evaporation proceeds (provided there is a sufficient quantity of liquid) until the space is uniformly filled with vapor. A space thus filled with the maximum quantity of vapor corresponding to the temperature of it is said to be saturated. If the dimensions of the space be diminished, a portion of the vapor is forced to condense; if the temperature of the space falls, a portion of the vapor condenses also; while if the temperature of the space is increased, the dimensions remaining unchanged, the space ceases to be saturated, because the quantity of the vapor that corresponds to saturation is greater the higher the temperature. When there is not a sufficient quantity of liquid present to saturate the space completely, the whole of the liquid evaporates, and the vapor diffuses uniformly through the space. The space is then said to be non-saturated. See BOILING POINT; VAPOR.

Evart, Mich., a village of Osceola County, 60 miles east of Ludington, and 76 miles west-northwest of East Saginaw; on the Muskegon River and the Flint & Père Marquette railway. It is located in the centre of an important lumbering region, and has, besides saw-mills and shingle manufactories, a machine-shop and a foundry. Pop. (1890) 1,269; (1900) 1,360.

Evarts, Jeremiah, American editor and missionary secretary: b. Sunderland, Vt., 3 Feb. 1781; d. Charleston, S. C., 10 May 1831. He was graduated at Yale 1802, and settled in New Haven as a lawyer. His life was largely devoted to the interests of missions, he being editor of the 'Missionary Herald' for a long term, and corresponding secretary of the American Board of Commissions for Foreign Missions 1821–31.

Evarts, William Maxwell, American lawyer and statesman: b. Boston, Mass., 6 Feb. 1818; d. New York 28 Feb. 1901. He was graduated from Yale in 1837, studied law in the Harvard law school and the office of Daniel Lord of New York, in 1841 was admitted to the bar, and in 1849–53 was assistant district attorney in New York. In 1851 he was successful in the conduct of the prosecution of the Cuban filibusters of the Cleopatra expedition. He was retained in 1857 and 1860 to argue the Lemmon slave case on behalf of the State of New York against Charles O'Conor, council for Virginia. An active and prominent Republican, he made the speech nominating Seward for the Presidency at the Republican national convention in Chicago in 1860, though subsequently moving to make the nomination of Lincoln unanimous. In 1861 he and Horace Greeley (q.v.) were rival candidates before the State legislature for appointment to the senatorship vacated by Seward, newly made secretary of state. As a compromise, Ira Harris was finally appointed. Evarts' legal knowledge was frequently employed in the service of the administration. On behalf of the government he conducted numerous important cases. Among such were that before the Supreme Court to establish the right of the United States during the Civil War to deal with the captured ships as maritime prizes (1862), and that maintaining the unconstitutional character of the State laws taxing United States bonds or stock of the national banks without authorization of Congress (1865–6). He was principal counsel for Andrew Johnson (q.v.) in the President's trial for impeachment, and by his lofty judicial argument contributed much to a result which has since been regarded as most fortunate. He then went into Johnson's cabinet as attorney-general for the remaining year of the term. In 1872 he was chief counsel for the United States before the Geneva tribunal for settlement of the Alabama claims (q.v.). As chief counsel for the Republican party before the electoral commission (q.v.) that settled the Hayes-Tilden Presidential dispute, Evarts based his argument on the constitutional idea that sovereign States must conduct their elections and govern themselves without Federal interference, pointing out that the electoral returns from Louisiana revealed the choice of Hayes electors. During Hayes' administration he was secretary of state. He made, in 1880, a report upon the matter of American control of a trans-isthmian canal, whether at Nicaragua or Panama. His administration of the office was marked by skill in diplomatic questions, the improvement of the consular service, and the publication of consular reports on the economic and commercial status of foreign lands. In 1881 he was a delegate to the international monetary conference at Paris, and in 1885 entered the United States Senate, his term expiring 3 March 1891. He was the senior partner in the law firm of Evarts, Choate, and Beaman, and was frequently retained in important corporation cases. While in the Senate he made several noteworthy speeches, and he also pronounced many distinguished occasional addresses, including the Centennial oration at Philadelphia in 1876.

Eve. See ADAM.

Eve, Paul Fitzsimons, American physician: b. near Augusta, Ga., 27 June 1806; d. Nashville, Tenn., 3 Nov. 1877. He was graduated from the University of Georgia in 1826, and from the medical department of the University of Pennsylvania in 1828; studied also for several years in Europe; and was an ambulance surgeon during the French revolution of 1830, and a regimental surgeon in the Polish war of 1831. In 1832 he became professor of surgery in the Medical College of Georgia; and he obtained a similar chair in Louisville University (Ky.) in 1849 and in Nashville University (Tenn.) in 1850. Made surgeon-general of Tennessee in 1861, he was hospital surgeon on the medical examining board during the War, in 1868 was appointed professor of surgery in the Missouri Medical College (Saint Louis), and in 1870 in the University of Nashville. For a time he was editor of the 'Southern Medical and Surgical Journal,' and assisted in editing the Nashville 'Medical and Surgical Journal.' He published 'Remarkable Cases in Surgery' (1857) and other works.

Evec'tion (Lat. *evectio*, «a turning upward»), the second inequality in the motion of the moon, due to the attraction of the moon by the sun. Owing to the evection the position of the moon may vary 1.25°. It was discovered by Hipparchus nearly 200 years before the Christian era, and more completely determined by Ptolemy.

Eveli'na, a novel published 1778, by Frances Burney. In 'Evelina: or, the History of a Young Lady's Entrance into the World,' Miss Burney, describing the experiences of her heroine in London, gives a vivid picture of the manners and customs of the 18th century. The story is told by letters, principally those of Evelina to her guardian.

Evelyn, ĕv'ē-lĭn, **John,** English writer: b. Wotton, Surrey, 31 Oct. 1620; d. there 27 Feb. 1706. After completing his course at Oxford he began to study law at the Middle Temple. He made some efforts in favor of the royal cause in 1659, on which account he was much favored by Charles II. after his restoration. In 1662 he published 'Sculptura, or the History and Art of Chalcography or Engraving on Copper.' On the foundation of the Royal Society he was nominated one of the first Fellows, and at its meetings he read a discourse on forest-trees, which formed the basis of his most celebrated publication, 'Sylva, or a Discourse of Forest-trees' (1664). He continued in favor at court after the revolution, and was made treasurer of the Greenwich Hospital. He lived for many years at Sayes Court, Deptford, and subsequently succeeded to his brother's estate of Wotton, his life being that of a loyal, worthy, public-spirited country gentleman. Evelyn left a most interesting diary, picturing his life from 1641 to 1706, first published with his correspondence in 1818. A new edition of the 'Diary' was issued in 1827; another, with life, by Wheatley, in 1879.

Evening Grosbeak, a large finch (*Coccothraustes vespertinus*) of western North America. It is olivaceous, with the crown, wings, tail and feet black; forehead and rump yellow; bill yellowish, and a white patch on the wing. It inhabits the forests of northwestern Canada and the Rocky Mountain region, occasionally coming south into the upper Mississippi valley in winter. It has the general habits of its relative, the pine grosbeak (q.v.), and is noted for its rich song.

Evening Primrose, the common name of American plants belonging to the different genera of the natural order *Onagraceæ,* or evening primrose family. They are annual herbs, the yellow flowers opening either during the night or at evening. There are upward of 40 species to which the name is applied, nearly all natives of North America, but many of them naturalized in Europe, particularly in England, where the small-flowered evening primrose (*Onagra cruciata*) formerly *Œnotherabiennis,* is a much prized garden plant.

Evening or **Night Schools,** schools in which instruction is given to pupils debarred, generally by reason of being wage-earners, from the advantages of the day schools. Evening schools arose at a time when compulsory education was not as wide-spread as at present and when more children were consequently growing up without instruction. Beginning with the idea of imparting the more rudimentary branches, such schools have extended their scope until in some cases they form departments of institutions devoted to the study of art, science, or technology. In some of its wider aspects their work has become allied to the university extension movement.

Central Europe.— The evening schools in central Europe are largely the outgrowth of Sunday-schools which shortly after the middle of the 18th century began to add elementary secular instruction to religious teaching. The school age limit being less than at present, a review or continuation of school studies seemed of great importance. In Germany, beginning with lessons in arithmetic and the mother tongue, the range of instruction gradually widened. Some states made attendance obligatory at such Sunday-schools in certain cases. At present the term *Fortbildungsschulen* (literally «further developing schools») is applied in Germany and Switzerland to schools intended for pupils who have passed the elementary school age and yet who study the elementary branches. These *Fortbildungsschulen* are open only in winter and rarely require more than six hours of attendance in the week. Their object is to give boys a practical turn of mind by instruction fitted to bear upon their future callings. They do not furnish instruction in foreign or dead languages or the higher mathematics. In Switzerland, all the 25 cantons have systems of *Fortbildungsschulen* held on Sundays, holidays, and in the evening. The evening schools of France, now numbering many thousands, appear not to date back farther than 1820. The tendency is toward technical training rather than liberal studies, but there are also evening classes or lectures open to those who desire a broader culture.

Great Britain.— In 1806 a benevolent association founded an evening school in Bristol, England, for young persons who were working for a living. In 1811 a school for adults was started in Bala, Wales, and others shortly followed in London and other towns. Such schools were originally supported by private benevolence or local funds, but the government after a time saw the wisdom of aiding them by grants. Since 1861 this aid has been greatly increased, but is not intended to supersede local effort. According to regulations issued by the Board of Education of Great Britain for the school year ending 31 July 1903, local funds are expected to meet 25 per cent of expenditure for the evening schools, and such expenditure must be approved by the board. The schools must not be conducted for private profit. They are under supervision and examination by the board, are subject to its examinations, and must report to it. Schools charging no fees are not generally recognized. Instruction must begin after 4 P.M. or on Saturday after 1 P.M. Students under 12 are not admitted nor those who attend day schools under government inspection (art students being excepted). Not more than 160 hours of instruction may be counted for any student in one year. The courses are as follows: (1) Literary and commercial; (2) art; (3) manual instruction; (4) mathematics and science; (5) home occupations and industries. The last course is largely for girls and includes "home nursing." The boys may take a course in ambulance training, in gardening, etc. Throughout London the evening schools give instruction in gymnastics, and swimming and life-saving methods have been taught to some of the pupils. Evening classes have been held in London at various institutions such as University College, King's College, South Kensington Museum, etc. In the so-called provincial colleges evening classes constitute an important part of the work. Special schools give instruction in commercial branches, courses for women, art, technology, and advanced science. The Education Department of Great Britain reported 28 Feb. 1900 for the evening schools of England and Wales 5,008 schools inspected, 474,563 pupils enrolled and grants equivalent to $914,370.

In Scotland the parliamentary grants for evening schools are administered by the Scotch Education Department, and are used as in England to supplement locally raised funds. The courses of study cover about the same ground. Gaelic is found on the curriculum, and agriculture, horticulture, navigation, military drill, and swimming may all be learned. The evening schools of Ireland are subject to more restrictions and are less flourishing than those of Great Britain.

United States.— The first successful evening schools of the United States began near the middle of the 19th century, although an attempt without permanent results was made in New York in 1834. Boston and other large cities soon followed and evening schools gradually became a recognized part of the common school system. The aims of the pupils in the evening schools being generally very practical and their minds more mature, the methods and subjects of instruction are varied from those of the day schools. Branches relating to commercial and industrial occupations are naturally preferred. Free evening schools for instruction in drawing exist in some cities and drawing is included in the curriculum of some of the regular schools. Evening high schools have become common and in addition to these extensions of the public school system, various important institutions, such as Cooper Union, New York; the Maryland Institute, Baltimore, and the Drexel Institute, Philadelphia, offer evening courses of a highly varied and very valuable character, and of a range resembling that of the day classes. Free lectures also connect such schools with university extension methods. One disadvantage recognized in evening classes for industrial workers, both here and abroad, is the fact that the fatigue consequent upon the physical exertion of the day prevents mental alertness and freshness. The evening schools conducted by the Young Men's Christian Association in the United States instruct 26,000 students. Their finishing certificates are accepted in about 100 institutions of college grade. The Young Men's Christian Association Evening Institute of Boston and the McDonald Educational Institute of Cincinnati, under the same auspices, have night law schools. In the 407 business and commercial schools reporting to the United States Bureau of Education in 1901, there were 20,470 students in evening classes. The evening schools connected with the city school systems of the United States reported in 1901, for cities of over 8,000 inhabitants, a total of 921 schools, 5,115 teachers, and 203,000 pupils, the greatest number of schools (718) being in the nine North Atlantic States, and the smallest number (12) in the nine South Central States and Territories.

Evening Star (also called **Hesperus** and **Vesper**), the name given to any one of the planets seen above the horizon before midnight; especially applied to the planet Venus on account of its brightness. Mars, Jupiter, and Saturn are the other chief evening stars.

Everdingen, ev'er-dĭng-en, **Aldart** or **Allart van**, Dutch landscape painter: b. Alkmaar 1621; d. Amsterdam November 1675. His sea pieces, in which he represents the disturbed elements with great truth to nature, are particularly celebrated. In forest scenes, too, he was a master. He is known also as an able engraver by his plates to 'Renard the Fox.'

Ev'erest, Mount, or **Gaurisankar**, that is, Mountain of the Gods, the highest known mountain in the world, is a peak of the Himalayas, in Nepal. It is 29,012 feet high, or about five and one half miles. It was named in honor of Sir George Everest, an Englishman who for a time was surveyor-general of India.

Ev'erett, Alexander Hill, American diplomatist: b. Boston, Mass., 19 March 1792; d. Canton, China, 29 May 1847. Graduated from Harvard in 1806, he was admitted to the bar, and, after serving as *charge d'affaires* at The Hague, was minister to Spain in 1825–9. He then became editor of the 'North American Review,' and was elected to the State legislature of Massachusetts. In 1840 he was appointed special agent to Cuba, and from 1845 until his death he was a commissioner to China. His work on 'Europe, or a General Survey of the Political Situation of the Principal Powers, with Conjectures on their Future Prospects' (1822) was highly esteemed in its time, and was published in French, Spanish, and German. In 1827 appeared his somewhat similar book on 'America.' Among his other volumes are 'Critical and Miscellaneous Essays' (1st series, 1845; 2nd series, 1847) and 'Poems' (1845). He wrote also biographies of Patrick Henry and Joseph Warren for Sparks' series of 'American Biography.' To the 'North American Review' he contributed a large number of essays. While resident in Cuba he was appointed to the presidency of Jefferson College, but ill health compelled his return north. He was at first a member of the National Republican or Whig party, but later supported Jackson.

Everett, Charles Carroll, American Unitarian clergyman: b. Brunswick, Me., 19 June 1829; d. Cambridge, Mass., 17 Oct. 1900. He was graduated at Bowdoin College; and studied at the University of Berlin. He returned to Bowdoin College, where he was tutor for two years, librarian for five, and professor of modern languages 1855–7. He was ordained pastor of the Independent Unitarian Congregational Church in Bangor, Me., 1859, but resigned in 1869 to become professor of theology in Harvard Divinity School, and was dean of the school from 1879 till his death. Among his published works are: 'The Science of Thought' (1869); 'Religion Before Christianity' (1883); 'Fichte's Science of Knowledge' (1884); 'Poetry, Comedy, and Duty' (1888); 'Ethics for Young People' (1891); and 'The Gospel of Paul' (1893).

Everett, David, American writer: b. Princeton, Mass., 29 March 1770; d. Marietta, Ohio, 21 Dec. 1813. He studied law in Boston, and while there wrote for 'Russell's Gazette' and a literary paper called the 'Nightingale.' He edited the 'Boston Patriot' (1809), and the 'Pilot' (1812). His works include: 'The Rights and Duties of Nations,' an essay; 'Darenzel, or the Persian Patriot,' a tragedy (1800); 'Common Sense in Déshabille, or the Farmer's Monitor.' He wrote the well-known lines beginning —

> You'd scarce expect one of my age
> To speak in public on the stage.

Everett, Edward, American statesman and orator, brother of A. H. Everett (q.v.): b. Dorchester, Mass., 11 April 1794; d. Boston 15 Jan. 1865. Graduated from Harvard in 1811, he pursued studies in divinity, became in 1813 pastor of the Unitarian Church, Brattle Street, Boston, and in 1814 published his 'Defence of Christianity' in reply to the 'Grounds of Christianity Examined' of George B. English. In 1814 he was also chosen to occupy the newly established chair of Greek literature. To qualify himself for the post he went to Europe in 1815 for a course of travel and study. He was for two years at the University of Göttingen, and later sojourned in France, England, Italy and Greece. In 1819 he returned to enter on the duties of his professorship. He became also in 1820 the editor of the 'North American Review,' and in 1820–4 contributed to it about 50 papers. He was elected to Congress in 1824, and by successive re-elections held his seat until 1834. Throughout this period he was a member of the committee on foreign relations, and in the 20th Congress its chairman. He drew either the majority or the minority report of many select committees. In politics he was a National Republican (Whig). He declined a renomination to Congress in 1834. In 1835 he was elected governor of Massachusetts, subsequently was three times re-elected, holding the office for four years, and in 1839 was defeated by a majority of one vote. While in Europe in 1840 he was appointed minister plenipotentiary to England. At a time when there were many points of controversy between England and the United States he was successful in the adjustment of numerous important questions. He declined in 1843 an appointment as commissioner to China, and in 1845 was recalled. In 1846–9 he was president of Harvard, and in 1852 he became secretary of state in Fillmore's cabinet for the last four months of the latter's administration. During this brief term of office he settled several difficult matters. In a diplomatic note he declined the joint proposition of Great Britain and France that the United States should enter a tripartite convention which should guarantee to Spain exclusive possession of Cuba in perpetuity. Before he left the department of state he was elected to the Senate. There he vigorously opposed the Kansas-Nebraska bill for the repeal of the Missouri Compromise. He resigned his seat in May 1854. From 1856 to 1859 he pronounced his well-known lecture on Washington in all on 122 occasions, realizing thereby nearly $60,000, which he turned into the treasury of the Mount Vernon Association for the purchase of Mount Vernon by private subscription. He prepared a collective edition of the orations and speeches of Daniel Webster, with an introductory biographical notice; wrote a life of General Stark for Sparks' 'American Biography'; and prepared for the 'Encyclopædia Britannica,' at the instance of Macaulay, a life of Washington afterwards separately published (1860). In 1860 he reluctantly became a candidate for the Vice-Presidency on the Constitutional-Union, or, as it was sometimes known, the Bell-Everett ticket,— John Bell (q.v.) being the Presidential candidate. The ticket received 39 electoral votes,— those of Kentucky, Tennessee and Virginia. During the Civil War he was a staunch Unionist, but disposed also toward a policy of reconciliation. He delivered the address at the dedication of the national cemetery at Gettysburg, Pa., 19 Nov. 1863, and in the Presidential election of 1864 as an elector-at-large he cast his ballot for Lincoln and Johnson.

His last public appearance was at his Faneuil Hall oration, 9 Jan. 1865, on behalf of the sufferers at Savannah.

Everett was noteworthy in his versatility,— a preacher and theologian, a Greek scholar, an editor and author, orator, diplomat, and statesman. He attracted much attention by his pulpit eloquence. As a Grecian he was thoroughly equipped and gave in his time a considerable stimulus in America to the study of Greek letters, antiquities, and history. His literary productions were carefully wrought and marked by his scholarship; but, through interruptions by other activities, they were limited, so far as published, chiefly to his 'North American' articles and the above-mentioned 'Defence of Christianity.' He did not complete a treatise on public law — a subject he was eminently fitted to expound,— on which he was for some time at work. His utterances in Congress showed him rather the orator than the debater, and while a member of the lower house he stood apart from much of party contention as it there appeared. He took, however, a prominent part in discussion, and, as indicated above, was a most valuable committee member. While he was a foreign minister the general negotiations regarding the northeastern boundary and Oregon difficulties were transferred from him through the appointment by Great Britain of Ashburton as special ambassador, yet many of the points in dispute were left to Everett's skilful adjustment. As representative, secretary, and senator he held to the possibility of saving the Union by compromise on the slavery question, but, the war once begun, he was among the ablest supporters and advisers of the Federal government. It is as an orator that Everett is best known. His addresses were generally written with elaborate care, and were of the Ciceronian type in the knowledge and culture displayed as well as in their finished rhetoric. More fully than any other American orator he combined the resources of learning with the arts of the speaker. He lacked Webster's fire and Phillips' magic, but his manner was always impressive and symmetrical. Even in his own time, however, his oratory did not escape criticism for lack of directness and artificiality, and this charge has frequently been made against it. He may be called the pioneer in the American "lyceum," which long had such a reputation. His 'Orations and Speeches on Various Occasions' were collected in four volumes in 1853-68. Consult also Dana, 'An Address upon the Life and Services of Edward Everett' (1865); 'A Memoir of Edward Everett' (1865); and Whipple's remarks in 'Character and Characteristic Men,' pp. 243-52 (1866).

Everett, Joseph David, English physicist: b. Rushmere, near Ipswich, 11 Sept. 1831. He was educated at Glasgow University; was professor of mathematics King's College, Nova Scotia, 1859-64; assistant in mathematics Glasgow University 1864-7; and professor of natural philosophy in Queen's College, Belfast, Ireland, 1867-97. His scientific career has been a most distinguished one. He took a leading part in the selection and naming of dynamical and electrical units, and drafted a report (1873), the adoption of which originated the C. G. S. system now generally employed. The names "dyne," "erg," and "C. G. S. unit" were introduced at his suggestion. His 'Universal Proportion Table,' published in the 'Philosophical Magazine' (1866), was the first application of the parallel column arrangement for obtaining a slide-rule with very open scale. His English version of M. Privat-Deschanel's 'Traité Elementaire de Physique' (1870-2) was so largely re-written as to be almost an original work. Other of his publications are: 'Centimètre-Gramme-Second System of Units' (1875); 'Elementary Text-Book of Physics' (1877); 'Shorthand for General Use' (1877); 'Vibratory Motion and Sound' (1882); etc.

Ev'erett, William, American educator, youngest son of Edward Everett (q.v.): b. Watertown, Mass., 10 Oct. 1839. From 1870 to 1877 he was assistant professor of Latin at Harvard. He has been master of Adams Academy at Quincy, Mass., 1877-93 and since 1897, and was member of Congress 1893-5. He has preached occasionally in Unitarian churches, and is the author of 'On the Cam' (1865); 'Changing Base' (1868), 'Double Play' (1870), two books for boys; a poem, 'Hesione, or Europe Unchained' (1869); 'School Sermons' (1881); 'Thine, Not Mine'; and many pamphlets on political, literary, and religious subjects.

Everett, Mass., city in Middlesex County, three miles north of Boston; on the Boston & Maine Railway, and with connection by electric surface lines with Lynn, Salem, Chelsea, Boston, and adjacent towns.

Industries, etc.— According to the report of the 12th United States census there were in Everett 168 establishments, with a capital of $6,107,735, employing 2,141 wage-earners at wages amounting to $1,068,987, and having a product valued at $5,038,120. The most important manufactories are a chemical plant, structural iron foundries, steel works, and gas and coke works.

Institutions, Buildings, etc.— There are two public libraries, the Shute Memorial and the Parlin Memorial, and the Whidden Memorial Hospital is also located here.

History, Government, etc.— Everett was settled in 1643, and until 1870 it was a part of Malden. It received its city charter in 1892. Its chief development was in the decade 1890-1900. The government is administered by a mayor, chosen annually, and a municipal council in which members of the lower chamber are elected by wards for one year, those of the upper chamber at large for two years. The more important of the subordinate officials are nominated by the mayor and confirmed by the council; the others are chosen by the council. Pop. (1903) 28,317.

Everett, Wash., city, county-seat of Snohomish County; on Puget Sound; on the Northern P., the Great N., the Everett & M. C. R.R.'s; about 55 miles east by north of Tacoma, and 30 miles north of Seattle. It has an excellent harbor with water communication with the Pacific, and agricultural lands, forests, and valuable mines nearby. Such a combination of natural resources is not common. Everett is the entrepôt of the towns and camps in a rich mining belt. Within a district 36 miles long and 20 miles wide, the Monte Cristo, Great Lake, Silver Creek, Troublesome, Sultan, Stillaguamish, and North Fork district send ores to the great smelter in Everett, and in various ways contribute naturally to the substantial growth of the city. The smelter and refinery plant obtains mineral from all over the Northwest. The city contains railroad shops, flour- and lumber-mills, factories, well-built brick buildings, churches, a theatre, a hospital, graded streets, electric light and motive power, sewers, schoolhouses, newspapers, etc. Its school system is excellent. Everett was settled in 1891, incorporated in 1893. Pop. 12,000.

Everett-Green, Evelyn, English writer: b. London 17 Nov. 1856. She is the daughter of Mary Wood Everett-Green (q.v.). She was educated at Bedford College, London; studied music at the London Academy; and for two years was a nurse in a London hospital. Since 1883 she has devoted herself entirely to writing. Among her many published works the best known are: 'The Last of the Dacres' (1886); 'St. Wynfriths' (1893); 'Dare Lorimer's Heritage' (1892); 'Dominique's Vengeance'; 'Shut In' (1894); 'Over the Sea Wall' (1894); 'Arnold Inglehurst the Preacher' (1895); 'Squib: His Friends' (1896); 'French and English' (1898); 'Odeyne's Marriage' (1899); 'The Heir of Haskett Hall' (1899); 'Monica' (1900); 'After Worcester' (1901); 'For the Faith' (1901); 'Olivia's Experiment' (1901); 'In Fair Granada' (1901); 'Fallen Fortunes' (1902); 'Alwyn Ravendale' (1902); 'Hero of the Highlands' (1903).

Everett-Green, Mary Anne (Wood), English author: b. Sheffield 1818; d. London 1 Nov. 1895. She moved to London in 1841 and for nearly 40 years was employed in the record office as one of the editors of the 'Rolls Series of State Paper Calendars.' The works edited by her include: 'Letters of Royal and Illustrious Ladies of Great Britain' (1846); 'Diary of John Rous' (1856); 'Letters of Henrietta Maria' (1857); 'Life of William Whitingham' (1870). Her only original work was the 'Lives of the Princesses of England from the Norman Conquest' (1850–5).

Everglades. The name given to a vast tract of land and water in the southernmost part of Florida, a region, though under the very eyes of the early pioneers and bordered by our own advanced lines of commerce and travel, as yet practically undiscovered. It is not a marsh, a swamp, nor a stagnant pool; neither land nor water. No white man has yet penetrated it for any great distance, either by boat or on foot, owing to the variance in the depths of the water and the dense tangle of saw-grass, scrub-willow and custard-apple which abound there. The State of Florida is one immense mountain top of limestone formation, covered with a network of pot-holes, varying in size from a few feet to thousands of acres; it has countless lakes of fresh water, fed by springs and subterranean streams, and among these is Lake Okeechobee, named by the Indians, Lake Mayaimi, and now known as the Everglades, an irregular body of water 130 miles north and south, and 70 miles east and west, the altitude of its rim being 12 feet above mean low tide in Biscayne Bay and a little less above the Gulf of Mexico. Over the rocky bottom of this lake lies a layer of muck, formed of alluvial deposit and decayed vegetation, varying in thickness from a few inches to several feet, and in this muck the saw-grass finds its origin, takes root and sometimes grows to a height of 10 feet. This saw-grass is one of the most peculiar and interesting features of the Everglades. Shooting up rapidly, pale green in color, as it goes through the water, fading in the sunlight to a dull golden tint, its blades are tough as bamboo, its edges sharp and jagged as a saw. Toward the western end of the lake it is interwoven with wild myrtle and forms an almost impassable barrier, running through the entire length of the lake, although there are some passages through it, known familiarly to the Seminole, but which are almost impossible to locate by the explorer.

Scattered along the eastern and western edges of the lake are numerous islands, some very small, others hundreds of acres in extent, covered with luxuriant growths of live oaks and bays, interspersed with wild cucumber, lemon, and orange trees. The papaya, the custard-apple, and prickly-ash are of frequent occurrence, and here and there may be seen the cabbage palmetto, the pine, and the rubber-tree.

The first white man to enter this mysterious, silent country was a Spaniard, one Escalente de Fontenada, who, after being shipwrecked in the Strait of Florida, was made captive and slave by the great cacique, Calos, but he has left us only a few meagre details of his experiences during his 17 years of captivity. Frequent expeditions of exploration have been sent out by the United States government to penetrate this wilderness if possible, but all have failed, each bringing the explorers, after days of hardships and privations, to the conclusion that the Everglades, though fascinating in its wildness, is a region to be avoided; a forest of trees, rank undergrowths, and saw-grass, impenetrable and practically valueless; and the lake a mixture of currents which seem to begin without reason, lead nowhere in particular, and generally end in a comparatively still pool, with a labyrinth of passages from which there seems no direct egress.

Animal life in the Everglades is fairly abundant, deer being found on both eastern and western shores, otter are plentiful, alligators and crocodile quite numerous, while the snake is there in large numbers. The Glades were once the breeding place for the egret, the ibis, and the heron, and, while many of them are yet to be found, the plume hunter has made such inroads that all are nearly extinct. The region is almost free of all insects, the constantly moving water affording no breeding-place for insect life. Small flies and gnats are found where the foliage is thick, as in all regions, and at certain seasons of the year the Everglade waters contain an annoying bug called the "alligator flea." Fish abound in the fresh waters, and the terrapin and a flat, soft-shell turtle are quite plentiful.

Probably the most interesting of the denizens of the Everglades are the Seminole Indians, divided into two clans or families, the Muskokis and the Mikasukes, who for hundreds of years have inhabited this section of Florida, defying all attempts to dispossess them, and in 1835, during the Seminole War, killing a large number of troops, under Major Dade, sent against them. A few have been captured and transported, but the majority still live there, having well earned the right to their homes, close to Nature's touch and with that indefinable bond of friendship which gives them access to her solitudes, knowing little of the white man's civilization and caring less. The shores of the streams by which the Glades are entered are covered with the cocoa-plum tree, which also grows about the edge of the Glades, producing a blue fruit on the eastern and a white fruit on the western edge. Wherever the land is sufficiently dry, the coontie-plant, really the Florida arrow-root, grows, and from these the Indian gets his sustenance, extracting flour and starch from the roots.

The physical features of the Everglades are beyond description, beauty and charm blending in a strange, sweet sense of mystery. In dry weather, when the water is low, it is possible to drive into the Glades, but the most beautiful and ideal approach is by water, all the rivers of the Glades finding their way to the sea, some by the rocky channels worn by their own age-long floods, and some through miles of wandering curves, their shores lined with forests of mangrove trees.

Looking into these forests, only the dark waters are to be seen. Ascending, the fresh water of the Glades overcomes the brackish tidal water, and the cocoa-plum takes the place of the mangrove. Still farther up the river, the cocoa-plum gives way to the cypress, and pond lilies are seen, the whole panorama of shifting green,— the lemon-like foliage of the cocoa-plum, the dark olive of the mangrove, and the lighter green of the cypress, enlivened by the sunlight,— making a scene of unique beauty.

In the perspective, when the water is low, the Glades, with its numerous islands and with the tall golden grass, gleaming in the sunshine, waving over a field of silver, ending with a sky-line of blue, has a charm for the eye, unequaled, perhaps, by any other spot in the world, and gives to the sightseer or explorer that subtle impulse and uncontrollable desire to adventure into this never-ending plain of grass and water, never reaching the goal but always seeking for something that lies just beyond the horizon.

The climate of the Everglades is faultless, showing no extremes of heat or cold, nor is it subject to sudden change. There are two seasons in the year, the rainy and dry, the latter including June and September, although light showers may be expected at any season, and in the autumn the humidity is very high. Malaria is seldom heard of, the pure air giving the best assurance of health, and it is small wonder that the ancient explorers spent years here trying to find the "Fountain of Youth."

The title to the Everglades is vested in the trustees of the Internal Improvement Fund of Florida, under patents from the Department of the Interior of the United States, by virtue of an act of Congress of 1850, and they are making efforts to drain the Glades and open it to actual settlers, the cost of reclamation being small compared to the great agricultural value, for once dried it would open up the best sugar lands in the South.

Ev'ergreen, Ala., town, county-seat of Conecuh County; on the Louisville & N. R.R.; about 100 miles northeast of Mobile. An agricultural school and experiment station, and the State Baptist Orphan Asylum are located here. Its mineral springs and agreeable climate make it a winter resort. Pop. 1,305.

Evergreen Isle, a poetical name given to Ireland.

Ev'ergreens, plants that retain their leaves in full verdure throughout the winter till the ensuing spring, when they ultimately fall. It was at one time a common error to suppose that evergreens never part with their leaves. The cause of the belief was that the old leaves do not fall until the young leaves have begun to appear, so that trees of this sort are never wholly without leaves. In warm climates many plants retain their leaves for several years, but no such plants are to be found native to temperate and polar climates. Among the best-known evergreens are most of the trees belonging to the order of the *Coniferæ*, the holly and ivy, box, privet, rhododendron, myrtle, etc.

Ev'erhart, Benjamin Matlack, American botanist: b. West Chester, Pa., 24 April 1818; d. 22 Sept. 1904. After a successful business career in his native town and Charleston, S. C., he retired in 1867, and devoted himself to botanical study, becoming a recognized authority on cryptogamic botany. With J. B. Ellis, of New Jersey, he published in 50 parts a notable work entitled 'The Century of North American Fungi,' describing 5,000 species, many of which were discovered by Everhart. With W. A. Kellerman, professor of botany in Ohio State University, he founded and edited 'The Journal of Mycology,' to which he contributed numerous articles on his specialty. Several new fungi discovered by him have been named after him by his fellow-scientists.

Everlas'ting Flowers, a name applied to certain plants belonging to the natural order *Compositæ*, from the fact that when dried they suffer little change in their appearance. By the French they are called *immortelles*, and this name has been introduced into our own language as applied to wreaths made of such flowers to be placed beside recent graves as emblems of immortality. The plants to which this name is peculiarly applied belong to the genus *Helichrysum*, and are natives of Cape Colony and Australia; but it is also given in America to members of allied genera, such as *Antennaria*, *Gnaphalium*, *Anapalis*, etc. The native women of Australia are fond of decorating their hair with the flowers of *Helichrysum elatum* and *Helichrysum bracteatum*. See AMARANTHUS.

Everlasting Pea, a popular name for plants of the genus *Lathyrus*, of the pea family. In the United States it is applied to the beach pea (*L. maritimus*), because it often blossoms until late in the fall. In England the everlasting pea is *L. latifolis*, a cultivated plant like the sweet pea.

Everts, Orpheus, American physician: b. 18 Dec. 1826. Since 1880 he has been superintendent of the Cincinnati Sanitarium. He has published 'Giles & Co., or Views and Interviews Concerning Civilization' (1878); 'What Shall We Do for the Drunkard' (1882); 'Facts and Fancies' (1896); 'The Cliffords, or Almost Persuaded' (1898).

Evesham, ēvz'ham or ēvz'am, England, a municipal borough and market town in the county of Worcester; on the Avon; 15 miles southeast of Worcester, beautifully situated in the vale of Evesham. It is an ancient place, and was the scene of a battle fought in 1265, which replaced Henry III. on the throne. It had a celebrated abbey, of which a fine tower and some other structures still remain. Market gardening is the chief industry. Pop. (1901) 7,101.

Eviction. See EJECTMENT AND EVICTION.

Evidence. "The word evidence considered in relation to law includes all the legal means which tend to prove or disprove any matter of fact the truth of which is submitted to judicial investigation." (Taylor.) Evidence may be either oral or documentary. Oral evidence is the statements made by witnesses during the trial; and documentary evidence consists of the production of papers, on which is writing, marks, or characters capable of being read, which are submitted during the course of the trial. Oral evidence must in all cases be direct: if it is of something that was seen, by the person who saw it; if of something heard, by the person who heard it; if of an opinion, by the person who holds that opinion; or if the knowledge was acquired in any other manner, by the person who perceived it in that manner. The general rule is that hearsay evidence is not admissible. Documentary evidence may be either primary or secondary. Primary evidence of a document is where the document itself is produced for the inspection of the court. When a document has been executed in counterparts, each counterpart is primary evidence against the party executing it; and where a document has been made by printing or any other means that will ensure an exact reproduction, each copy is primary evidence of the other copies, but none of them is primary evidence of the original. Secondary evidence of a document would be counterparts of the document as against the party who did not execute them, copies made from the original and compared with it, office copies, official copies, and oral evidence of the contents of a document by a person who has een the original. Before secondary evidence will be received the party offering it must show a legal reason why the original is not produced, such as being lost, destroyed, in possession of the adverse party, who refuses to produce it after notice to do so, or when it is a public document, or when it is in a country or place from which it is not permitted to be removed.

Either oral or documentary evidence may be given of any fact in issue or relevant to the issue; and where two facts are so connected, although one fact is and the other fact is not the issue or relevant to the issue, yet evidence of both may be given if that fact will render probable the existence or non-existence of the other fact which is in issue or relevant to the issue.

Admissions are statements made by a party to any proceeding and in reference to that proceeding, and they are admissible against the party making them, but not in his favor. Admissions may also be made by an agent, but to bind the principal they must be made by the agent in his regular course of business or employment. If an admission is made after an agreement has been entered into between the parties not to use it as evidence, it is not admissible, nor is it admissible in evidence made under duress. A confession is a statement made by a person charged with a crime stating or suggesting that he committed that crime. If made voluntarily it is admissible as evidence against him, but if made while the person is under any threat or promise which has been given by a person in authority, it is not admissible. Confessions may be made during the course of the trial, but if the question which produced the confession is an improper one, and after the witness had refused to answer it he had been compelled to do so, it is not a voluntary confession and therefore inadmissible. But if he made no objection to answering the question, it is admissible as a voluntary confession. A witness' opinion is received in evidence when it falls under the head of expert testimony; as, when the question is of some science or art, the opinions of persons specially skilled in that art or science are relevant. Any subject on which special study or experience is necessary to the formation of a correct opinion, is a science or art. The most frequent illustrations are medical and hand-writing experts. Before the testimony of a person called as an expert is received, he must satisfy the court as to his ability to form a correct opinion on the particular subject on which he is to testify. The general rule is that evidence as to a person's character is not admissible unless it is the fact in issue, except in criminal cases, but if a person introduce evidence to show good character, the other side may produce witnesses to show the contrary. All facts should be proved by the best or highest evidence. If a fact can be proved by a written instrument, the writing should be produced, and the party alleging a fact must prove it.

Evidences of Christianity, in favor of its divine origin, may be divided broadly into two great classes, namely, external evidences, or the body of historical testimonies to the Christian revelation; and internal evidences, or arguments drawn from the nature of Christianity itself as exhibited in its teachings and effects.

Among the earlier Christian apologists were Justin Martyr, Minucius Felix, Tertullian, Origen, Arnobius, and Augustine. Their work was continued by the schoolmen during the Middle Ages. In the 16th and 17th centuries the influences of the Renaissance and the Reformation gave rise to a spirit of inquiry and criticism which developed English deism as represented by Herbert and Hobbes in the 17th century, and Collins and Bolingbroke in the 18th. The general position of English deism was the acceptance of the belief in the existence of God, and the profession of natural religion along with opposition to the mysteries and special claims of Christianity. It was in confutation of this position that the great English works on the evidences of Christianity of Butler, Berkeley, and Cudworth were written. In France the new spirit of inquiry was represented by Diderot, D'Holbach, and the encyclopedists, who assailed Christianity mainly on the ground that it was founded on imposture and superstition, and maintained by sacerdotal trickery and hypocrisy. No reply of any great value was produced in the French Church, though in the previous age Pascal in his 'Thoughts' had brought together some of the profoundest considerations yet offered in favor of revealed religion. The 19th century was distinguished by the strongly rationalistic spirit of its criticism. The works of such writers as Strauss, Bauer, and Feuerbach, attempting to eliminate the supernatural and the mysterious in the origin of Christianity, were answered by the works of Neander, Ebrard, and Ullmann on the other side. The historical method of investigation, represented alike by the Hegelian school and the Positivists in philosophy, and by the Evolutionists in science, is the basis of the chief attacks of the present time against the supernatural character of Christianity, the tendency of all being to hold that, while Christianity is the highest and most perfect development to which the religious spirit has yet attained, it differs simply in degree of development from any other religion. Notable among later apologists of Christianity have been Paley ('Natural Theology'), Chalmers ('Natural Theology'), Mansel, Liddon, and others, Lecturers of the Bampton Foundation; in Germany, Luthardt, Ewald, Baumstark, and others. Consult: Hopkins, 'Evidences' (1864); and Fisher, 'Grounds of Theistic and Christian Belief' (1883; revised ed. 1902). See CHRISTIANITY; HIGHER CRITICISM.

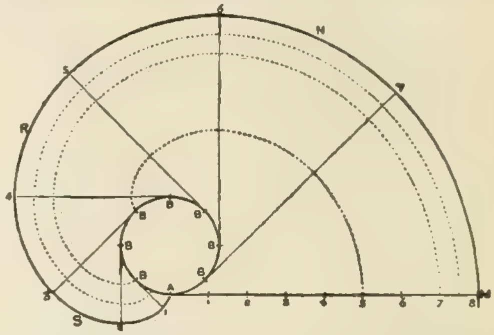
Evil, King's. See SCROFULA.

Evil, Origin of, the subject of extensive theological and philosophical speculation. The difficulty of the question lies mainly in the fact that the existence of evil in the world seems inconsistent with the view that it was created and is maintained by an omnipotent and beneficent creator. The various theories on the subject have all sought to elude this difficulty either by the supposition of some principle of evil equally eternal with that of good, or by regarding evil as having only a relative existence, being a kind of good in an imperfect and immature stage.

Perhaps the oldest theory on this subject is that of Parseeism, or the religion of Zoroaster, according to which there were two original antagonistic principles, one good (Ormazd) and the other evil (Ahriman). This is the doctrine that is now very often spoken of as Manichæism. In contradistinction to this dualistic theory with reference to the origin of evil stand the Monistic theories of Brahmanism and Platonism. According to the Brahmanic doctrine of the emanation of all things from one original being (Brahma), this original being was regarded as the sole true existence, and the phenomenal world, with all the evils appearing in it, was held to be mere illusion. Similarly Plato held that the good was the essence of all things, and that the evil and imperfect contained in them had no real existence. The theory enunciated by Leibnitz in his 'Theodicée' ('Vindication of God') resembles that of Plato. In that work he assigns to the evil existing in the world created by God, which he holds to be the best of all possible worlds, a merely relative existence; all that we call evil is, he holds, only evil to us because we do not see it in relation to the rest of the universe, for in relation to the universe it is not evil but good, and accordingly cannot be evil in its own nature. The traditional Christian account of the origin of evil is that given in Genesis. In the theology based thereon, Satan, the personal principle of evil, differs from the Zoroastrian Ahriman only in not being co-ordinate with the personal principle of good.

Evil Eye. See SUPERSTITION.

Ev'olute, In'volute, in mathematics, correlative terms first applied to the tracing of curves by Huygens, whose discussion of the subject is contained in his 'Horologium Oscillatorium' (1673). Under this distinction every mathematical curve is considered as one of a pair which are mutually produced. This may be explained in the following manner. Around a circular disk wrap closely a thread free at one end and fastened at the other. To the free end



Circle, BBB, as Evolute and its Spiral Involute, MNRSA

attach a lead-pencil. If, now, the string be held taut and unwound from the curve, a second curve will be traced by the pencil. The curve so traced is the involute of the curve whence the string is unwound. The given curve is the evolute of the curve traced. See CURVES.

Evolution, in the natural sciences a term used to denote the process by which an established state of affairs, or system of things, or degree of organization, after persisting for a time, gives rise to another. Thus, we speak of the evolution of the solar system, the evolution of continents, the evolution of plants, the evolution of animals, the evolution of man, the evolution of the brain, and so on endlessly. Evolution expresses the same idea as the term development, but it is convenient in biology to restrict the latter to the growth of the individual (ontogeny), and to keep the former for the growth or history of the race (phylogeny). The fundamental idea of evolution is the essentially simple one, that "the present is the child of the past and the parent of the future"; or, from another point of view, that "there is nothing in the end which was not also in the beginning." More concretely, when we say that the living creatures which we see around us have been evolved, we mean that they are descendants of ancestral forms on the whole simpler, and that these ancestors were descended from still simpler forms, and so on backward — till the scientific imagination loses itself in the mist of life's beginnings. The process of change has been on the whole, as the rock records plainly show, toward increased complexity of structure (differentiation) and toward increased unification and harmonious control of life (integration); but there are many cases of degeneration, both among plants and among animals, where the usual direction of evolution has been in a sense reversed, and where degenerate forms having bcome adapted to parasitic or sedentary or easy-going conditions, are in many respects simpler than their ancestors. In its higher reaches, especially in mankind, evolution has been in great part a progress in psychical integration; but the general idea is the same whether we are dealing with the increasing complication of skeletal architecture in sponges or with the increasing complication of cerebral convolutions in mammals.

Historical.— The evolution idea seems to have been recognized first in relation to human history; thence it was projected upon inanimate and animate nature. One form of institution grows out of another, one race out of another, one language out of another; thus the question arose whether the same may not be true of the order of nature as a whole. Laplace applied the idea in astronomy, and in his famous nebular hypothesis sought to show how the solar system may have been evolved from a simpler antecedent state of affairs. Similarly, Lyell was the most prominent among those who showed that in regard to the configuration of the earth the evolution formula is vividly descriptive. From inanimate nature and human affairs the fertile idea spread like a leaven to the study of fauna and flora and man himself. What Lucretius and much earlier thinkers had dreamed of, what Leibnitz and Schelling and Kant and other philosophers with strong interests in the outer world had sketched in general terms, what Buffon, Erasmus Darwin, Lamarck, Treviranus, Etienne Geoffroy St. Hilaire, Goethe, and others had ventured to promulgate, became through the work of Charles Darwin, Alfred Russel Wallace, Herbert Spencer, and Ernst Haeckel current intellectual coin — the theory of descent. From biology the idea spread to psychology, and the origins of instinctive, intelligent, and rational activities were sought after; finally the idea came home again to its original starting point, as a formula applicable to human history. Already the idea is fast becoming organic in our way of thinking about the origin of all present appearances — whatever be their nature — as a thought economizing formula applicable to all orders of facts.

Analogy of Evolution and Development.— Applied to plants and animals, the suggestion involved in the evolution idea is that the forms now existing are the descendants of relatively simpler ancestors, that they represent, as it were, the tips of many branches which gradually run together as we trace them backward or downward, till they finally unite in a common base — the original forms of life of which nothing is directly known. Moreover, it is implied that the evolution of a race, say of horses or of roses, has been a continuous natural process of slow transformation, just as the individual development of horse or rose-bush is demonstrably a continuous natural process of slow transformation from the apparently simple to the obviously complex. We know as yet but little in regard to the actual factors at work in the marvelous process by which a plant or an animal develops in a few days or weeks or months out of an apparently simple fertilized egg cell; similarly, we know as yet but little in regard to the actual factors which were at work in the marvelous process by which a race of plants or animals, or a particular type, is supposed to have evolved through unthinkably long ages from its apparently simpler presumed ancestors. In neither case has biology advanced far in its analysis of the factors, yet in both cases the majority of biologists would unhesitatingly accept the fact — that a bird grows from an egg by a process of natural development, and that the race of birds has arisen from a reptilian ancestry by a process of natural evolution. But while the development of the bird may be seen taking place, the evolution of the race of birds is hidden in the past; so that we naturally ask for the evidence which has led naturalists to the confident acceptance of the evolution doctrine.

Evidences of Evolution.— The evolution idea has been accepted by naturalists partly because it has proved illuminative in regard to other orders of facts, partly because it has been so useful in promoting and giving point to research, and partly because of certain so-called "evidences" which, though not demonstrative, have nevertheless a cumulative value in establishing a presumption in favor of the interpretation suggested. For it must be clearly recognized that the doctrine of organic evolution does not stand on a secure inductive basis, like for instance the doctrine of the conservation of energy or the theory of gravitation. We are aware of no facts which are contradictory to it, the constant accumulation of new facts brings none to light which it does not fit, but it is a logical error to speak of the doctrine as demonstrated. There is even a slight confusion of thought in speaking of the "evidences of evolution," since all the known facts of life may be construed as part of the evidence. But as there are certain kinds of facts which suggest the evolution idea more forcibly than do others, the nature of these may be indicated.

(a) It is well known that even within the short period covered by careful observation, the forms of life do not remain constant in their characters. Even among forms that are so essentially like one another that they are called by one name — the name of their species — changes are continually occurring. Some of these changes seem to be definitely related to use or disuse or to some alteration in the external conditions (or environment), and we call these modifications or acquired characters. It is very doubtful whether these are transmissible. But there are other changes which begin to appear before or at birth, and cannot be referred directly to changes in function or environment, but seem plausibly due to changes in the germinal material or hereditary substance before or during or after fertilization, and we call these germinal or congenital variations. There is no doubt that these are in varying degrees transmissible, though they may not always be transmitted. By selecting the possessors of suitable variations and causing them to interbreed, cultivators of plants and breeders of animals have in a short time reared many distinct races, as is well known in the case of cabbages and chrysanthemums, pigeons and rabbits, horses and dogs. If man by slight interference can secure these results in a very short time, the inference is suggested that in the enormous time during which living creatures have existed in the earth, proportionately great changes may have been wrought out.

(b) The immense array of plants and animals — living and extinct — that we know can be classified in orderly series. We see various types of organic architecture, bound together by structural affinities, grading into one another, rising one above the other in more and more elaborate complexity and gradually increasing integration. They can be arranged in a scheme of classification, which though still very imperfect may be expressed in the form of a genealogical tree. The suggestion is, that the affinities and gradations on which the classification is based, have a historical meaning, that they express blood relationships, that they point to a descent from common ancestors. Moreover, in a large number of cases the boundaries between what are called distinct species are seen on closer examination to be much less definite and discontinuous than they at first sight appear to be. Species is linked to species by intermediate varieties; genus is linked to genus, and family to family; nor are there wanting synthetic types or "missing links" which help us in imagination to bridge the gulf between distinct types, for example, *Peripatus* between annelid worms and insects, or *Balanoglossus* between some worm-like stock and vertebrates. Remarkable also is the manner in which in distinct groups the same organic material is turned and twisted to diverse results; how, for instance, essentially the same structure of muscle and bone, nerve and blood vessels, is used in vertebrate animals to form the frog's anterior limb, the bird's wing, the horse's fore leg, the whale's flipper, the man's arm, and so on. These homologies or essential similarities in structure and development seem to be most readily interpreted as expressions of a natural descent from common ancestors. Another notable fact is the frequent occurrence of vestigial structures, such as the rudimentary hind limbs of whales, the rudimentary two sets of teeth in the whalebone whales, the visceral clefts in reptiles, birds, and mammals, which are certainly homologous with gill clefts though all possibility of branchial respiration has disappeared. They are only of indirect use, and yet they persist, like, as Darwin said, the unsounded letters in certain words — practically of no direct use — yet giving (here the interpretation comes in) a hint as to the ancestry of the forms which possess them. They are relics of the past, and man himself in this regard carries about with him in his body a museum of antiquities.

(c) Alike in the history of a race as revealed in the geological record, and in the development of the individual organism, which is the problem of embryology, we find numerous facts which suggest, though they do not demonstrate, that the evolution conception is an adequate modal interpretation of the world of life. Thus we have the broad fact that in the history of the earth fishes preceded amphibians; amphibians preceded reptiles, reptiles preceded birds; and many other illustrations show that lower races appeared on the scene before higher ones. It is also possible to work out what are called "palæontological series," in which there is a structural progress in certain stocks, families, or genera, as we pass from later to more recent formations; for example, the series of horse-like mammals, of crocodilian reptiles, of nautiloid cephalopods, of ammonites, and so on through a long list. And again, the rock record discloses extinct types which bridge some of the structural gaps between the living races; thus, *Archæopteryx*, the oldest known bird, helps to link the modern birds to their presumed reptilian ancestry, and the extinct eurypterids lessen the apparent gap which separates the king-crab (*Limulus*) from other jointed-footed or arthropod animals. Not less suggestive is the study of individual development, showing a strikingly gradual progress from the apparently simple to the obviously complex, and an undeniable parallelism between stages in individual growth and grades of organization expressed in the adults of lower forms. It is more rhetorical than scientific to say that an animal in its individual development "climbs up its own genealogical tree," especially since the construction of that hypothetical genealogical tree depends partly on the data furnished by the study of development; but even a brief study of the fortunately preserved stages in the individual growth of fossil cephalopods, or of the familiar circuitous life history of the common frog, shows a parallelism between individual development and racial history which is strongly suggestive of the evolution idea. At the same time, it must be re-emphasized that conviction as to the value of the evolution theory is to be attained, not by a laborious induction, but by its practical justification of itself as a working formula in the study of all orders of facts.

Factors in Organic Evolution.— By the cumulative force of the presumptive evidence we may become convinced that the race of birds evolved from a more ancient reptilian stock, and that the thousands of different kinds of living forms have evolved from a few primitive types, of which we get some hint in *Archæopteryx*, the oldest of the extinct birds. It is quite another matter, however, to profess to understand the precise steps and factors in the process by which "the slow, cold-blooded, scaly beast ever became transformed into the quick, hot-blooded, feathered bird, the joy of creation." The only possible method is to discover the factors which are at present at work in nature, to combine these in a consistent theory, and to test this by applying it to the concrete facts. As it is quite likely that we have not as yet detected all the factors at present operative in producing organic change, and still more likely that we have not succeeded in rightly estimating the relative value of these factors, no completeness can be claimed for the theory of organic evolution in any of its forms. It is also evident that the process of verification which must succeed the process of interpretation will necessarily demand prolonged observation and experiment. The logical possibilities deduced from a study of particular cases, must be shown to be real possibilities for each particular case. Already, however, considerable progress has been made in this respect, and a more stable evolution theory is being gradually evolved.

Originative Factors.— When we compare children with parents, brother with brother, neighbor with neighbor, native with foreigner, but always keeping within the limits of what is called a species, such as the domestic sparrow (*Passer domesticus*), or the edible snail (*Helix pomatia*), or the buttercup (*Ranunculus Ficaria*), we find that the individuals are not by any means always alike in all their characters. We can measure many of the observed differences, and make curves expressing the results. There is no fact more certain than that changes in the structure of plants and animals do occur from generation to generation, and it is in such changes that we must find the raw material of evolution. When the observed differences are studied more carefully, it becomes apparent that a number of them may be directly connected with changes or differences in the surrounding influences or environment, or with changes in the activity or functions of the organism. It is characteristic of these changes that they do not appear till some particular change or difference in the environment or function occurs, and that they are usually exhibited in some measure by all the members of the species who may be subjected to the given environment, or who may exhibit the given change of function. In other words, they can be induced experimentally. It is convenient, as we have already noted, to call these changes "modifications," but they are often referred to under the title "acquired characters." A "modification" is a change in bodily structure which transcends the limits of organic elasticity, which has, that is to say, some persistence, which may, moreover, be correlated with definite changes in environment or in function. To take simple examples; the sun-burning of the skin in a tropical country; the changes in a plant's leaves and flowers when it is transplanted to a quite different habitat; the alterations of even skeletal structure which follow a peculiar occupation or function, like shoemaking; the change of color in a canary's plumage after a special diet; the dwarfing of water snails which are reared in confined space where they have insufficient exercise, etc.; the changes in a brine shrimp's tail induced by altering the salinity of the water, these are all "modifications"— bodily changes which have some measure of persistence. Such "modifications" are often of considerable value to the individuals who acquire them, as may be illustrated by unusual hardening of the skin on positions, like the sole of the foot, which are subjected to unusual influences of pressure, etc., in people who go barefoot. Many naturalists regard these bodily modifications as forming part of the raw material of evolution; but this cannot be the case unless modifications are as such in some degree transmissible to the offspring, and this has not as yet been proved experimentally. Unless the bodily modifications have a specific and representative effect on the germ cells, such that these, when they develop into offspring, will reproduce the modification in some measure, then these modifications, however important in the individual life, are not of direct importance in the racial evolution. It is much too soon to venture on any dogmatic statement on the subject, but as yet no secure evidence of the transmission of acquired characters has been furnished.

Now, when we consider the sum of observed differences, and the sum of what may be proved to be, or may be plausibly regarded as "modifications," we find that the latter do not nearly equal the former. It is necessary, therefore, to seek for some other source of the observed differences, and it is customary to call the residual differences (which remain after subtracting the modifications from the observed differences) by the technical name of "variations," the term being often qualified by such adjectives as "spontaneous," "congenital," "constitutional," "germinal" — all of which refer to the fact that we cannot relate them to differences or changes in environment or in function. These "variations" may appear very early, even before birth; they are exhibited unequally by the members of the species; they are certainly transmissible, though not always transmitted; they are such as may be fairly regarded as forming the raw materials of possible evolution. As to their causes, it is almost premature to speak, but there are several obvious possibilities, none of which is without some basis of fact. Thus (a) the variations may be due to the readjustment brought about in the mingling of hereditary qualities which occurs in the fertilization of the egg cell by the spermatozoon; or (b) they may be due to the influences on the complex germinal material exerted by the variable nutritive conditions within the body, or by the variable environment external to the body. There is no doubt that many diseased conditions have their beginning in a more or less mysterious germinal source; they cannot be ascribed to the direct action of environment or of function on the body; they are congenital, constitutional, innate changes. In some cases, where the rock record is very complete, it is possible to study the variations which occurred in the distant past. Thus, in ammonites and nautiloids, or in gasteropods like *Paludina* and *Planorbis*, the variations which lead on from one species to another have been studied with much success. In most cases, however, the rock record is much too imperfect to admit of this, and it thus becomes of fundamental importance to discover as much as possible in regard to the variations occurring in nature at the present time. For it is only when we have certain knowledge that such and such variations do actually occur now, that we are justified in supposing that similar variations may have occurred in the past. With this study of variation, especially by the use of statistical methods, considerable progress has been made. Thus we know that variations are continually occurring, and that some forms are more variable than others; that the variations can in many cases be registered on symmetrical curves, so that the use of the word "chance," except in its mathematical sense, is inappropriate; that it is common for an organism to vary, not in one particular feature by itself, but in many characters at once, as if it changed as a whole and not piecemeal; that some variations are merely what may be interpreted as due to an incompleteness in the expression of the normal inheritance, while others are new departures; that some variations are very minute, the variant differing from its parent just as one stage of individual growth differs from its antecedent; that other variations imply changes of considerable magnitude, new structural arrangements appearing suddenly and with some measure of completeness, so that they may be said to be "discontinuous" or "transilient," that some variations are disadvantageous and lead on to disease, while others seem from the first useful and adaptive to the conditions of life.

Directive Factors.— As we have seen, the raw material of progress is found in the continual crop of variations, and, according to some, in the continual occurrence of modifications. But as it is not certain that modifications are transmissible, they must at present be left out of the evolution scheme. It has been pointed out, however, that useful modifications may be of indirect importance in evolution by favoring the survival of those organisms which are plastic enough to acquire them till coincident congenital variations in the same direction may have had time to acquire strength and persistence. The adaptive modification acquired by each successive generation afresh, may act as "a screen to perpetuate and develop congenital variations and correlated groups of these." But this requires to be substantiated by concrete instances. Similarly, we require a period of precise observation before we can form a secure judgment in regard to the scope and adequacy of the directive factors of evolution, which are summed up in the terms "natural selection" or "elimination," and "isolation." At present our view must depend on our conclusions as to three debatable subjects: (1) The transmission of modifications or acquired characters; (2) the nature of variations and the proportion of these which are non-adaptive; and (3) the extent to which discriminative elimination occurs in the struggle for existence.

Natural Selection.— The "struggle for existence" is a convenient formula for a certain aspect of animate nature. Most living creatures have a tendency to rapid increase; the results of this often come into conflict with the increase of their means of subsistence, or even with the limitations of space; a further result is the elimination of the many and the survival of the few. In other words, many members of a species have a shorter life, and leave fewer or less successful offspring, than others. The so-called "struggle" — a term which must not be taken too literally — may begin before birth; for example, between the numerous possible egg cells among which only a few may survive, or between the numerous spermatozoa, only a small percentage of which may survive in successful fertilization. And the struggle may, as Darwin said, continue on to the hour of death. There is a second fundamental reason for the struggle, namely, the variability of the physical environment — climate, weather, temperature, illumination, pressure, etc.— to which organisms are at the best only relatively well adapted. On these primary conditions of struggle others depend; for example, that one kind of organism naturally feeds on another, or that there may be a disproportion between the numbers of the sexes, so that all cannot be mated. The struggle may be between the living creature and inanimate nature, between plants and animals, between one race of animals and another, between members of the same species, between rival males, . . . and so on till we come down to the germ cells. The objects, too, are as diverse as the possible parties; they include especially (1) individual existence and well-being; and (2) the continuance of family and kin — both of them objects of great complexity. The degrees of intensity are not less diverse — from life-and-death struggle for bare subsistence to a rivalry in the pursuit of increased pleasure; but the intensity will mainly depend on the rate of reproduction and the variability of the environment. In short, the struggle for existence is a function of numerous, partly dependent, partly independent variables. It is a general technical expression of what occurs whenever the effectiveness of an organic response is of critical moment in relation to continuance and well-being.

The fact of elimination is obvious, the difficulty is to decide how far it is discriminative. The occurrence of a storm may thin the ranks of an overcrowded community, but it cannot be assumed that the survivors do survive in virtue of the possession of particular characters. This has to be proved by careful comparison of the survivors and the eliminated, and it cannot be said that this has yet been done in a sufficient number of cases to give us the security we should wish to have in speaking of discriminate elimination or selection. The task is the more difficult since elimination does not necessarily mean immediate death, but may only mean a shorter or less vigorous life and fewer and less vigorous offspring. It is evident that when the farmer thins the turnip crop with rapid strokes of the hoe, he is for the most part an indiscriminating eliminator, though he may now and again pause to spare a particularly promising plant which happens to catch his eye. The theory of natural selection is based on the assumption (in some cases verified) of discriminate elimination, for the fundamental idea of the theory is that in the struggle for existence those forms are eliminated which are relatively unfit, the survivors being those which are varying in the direction of greater fitness or more perfect adaptation to the particular conditions of their life. It must be borne in mind that by the phrase "survival of the fittest," evolutionists always mean the survival of the fittest relative to given conditions.

Isolation.— It has often been urged as an objection to the Darwinian theory, that particular variations of small amount would tend to be lost or neutralized by intercrossing. In his artificial selection the breeder takes measures to prevent this by isolation, but what is the factor in natural conditions? In answer to this objection, it has been suggested that numerous similar variations may occur at once, for example, under the influence of a similar environmental stimulus. It may also be answered that the experience of breeders and cultivators shows that variations are by no means always readily swamped, even in the absence of isolation. Some new departures have a remarkable potency for persistence even when the conditions do not appear favorable. It is possible to conceive of a struggle for existence within the fertilized ovum, wherein the physical basis, corresponding, let us say, to a strongly marked paternal variation, asserts its "prepotency," and expresses itself in development through succeeding generations even without co-operation from a similar characteristic on the maternal side. But the answer which has been emphasized, especially by Romanes and Gulick, is expressed in the word isolation. Under this term is included a variety of ways in which free intercrossing between members of a species is prevented, for example, by geographical barriers, by changes of habit, by reproductive variations causing mutual sterility or incompatibility between two sections of a species living on a common area, and so on. There can be little doubt that isolation in some of its forms has been an important factor in evolution, but there is still lack of sufficiently precise evidence in regard to the supposed swamping without isolation, and in regard to the general prevention of free intercrossing.

Thus, at the present date, we are led to the conclusion that while the general conception of evoution stands more firmly than ever as a reasonable modal interpretation of organic nature, there is great uncertainty in regard to almost every question concerning the factors in the evolution process. It may also be noted in conclusion that the evolutionist's task is altogether a scientific one, and has in itself nothing whatever to do with ultimate problems. The evolutionist interpretation is not in the slightest degree a philosophy of nature, but an attempt to show how the present may be accounted for in terms of the past by the intrinsic factors observed to be at work. Neither in this nor in any of his tasks does the scientific investigator seek after ultimate explanations. At some point or other he assumes to start with an original institution of the order of nature, in other words a creation, and at no point does he imagine that he is doing more than working out a formula to fit facts.

JOHN FISKE.

Evora, ā'voo-rä (ancient EBORA), Portugal, capital of the province of Alemtejo, 72 miles east of Lisbon. It is a very ancient city; Quintus Sertorius took it in 80 B.C., and it was also conquered by the Moors in 715, but recovered from them in 1139. Among the famous Roman antiquities of Evora are the temple of Diana, with fine Corinthian columns; an aqueduct erected by Quintius Sertorius, and restored in the 16th century, which still supplies the city with water; and the beautiful tower, surrounded by Ionic columns, at the extremity of the aqueduct, and which, although it has existed since 70 B.C., is in almost perfect preservation. It has an archiepiscopal library, containing, besides some 25,000 volumes, several pictures of great merit. There are some manufactures of cotton, cloth, and hats, and a trade in wine. Pop. 15,134.

Evremond, ävr-môṅ. See SAINT EVREMOND.

Evreux, ā-vrė (ancient CIVITAS EBUROVICUM), France, the capital of the department of Eure; on the Iton; 57 miles west by northwest of Paris. It is one of the oldest towns of France, and its ruins and existing ancient Norman buildings show its antiquity. The most noted of the buildings are the Church of Saint Taurin, the bishop's palace, dating back to 1484; the Tour de l'Horloge, built in the same century, is also one of the prominent features of the town. The educational institutions located there include two theological seminaries, a library, a lycée, and a small museum. The history of the town has been of the same tumultuous order as that of many other towns in that section of France, having been taken from the Romans by Clovis; the Normans under Rollo pillaged the town in 892; Henry I. of England captured it in 1119, laying it in waste by fire; Philip Augustus of France took it in 1194 and in 1199; and during the wars of the 15th century between the French and English it was the scene of many bloody conflicts, being passed from the control of one to the other many times. The principal manufactures are hosiery, leather, tiles, and bricks. Pop. (of the commune) 17,113.

Ewald, Georg Heinrich August, gā-ōrg hīn'rĭH ow'goost ā'vält, German Orientalist and biblical critic: b. Göttingen 16 Nov. 1803; d. there 4 May 1875. As a student he published his first critical work, 'Die Composition der Genesis.' He became professor of theology at Göttingen in 1831, and in 1835 professor of Oriental languages. As one of the seven professors of Göttingen who signed the protest against the abrogation by King Ernest Augustus of the Hanoverian constitution, he lost his position, and accepted, in 1838, a call to Tübingen as professor of philosophy. He returned in 1848 to Göttingen, and resumed his old position. When Hanover was annexed by Prussia in 1866 he became a zealous defender of the rights of the ex-king, and this led to his removal from his university chair, though his salary was continued. He was elected several times a member of the diet, where he spoke strongly in favor of the restoration of the Hanoverian monarchy. His 'Kritische Grammatik der hebräischen Sprache' (Critical Grammar of the Hebrew Language) (1827), afterward merged in his 'Ausführliches Lehrbuch der hebräischen Sprache,' and continually enlarged (8th edition, 1870), formed an epoch in the study of Hebrew and placed Ewald in the first rank among scholars. 'Das Hohe Lied Salomos' (The Song of Solomon); 'Die poetischen Bucher des Alten Bundes' (The Poetical Books of the Old Testament); 'Die Propheten des Alten Bundes,' containing a translation and interpretation of all the prophets in chronological order; together with his 'Geschichte des Volks Israel' (History of the People of Israel); and 'Die Alterthümer des Volks Israel' (The Antiquities of the People of Israel), are his principal works on the Old Testament. The 'History of Israel' is considered his greatest work, and, like others of his more important writings, has been translated into English. On the New Testament he wrote, among other works: 'Uebersetzung und Erklärung aller Bücher des Neuen Testaments' (Translation and Explanation of all the Books of the New Testament). Another important work is 'Die Lehre der Bibel von Gott, oder Theologie des Alten und Neuen Bundes' (the Doctrine of the Bible regarding God, or Theology of the Old and New Testaments). He also wrote philological treatises on various eastern languages, and on subjects connected with them, among which may be mentioned works on the Book of Enoch, on Phœnician inscriptions, on Phœnician views regarding the creation of the world, on Arabic Grammar, and 'Linguistic Studies.' From 1849–65 he issued a serial almost entirely written by himself called 'Die Jahrbücher der biblischen Wissenschaft' (Year Books of Biblical Science).

Ewald, ā'väld, **Herman Frederik,** Danish novelist: b. Copenhagen 13 Dec. 1821. The most noteworthy of his novels are: 'Valdemar Krone: Story of His Youth' (1860); 'The Nordby Family' (1862); 'Johannes Falk' (1865); 'Charles Lyng,' a fine character study. He also wrote several historical novels popular both in the original and in German translations: 'The Swedes at Kronborg' (1867); 'Agathe' (1873); 'Knud Gyldenstjerne' (1875); 'Anna Hardenberg' (1880); 'The Queen's Maidens' (1885); 'Griffenfeld' (1888); 'Clara Bille' (1892).

Ewald, or **Evald, Johannes,** yō-hän'nĕs, Danish poet: b. Copenhagen 18 Nov. 1743; d. there 17 March 1781. At 15 he ran away and enlisted in the Prussian service. Being compelled to join a regiment of artillery at Magdeburg, instead of being attached to the hussars as he had been promised, he deserted the Prussian standard in the Seven Years' war, and entered the Austrian service. After a few months he returned home and began to apply himself seriously to theology. On the death of Frederick V. of Denmark he was requested to compose an elegy (1766); and the general admiration with which it was received roused his ambition and he soon became one of the most eminent lyric and tragic poets of his nation. His opera the 'Death of Balder' (1774), the subject of which is taken from the northern mythology, and his 'Rolf Krage' (1770), a tragedy taken from the ancient history of Denmark, are works which, notwithstanding many defects, bear the impress of true genius; but by some his lyrical drama 'The Fishers' (1779) is ranked as the finest of all his works. As a lyric poet he is most popular at the present day, and several of his odes and elegies are among the best that modern times have produced. Consult Jorgensen, 'Johannes Ewald' (1888).

Ewart, James Cossar, British zoologist: b. Penicuik, near Edinburgh, 26 Nov. 1851. He was educated at Edinburgh University, where he graduated M.D., and was appointed demonstrator of anatomy 1874. In 1875 he became conservator of the museum, University College, London; in 1878 professor of natural history, Aberdeen University; and in 1882 professor of the same, Edinburgh University, when he was also appointed member of the Scottish Fishery Board. In London he made researches into the bacillus of splenic fever, etc., and at Aberdeen founded the first marine laboratory in Britain, where, with the late Dr. Romanes, he made researches into the locomotor system of the echinoderms, which was the subject of the Croonian lecture of the Royal Society 1881. He conducts the fishery investigations into the fertilization and life history of the herring, whitebait, and other food-fishes, and directs a large corps of assistants in the work at various stations. He established lectureships in his university in embryology and the philosophy of natural history, and organized, for the students, a union. At Penicuik he has conducted the costly experiments, with which his name is widely known, into the development of the horse, and hybridizing of equine species, including the quagga, zebra, and island pony, in different ways; and disproved the hoary theory as to the influence of previous impregnation (telegony). Among his publications are: 'The Electric Organs of Skate' (1888–9); 'The Cranial Nerves and Lateral Sense Organs of Elasmobranchs' (1889); 'The Development of the Horse' (1894); 'Telegony and Reversion' (1887); 'A Critical Period in the Development of the Horse' (1889); 'Guide to Hybrids' (1900).

Ewbank, ū'bank, **Thomas,** American scientist: b. England 11 March 1792; d. New York 16 Sept. 1870. He came to America about 1819 and engaged in manufacturing (1820–36). He was United States commissioner of patents 1849–52. His publications include: 'The World a Workshop, or the Physical Relation of Man to the Earth' (1855); 'Life in Brazil,' with an appendix on a collection of American antiquities (1857); 'Reminiscences in the Patent Office' (1859); 'Thoughts on Matter and Force' (1858); and 'Inorganic Forces Ordained to Supersede Human Slavery,' an essay.

Ewell, ū'ĕl, **Alice Maude,** American novelist: b. Prince William County, Va., 7 Nov. 1860. She has published 'A White Guard to Satan,' an historical novel (1900).

Ewell, Benjamin Stoddert, American educator: b. Washington, D. C., 10 June 1810; d. James City, Va., 19 June 1894. He was graduated at West Point 1832, taught mathematics there until 1836, and later served as assistant engineer of the Baltimore & Susquehanna Railroad, becoming professor of mathematics at Hampden-Sidney College 1839, where he remained till 1846. He filled a similar chair at Washington University, Lexington, Va., 1846–8, when he went in the same capacity to William and Mary College, becoming its president 1854, and president emeritus 1888. He was in command of the 32nd Regiment, Virginia Volunteers, from 1861–2, and adjutant-general of the Confederate army on the staff of Gen. Joseph E. Johnston, when he was commander of the departments of Tennessee and Mississippi 1862–4.

Ewell, Marshall Davis, American lawyer: b. Oxford, Mich., 18 Aug. 1844. He was graduated at the University of Michigan Law School (1868), and was professor of common law in the Union College of Law, Chicago, from 1877 until the founding of the Kent College of Law, in which he became professor of international law, dean, and president. He is well known as a microscopist, and was elected a Fellow of the Royal Microscopical Society of London (1886), and president of the American Microscopical Society (1893). He has edited: 'Blackwell on Tax Titles' (1875); 'Illinois Reports' (Vols. XXXII.-XXXVI. inclusive, 1877); 'Washburn's Manual of Criminal Law' (1878); 'Evans on Agency' (1879); 'Lindley on Partnership' (1881); and written: 'Leading Cases in Disabilities' (1876); 'Treatise on the Law of Fixtures' (1877); 'Essentials of the Law' (1882); 'Student's Manual of Medical Jurisprudence' (1887).

Ewell, Richard Stoddert, American soldier: b. Georgetown, D. C., 8 Feb. 1817; d. Springfield, Tenn., 25 Jan. 1872. He was graduated at the United States Military Academy in 1840, and served during the Mexican war with Scott from Vera Cruz to the City of Mexico. At the outbreak of the Civil War he resigned his commission in the National army; joined the Confederates; was actively engaged throughout the war and attained the rank of lieutenant-general. He was at the battles of the first and second Manassas, where he lost a leg, Front Royal, Cross Keys, Port Republic, and Cedar Mountain; and was later placed in command of the Second Corps of Gen. Lee's army, upon the death of "Stonewall" Jackson. In this capacity he was in personal command and led the charges of the corps at the capture of Winchester at Gettysburg, the Wilderness, and Spottsylvania Court House, but was transferred to the Department of Richmond after these engagements, owing to his inability to withstand the hardships of another campaign, on account of his wounds. He was later captured at Sailor's Creek. After the war he retired to private life.

Ewer, ū'ėr, **Ferdinand Cartwright,** American Episcopal clergyman: b. Nantucket, Mass., 22 May 1826; d. Montreal, Canada, 10 Oct. 1883. He was graduated at Harvard 1848. After several years devoted to journalism he entered the Episcopal ministry and became rector of Grace Church, San Francisco, 1858. In 1862 he was chosen rector of Christ Church, New York, but his introduction of ceremonies and practices not usual in Episcopal churches caused so much opposition that he resigned 1871. Some friends organized for him the parish of St. Ignatius, New York, of which he continued rector till his death. He was an able controversialist, and wrote: 'Two Eventful Nights, or the Fallacies of Spiritualism Exposed' (1856); 'Sermons on the Failure of Protestantism' (1869); 'Catholicity in its Relations to Protestantism and Romanism' (1878); 'The Operation of the Holy Spirit' (1880); 'Grammar of Theology' (1880).

Ewers, ū'ērz, **Ezra P.,** American military officer: b. New York. He entered the army in January 1862, and after successive promotions was commissioned brigadier-general of volunteers in December 1898; and placed in command of troops in San Luis, Cuba. During the Civil War he distinguished himself at Hoover's Gap and in the battle of Chattanooga, and was brevetted major, 27 Feb. 1890, for gallantry in action against the Indians under Crazy Horse, Tongue River, Montana, 8 Jan. 1877.

Ewing, ū'ing, **Emma Pike,** American educator: b. Broome County, N. Y., July 1838. She was married to W. P. Ewing in 1863. Since 1880 she has been prominent as a teacher of and lecturer on cookery and domestic economy. She conducted a school of cooking in Chicago (1880–3); was professor of domestic economy, Iowa Agricultural College (1883–7), and Purdue University (1887–9). She has also been dean of the Chautauqua Assembly Cooking School (1882–99), and director of the model school of household economics in connection with Marietta College, Ohio (1898). She has published: 'Cooking and Castle Building' (1880); 'The Art of Cookery' (1897); 'Cookery Manuals' (1884); 'Text-books of Cookery' (1898).

Ewing, Hugh Boyle, American soldier: b. Lancaster, Ohio, 31 Oct. 1826; d. there 30 June 1905. He was educated at the United States Military Academy; in 1849 went to California in charge of an expedition sent out by his father, then Secretary of the Interior, to rescue emigrants from the snowbound Sierras, whence he returned in 1852; practised law in St. Louis 1854–6, and in Leavenworth, Kan., 1856–8. He served through the Civil War, becoming a brevet major-general; was United States minister to The Hague 1866–70, and wrote: 'A Castle in the Air' (1887); 'The Black List' (1893); etc.

Ewing, James Alfred, Scotch engineer: b. Dundee 27 March 1855. From early childhood his mind was bent on the study of scientific subjects, especially mechanical engineering, and after receiving an elementary education at the Dundee High School, he took a course of scientific studies at the University of Edinburgh. For several years until 1878 he was assistant in telegraph engineering, in which year he was appointed to the chair of mechanical engineering at the University of Tokyo, Japan. During his term of five years as instructor there he did much important work in measuring the vibrations of the earth during an earthquake by means of instruments of his own invention. So entirely new, original, and exhaustive were these investigations that in 1883 the university published them under the name 'Earthquake Measurement'; the Seismological Society of Japan also published some of the results of his researches. In 1883 he returned to Dundee, where he became professor of engineering in University College; in 1890 accepting the professorship of applied mechanics at Cambridge. He has published: 'Magnetic Induction in Iron and Other Metals' (1892); 'The Steam Engine and Other Heat Engines' (1894); 'The Strength of Materials' (1899); etc.

Ewing, John, American Presbyterian minister and mathematician: b. Nottingham, Md., 22 June 1732; d. Philadelphia, Pa., 8 Sept. 1802. As a youth he exhibited marked ability in mathematics and later took a course of study in Princeton College, where in his senior year he also acted as a tutor in the grammar school. Upon graduating in 1755 he was appointed instructor in the college. He then became interested in theology and after finishing his course in divinity was licensed to preach by the presbytery of Newcastle, Del. In 1758 he received his appointment as instructor of the philosophical department in the College of Philadelphia and in 1759 became pastor of the first Presbyterian church in that city, remaining such until 1773 when he was sent to England to solicit pecuniary aid in the establishment of an academy. In 1775 he returned to his native land, and in 1779, when the College of Philadelphia was changed to the University of Pennsylvania, he was placed in the station of provost, and officiated in that capacity until his death. He was elected to the vice-presidency of the American Philosophical Society and contributed many valuable articles to its 'Transactions.' He also contributed many articles on astronomical subjects to the American edition of the 'Encyclopædia Britannica.' He was also selected to serve on the commission to establish the Delaware State boundary line, and also to settle the boundary lines between Massachusetts and Connecticut, and Pennsylvania and Virginia. His 'Lectures on Natural Philosophy' (2 vols. 1809), and a collection of sermons were published after his death.

Ewing, Juliana Horatia Gatty, English writer for young people: b. Ecclesfield, Yorkshire, 1841; d. Bath, Somerset, 13 May 1885. She contributed largely to a magazine started by Mrs. Gatty, her mother. On her mother's death the magazine was edited by her and her sister conjointly, and many of her best stories first appeared in it. Of her delightful tales of child-life we may mention: 'Mrs. Over-the-Way's Remembrances' (1869); 'The Brownies' (1870); 'A Flat-iron for a Farthing' (1873); 'Lob-lie-by-the-Fire' (1874); 'Six to Sixteen'; 'Jan of the Windmill' (1876); 'A Great Emergency' (1877); 'We and the World' (1881); 'Old Fashioned Fairy Tales'; 'Brothers of Pity' (1882); 'The Doll's Wash'; 'Master Fritz'; 'Our Garden'; 'A Soldier's Children'; 'Three Little Nest Birds'; 'A Week Spent in a Glass House'; 'A Sweet Little Dear'; and 'Blue Red' (1883); and 'Jackanapes' (1884). A biography by her sister, Horatia K. T. Gatty, was published in 1885 under the title 'Juliana Horatia Ewing and Her Books.'

Ewing, Thomas, American statesman: b. near West Liberty, Va., 28 Dec. 1789; d. Lancaster, Ohio, 26 Oct. 1871. He was graduated at the Ohio University in Athens in 1815; admitted to the bar in 1816; and practised law for 15 years. He was a United States senator from Ohio 1831–7 and 1850–1; secretary of the treasury under President Harrison in 1841; and secretary of the interior under President Taylor in 1849. In the United States Supreme Court he ranked among the foremost lawyers of the nation. During the Civil War his judgment in matters of state was frequently sought by President Lincoln. When the capture of Mason and Slidell brought England and the United States to the very point of hostilities, Ewing sent the famous telegram that was really decisive of the whole trouble: "There can be no contraband of war between neutral ports" — and it was his advice that finally prevailed over Everett's opinion, and the envoys were set free.

Ex Parte, ĕks par'tē (Lat. "from a part"), a law Latin term used in reference to an action taken by either party to a suit or other legal proceeding, or on behalf of such party, without notice to the other. Ex parte evidence or hearings are frequently made use of without being regarded as an infringement of the rights of the opponent. In a derived sense the term indicates a lack of accuracy or impartiality in a statement.

Ex Post Facto (eks pōst făk tō) **Law** (Lat. "from what is done afterward"), one made after an offense and taking effect retroactively. The provision in the Constitution of the United States, Art. I., sec. 9, clause 3, that "no . . . ex post facto law shall be passed," has been interpreted to refer only to crimes, and in that sense the words are commonly used. The following have been decided to come within the scope of the phrase: Every law that makes an action done before its passage, and innocent when done, criminal, and punishes such action; every law that aggravates a crime, or makes it greater than when committed; every law that changes the nature of the punishment, or makes it greater than at the time the act was committed; every law that alters the rules of evidence so as to make it easier to convict the offender; every law that, while not avowedly relating to crimes, in effect imposes a penalty or the deprivation of a right; every law that deprives persons accused of crime of some lawful protection to which they have become entitled, as a former acquittal. Such laws are therefore contrary to the Constitution. Consult: Cooley, 'General Principles of Constitutional Law in the United States' (3d ed. 1900).

Exactions (from Lat. *exactio,* act of driving out, forcing out, a forced contribution), a legal term of ecclesiastical jurisprudence, used in the Middle Ages to denote such duties or contributions, demanded by the clergy of their parishioners, as were extraordinary, either because they were new and against custom or because their amount was unduly increased. They were illicit, and it was found necessary repeatedly to denounce their unlawfulness. The power of the clergy over their parishioners, or of the bishops over the subordinate clergy was so great that it was easy for them to make the most outrageous exactions. In 589 the third Council of Toledo forbade the bishops *exactiones diociesi vel damna infligare,* and the meaning of this is more exactly defined by Leo IV., who, in 853, forbade the bishops to exact from the clergy and ecclesiastical institutions of their dioceses "dationes ultra statuta patrum aut super appositæ in angariis." Yet, in 1179, Alexander III. found it necessary to repeat: "Prohibemus ne ab abbatibus vel episcopis, aliisve prælatis novi census imponantur ecclesiis, nec veteres augeantur nec partum redituum suis usibus appropriare præsumant."

Examiners, Medical, in some States, as Massachusetts and New York, county officials whose duties are practically those formerly discharged by coroners, whom they have superseded. See CORONER.

Exanthemata, ĕk-săn-thē'ma-ta, a name formerly widely employed to designate the acute infectious diseases that were characterized by an eruption — the eruptive fevers. The most important of these are measles, scarlet fever, chickenpox, smallpox, typhoid fever, and typhus fever (qq.v.).

Exarch, ĕks'ärk (Gr. ἔξαρχος, *exarchos,* leader), a title equivalent to governor (Lat. *rector*), in the terminology of civil government after the seat of empire was transferred to Constantinople. But already in the 4th century it acquired the signification of archbishop, metropolitan, or patriarch. In the acts of the first Council of Constantinople (381) the bishops of Alexandria, Antioch and Constantinople are styled exarchs; and the field of jurisdiction of an exarchos is exarchia. In the same period exarchos, exarchia were in use as designations of civil magistrates and their jurisdictions, the term diocese (διοίκησις, *diôecesis*) was also used. In ecclesiastical usage exarch came in time to be a title of honor apart from jurisdiction; thus, by the Council of Chalcedon (451) the bishops of Ephesus, Heraclea and Cappadocian Cæsarea, though deprived of their jurisdiction over the metropolitans previously suffragan to them, were permitted to be called by the title exarch.

Exauvilliez, Philippe Irenet Boistel D', fē-lēp ē-rē-nā bwäs-tĕl dĕks-ō-vē-ē-ā, French author: b. Amiens 6 Dec. 1786; d. 1858. His essay, 'The St. Gervais Library' (1831), gave the first impulse to the establishment of small libraries all over France. He translated Walter Scott's novels, from which he eliminated every passage which could be interpreted as telling against the Roman Catholic religion, and also all love passages as far as possible.

Excal'ibur, the famous mystic sword of King Arthur (q.v.) which, in accordance with the promise of Merlin, was given him by the Lady of the Lake. At Arthur's death it was hurled by Sir Bedivere into the lake, where it was seized and conveyed from sight by a mysterious hand. Consult: Tennyson, 'Idylls of the King.'

Ex-cath'edra (Lat. "from out the chair"): a phrase originally applied to decisions given by popes or prelates in a solemn judicial manner. Hence it is applied to every decision pronounced by any one in the exercise of his proper authority, as judge on the bench, etc.

Excavator, a machine for digging, moving, and transporting gravel, soil, etc. Excavators are made of two kinds, each adapted for different kinds of work. In making a long cutting, the first to come into operation is operated on rails, and employs a large «scoop» or bucket, with a lever heavy enough to counterbalance the bucket when filled with clay. The scoop is lowered and driven into the bank until full. It is then raised by the suspension chain, and dumped by the chain on the lever. The second class of excavator is employed to make the cutting wider. Its sides are made sloping to an angle of 45°, and on the top of the bank a temporary line of rails is laid a few feet from the edge. The machine is placed on the rails at the end of the cutting; the jib is lowered until the row of buckets it carries can cut into the clay; these scrape up the bank, reaching the top of it full of soil; they next pass over the machine, and are emptied into the wagons beyond it.

Excellency (from Lat. *excellentia*, superiority) a title of honor given to ambassadors, governors of British colonies, and the governor of Massachusetts. The President of the United States and the governors of many of the States have the same title by courtesy. In former times it was applied only to sovereign princes.

Excelmans, ěk-sěl-män, or **Exelmans, Rémi Joseph Isidore**, rā-mē zhō'zěf ē-sē-dōr, Baron, French marshal: b. Bar-le-duc 13 Nov. 1775; d. 10 July 1852. He entered the army in 1791, served with distinction at Austerlitz in 1805, and gained the rank of general of brigade for his conduct at Eylau in 1807. In the Russian campaign (1812) he commanded a division. He directed a corps at the battle of Waterloo, after which he passed four years in exile; was restored to his title as a peer in 1831, and became a marshal of France in 1851.

Excel'sior (Lat. «higher») (1) the motto of New York State. (2) A well-known poem by H. W. Longfellow, published in 1841, of which the opening words are: «The shades of night were falling fast.» The poem in its musical setting became in America a favorite academic song.

Excelsior, the trade name of a material invented in America and widely used for packing and as stuffing in mattresses and upholstery. It is made from logs of wood which have first been divided into 18 inch blocks. The fibres are separated from the blocks with great rapidity by knife-points, and packed in bales of 250 pounds weight. Not far from 45,000 tons are annually manufactured in the United States, and of this output large quantities are exported.

Excelsior Geyser, a geyser in the Yellowstone National Park, and one of the largest in the world. It has thrown a column of water to a height of 200 to 300 feet. See Yellowstone National Park.

Exchange, the act of exchanging or giving one thing for another. The term also signifies that which is so given. In commerce it is applied to a place where merchants, brokers, etc., meet to transact business; it is generally contracted into 'Change. The institution of the modern exchange dates from the 16th century. They originated in the important trading cities of Italy, Germany, and the Netherlands, from which last-named country they were introduced into England. The most celebrated are the Royal Exchange of London, the *Bourses* of Paris and Amsterdam, the Börse of Hamburg, and the New York Stock Exchange in Wall Street. In some exchanges only a special class of business is transacted. Thus there are stock exchanges, corn exchanges, coal exchanges, cotton exchanges, etc. For Bill of Exchange, see Bill.

Course of Exchange is the current price of a bill of exchange at any one place as compared with what it is at another. If for $500 at one place exactly $500 at the other must be paid, then the course of exchange between the two places is at par; if more must be paid at the second place, then it is above par at the other; if less, it is below it. *Arbitration of exchange* signifies the operation of converting the currency of any country into that of a second one by means of other currencies intervening between the two. In arithmetic *exchange* is a rule for ascertaining how much of the money of one country is equivalent in value to a given amount of that of another. In law, a mutual grant of equal interests, in consideration the one for the other is termed *exchange*. In physics the *theory of exchange* is a hypothesis with regard to radiant heat, devised by Prevost of Geneva, and since generally accepted. All bodies radiate heat. If two of different temperatures be placed near each other, each will radiate heat to the other, but the one higher in temperature will receive less than it emits. Finally, both will be of the same temperature, each receiving from the other precisely as much heat as it sends it in return. This scale is called the mobile equilibrium of temperature.

Exchange, an association providing an organized market for transactions in stocks or commodities. Thus a stock exchange deals in the shares or certificates of indebtedness of stock companies, a cotton exchange in cotton, and a produce exchange in grain and provisions. The rules of these exchanges establish a system by which stocks or commodities may be traded in either for investment or speculation; for immediate or future delivery; for cash, that is, payment in full, or to be carried on margin or security representing a certain percentage of the value of the stocks or commodities purchased. This system enables the trader or operator to be either long or short, to buy what he may not have the means to pay for in full, in hopes that he may sell at a profit on rising prices; or else to sell what he does not own, but is able to borrow in order to make delivery, the desire being that prices will decline so that he can buy at a profit, thus returning what he has borrowed.

There are stock exchanges in nearly every leading city of Europe and America, the London Stock Exchange, the Paris Bourse, and the New York Stock Exchange being, by far, the most important, their transactions leading all others in magnitude and scope. In the United States there are stock exchanges in Philadelphia, Boston, Chicago, Pittsburg, Baltimore, Cleveland, Cincinnati, Detroit, New Orleans, Denver, Indianapolis, San Francisco, Washington, Kansas City, Los Angeles, Providence, and Richmond. In Canada there are stock exchanges in Montreal and Toronto. Mining stock exchanges exist in Colorado Springs and Cripple Creek. The principal cotton exchanges are at New Orleans, New York, and Liverpool. The Chicago Board of Trade and the New York Produce Exchange are the leading markets for grain. There are prosperous coffee exchanges in New York and Hamburg. In New York be sides the Stock Exchange, there is a rival institution, called the Consolidated Stock & Petroleum Exchange, where there are dealings in stocks, oil, and other commodities. New York also contains, in addition to these two stock exchanges and the Produce, Cotton, and Coffee exchanges, a Maritime Exchange and a Metal Exchange. Chambers of Commerce and Boards of Trade may also be exchanges. For instance the Chicago Board of Trade is the controlling market for grain. But commonly they are not; and the Chamber of Commerce, and the Board of Trade and Transportation, in New York, are in no sense of the word exchanges, no buying or selling taking place within them. They are simply associations of business men for the promotion of commerce and its protection against adverse legislation.

Exchanges are an evolution of modern business. It was not until late in the Middle Ages that anything like the exchanges as they exist to-day were established. At first these were associations of merchants and bankers. The stock exchange is a product of the 18th century, and the produce and cotton exchanges of the 19th century, the system of option trading being a creation of the past 40 years. The Paris Bourse was founded in 1726, and the London Stock Exchange in 1773. The first stock exchange in the United States was founded early in the 19th century in Philadelphia. The New York Stock Exchange was organized in 1817, but the stock brokers had even then been working, for 25 years, under an agreement as to commissions, this agreement having been entered into as early as 17 May 1792. The merchants had a meeting place or exchange on Broad Street near Pearl in 1752. Sixteen years later the Chamber of Commerce was organized. The Tontine Coffee House built in 1794 was for many years the principal market place of the merchants, bankers and brokers of New York.

It is usual for the exchanges and the principal banks to be located in one quarter of the city and this quarter thus becomes the financial centre. In London the Bank of England and the principal banking houses and the stock exchange are located in Threadneedle, Throgmorton, and Lombard streets and Capel Court. In New York the financial district centres in Wall Street; which is a short narrow street reaching from Broadway to the East River. In this street are the Custom House (soon, however, to be moved to Bowling Green), the sub-treasury, the assay office, and many of the banks and trust companies. The financial district has, however, outgrown the narrow area of Wall Street, and takes in Broad, New, William, Nassau, and Beaver streets, and Exchange Place. But still the term «Wall Street» is commonly applied to the entire financial district, in which are located seven exchanges, the sub-treasury, 35 banks, 29 trust companies, and the general offices of fully 500 great railroad, insurance, express, telegraph, mining, industrial, and manufacturing corporations as well as of several thousand brokers. Many of the brokers are members of several exchanges, and there are close business relations between the banks, the exchanges, and the corporations.

Wall Street is not only the financial centre of America, but it is second only to London in the extent and volume of its transactions. Indeed the transactions of its clearing house now exceed those of the London Clearing House. Prof. Bryce in his 'American Commonwealth' says that the operations of Wall Street are vaster, more boldly conceived and executed with a steadier precision than those of European speculators. There are many and marked differences between the London and the New York Stock Exchange systems. These differences are, however, not essential. Both lead to the same result, though by different ways. Moreover both have a common origin in the natural desire of men to invest their surplus earnings in such a manner as to yield the utmost income possible with the largest safety. Formerly, all investments were practically limited to land, but the area of real estate investments is necessarily restricted, and moreover land, in order to be made to yield a profit, must be developed and tilled. This involves labor for which the merchant and professional man have no time or skill. But in the 17th century a new field for investments was opened. In the first years of that century the East India and Hudson Bay companies were formed and toward its close their shares began to be actively traded in. Stocks were thus added to land as objects of investment, and it is of interest to note that it was the shares of trading and promoting companies which formed the basis of the first stock market. For many years past the shares of transportation companies have been the chief objects of speculative interest, but recently the industrial and trading companies, as in the first years of the stock market, are becoming the most active.

Macaulay, in his history of England, gives a brief but graphic account of the beginnings of the London stock market. The step from investment to speculation was easy, and an extraordinary demand for stocks set in, which was met by the creation of many new companies, modeled on the East India and Hudson Bay companies, and as might be expected, many of these new corporations were bogus concerns, the offspring of criminal promotion. Early in the 18th century a remarkable speculation set in in the shares of the South Sea Company in England and of John Law's Mississippi Company in France. When these speculative bubbles burst, the inevitable panic followed, quickly made fortunes were wiped out, and persons who had invested their all, suddenly found themselves penniless. Many were forced into bankruptcy, and loss and distress were widespread.

For upward of a century the stock market of England existed on the curbstones and in the coffee houses of 'Change Alley. It was without habitation or name, or organization, and yet the business transacted was often of immense volume, and most of the terms of speculation, the slang of the market, were coined at that time. At length the need of organization became apparent and the London Stock Exchange was formed.

There was much the same evolution in America although, of course, it came later, and at first on a much smaller scale. The evolution began after the close of the long war for independence. The national government assumed the war debts of the States and the first Congress issued bonds to take these up. Banks were organized. Investments in these bonds and the shares of these banks were made by those people whose incomes were larger than their expenditures. Out of this demand for investment, speculation soon developed, and under a buttonwood tree, near 68 Wall Street, a number of stock brokers began to assemble every day to buy and sell the few then existing securities. As has been said they entered into an agreement, establishing regular rates of commission. For a quarter of a century the stock market thus existed on the Wall Street curb. In 1801 the stocks of three banks and three insurance companies and the bonds (then called stock) of the United States were traded in. In 1818 the market had increased to 29 different issues, including the shares of 10 banks and 13 insurance companies. The chief speculation was in the stock of the United States Bank.

After the organization of the New York Stock Exchange in 1817, the stock market developed rapidly with the expansion of the country. It was not many years before it outstripped the Philadelphia exchange, which had been the pattern on which it had been modeled. Bank, canal and industrial stocks long constituted the market, but in 1830 the first railroad stock was listed. Eight years later London also began to trade in American «rails.» In 1835 there were transactions in the shares of five railroads as well as of a number of bank and insurance stocks. The invention of the telegraph added greatly to the scope and power of the stock market. The establishment of the Bank Clearing House in 1853 contributed largely to its security. The creation of a national banking system in 1863, making New York a central reserve city, has by augmenting the deposits of the New York banks, promoted the expansion of the stock market. After the laying of the Atlantic cable in 1866 London prices began to be daily received in Wall Street, the markets of New York and London were brought closer together and arbitrage dealings between the exchanges of the two cities were established. The stock indicators or «tickers»— these being instruments by which quotations are simultaneously recorded in every banker's and broker's office as soon as made in the exchange — were adopted in 1867. Telephones were introduced in 1878.

The Exchange moved from place to place during the first 50 years of its life. It met for several years in the Tontine Coffee House and later in the Merchants Exchange (now the Custom House). Still later its board room was in Lord's Court. It was not until 1865 that it occupied a building of its own in Broad Street. Its earlier methods seem very primitive and crude compared with those of to-day. Its great defect consisted in the lack of a continuous market and in the secrecy with which its business was transacted and its quotations guarded. Still a very active speculation was developed, and during the Civil War the transactions overflowing the regular exchange, were carried on in the streets and were continued in the evening in the corridors of the Fifth Avenue Hotel and in uptown exchanges. The business was indeed larger outside of the exchange than in it. In 1864 a rival exchange was organized, known as the Open Board of Brokers. This was in 1869 consolidated with the older institution, and from this date the history of the Stock Exchange substantially as it now exists, begins. Radical changes were then made in government and methods, the most important being the establishment of a continuous market within specified hours, trading outside of those hours being prohibited. In 1892, the Exchange added to its mechanism a stock clearing house, which by eliminating unnecessary deliveries and reducing the number of certified checks employed in payment for stocks, has diminished the over-certification required by the brokers from the banks, and has thus expanded indefinitely the capacity of the Exchange to transact business. In 1903 the Exchange further increased its capacity by the erection of a new building containing a board room 138 feet long by 112 feet wide and 80 feet high, with every convenience of lighting, heating, and ventilating. So rapid had been the growth of its business in the preceding seven years that the Exchange imperatively needed the larger plant thus provided.

Since its organization in 1817 the Exchange has passed through a series of panics, the most severe having been those of 1837, 1857, 1873, and 1893. In 1873 the panic was so disastrous that the Exchange was compelled to close its doors for 10 days. There were briefer and less severe crises in 1818, 1826, 1848, 1866 and 1884. All these were periods of commercial reaction, the effects of which were felt all over the country, and indeed in all parts of the world. But there have been many periods of excitement in the market that were confined almost entirely to the arenas of the stock exchanges alone. The most notable of these was Black Friday, 24 Sept. 1869, which date marked the collapse of the celebrated gold conspiracy of that year. No other day in Wall Street history has equaled that in its concentrated excitement and passion and its wide contrasts of hopes and despair. The suspension of the Barings in London in 1890 produced a severe convulsion in the stock markets of Europe and America. In December 1895 the London and New York exchanges were convulsed by a sharp fall in prices as a consequence of President Cleveland's Venezuelan message, which contained a clause that seemed to threaten war between the United States and England. The excitement died out and the markets recovered their equilibrium as soon as it appeared that war would be averted. Another notable day in Wall Street was 9 May 1901, when the Northern Pacific corner and panic resulted in a collapse of prices, and the heaviest day's transactions on record, the total sales of stocks having been 3,336,695 shares.

As the New York Stock Exchange is the most important institution of its kind in the United States, and one of the three most important in the world, a description of its mechanism will answer for all the others. Its membership is limited to 1,100. Vacancies occur only by reason of death, resignation, insolvency or expulsion for fraud. A membership or «seat,» as it is called, is a valuable asset, and can be transferred by sale to any one approved by the governing body of the Exchange. The price of seats vary, being high in time of speculative activity and low in periods of stagnation. In 1871 seats were sold at $2,750. In 1885 the price had advanced to $34,000. In the dull year of 1896 it was as low as $13,000. Late in 1901 and early in 1902 it reached the high point of $81,000. In 1903 seats were sold at $60,000. The price of seats is a good index to stock market activity. Besides the price of a seat the applicant for membership must pay an initiation fee of $1,000. He must be a citizen, of legal age and receive 10 affirmative votes out of a committee on admissions composed of 15 members.

The London Stock Exchange has upward of 5,000 members, who are re-elected every year. Applicants for election must be recommended by three members of fours years' standing. Unlike the New York Exchange, the London institution admits to its floor a large number of apprenticed clerks of members, and these clerks may, after four years' service, themselves become members on fulfilling all the requirements governing admission. The Paris Bourse is composed of 60 agents de Change. To secure election, the applicant must be recommended by his predecessor and approved by the authorities of the Bourse and the minister of finance.

The membership of the New York Stock Exchange represents many parts of the United States. Bankers and brokers doing business in Chicago, Philadelphia, Boston, St. Louis, Buffalo, Detroit, and other cities are included in it. Many well-known financiers, as for instance, John D. Rockefeller, George J. Gould, E. H. Harriman and Russell Sage are members. But there are other capitalists equally prominent, as for instance, J. Pierpont Morgan and Jacob H. Schiff, whose names are not on its rolls. Such men as have been named, whether members or not, do business through those members who serve as brokers. Only about one half of the members act directly for outside speculators and outside investors. The others are either capitalists whose memberships enable them to have their orders executed at reduced commissions, or "room traders," who speculate on their own account, or "two dollar brokers," who execute the orders of other brokers, or "specialists," that is, men who are expert in certain inactive securities of which they make a special study.

The Exchange requires of its members the most honorable conduct and imposes severe penalties for fraud. It requires its members to maintain certain established rates of commission. For outsiders the rate is one eighth of 1 per cent, which amounts to $12.50 on 100 shares having an aggregate par value of $10,000. Business is done by members for members, who do not give up the names of principals at 1-32 per cent, and for members naming their principals, at 1-50 of 1 per cent, or $2 per 100 shares. The exchange is open every business day at 9.30 A.M., but no business is allowed until 10 o'clock. The sessions last until 3 P.M., except on Saturday, when the close is at noon. There is a chairman, but his duties are simply to open and close the sessions, make any necessary announcements, such as insolvencies and deaths, and to maintain order by fining members guilty of unruly conduct.

There are no "calls" and no formalities whatever. The members simply meet on the floor and those having stocks to buy or to sell make oral announcement of the fact, together with the amount and the price. Prices are made in fluctuations of eighths of 1 per cent, and no seller can offer stocks down more than one eighth of a point at a time. In the Board Room are a number of posts on which the names of the more active stocks are recorded and transactions in these stocks take place around these posts. All transactions are by word of mouth, the brokers simply recording the sales on little pads and communicating them to their offices by telephone. Nowhere else in the world is a man's oral promise so faithfully fulfilled as in a stock exchange. The sales, as made, are obtained by a corps of official reporters, and are immediately recorded on the "tape" of the stock indicator, of which there are about 1,800 in different offices and hotels throughout the city. The "tape" is a narrow ribbon of paper which feeds itself into the indicators and after receiving the printed impressions giving the sales and prices made in the Exchange, falls into baskets placed under the machine. No stocks or bonds are actually exchanged in the board room. All that takes place there are oral promises to deliver or receive a certain number of securities at a certain price. The actual delivery, if the transaction is "regular," must be made before 2.15 P.M. on the day following the sale. Transactions, however, may be made for delivery the same day, or for 3 days later, and there are buyers or sellers' options for not less than 4 or more than 60 days. No fictitious sales are permitted. Transactions are commonly for 100 shares or multiples thereof. The certificates of stocks must be in approved form for acceptance on delivery. Not later than one hour after the close of the Exchange the seller is obliged to compare or endeavor to compare each sale at the office of the buyer. All active stocks pass through the clearing house of the Exchange.

A stock clearing house was first established in Frankfort in 1867, and was speedily adopted in other European cities, and later in Philadelphia, but it was not until 1892 that it was put into operation in New York. Its success there is shown by the fact that in the great year of speculation of 1901 the number of shares cleared, both sides, including balances, was 926,347,300, having a value of $7,853,500,000. Clearances reduced the actual deliveries to 134,391,000 shares, having a value of $10,930,853,000. The check certifications that were obviated amounted to $17,065,042,800.

All sales made at the Exchange are for actual delivery and for payment in full on delivery. The broker carries stock for his customer on margin, which is usually 10 per cent of the market price, but the broker himself pays for the stock in full. In order to do this he deposits these securities with a bank, trust company or other lender of money as security for a loan. The lender usually requires from the broker a margin of 20 per cent. The process of speculation in brief, thus proceeds as follows: The customer orders his broker to purchase a certain number of shares at a certain price, or at the prevailing market price, at the same time depositing with the broker a sum of money equal to at least 10 per cent of the value of the stock. The broker immediately executes the order on the floor of the exchange. He compares the transaction with the broker who sold him the stock within one hour after the close of the Exchange. The transaction, if in an active stock, then passes through the clearing house. Unless it is eliminated by the clearing, the broker selling has to deliver the stock before 2.15 P.M. the following day, the broker buying giving a certified check, in full payment for the same. He then takes the stock and obtains a loan upon it from a bank. In this way transactions may be extended almost indefinitely, the only limit being the capacity of the banks to extend the necessary credit. The customer who has bought the stock may order it to be sold when the price has advanced, and his profit is the difference between the purchase and the selling price, minus the broker's commission and interest on the credit he has obtained.

If the operator sells for a decline in price the transaction is the reverse of this, although it follows substantially along the same lines. In this case stock is sold which the customer does not own. The broker, however, borrows the shares from another broker in order to make delivery, and when the price declines, if the customer so orders, he buys to cover the shortage, the profit to the customer being the difference between the selling and the buying prices, less commissions and interest. Speculation is mostly in the common stocks, preferred stocks and bonds being, as a rule, of the investment class. Investment, as distinguished from speculation, means the purchase of securities, paying for the same in full, and keeping them in safe deposit vaults for the income they yield.

The speculative transactions vastly outnumber the investment. In 1901 the sales of stocks aggregated 252,723,292 shares, an average of nearly 900,000 shares every day, and the vast bulk of this business was in the common stocks and for speculation upon margins. The total par value of the shares traded in amounted to $25,272,329,200.

The Exchange has strict regulations governing the admission of securities to the privileges of its market, and requires a large degree of publicity in regard to their financial condition from the corporations applying for the privileges of the list. The Exchange, however, has an unlisted department in which stocks and bonds which do not conform to these regulations may be traded in. Such unlisted securities labor, however, under some disadvantages, the banks often discriminating against them in the making of loans. In 1903 there were about 1,300 different stocks and bonds admitted to dealings in the listed and unlisted departments, these having an aggregate value of about $18,000,000,000. Less than 8 per cent belonged to the unlisted class. Securities not admitted to the Stock Exchange are traded in on the curb. The curb market requires the services of over 100 brokers and at times does an active business.

The Stock Exchange has a language of its own, the processes of speculation requiring many terms not commonly used in other lines of business, though some of them are now being generally adopted throughout the country. A «bull» is one who buys in anticipation of higher prices. He is «long» when he has bought or «loaded up» with a «line» of stocks. He sells to «realize» his profits, or is «wiped out» when his «margins» are exhausted. A «bear» is one who sells in anticipation of lower prices. He is «short» when he has thus sold what he does not own. He «covers» when he buys to realize his profits, or to protect himself against further loss in case prices advance instead of decline. He is caught in a «corner» when he finds that he cannot buy in order to make good the stock he has borrowed for delivery, the return of which has been demanded. He is then obliged to settle practically at a price fixed by those to whom he and other shorts have sold. «Lambs» are novices in speculation, and they are well «sheared» when the professional operators have succeded in relieving them of their margins. A «bucket shop» is a bogus brokerage establishment where there is no actual transfer of securities, but where bets are registered on the course of prices. These are a few of the best-known Wall Street terms. There are, however, many others.

The other stock exchanges in the United States are commonly conducted on the same system as that of the New York Stock Exchange. Their business, however, is for the most part in local securities, while the New York Stock Exchange is national in its scope, its market including the securities of the entire country, and a very few of other nations. The methods of the London Exchange are quite different. There the settlements are made every two weeks. In New York they are made every day. In London, there is a system of jobbers and brokers which is unknown on this side of the water. The jobbers are the wholesalers and the brokers the retailers in stocks. The brokers deal with the public, and the jobbers only among themselves and with brokers. The term «stock jobbing» springs from this system. The New York Exchange is governed by a governing committee elected by the members. This committee has almost absolute power like the directors of a corporation. There is a president elected every year. Governors serve four years, but their terms are so arranged that one fourth of their number retire each year. The London Exchange is controlled by a stock company, commonly called the «house,» having £240,000 capital, the shares being held by about one fifth of the members of the exchange. No more than 200 shares can be owned by one member.

Exchanges dealing in grain, cotton and coffee employ a system of which the principles are the same as in the stock exchange though worked out somewhat differently. Actual delivery of all product sold is contemplated in every trade, although the number of deliveries is reduced by clearances involving the settlement of differences. Brokers carry the grain, cotton or coffee for their customers on margin. The products may be bought for immediate or cash delivery or for delivery at some future period. The «option» system, as it is called, involves this principle of purchases for delivery months ahead. For instance, grain may be bought in March for delivery in December. Contracts mature on the last day of the month. If not settled for then, there is a default of contract. The established brokers' commissions for round trades, that is to say, for buying and then selling (thus completing the transaction), are $6.25 per 5,000 bushels of grain; $10 per 100 bales of cotton, and $20 per 250 bags of coffee. The usual margins demanded are, on grain, $250 per 5,000 bushels; on cotton $100 per 100 bales; and on coffee $325 per 250 bags.

The difference of one «point» in the price of stock amounts to $100 per 100 shares. The difference of one eighth of a cent a bushel in the price of grain amounts to $6.25 per 5,000 bushels. A point in cotton is one one-hundredth of a cent and amounts to $5 per 100 bales of 500 pounds each.

Ever since the first stock market was established, numerous attempts have been made to limit its operations and reduce the evils of over-speculation by legislation. The English Parliament passed an act to suppress stock jobbing in 1734. About 10 years ago an effort was made in this country to prohibit option dealings in agricultural products by law, and it has several times been proposed to restrict the operations of the stock exchanges by heavy taxation of all margin transactions. Legislation of this character has, however, failed of passage in the United States. In Germany, however, in 1894, laws were passed which greatly reduced speculation on the Berlin Bourse and for a time closed the Produce Exchange. So injurious was this to the financial and agricultural interests of Germany that the government is strongly in favor of the repeal or amendment of the law, and has in fact largely modified its enforcement. Those interested in this branch of the subject may read with profit an article on the Berlin Bourse which appeared in the 'Century Magazine' of September 1903. A powerful defense of the functions of the stock exchanges against the many criticisms which have been made upon them was given in an article in the 'Atlantic Monthly' early in 1903, written by Charles A. Conant. Books on Wall Street are not numerous, although there are many volumes of statistics, and brokers often issue works of reference and advice in the art of speculation. One of the earliest books which I have seen relating to Wall Street was issued in 1837, and is entitled 'A Week in Wall Street.' It gives an account, although an inadequate one, of the then existing mechanism of the exchange. An excellent 'History of the New York Stock Exchange' by its former president, Francis L. Eames, was printed in 1894 for private circulation, and is now out of print. A comprehensive account of the London Stock Exchange is contained in Charles Duguid's 'The Story of the Stock Exchange' (1901). The general description of the entire mechanism of Wall Street, with a history of its evolution, is given in 'The Work of Wall Street,' by Sereno S. Pratt (1903). Several excellent little volumes have been issued by S. A. Nelson entitled, 'The A B C of Wall Street'; 'The A B C of Stock Speculation'; 'The Theory of Stock Speculation'; etc. The best account of the laws governing speculative transactions is given by John R. Dos Passos' 'Treatise on the Law of Stock Brokers and Stock Exchanges' (1882). George R. Gibson has issued several pamphlets describing the operations of the European exchanges. Those interested in the history of speculation in the United States will find entertaining matter in Henry Clews' 'Twenty-eight Years of Wall Street.'

The exchanges are described by many writers as simply gambling establishments, but speculation has its uses as well as its abuses. One of its advantages is to give mobility to capital, which is thus enabled to turn quickly from one enterprise to another. Thus have the achievements of centuries been crowded into as many decades. There is no doubt that the exchanges, notwithstanding the great evils of over-speculation, have contributed mightily to the rapid development of America.

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Exchequer, ěks-chěk'ėr, in Great Britain, the department which deals with the moneys received and paid on behalf of the public services of the country. The public revenues are paid into the Bank of England, or the Bank of Ireland, to account of the exchequer, and these receipts as well as the necessary payments for the public service are under the supervision of an important official called the controller and auditor-general. The public accounts are also audited in his department.

Exchequer Bills, bills of credit issued by authority of the British Parliament as a means of raising money for temporary purposes. They are of various sums — £100 or any multiple of £100 — and bear interest (generally from 1½d. to 2½d. per diem on £100) according to a rate fixed at the beginning of each year. These bills pass from hand to hand as money, and form a principal part of the public unfunded debt of Great Britain. Exchequer bonds are similar, but they run for a definite number of years at a fixed rate of interest.

Exchequer, Chancellor of the. See CHANCELLOR.

Exchequer, Court of. See COURT.

Exchequer Tallies, seasoned wands of asn hazel or willow, formerly used for checking accounts in the English exchequer. Notches cut on the tally indicated by their form the class to which the account belonged.

Excipient (from Lat. *exipere,* take up, undertake), in pharmacy, an inert substance used to give form and consistence to solid preparations, such as pills, or to give palatability and the necessary qualities for administration to any medicine. The various conserves, also honey, treacle, simple syrups, glycerin, white of egg, and mucilage of acacia are among the most useful excipients.

Excise, a government inland duty or impost laid on commodities consumed, or on their retail, which is the last stage before consumption. Many articles, however, are excised at the manufactories. The word seems to be derived from a Dutch term of similar meaning, which in turn may be of same origin as *assise,* its present form being influenced by a supposed derivation from Latin *excisus.* For a more detailed explanation of excise, see CUSTOMS; INTERNAL REVENUE.

Excise Laws, in the United States. The long struggle of the English people against excise was not due to any intrinsic iniquity in the tax, but partly to popular dislike of all direct taxes (see CUSTOMS; TARIFF); partly to the inquisitorial methods involved, partly to their use as a means of strengthening the royal power against popular control. At any rate, the colonists inherited this unreasoned dislike, even under totally different conditions; though Connecticut had laid an excise on spirits and all use of foreign articles, and Massachusetts and Pennsylvania on spirits, before the Revolution. But all shrank from giving the national government such power, and several States proposed amendments to the Constitution forbidding the United States ever to lay excises. Hamilton, however, recommended to Congress in 1790 an excise on spirits, upon the most advanced modern grounds — that it would not only produce a revenue without burdening any worthy industry or person, but would check the consumption, to the great advantage of the community. With great opposition the law was passed, imposing a duty of 9 to 25 cents a gallon (according to strength) on all native spirits, and a higher one on imported. In 1792 the tax was lowered somewhat. Later, under Hamilton's advisement, the scope was extended to other articles of luxury, auction sales, stamp duties on instruments of exchange, etc. But it was nullified in some sections by passive resistance; at last in 1794 a furious open defiance began in Pennsylvania (see WHISKEY INSURRECTION), which had to be quelled by the regular army. There was no further resistance, but no cessation of the dislike, which was naturally a Democratic tenet, from the power it gave the general government; and when Jefferson became President, on his recommendation Congress abolished the entire system, which was possible from the large increase in customs receipts. The War of 1812, however, necessitated a fresh resort to it; and duties were laid on spirits (license tax), and the same articles Hamilton had chosen — sugar, carriages, auctions, and exchanges — with salt added. They were repealed in December 1817, and no further excises were levied till the system of internal revenue taxes (q.v.) was adopted in 1862.

Excito-motor Action, the action of nerves distributed to muscular organs the stimulation of which leads to movement. Thus, irritation of a nerve supplying a muscle will lead to contraction of the muscle by excito-motor action, and irritation of certain nerves distributed to blood vessels will lead to contraction of the vessel by acting on its muscular coat. See NERVOUS SYSTEM.

Exclusion, Bill of, a bill introduced into the British Parliament during the reign of Charles II. for the purpose of excluding the Duke of York, he being a Roman Catholic, from the throne. See CHARLES II.; JAMES II.

Excommunication, an act of ecclesiastical jurisdiction whereby a Christian is separated from the communion of the Church. This power was exercised by the Apostle Paul when in his first letter to the Corinthians, ch. v., he writes concerning a man guilty of incest that he «delivers such a one to Satan.» Authority for excommunication is found in the words of Christ reported in Matt. xviii. «If he will not hear the church let him be to thee as the gentile and the publican.» In the Roman Catholic Church there are two degrees of excommunication — major and minor. By the minor an offender is deprived of the use of the sacraments; by the major one is deprived of all manner of communion or communication with the faithful. In the times when the laws of the Church were enforced in their primitive rigor, the excommunicated were denied communication with the faithful not only in sacred things but in the common life. This is greatly modified now, and persons who have incurred the uttermost ecclesiastical censures suffer only the spiritual penalties attached to their offenses. But though the Church's excommunication has in the present time lost all its civil effects, a brief notice of these effects is necessary for an appreciation of the condition of an *excommunicatus vitandus,* that is, of a person under the major excommunication, who must be avoided by the faithful, under penalty of themselves incurring the minor excommunication.

A person who is under the major excommunication is disqualified for acting as judge or juror, notary, witness in courts of law, advocate, attorney; but he is competent to plead his own cause and to sue others on his own behalf. He cannot be a guardian of a minor, nor curator, nor executor of a last will, nor can he make contracts. He cannot act as a legislator. After death his body is deprived of Christian burial: and if it does get burial in consecrated ground in whatever way, it is to be dug up and cast out. The excommunicate under major excommunication must be shunned by all the faithful: they must not, under pain of excommunication (minor), communicate with him either by word of mouth or by writing; must not greet him, nor have exchange of gifts with him. If an *excommunicatus vitandus* happens to enter a church while the Mass is proceeding, he must forthwith be put out; if that cannot be, then the service must be suspended. Such is the letter of the laws; but long before these stern prescriptions went into desuetude there were notable assuagements of their rigor through the interpretations of moralists. To illustrate this by one example only: The serfs and servants and the children, grandchildren and other relatives (even by affinity only) were permitted to continue their relations of obedience and respect to their head even after he was excommunicated.

Excretory System, Comparative Anatomy of the. See ANATOMY.

Execu'tion, in law, the carrying into effect the final judgment, decree, or order of the court. Execution is effected by a writ or order directed to the proper officer and commanding him to do a certain thing. In civil law it is the means of obtaining that which the court ordered to be done by one of the parties. Execution may be had for either plaintiff or defendant. When taken out by the plaintiff it depends on the cause of action as to what is to be recovered under the writ; generally it is for the debt and costs, or for the goods, damages, and costs. When taken out by the defendant it may be for goods, damages, and costs, and in some cases it may be only for costs.

As soon as final judgment has been entered, the party entitled to it may take out his writ of execution, and he is entitled to this writ until the other party has taken some step which is a *supersedeas,* such as an appeal or writ of error. The writ issues from the court which last passed on the judgment on which the writ of execution is taken out. Execution may be against personal property, taking and selling it, or it may be against real estate, either holding it until the judgment is paid, or selling it, or in some cases by the seizure of the person of the defendant and holding him until the judgment is satisfied, or until he is declared insolvent. If the property is sold the fund derived from the sale is applied to paying the judgment and costs, and the surplus, if any, is returned to the former owner of the goods. A writ of execution, although issued at the instance of the party in whose favor the judgment is, must be directed to the sheriff, who must carry out the direction of the writ. If he fails to do so he must answer in damages to the injured party. When the execution is against personal property, such as goods and chattels, the writ of *fieri facias* is used. When the personal property consists of choses in action it is reached by a writ of attachment. If the execution is against real estate a writ of *scire facias* is used, and it is sold under a writ of *venditioni exponas*. In some cases, when the judgment is confined to a particular piece of real estate, the writ of *levari facias* is issued first, and it is sold under a writ of *venditioni exponas*. If the execution is against the person of the defendant a writ of *capias ad satisfaciendum* is issued, under which the defendant is arrested and his person held until the judgment is satisfied, or until the defendant is declared insolvent. Sometimes the defendant is released if security is given that the defendant will abide by the order of the court.

A general judgment binds all property owned by the person against whom the judgment is recovered at the time the judgment is entered, and it also attaches to all property he acquires up to the time the judgment is satisfied, and if the debtor sells any real estate before the judgment is satisfied, the property is not released from the lien of the judgment. When property is sold under an execution the purchaser only buys the title of the debtor, and all equities under which he held it still attach to the property.

In the criminal law execution is the carrying into effect the judgment of the court in relation to the person convicted. It consists in putting the convict to death according to his sentence. See CAPITAL PUNISHMENT.

Execu'tioner, the official who carries into effect a sentence of death, or inflicts capital punishment in pursuance of a legal warrant. In England it is the province of the sheriff to execute the extreme sentence of the law, but in practice the disagreeable duty is performed in his presence by an officer retained for this purpose. In Scotland the duty devolves upon the civic magistracy, but the strict letter of the law is avoided as in England by the attendance of a magistrate to witness the proceedings. Several executioners have become famous from their names being dragged into literature; such as Richard Brandon, the supposed headsman of Charles I.; Jack Ketch, commemorated by Dryden (Epilogue to the Duke of Guise), whose name was long vulgarly given to all who succeeded him (in London) in this odious office. In America, the title and duties of the public executioner differ in the various States. In some States the sheriff of the county becomes the executioner, but in New York State the warden of the penitentiary is technically the executioner. The duties are usually performed by one of his subordinates. In the army the provost-marshal is the military executioner. See CAPITAL PUNISHMENT; ELECTROCUTION; GUILLOTINE; HANGING.

Exec'utive, in the United States, roperly the entire official body charged with the execution of the laws, from the head to the lowest subordinate; but in current use, restricted to the head officer, as President (of the United States), governor (of a State), mayor (of a city), etc. (See CABINET.) The general executive of the colonies was the king; their individual executives, the governors, appointed by the crown or (in Rhode Island and Connecticut, and for a few years in Massachusetts) chosen by the people. These were succeeded *de facto* by the committees or councils of safety; then by officials usually called governor, sometimes president, and sometimes not by single persons, but by executive councils as in Switzerland. The general government had no executive till the adoption of the Constitution. The Continental Congress had only such functions as the State legislatures allowed it, which were to debate and ask for supplies and make recommendations, and the Articles of Confederation provided for no executive. The Constitution, although it gives the President large executive powers, compels him to share the most important, as appointments and treaties, with the Senate; it was only after debate, indeed, that a single executive was resolved on, there being a strong sentiment in favor of a plural executive representing different sections of the Union, and three States voted in favor of the latter in committee of the whole. (For the steady encroachments of Congress upon the President's executive powers, see CONGRESS.) The question of succession of executive power in case of the death or disablement of the chosen executive has been elaborately provided for by statute; in case of the President, first by succession of the Vice-President, then by a series of devolutions upon the various officers of the Cabinet, beginning with the secretary of state — so that nothing but a successful Gunpowder Plot, or rather a number of simultaneous ones, could paralyze national executive authority. The embarrassing cases of possible lunacy, paralysis, etc., have never arisen, nor has capture by the enemy; though the latter has twice been imminent — of Madison by the British in 1814, of Lincoln by Booth (the original plan) in 1865. But cases which have not occurred in 114 years may be left to deal with when they do occur. (For the problems of presidential elections, see ELECTORS; ELECTORAL COMMISSION.) The executive departments were first created in 1781 — Foreign Affairs, Finance, War, and Marine; previously, their work had been done by Congressional committees, or commissions appointed by them. They were reorganized in 1790.

Exec'utor (Lat. "performer"). An executor is one to whom another man commits his last will and testament for execution of that last will and testament (2 Black. Comm. 503). A person to whom a testator by his will commits the *execution*, or putting in force, of that instrument and its codicils. The following is a brief summary of an executor's duties:

(1) He must bury the deceased in a manner suitable to the estate left behind. But no unreasonable expenses will be allowed, nor any unnecessary expenses if there is risk of the estate's proving insolvent. (2) Within a convenient time after the testator's death, he should collect the goods of the deceased, if he can do so peaceably; if resisted he must apply to the courts for relief. (3) He must prove the will, and take out administration papers. (4) Ordinarily, he must make an inventory of personal property, and, in some States of real estate also. (5) He must next collect the goods, and chattels, and the claims inventoried, with reasonable diligence. And he is liable for a loss by the insolvency of a debtor, if it results from his gross delay. (6) He

must give notice of his appointment in the statutory form, and should advertise for debts and credits. (7) The personal effects he must deal with as the will directs, and the surplus must be turned into money and divided as if there was no will. An administrator must at once collect, appraise and sell the whole. The safest method of sale is a public auction. (8) He must keep the money of the estate safely, but not mixed with his own, or he may be charged interest on it. (9) He must be at all times ready to actually file an account within the year generally prescribed by statute. (10) He must pay the debts and legacies in the order required by law. Funeral expenses are preferred debts. See ESTATE.

Exegesis, Biblical. The world "exegesis" is from the Greek ἐξήγησις, primarily *a leading out,* and coming to mean, *an interpretation, an explanation, a making clear.* The verb ἐξηγέομαι occurs six times in the New Testament, always in the sense of revealing a fact or making clear a truth, Luke xxiv. 35; John i. 18; Acts x. 8; Acts xv. 12, 14; Acts xxi. 19. In John i. 18, we read, "No man hath seen God at any time; the only-begotten Son, who is in the bosom of the Father, that one became his exegete" (ἐκεῖνος ἐξηγήσατο). That is to say, Jesus *revealed* the inmost character of God. He *made manifest* what otherwise would have remained hidden. He *interpreted* God's being. He *made clear* the Divine providence and plan. His person and his whole teaching and life were an exegesis of the invisible and previously incomprehensible Godhead. What Jesus did for God's being and providence, the exegete endeavors to do for the Bible. He searches for its inmost meaning, explains what is obscure, leads out to the light what is less manifest, makes clear all its implications, and sets its complete import before the mind's eye. The task of Biblical exegesis, therefore, is to clear up all difficulties and to make plain the meaning of the Bible text. It might seem a comparatively easy thing to do this; but centuries of endeavor have shown that while all the essentials of the revelation in the Bible are reasonably clear there are problems connected with all of the Bible books which tax the utmost powers of the greatest minds to master them. Then at least four temptations beset the interpreters of Bible truth. One of these is apparent in those exegetes who

> "Each dark passage shun
> And hold their farthing candle to the sun."

What is clear in itself needs no further explanation. The office of the exegete becomes a necessity only when the meaning seems obscure. Another danger in exegesis is that of bringing a meaning *to* the text instead of drawing the meaning *from* it. The text is forced into agreement with previous prejudice or opinion. This is nearly always fatal to the truth. As an old monk said, "Whosoever seeketh an interpretation in this book shall get an answer from God; whosoever bringeth an interpretation to this book shall get an answer from the devil." Jerome put the same truth more mildly when he said, "He is the best teacher who does not bring his doctrine into the Scripture but out of the Scripture." Sometimes the obvious meaning of the text is unpalatable to the exegete, for doctrinal or other reasons, and then he is tempted to explain the meaning away. This is rankest treason to his calling. He is expected to be loyal to the truth and nothing but the truth. If he betray the truth in behalf of a political party or a church organization or a doctrinal system he is no longer worthy of his office or name. A fourth temptation is that of adding to that which is written, improving upon the text by the addition of unwarrantable inferences and subjective fancies and unjustifiable subtleties of every sort. It represents the presumption of the apostle Peter at Cæsarea Philippi, who thought he knew better than his Lord what ought to be said and done. These are four fundamental faults of all exegesis; a failure to explain the meaning that is obscure, a distorting of the meaning that seems obvious, an utter perversion of the plain truth, and a supplanting of the truth with merely human verbiage or wisdom. Wilful miscarriage, maiming, murder, and the substitution of a changeling for the true child are crimes in the realm of interpretation, as well as under the civil law. The science of exegesis has sought from the first to free itself from these faults. If it has not wholly succeeded as yet, that is simply to acknowledge that like all other science its development has been entrusted to fallible men. We may trace various schools of exegesis through the history of the Church, and in all of them some one or other of these fundamental faults is likely to be manifest.

The first important school of exegesis was founded at Alexandria, and it flourished from 150 to 400 A.D. Its most distinguished representatives were Clement, Origen, Athanasius, Basil, and the two Gregories. Of these the peerless prince was Origen, the greatest scholar and saint the Christian Church has produced since apostolic times. A great injustice has been done both him and the Alexandrian school by associating their names almost exclusively with the allegorical interpretation of the Scriptures, in which they sometimes indulged, as though this method were their only method or were peculiar to them alone. Neither of these things was true. The allegorical interpretation was much older than the Alexandrian school and has persisted in dragging out its pernicious existence to this day. It was prevalent and predominant in the Rabbinical schools of exegesis before the Christian era began. The Talmudists finally found a watch-word for their mystical exegesis in Pardes, or Paradise. The four letters of this word in the Hebrew, P R D S, were made to indicate the four words, Peshat or explanation, Remes or hint, Darush or homily, and Sod or mystery; and these in turn represented the four-fold interpretation of which every passage in Scripture was capable. Rabbi Ishmael declared that by means of these any Scripture could be expounded in forty-nine ways and the expositor could break every text into fragments, even as a rock is broken by a hammer (Sanhedrin, 34). The apostle Paul carried at least one example of allegorical treatment into our New Testament, probably suggested by his Jewish training in the school of Gamaliel, Gal. iv. 22-31. This method was introduced into Alexandria by Aristobulus and pseudo-Aristeas, and it became authoritative as a method of exegesis under Philo, the foremost writer among the Alexandrian Jews contemporary with the Christ. Philo found the method ready made to his hand, not only by the Jewish rabbis, but also by the Greek philosophers who had allegorized Homer and Hesiod and the ancient Greek myths into conformity with their more advanced ethics and faith. The Alexandrian church fathers thus found the allegorical interpretation in vogue among their heathen and Jewish neighbors and forbears. They believed it had a Scriptural sanction. They accepted it without question. Their genius and wide influence gave it a standing in the Christian Church for centuries; but the Alexandrian school never had a monopoly of its use. It is unfair, therefore, to hold them responsible, either for the origination or for the promulgation of this method of Scriptural interpretation. Origen did teach that there was a three-fold sense in Scripture, corresponding to the body, soul, and spirit in man—a literal and a moral and a mystical sense. But Jerome also made it a rule that the Scripture should be interpreted in three ways, historically, tropologically, and spiritually; and he related this three-fold division to the doctrine of the Trinity. And Augustine formulated one principle of his exegesis in these words, "Whatever there is in the word of God that cannot, when taken literally, be referred either to purity of life or soundness of doctrine, you may set down as figurative" ('De Doctr. Christ.' III. ch. 10. sect. 14). He wrote to Honoratus, "All that Scripture, therefore, which is called the Old Testament, is handed down four-fold to them who desire to know it, according to history, according to ætiology, according to analogy, according to allegory" ('De util. credendi,' 5). This four-fold division was adopted by many of the church fathers and found its final formulation in the famous couplet of Nicholas of Lyra,

Littera gesta docet, quid credas Allegoria,
Moralis quid agas, quo tendas Anagogia.

A good example of this four-fold sense was the Scriptural use of the word, Jerusalem. Literally, it was a city; allegorically, the church; morally, the individual believer; anagogically, the heavenly state.

This much may be said for the Alexandrian school in connection with the allegorical interpretation of the Scripture. (1) It did not originate this method. (2) It never exercised any monopoly in its use. (3) It found what seemed to it a sufficient sanction in the typology and allegory of the Apocalypse, the Pauline epistles, and the epistle to the Hebrews. (4) No other method of interpretation would have availed them, in their stage of Biblical knowledge and in their environment, for the defense of many portions of the Old Testament. Their adequate apology for yielding to the fourth temptation mentioned above is to be found in the necessities of their case. (5) Their use of this method grew out of their very piety and spirituality. These simply joined forces with their poetical imagination and philosophical insight in the endeavor to save the Scripture from contemporary disrepute. (6) They never used the allegorical method dogmatically and they avoided most of the excesses of the later day. "They are always intelligent and reasonable. They evaporated the letter; they did not stereotype the spirit" (Bigg, 'Christian Platonists of Alexandria,' pp. 149-50). Making all allowance for fault at this point, the fact remains that "Origen was the greatest Biblical critic and exegete of the ancient church" (Terry, 'Biblical Hermeneutics,' p. 639). His one object was to find and to set forth the edifying truth in the Scripture. He said, "The passages that are true in their historical meaning are much more numerous than those which are interspersed with a purely spiritual signification." Having adduced many passages in which a literal meaning seems impossible, he concludes, "Therefore, the exact reader must, in obedience to the Saviour's injunction to search the Scriptures, carefully ascertain in how far the literal meaning is true, and in how far impossible; and so far as he can, trace out, by means of similar statements, the meaning everywhere scattered through Scripture of that which cannot be understood in a literal signification" ('De Principiis,' IV. 1; 19). This is seen at once to be, as Davidson said, "not so absurd or injurious as many represent" ('Sacred Hermeneutics,' p. 68). Bishop Lightfoot is fully justified in saying of Origen, "A very considerable part of what is valuable in subsequent commentaries, whether ancient or modern, is due to him. A deep thinker, an accurate grammarian, a most laborious worker, and a most earnest Christian, he not only laid the foundation, but to a very great extent built up the fabric of Biblical interpretation" ('Commentary on Galatians,' p. 227). Farrar declares, "His knowledge of the Bible and his contributions to its interpretation were absolutely unrivalled" ('History of Interpretation,' p. 188). Fairweather adds, "Properly speaking, Origen was the first exegete. Everything done in this direction previously had been merely preparatory to a scientific interpretation of Scripture . . . One of the great merits of Origen is that he never shirks a difficulty. . . . Nothing could exceed his passion for verbal and grammatical accuracy, or his linguistic and critical insight, while his knowledge of the ancient theology is unique" ('Origen,' p. 120). Harnack calls Origen "the father of ecclesiastical science in the widest sense of the word," and says that he "was an exegete who believed in the Holy Scriptures and indeed, at bottom, he viewed all theology as a methodical exegesis of Holy Writ" ('History of Dogma,' II. pp. 332, 335). In Origen, therefore, we find the founder of scientific exegesis and the great master in this field. His faults were those of his age; his excellences have been an abiding blessing to the Church. Our age is coming to agree with Gregory Thaumaturgus in his Panegyric, when he says of Origen as an exegete, "That greatest gift that man has received from God, and that noblest of all endowments, he has had bestowed upon him from heaven, that he should be an interpreter of the oracles of God to men, and that he might understand the words of God, even as if God spake them to him, and that he might recount them to men in such wise as that they may hear them with intelligence. . . . He explained whatsoever was dark or enigmatical, . . . and set it in the light, as being himself a skilled and most discerning hearer of God. . . . He alone of all men with whom I have myself been acquainted, or of whom I have heard by the report of others, has so deeply studied the oracles of God, as to be able at once to receive their meaning into his own mind, and to convey it to others. For that leader of all men, who inspires God's dear prophets, and suggests all their prophecies and their mystic and heavenly words, has honored this man as He would a friend, and has constituted him an expositor of these same oracles; the things of which He only gave a hint by others, He made matters of full instruction by this man's instrumentality; and in things which He, who is worthy of all trust, either enjoined in regal fashion, or simply enunciated, He imparted to this man the gift of investigating and unfolding and explaining them; so that, if there chanced to be any one of obtuse and incredulous mind, or one again thirsting for instruction, he might learn from this man, and in some manner be constrained to understand" (Argument, XV.) It is the picture of the perfect pattern of the union of scientific investigation and spiritual insight which makes the model exegete. The transcendent genius of Origen lifted him above his age at many points, and the twentieth century is beginning to see that his conception of revealed truth is far superior to that of most of his successors in the history of the church.

It has been customary to denounce Origen and the Alexandrian school for their indulgence in allegory and to contrast with them most favorably the next great school of exegetes at Antioch. The most distinguished names here were those of Lucian, Diodorus, Theodore, Theodoret, and Chrysostom. We are told that these men were literalists rather than allegorists. They held rigidly to the historical and grammatical sense, and it is but natural that the historical and grammatical critics of the nineteenth century should applaud their opposition to the allegorical flights of the Alexandrians. However, it is well for us to remember that this school had its dangers and faults as well as the Alexandrian. Its literalism resulted in a rationalism which was like a dry rot in the church. Historically, it led directly to Arianism, which threatened to cut the tap-root of the Christian faith; and against this the orthodox exegesis of Athanasius the Alexandrian, proved to be the only safeguard of the church at the last. Its tendency was to narrowness, rather than to richness. What it gained in straitness, it lost in breadth. However, among all the Greek fathers, Chrysostom will rank next to Origen in uniting the best characteristics of both schools. "Through a rich inward experience he lived into an understanding of the Holy Scriptures; and a prudent method of interpretation, on logical and grammatical principles, kept him in the right track in deriving the spirit from the letter of the sacred volume" (Neander, 'History of the Christian Religion and Church,' II. p. 693). Origen and Chrysostom had no worthy successors in the next millennium of church history. Jerome has been called the Origen of the Western Church, but he was too hasty in composition, too much influenced by his personal prejudice, and too vacillating and uncertain in his own opinions to deserve this name as an exegete. His services in other directions were invaluable. He was the greatest scholar in the West as Origen had been the greatest scholar in the East; but he lacked the depth of character, the consistency of principle, and the consequent spiritual intuition of that greatest master in the early church.

Augustine has exerted a wider influence upon the Christian Church than any other of the church fathers. He was the chief authority through the whole of the mediæval age. Martin Luther was an Augustinian monk at the time of his conversion; and he and Melanchthon and Calvin and Bucer all built upon the foundations which Augustine had laid down. The works of the great Latin father have been read and reverenced by Protestant and Roman Catholic alike, and it is only in our day that serious question has arisen as to his right to continued supremacy. In the present reaction from the theology of the Latin fathers to the older and purer theology of the Greek fathers, it is in the field of scholarly exegesis that the inferiority of Augustine becomes most apparent. He was not even the equal of Jerome in scholarship. He knew no Hebrew. He was very deficient in his knowledge of the Greek. He preferred a translation to the original text. He was continually making mistakes as to the meaning of words. He had all the defects of his predecessors, without their excuse for them. The Alexandrians had been driven into the use of allegory to harmonize the Gospel teaching with the truth of Greek philosophy and to command the hearing and respect of their Jewish contemporaries. But Augustine was an allegorist of the allegorists, when no necessity was laid upon him and when allegory had degenerated into mere imaginative ingenuities. Augustine had genius and a genuine Christian experience and consequently flashes of illuminative interpretation are found in his books, but these cannot compensate for the lack of the critical faculty and a sound basis of linguistic scholarship in exegesis. "Spiritual insight, though a far diviner gift than the critical faculty, will not supply its place. In this faculty Augustine was wanting, and owing to this defect, as a continuous expositor he is disappointing" (Lightfoot, 'Commentary on Galatians,' p. 233). His total influence has been an immeasurable bane to Christendom. He was chiefly responsible for subordinating exegesis to ecclesiastical authority. He said, "For my part, I should not believe the gospel except as moved by the authority of the Catholic Church" ('Ep. c. Manich.,' ch. 5. sect. 6). He declared, "Now Scripture asserts nothing but the Catholic faith" ('De Doctr. Christ.' III. ch. 10. sect. 15), and he bent his exegesis to make good that declaration. He fastened upon the Christian Church the dogmas which have been the chief hindrances to its progress for 1,400 years: "the exaggerated doctrine of total human depravity," the guilt of innocent infancy, arbitrary election involving a practical denial of the freedom of the human will, atonement by quantitative equivalence in suffering, the subtle systematization of divine counsels and schemes, the imperious necessity of sacerdotalism and sacramentarianism, intolerance of opinion contrary to churchly authority, even when based upon an earnest and intelligent study of the revealed Word. Following his lead the Church has floundered for centuries through sloughs of despond and has almost forgotten the broader horizon and the fresher air of the high table-lands of the earlier theology. Among the Greek fathers no one of these questions which have afflicted our Latinized christianity found an atmosphere congenial enough in which to thrive. We owe much to Augustine, but it is hard for us to believe that his good influence can begin to equal his evil influence upon the Christian Church. His is the last great name among the church fathers. For a thousand years little or no progress was made in the interpretation of the Scriptures.

The Schoolmen contented themselves for the most part with copying and compiling the work of their predecessors in this field. It became a proverb among them, Si Augustinus adest sufficit ipse tibi. One of them stated plainly that no interpretation of Scripture must be accepted which ran counter to the authority of the Church, "however much such a sense may be in conformity with the literal meaning. Indeed that ought not to be called the literal sense which is repugnant to ecclesiastical authority" (Paulus of Burgos, 'Prol. in Additiones'). Even Gerson declares, "The literal sense must be judged according as the Church has determined" (Propp. de sens. lit. 3). With no independence of thought and with no fresh scholarship the schoolmen added no new principle of exegesis in a thousand years of commentary writing. They were expending their energies upon subtle and futile speculations. They composed great folios which aimed at nothing original and arrived nowhere in particular. They labored hard in a treadmill. They were weakest in exegesis. Only two or three of them knew any Hebrew, and the most of them knew very little if any Greek. They were unoriginal, uncourageous, uncertain, uninformed. They had a wrong notion of the Church and a wrong conception of inspiration, and it naturally followed that they had a wrong method of exegesis. They had their merits too, but not as exegetes.

With the Protestant Reformation we come to a new era in Scriptural exegesis. Coleridge said of the Reformers, "The least of them was not inferior to Augustine and worth a brigade of Cyprians, Firmilians, and the like" ('Remains,' III. p. 276). Calvin sweepingly asserts, "Modesty will not allow me to speak of ourselves as fact would justify; and yet I will most truly declare that we have thrown more light upon the Scriptures than all the doctors who have appeared under the Papacy since its commencement. This praise even they themselves dare not deny us" ('Antid. in Conc. Trid.,' Sess. IV). The Bible seemed like a fresh discovery to the Church of that day. For the first time it became the property of the common people; and the printing press made it possible for it to become a common possession. It had been locked up in the Latin tongue and was supposed to be the peculiar property of the priests. Translations now made it accessible to all and the Protestant preachers constantly appealed to its authority in their opposition to the usurpations and the abuses of the hierarchy. That necessitated a renewed study of the sacred text on both sides. It soon became impossible for a man to be a doctor of divinity for eight years, as Carolstadt confessed that he had been, before he had read his New Testament. The Protestants delighted to circulate such stories as that of Sixtus of Amana concerning Albert, archbishop of Mayence, who read a few pages in the New Testament and then put it down, saying, "I know not what book this is, I only see that all things contained in it are hostile to us" ('Antibarb. Bibl.' II. 7). The churchmen and schoolmen had always based their doctrinal systems upon the Bible, but the stereotyped interpretation of the Scriptures had come to claim the authority of the Scriptures themselves. John Nathin said to Martin Luther in the convent at Erfurt, "Brother Martin, let the Bible alone; read the old teachers: they give you the whole marrow of the Bible; reading the Bible simply breeds unrest" (Lindsay, 'History of the Reformation in Germany,' p. 200). Heresbach, the friend of Erasmus, heard it said that the study of the original Greek was the prolific source of all heresies, while the study of Hebrew turned men into Jews at once. (D'Aubigne, I. ch. 3). It was deemed dangerous for the layman to attempt to understand the Scripture for himself; it was his duty to accept the interpretation of the book by the Church. It was at this point that the protest was made; and all the Reformers insisted that the Bible ought to be open to every man and that the Spirit of God would help every man to a safe and sufficient understanding of its contents. Luther came to take the position that no external authority could decide what was Scripture or what was the meaning of Scripture. He said, "How can we know what is God's Word and what is true or false? . . . . Who decides me there? No man, but only the truth which is so perfectly certain that nobody can deny it" (Dods, 'The Bible, Its Origin and Nature,' pp. 38-40). Calvin said, "Scripture is self-authenticated, carrying with it its own evidence. . . . It obtains the credit which it deserves with us by the testimony of the Spirit" ('Institutio.' I. 7; 5). Over against this position may be put the words of Lacordaire, "What kind of a religion is that which saves men by aid of a book? God has given the book, but He has not guaranteed your private interpretation of it. . . If there be a true religion on earth, it must be of the most serene and unmistakable authority" (cf. Lindsay. op. cit., p. 457). That authority is not, according to Lacordaire, found in private judgment but in the infallible decree of Pope or Councils. Such was the issue drawn by the Reformation, both parties claiming the authority of the Scriptures, the one as interpreted by the Church for all, and the other as interpreted by the Spirit to each man. It was equally incumbent upon all concerned to show that their interpretation was the true one. This battle over the Book led to such searching of the Scriptures as had not been seen in the Church in any period of its history.

The way was opened for an intelligent discussion of the Scripture text largely by the labors of Erasmus of Rotterdam. His edition of the Greek Testament became the standard text among the reformers. His translations annotations, and paraphrases entitle him to high rank as an exegete. He was independent in judgment, characterized by good sense, and a philologist without a peer. His aim was to make the meaning of the Word perfectly clear to all. He said, "I do not see why the unlearned are to be kept away, especially from the evangelical writings, which were proclaimed alike to learned and unlearned, equally to Greeks and Scythians, as much for slaves as for the free, at the same time to men and to women, not less to peasants than to kings" ('Praef. in Paraph. in Matt.'). Erasmus still clung to the mystical or allegorical interpretation of certain Scriptures and thought that the Holy Spirit had intended that some words should carry multiple meanings. It was Martin Luther who broke finally and conclusively with this ancient error. He deserves highest honor as an exegete as well as a reformer by the enunciation of this principle, "Each passage has one clear, definite, and true sense of its own. All others are but doubtful and uncertain opinions." He added, "The literal sense of Scripture alone is the whole essence of faith and of Christian theology. . . . Allegories are empty speculations. . . . An interpreter must as much as possible avoid allegory that he may not wander into idle dreams. . . . To allegorize is to juggle with Scripture. . . . If we wish to handle Scripture aright, our one effort will be to attain *unum, simplicem, germanum, et certum sensum literalem*" ('Commentary on Genesis'). Unlike Jerome and so many others who had recognized these truths before him, he is true to these principles in his own exegesis. He published 'Notes' on many portions of the Scripture, and a complete 'Commentary on Galatians.' His exegetical works were published in a score or more of volumes in both Latin and German, and were of paramount influence in introducing better methods of exegesis in the Reformed churches. Melanchthon, Bucer, Zwingli, Beza, and many others did notable work in exegesis in the Reformation period; but their books are for the most part unread to-day. The greatest exegete among the reformers was John Calvin. He wrote complete commentaries on nearly the whole of the Bible. The single exception in the New Testament was the book of the Apocalypse; and Judges, Ruth, Kings, Esther, Ezra, Nehemiah, Proverbs, Ecclesiastes, and Song of Solomon were the only books left untouched in the Old Testament. His commentary on the Psalms was justly celebrated for its religious insight; and in the Pauline epistles and the book of Acts he is at his best in the New Testament. He wrote to his friend Grynæus in 1539, "We were both of this mind, that the principal point of an interpreter did consist in a plain briefness. . . . We wished that there might be some one who gave his diligence not to trouble those who are desirous of learning with long commentaries" ('Praef. in Rom.'). This suggests one chief excellence of Calvin's exegetical work. It is clear and concise and not loaded down with references to a host of other authorities. Calvin has the learning necessary for his task, but he makes no needless display of it. He uses it simply to present plainly the meaning of the text. He was honest and independent in his comment, intelligent in his method, and comparatively free from the worst faults of all his predecessors in this line. He never agreed with Luther as to the adequacy of the private judgment; and yet he was a persecutor of those who did not agree with his own views. The prejudices of his peculiar theology appear throughout his commentaries, and the repudiation of his conception of the decree as the central idea of Christianity has gone far to detract from his use and usefulness in the America of the 20th century. However he is still worth consulting for his good sense in most things and his good style in all.

It seemed a necessity of the age that all Christians should be dogmatists, and Protestant dogmatism soon became as deadly an influence in the field of exegesis as Roman Catholic tradition had ever been. The successors of the great Reformers were like the schoolmen who succeeded the great Fathers of the early Church. They were subservient to authority and fettered by dogma; and in the 17th and 18th centuries very few exegetes appeared whose works are read to-day. The scholarship of the elder Lightfoot is valued. The practical comments of Robert Leighton on First Peter are still enjoyed. John Owen's Exercitations on the Epistle to the Hebrews is a monument of erudition and pious reflection; but, like Caryl on Job, it is too voluminous to hold attention in this modern age. Robert Hall said of Owen, "He always takes for granted what he ought to prove, while he is always proving what he ought to take for granted; and after a long digression, he concludes very properly with, This is not our concernment; and returns to enter upon something still farther from the point." Adam Clarke added, "To me he is one of the most unsatisfactory of writers. His sense and meaning he drowns in a world of words. He cannot condense his meaning, and never comes to the point, but by the most intolerable circumlocution" (Etheridge, 'Life of Adam Clarke,' pp. 317-18). He may stand as probably the last example the world will ever see of such intolerable prolixity. Arminius and Grotius introduced the reaction from Calvinistic and Lutheran and Augustinian exegesis, which has been gathering force ever since and which has about come to its triumph in America. Cocceius and Vitringa in their opposition to scholasticism and dogmatical bias furnished a series of commentaries with many excellent qualities, but reverting too far in the direction of the mystical or allegorical interpretation. Bengel's Gnomon is a model of brevity and learning in exegesis. Philip Schaff calls it "a marvel of *multum in parvo.*" Henry, Scott, and Adam Clarke wrote devotional commentaries which are still in use. Ernesti has been regarded as the founder of a new exegetical school, attempting to hold the *via media* between the allegorists and the dogmatists. His exegesis was predominantly grammatical. Semler, pietist and rationalist, introduced the historic method of exegesis, and prepared the way for the unparalleled exegetical activity of the 19th century. The most dominant influence in the 19th century in the whole field of theology was that of Schleiermacher. He was the founder of what has been called the psychological school of exegesis. He was both rationalistic and supernaturalistic in his interpretation of the Scriptures. He appealed to opposing classes and did much to bring all Germany back to a central emphasis upon the person and teaching and influence of Christ. In Germany and, through Coleridge and Maurice, in England and America his spirit and methods have been fruitful of much good in Biblical study. "Church history offers no parallel to him since the days of Origen" (Farrar, 'History of Free Thought,' p. 244). "He was the Plato and Origen of Germany in the 19th century" (Philip Schaff). He based his religion upon faith and feeling, and he made the Christian consciousness and personal experience the guiding lights of his Scriptural interpretation. He claimed a Divine compulsion in his teaching and spoke and wrote with prophetic fervor and authority. He said, "Divinely swayed by an irresistible necessity within me, I feel myself compelled to speak. . . Nor is it done from any caprice or accident. Rather . . . it is a divine call" ('Reden über die Religion,' I). His personal magnetism and pronounced genius, his eloquence and earnestness, the genuineness of his Christian experience, the remarkable breadth of his vision and thought, and the intensity of his spiritual zeal gave him a most extraordinary influence upon his own and succeeding generations. He vindicated the right of Christian experience to an equal hearing with the results of any purely scientific research. His spirit pervades the Christian world to-day and will maintain its permanent place in Christian thought. De Wette was the greatest exegete among the disciples of Schleiermacher. His work represents prodigious learning and "perfect loyalty in the search for truth" (Godet). He expresses himself clearly, but does not always come to a desirably definite conclusion. Credner occupied practically the same standpoint.

The year 1835 marked a new era in all scientific Bible study (Pfleiderer, 'Development of Theology,' p. 209). In that year Strauss published his 'Life of Jesus,' Baur, his work on the 'Pastoral Epistles,' and Vatke his 'History of the Religion of the Old Testament.' Each of these books may be regarded as epoch-making.

Eichhorn had reduced the rationalistic treatment of the Scriptures to a scientific system. Strauss was the first to put this rationalism into concrete and popular form. Baur was the founder of the Tübingen or Tendency school, which probably represented in Germany the greatest theological movement of the century. Baur endeavored to bring all his exegesis to the bar of historical investigation. He examined all traditional exegesis critically and subjected the New Testament books to a more thoroughgoing analysis than they had ever known. He emphasized the theological standpoint of each writer, and he thought he detected an irreconcilable antagonism between the Pauline and the Petrine wings of the Christian Church. He stimulated Bible study to an astonishing degree. His personal power was manifest in the remarkable group of disciples he gathered about him. Among these we may mention Zeller, Schwegler, Hilgenfeld, Holsten, Pfleiderer, and Volkmar. The entire movement inaugurated by Baur has been characterized by comprehensive and accurate scholarship, the value of which has been somewhat impaired by the critical presuppositions upon which it was based. Strauss came over into this school in the second edition of his 'Life of Jesus.' Ritschl began his career in it, but later swung clear of it and became the founder of a distinct school of thought, to which Harnack, Jülicher, Kaftan, Hermann, and Von Soden adhere.

Ritschl claimed to repudiate all metaphysical presuppositions and to found his system on the religious consciousness alone. He believed that the primitive faith sprang from the person and word of Jesus, with no philosophical alloy in the beginning. He held that experience limits the domain of knowledge. The Scriptures are sufficient in themselves to reveal the spiritual and moral worth of the kingdom of God, whose end is realized in love. Dogmatics and ethics unite in the higher synthesis of the revelation of the New Testament. Frank was the most determined opponent of Ritschlianism in Germany. He pointed out the lack of a true and deep conception of sin in this system of thought, and its consequently inadequate notion of atonement and conversion; and he claimed that, instead of rejecting metaphysics, the whole system was based on a highly developed but false and contradictory metaphysics of its own.

Vatke in 1835 outlined the revolution which has since taken place in the conception of Old Testament history. His book, however, was overloaded with philosophical terminology and met with no general appreciation and soon seemed to be forgotten. Reuss lectured along the same lines at Strassburg; and two of his pupils, Graf and Wellhausen, published the new hypothesis of the development of Old Testament ritual and literature. It was Vatke's theory brought to life again, and it has exercised increasing influence upon the exegesis of all the Old Testament books for the last half century. The prophets have come into new prominence as a result of this study. They are recognized as the founders of the Hebrew religion. The Law in its present form was of later growth in the Jewish Church. The Pentateuch has been resolved into a number of documents. Deuteronomy is believed to belong to the times of Josiah. Isaiah and other prophetic books are shown to be of multiple authorship. The Psalms come last in the Hebrew sacred literature. Stade, Budde, Smend, Schultz and others have represented this school of thought.

Germany has been the great battle-ground of the Higher Criticism through the last century; and the exegetes have enrolled themselves among the critical and the traditional, the more radical and the more conservative camps. Neander the champion of spirituality, Hengstenberg the bulwark of orthodoxy, Delitzsch the pre-eminent scholar did valiant service for what they deemed the traditional truth. Just before his death Delitzsch seemed disposed to go over into the critical ranks. Dillmann and Gunkel have adopted the newer views. The indispensable commentary in the New Testament field has been that of H. A. W. Meyer. Characterized by grammatical rigor and literary freedom, and brought up to date by frequent revisions, it has maintained itself as a standard authority for two generations. The principal contributor to the later editions has been Bernard Weiss, the present prince of all laborers in the exegetical field. Having completed more than 50 years of University service he stands to-day without a peer in his record of worthy achievement as a textual critic and commentator. He is incomparable for minute and searching investigation, exactness and solidity of scholarship. His associates in the Meyer Commentary series have been Wendt, Heinrici, Sieffert, Schmidt, Düsterdieck, and Beyschlag. Lipsius, Weizsäcker, Schmiedel, and Holtzmann have represented the more advanced school of commentators. Bleek did most admirable work in the earlier part of the century; and Luthardt and Hofmann have been conservative leaders in the later days.

Among the Dutch theologians the dominant tendency in the last century has been toward extreme radicalism. Scholten and Kuenen have represented advanced thought in the Old Testament field, while Loman, Pierson, Naber, Völter, and Van Manen have been generally considered hypercritical in the discussion of New Testament questions. Steck has represented the latter school in Switzerland; while Godet has nobly upheld the traditions of orthodoxy in this land. Godet combines a French felicity of style with a German thoroughness of scholarship and adds to these a genuine spiritual fervor which makes his commentaries on Luke, John, and Romans veritable masterpieces of exegesis. It may well be doubted if the century has produced more luminous and interesting contributions to this field.

France has furnished the brilliant and versatile and radical Renan, and the more profound and philosophical De Pressense; and it is making its influence felt to-day through the writings of the new Symbolo-Fideistic school, Stapfer, Sabatier, and Ménégoz being the chief theological representatives. This school emphatically repudiates the infallibility of Pope or Church and just as emphatically renounces the infallibility of Scripture or the Christ recorded in Scripture. It believes that philosophy can never deduce any religious truth from its premises, and so repudiates rationalism as a foundation for faith. It believes in a Divine revelation through the immanent Spirit of God. It identifies prayer and religion. All expression of religious impression must be through images or symbols. "All religious formulas are symbolic formulas; and Dogmatic itself is a great system of symbols" (Ménégoz). The essence of the gospel is to be distinguished from what is merely contingent. Jesus is the perfect manifestation of God in man. Salvation is by faith and faith consists in repentance and heart-surrender to God. The advocates of this school confidently claim that the future belongs to them.

In Great Britain the century has furnished some masterly exegetical work. Cambridge University has easily taken the honors in this field. Dean Alford in his 'Commentary on the Greek Testament' introduced the best results of German exegesis to English readers. Bishop Ellicott gave splendid examples of painstaking investigation of the Scriptural text. The great trio of later Cambridge scholars, Lightfoot, Westcott, and Hort have reached the highwater mark of English scholarship in their field. Bishop Lightfoot's commentaries upon the Pauline Epistles have been standard authorities ever since their publication. Westcott did equally fine work upon the writings of John and the Epistle to the Hebrews. Hort was generally reputed to be the greatest scholar of the three, but his extreme modesty and his realizing sense of the yet unattained perfection possible in his work kept him from the publication of any but fragmentary treatises. His influence lives among his students and associates. Mayor on James and Swete on Mark are worthy companions of the other Cambridge University commentaries. Prof. Davidson of Edinburgh was the leading Hebrew scholar of Great Britain in the century, and his pupils, W. Robertson Smith and George Adam Smith and others, have done yeoman service in revolutionizing and revitalizing the exegesis of the Old Testament. Sanday, Driver, Plummer, Beet, Findlay, Bruce, and Dods have done excellent interpretative work. The 'International Critical Commentary' and the 'Expositor's Greek Testament,' now in process of publication, bid fair to continue the best traditions in English exegesis.

America has had a share in the exegetical labor of the century. Moses Stuart, J. A. Alexander, Hackett, Hodge, Shedd, Harper, Mitchell, Moore, Toy, Vincent, and others have produced exegetical studies of acknowledged merit. Albert Barnes, Henry Cowles, J. A. Broadus, and D. D. Whedon have published series of helpful and devotional commentaries. Ezra Abbot, Edward Robinson, McGiffert, Mathews, Burton, Briggs, Bacon, Gilbert, Stevens, Allen, and Smyth have done first-class service in special fields.

The Roman Catholic Church began the century with two most worthy representatives of Biblical learning. Hug ably combated the rationalistic tendencies of his day and defended the traditional views of the origin of the New Testament writings. Herbst performed the same service for the Old Testament. During the greater part of the century, however, free inquiry has been more or less stifled by the authority of "the usual exegesis of Scripture." Scientific research has been systematically discouraged and any tendency toward a new or modified interpretation of the Scriptural text and any originality of conclusions, such as may not be guaranteed by the authority of the Fathers and the Councils of the Church, have been frowned upon by those in the places of power. A better condition of affairs seems to be on the point of realization now. A growing body of students within the pale of the Church have felt the influence of the great onward movements in the Protestant world and are beginning to demand the privilege of free inquiry and the use of modern methods in exegesis. They point to the critical work in the writings of Origen and Jerome and Eusebius and other Christian scholars and saints as proof that scientific research is no novelty in the Catholic Church, and they claim the right to follow in the footsteps of these illustrious critics of antiquity. A measure of freedom would seem to be already granted them since Pope Pius X. has written to Bishop Le Camus, "We should not approve the attitude of those who in no way dare to depart from the usual exegesis of Scripture, even when, faith not being at stake, the real advancement of learning requires such departure. You follow a wise middle course, and by your example show that there is nothing to be feared for the sacred books from the true progress of the art of criticism, nay that a beneficial light may be derived from it, provided its use be coupled with a wise and prudent discernment" (Dated Jan. 11, 1906). What this "wise and prudent discernment" may be is probably best illustrated in the decisions of the Biblical Commission appointed by Leo XIII., in its report upon the Pentateuch, published in the *Revue Biblique* and dated June 27, 1906. The report is presented in the form of questions and answers in catechism style. They may be summarized as follows: May one assert that Moses was not the author of the Pentateuch, but that it was made up largely of later elements? No. Must Moses then have written the whole of the Pentateuch with his own hand, or dictated it to secretaries? No. May Moses have committed the editing of it in whole or in part to secretaries and have permitted the publication of it under his name? Yes. May he have used sources, documents or oral traditions, borrowing sometimes the words, sometimes the sense? Yes. May the Pentateuch have undergone modifications, "additions made after Moses' death by an inspired author, glosses and parenthetical explanations, ancient words and phrases turned into more modern language, false readings to be attributed to errors of copyists, which criticism may examine and weigh according to its principles? Yes, the Church reserving judgment." The rights of the newer criticism to a hearing and standing in the Church are clearly allowed in this report, while the Church reserves the right to judge to what extent the findings of the critics may be compatible with its authority and peace.

Historical criticism has now come to the fore. The allegorical interpretation is discredited, it is to be hoped, finally and permanently. A vaster knowledge is at the service of the exegete than has been possible in any preceding age. The battles of the giants would seem to have ended for the time at least, and much of the smoke of conflict has cleared away. What ought the twentieth century exegesis to be? It ought to be capable of the production of both popular and critical work. It ought to meet the demand for edification on the part of the most humble and unlearned; and at the same time it ought to be proficient in the most exhaustive scholarship. It has at its disposal the accumulated wealth of material collected in the preceding centuries; and it may profit by the defects as well as the excellences of the masters who have gone before. Biblical knowledge was never more profound or more prevalent than now. The original text has been determined within approximate accuracy. The Bible has been freed from multiplied errors of manuscript transcription and restored to something like its original form and revelation. The original languages are better understood. The study of ancient inscriptions and fragments of newly discovered papyri have thrown a flood of light upon many new points. Modern travel and exploration and excavation in the Orient have taught us many things concerning the manners and customs of the ancient times. The marvellous advance made in the last century along the lines of scientific investigation and metaphysical research and literary criticism has had its beneficial influence upon the interpretation of the Bible. The exegete of to-day has an unprecedented equipment, and his task is comparatively clear. To-day, "the great body of evangelical expositors are united on the fundamental principles of interpretation. They agree that a proper commentary on the Bible or on any part of it, should clearly set forth the true meaning of the words and the train of thought intended by the sacred writer; and it should point out the grammatico-historical sense of every passage, giving careful attention to the context, scope, and plan" (Terry, 'Biblical Hermeneutics,' p. 738). The great exegetical works of the present are characterized by directness, accuracy, learning, independence of research, a careful consideration of the context and all the light that historical and literary criticism can throw upon the theme. There is a better conception of the nature of inspiration and more freedom in the exercise of the critical faculties of the commentator. Rationalism has come to its rights, together with a recognition of the due restraint laid upon the student of a divine revelation. Having escaped from the tradition of an absolutely inerrant text and a form of revelation infallibly fixed for all time, the exegete of to-day is freer to turn from the letter that killeth to the spirit that maketh alive. The tendency of the times seems to be away from the dominance of the Latin and the Reformation theology to the purer exegesis of the primitive faith. With the broader spirit of the Greek fathers and the better critical apparatus of the present day the promise of work in this field was never brighter than now.

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Exelmans, ĕks-ĕl-mŏng, **Remy Joseph Isidore,** Comte: French soldier, Marshal of France: b. Bar-le-duc, 13 Nov. 1775; d. 22 July 1852. He entered the army in 1791, when only 16 years of age, and by 1799 had reached the rank of captain. He subsequently served with great distinction under Macdonald and Championnet in the campaign of Naples, and in 1801 was appointed to the staff of Murat as aide-de-camp. He was arrested in 1808 while serving with Murat in Spain, and sent to England, but after three years of confinement there effected his escape and in 1812 joined Napoleon in his Russian campaign. For brilliant conduct during this campaign he was appointed general of division by Napoleon but upon the Emperor's fall was banished from France owing to his Napoleonic inclinations. He was, however, permitted to return in 1819 and seems to have been highly esteemed under every successive government. He was restored to the Chamber of Peers in 1831 by Louis Philippe and Louis Napoleon appointed him grand chancellor of the Legion of Honor, and on 11 March 1851 created him Maréchal de France. He was subsequently thrown from his horse which resulted in his death.

Exercise, Physical. The upbuilding of the muscular system of the body is of prime importance in preserving the health or the curing of disease, and whether by passive motion or volitional activity is now recognized as necessary to keep the various functions of the body in normal condition. Artificially devised methods have been brought into use but regular daily out-of-doors exercise is preferable. Instruction in gymnastics is now given in many educational institutions and public schools, well-appointed gymnasiums being maintained for that purpose. In these gymnasiums outdoor sports are often practised, but the chief courses of exercise consist of a systematic use of dumb-bells, wands, Indian clubs, horizontal and parallel bars, chest-weights, swinging rings and other specialties. In many gymnasiums there are running tracks, baseball cages, swimming tanks, bowling alleys, etc. The chief outside sports are tennis, golfing, bicycling, baseball, football, rowing, walking, running, skating, swimming, and the various forms of track athletics. See GYMNASIUM, HISTORY OF; HYGIENE; PHYSICAL TRAINING; EDUCATIONAL ATHLETICS; etc.

Exercises, Spiritual. See SPIRITUAL EXERCISES.

Exeter, England, a city, seaport, and county, parliamentary and municipal borough, in the county of Devon, on the left bank of the Exe, 10 miles northwest from its outlet in the English Channel, on the Great Western and London and Southwestern railways. Though still presenting many indications of antiquity, the city can now boast of as handsome squares, terraces, streets, and houses, all of modern erection, as any other in the kingdom. The principal object of interest is the cathedral, a noble edifice of high antiquity. It is cruciform, 408 feet in length, and consists of a nave, with two side aisles; two short transepts formed out of two heavy Norman towers, each 130 feet in height; a choir of the same width as the nave, and 128 feet in length; 10 chapels or oratories, and a chapter-house. The west front is richly decorated, presenting one of the most picturesque façades of any building in Europe. The interior, now restored by Sir G. Gilbert Scott, is magnificent. Other architectural antiquities are the remains of the castle of Rougemont, portions of the ancient city walls of Athelstan, Norman work in some of the churches, and the noble guild-hall, tastefully restored. Among several fine modern churches Saint Michael's may be mentioned. Among the numerous educational establishments is the Exeter school, founded by the citizens in the time of Charles I., to which there are a number of free scholarships. It has 16 exhibitions to either of the Universities of Oxford or Cambridge. The Exeter Diocesan Training College is also situated in the city. The charitable institutions of various kinds are numerous. They comprise the Devon and Exeter Hospital, many almshouses, a dispensary, a lunatic asylum, a deaf and dumb institution, a penitentiary, an eye infirmary, a lying-in charity, a humane society, a stranger's friend society, etc. The principal scientific and literary institutions are the Devon and Exeter Institution for the Promotion of Science, Literature, and Arts, established in 1817, and possessing a valuable library; the Exeter Literary Society, established in 1835; and the Royal Albert Memorial College, Museum, and Free Library, whose enlarged buildings were opened in 1899. The college has over 1,000 students. Exeter is not an industrial town, its woolen manufacture, once one of the largest in England, being extinct; but it has iron-foundries, manufactories of agricultural implements, paper-mills, corn-mills, tanneries, etc. Glove-making and lace-making are also carried on. By means of a canal, 5 miles in length and 15 feet in depth, vessels of 400 tons can reach the city, and there is a large floating basin. The Exe itself is not navigable to the city. Exeter is a place of remote antiquity, having been a British settlement long prior to the invasion of the Romans, by whom it was called *Isca Damnoniorum.* Pop. (1901) 46,940.

Exeter, N. H., town, one of the county-seats of Rockingham County; on the Squamscott River, the Boston & M. R.R.; 26 miles east of Manchester, and about 13 miles southwest of Portsmouth. Exeter was founded in 1638 by John Wheelwright, a Congregationalist clergyman, who was banished from Massachusetts. Massachusetts claimed control over the place until 1680. It was the capital of New Hampshire, and the centre of military movements of the colony during the Revolution. The town is well known as the seat of the Phillips Exeter Academy (q.v.), established in 1781. The Robinson Female Academy is located in Exeter. The town contains a large public library and a number of manufacturing establishments: a large shoe factory, cotton-mills, iron, brass, and machinery manufactories. Pop. 5,010. Consult: Fassett, 'Colonial Life in New Hampshire'; Bell, 'History of the Town of Exeter.'

Exeter Book, or **Codex Exoniensis,** a unique manuscript of Anglo-Saxon poetry in the library of Exeter cathedral. It was presented to the chapter by Leofric, first bishop of Exeter (1050–72), contains 246 pages of vellum, and is the extant original copy of some valuable remains of Anglo-Saxon literature. The text with a translation is to be found in Gollancz, 'The Exeter Book' (1895).

Exeter College, Oxford. This college, originally called Stapledon Hall, was founded by Walter de Stapledon, bishop of Exeter, sometime lord high treasurer of England, who removed to this place his scholars from Hart Hall, and made a foundation for a rector and 12 fellows. In 1404 Edmund Stafford, bishop of Exeter, added two fellowships and obtained leave to give the college its present name. In 1565 Sir William Petre, secretary of state, added eight; in 1636 Charles I. annexed one for the Channel Islands, and lastly, Mrs. Shiers left certain rents in 1770, out of which two fellowships were founded. Under the authority of 17 and 18 Vict., cap. lxxxi., the fellowships (a number of which were appropriated to various archdeaconries or counties) were reduced from 25 to 15, and were thrown open; they are now 12 in number. From the revenues of suppressed fellowships over 20 scholarships were founded, eight of which (called Stapledon scholarships) are limited to persons born or educated in the diocese of Exeter, and one or more to persons born in any of the Channel Islands, or educated at Victoria College, Jersey, or Elizabeth College, Guernsey.

Exeter Hall, a large building on the north side of the Strand, London, opened in 1831. It is capable of containing over 3,000 persons. In it the "May Meetings" of the several religious societies are held. It is now the property of the Young Men's Christian Association.

Exhaus'tions, Method of. The ancient geometricians employed the method of exhaustion for determining the areas of curves, and for the solution of similar problems. The method consists in comparing the magnitude to be determined with rectilinear magnitudes; thus, the area of a curve with the area of a polygon constructed so as to be comparable with the curve in question. The use of the method is exemplified in the second proposition of 'Euclid's Twelfth Book.' The method was applied with all the rigorous logical exactness for which the Greek geometricians are so famous. See GEOMETRY; MATHEMATICS.

Exhibi'tion, an endowment or benefaction. See ENDOWMENT.

Exhibition, Industrial. The promotion of trade and manufactures by means of collections of works of industry and art has no claim to the merit of novelty. In modern times, however, the idea has been more systematically carried out, and was probably suggested by the good effects produced by two institutions of a like nature — the galleries of rare productions of art or nature collected by the wealthy and educated, and the exposure for sale of ornamental and useful articles in the stores of individuals, and more particularly on a large scale at the great fairs which in former times were more important features of commercial enterprise than they now are. The beneficial effect thus derived from the exhibition and comparison of the manufactured products of different localities could not long escape notice. In England this knowledge was brought to practical purposes in the 18th century, when the Society of Arts in 1756–7 not only offered prizes for specimens of manufactures, but exhibited the works of the competitors. In France an exhibition embracing all kinds of manufactures was held in the year 1798, and another under the consulate of Bonaparte in 1802, and the gratifying results attained led to the idea of holding them every three years, which was carried out as far as the political troubles of the country would allow. Many exhibitions were subsequently held at different cities on the continent of Europe, and in the British Islands exhibitions of a more or less local nature were held in Dublin, Manchester, Liverpool, and Birmingham, as well as in London in the premises of the Society of Arts. All these had been generally successful, but the necessity of having an exhibition on an international scale had become with some a fixed idea. This was first brought fairly before the British public in 1848 by Prince Albert, then president of the Society of Arts. In 1849 the project for an exhibition in which all nations might join began to take a tangible shape; and it was at last determined by government to issue a royal commission to deal with the matter, which was gazetted 3 Jan. 1850. The better to enable the commissioners to enter into contracts and otherwise incur obligations, subscriptions were procured to a guarantee fund, the queen leading the list with $5,000. A vast structure of iron and glass, generally designated the Crystal Palace, built from the design of Joseph Paxton, was erected in an incredibly short space of time in Hyde Park, London, and was opened by Her Majesty on 1 May 1851. The extreme length of the building was 1,851 feet, the width 408, and the height about 64 feet. The entire area was about 19 acres. In the ground floor and galleries there were about eight miles of tables set apart for the exhibitors. The articles sent for exhibition were divided into four great sections: Raw materials, machinery, manufactures, and fine arts. The number of exhibitors was about 15,000. The exhibition remained open until 11 October, and the number of visitors during the 144 days amounted to about 6,170,000. After all expenses were defrayed there was a balance of $700,000 left. The immense success of the undertaking encouraged the local and national exhibitions of Dublin and New York in 1853 and of Munich in 1854; and the French nation in 1855 opened its first Exposition Universelle. The main building was an imposing structure of white stone and of classic architecture. The buildings were erected in the Champs Elysées, and covered about 24 acres. There were in all about 24,000 exhibitors, and the contents were pronounced greatly in advance of those exhibited in London in 1851. It was said that continental manufacturers had taken lessons from the British exhibition which the British had failed in fully profiting by, and so exhibited a vast improvement in works in which the latter considered themselves unrivaled. This was followed by the national exhibitions of the Dutch at Haarlem and the Belgians at Brussels, both in 1861, and the following year by the second great international exhibition held in London. It occupied a vast brick building, lighted by a roof and two immense cupolas of glass, and erected in the garden of the Horticultural Society at South Kensington. The space covered was about 17 acres. There were 26,348 exhibitors in the industrial division, of whom 8,487 were British, and in the fine art division 2,305, of whom 990 were British. The aggregate number of visitors from 1 May to 31 October was 6,211,103, giving an average of 36,328 per day. The productions, which came from almost all parts of the globe, were divided into 40 classes, and included manufactures of all kinds — machinery, chemical products, railway plant, and ordinary vehicles, animal and vegetable products used in food or manufacture, architecture, painting, sculpture, engraving, etc. This exhibition was also eminently successful, and enabled the public to judge of the progress or shortcomings of British home manufactures and art as compared with others. In 1865 a rather important exhibition was held in Dublin which was a pecuniary failure. The second French International Exhibition was opened on 1 April 1867, and closed on 3 November. On 1 May 1871 the first of the British annual international exhibitions of fine arts and industry was opened by the Prince of Wales. On 1 May 1873 the first Austrian international exhibition was opened by the Emperor Franz Josef with great pomp and ceremony. The building was situated in the Prater, or, as it may be called, the park of Vienna, and was 2,940 feet in length, with an average breadth of 570 feet. A great exhibition was opened by President Grant at Fairmount Park, Philadelphia, upon the occasion of the centennial festival of the American declaration of independence. It occupied 60 acres, and had nearly 10,000,000 visitors. A third French International Exhibition was held at Paris in 1878; area occupied 140 acres; visitors 17,000,000. A fourth French International Exhibition was opened by President Carnot in 1889 to commemorate the centenary of the Revolution, the visitors to which numbered over 25,000,000. One of its chief features was the Eiffel tower, of iron, 984 feet high. The series of exhibitions which were held at South Kensington, London, included The Fisheries (1883), The Health (1884), The Inventions (1885), and the Exhibition of Colonial and Indian products (1886); the latter of which was visited by 5,550,749 visitors. Besides these, exhibitions have been held in Edinburgh (1886), at which there were 2,769,632 visitors; Manchester (1887) at which there were 4,765,000 visitors; and Glasgow (1888), with 5,748,379 visitors. In 1899–1900 a huge International Exhibition was held at Paris, but, though visited by about 47,000,000 persons, was not a financial success. It occupied the Champ de Mars and extensive areas on both sides of the Seine.

In 1893 the fourth centenary of the discovery of America by Columbus was celebrated by the World's Columbian Exposition, at Chicago. It excelled all predecessors in conception, scope, and grandeur. Every nationality contributed to the exhibits, and many countries possessed their own buildings. The "White City," as it was called, was opened by President Cleveland, 1 May and closed 30 October. It occupied about 600 acres, at Jackson Park, on the shore of Lake Michigan, including the "Midway Plaisance." Nearly every State in the Union was represented by its own edifice. The principal buildings were Machinery Hall, the Art Palace, and those devoted to transportation, mining, electricity, agriculture, manufacture and liberal arts (covering 44 acres), government, administration, fisheries, horticulture, and anthropology. The total admissions for the period named were 27,539,521, and the receipts from this source $10,317,814. The largest attendance on any one day — Chicago day, 9 October — was 716,881. Other notable exhibitions in the United States were the California Mid-Winter Exhibition, held in San Francisco in 1894; the Cotton States and Industrial Exposition held in Atlanta, Ga., September to December, 1895; the Tennessee Centennial Exposition, held in Nashville, Tenn., 1 May to 31 Oct. 1897; the Trans-Mississippi Exposition in Omaha, Neb., 1 June to 1 Nov. 1898; the Pan-American Exposition, in Buffalo, N. Y., from 1 May to 2 Nov. 1901; the South Carolina Inter-State and West Indian Exposition, held in Charleston, from 1 Dec. 1901 to 1 June 1902, and the World's Fair at St. Louis, Mo., in 1904, in celebration of the Louisiana Purchase, its projectors claiming for it "the greatest exposition in all history. The buildings in Forest Park to the number of 15 great structures stand in a tract of 1,180 acres, and the total amount of money expended exceeds $15,000,000. A feature of the exhibition was 250 original groups of sculpture containing 1,650 figures. The exhibition included an air-ship contest, a fashionable horse show, a live stock show covering 40 acres, and a Philippine exhibit covering 50 acres. See FAIRS.

Ex'moor, a wild and hilly district in the extreme southwest of Somersetshire, extending also into Devonshire, England. It was formerly a forest, but, with exception of a considerable portion lately cultivated, it is now mostly heath and marsh. It embraces ranges of hills of considerable elevation (the loftiest being Dunkerry Beacon, 1707 feet), and in the time of the Druids was a favorite spot for the celebration of their religious rites. Red deer still exist here in a wild state. Good descriptions of Exmoor may be found in Blackmore's 'Lorna Doone,' and Sir Conan Doyle's 'Micah Clark.'

Exmouth, ěks'mŭth, **Edward Pellew,** VISCOUNT, English naval officer: b. Dover, England, 19 April 1757; d. 23 Jan. 1833. He served as midshipman in the Blonde frigate during the American Revolution, and greatly distinguished himself at Lake Champlain. In 1809 he had attained the rank of vice-admiral, and in 1814 he was made Baron Exmouth. In 1816 he proceeded to Algiers in command of a combined fleet of English and Dutch ships to enforce the terms of a treaty which the dey had violated. He bombarded the city for seven hours, and inflicted such immense damage that the dey consented to every demand. Twelve hundred Christian slaves were by this exploit restored to liberty. Lord Exmouth was raised to the dignity of a viscount for this service.

Exmouth, England, seaport, market town in the county of Devon; on the English Channel at the entrance to the estuary of Exe. It is one of the favorite resorts, on the coast of Devon, for sea-bathing. The chief industry is fishing, and the shipping trade is considerable; the new docks are commodious. Exmouth was one of the principal ports of the country in the reign of Edward III.; but subsequently it became a mere fishing hamlet. Late years it has increased steadily in population and trade. Pop. (1901) 10,500.

Exodus (Gr. "departure"), the name given in the Septuagint version to the second book of the Pentateuch, because it describes the departure of the Israelites from Egypt. The contents of the book, though not embracing such a variety of incidents as Genesis, are of a more diversified character, being not only historical, but also, and in a greater part, legislative. The subject-matter, arranged according to historical order, forms three divisions. (1) The condition of Israel in Egypt, and the preparations for their departure (ch. i.-xii. 36). (2) The march from Rameses to Mount Sinai (ch. xii. 37-xix. 2. (3) The abode in the desert and the promulgation of the Sinaitic Law (ch. xix. 3-xl).

Exog'amy, the usage by which in many primitive races a man is forbidden to marry a woman of his own stock or tribe. See MARRIAGE; TRIBE.

Exogenous (ĕks-ŏj'ĕ-nŭs) **Plants,** an old and now disused name for dicotyledons. Monocotyledons were similarly known as endogenous plants, or endogens. See BOTANY.

Exophthal'mic Goitre, enlargement with turgescence of the thyroid gland, accompanied by protrusion of the eyeballs, breathlessness, palpitation, and anæmia. Also called Basedow's or Graves' disease (q.v.).

Ex'orcism, the act of expelling evil spirits by adjuration. The word is of Greek origin, *exorkismos,* from the verb *exorkizo,* which in classic Greek means to put one on oath, but in the New Testament to drive out by adjuration. Demonic possession was a notion generally entertained by the Jews in the time of Christ; and that it was entertained by Jesus Christ and his apostles is as certain as any fact recorded in the Scripture. Hence, till modern times it was believed by all Christians, though now it is repudiated expressly or tacitly, or is explained in a naturalistic sense, or at least ignored by very many who profess belief in the gospels as a divine revelation and the very word of God. The Catholic Church, while it does not stand committed to the popular beliefs of the faithful upon this matter, nor to the views even of her most eminent doctors, except so far as she may have formally adopted them in her authoritative symbols, claims to possess and to exercise in these days no less than in apostolic times the power to expel evil spirits from the obsessed or possessed. One of the minor orders of clergy in the Catholic Church is that of the "exorcist," and the ritual of the Church to this day has an official formula of prayers and adjuration for driving out demons. Pope Innocent I. (d. 417) forbade exorcists to exercise their ministry save with the express permission of the bishop, and that rule is still in force.

Ex'orcist, the name of one of the minor orders of the clergy in the Roman Catholic Church. See ORDERS, HOLY; EXORCISM.

Exosmo'sis. See OSMOSIS.

Exostem'ma, a genus of American shrubs and trees of the natural order *Rubiaceæ,* several species of which yield barks sometimes used in medicine. Though closely related to the genus *Cinchona* (q.v.) which yields quinine, the species of this genus are lacking in similar alkaloids. St. Lucia bark and Caribbee bark, obtained from West Indian species, are probably the best-known.

Exoter'ic. See ESOTERIC.

Exot'ic, an appellation for the produce of foreign countries. Exotic plants are such as belong to a soil and climate different from that to which they have been transplanted. It is implied that the exotic is more or less of a rare or tropical character and can be preserved only in greenhouses.

Expan'sion. See TERRITORIAL EXPANSION.

Expansion, in physics, is the increase in the bulk of bodies, in consequence of a change in their temperature. This is one of the most general effects of heat, being common to all bodies whatever, whether solid or fluid. The expansion of solid bodies is determined by the pyrometer, and that of fluids by the thermometer. The expansion of fluids varies considerably, but, in general, the denser the fluid, the less the expansion; thus water expands more than mercury, and spirits of wine more than water; and, commonly, the greater the heat, the greater the expansion; but this is not universal, for there are cases in which expansion is produced, not by an increase, but by a diminution of temperature. Water furnishes us with the most remarkable instance of this kind. Its maximum of density corresponds with 39.2° F. This fact is of the utmost importance in the economy of nature. When the surface of rivers and lakes is cooled, the superior layer of water sinks, and warmer water from below takes its place till the whole mass is cooled to 40°. After this the circulation ceases, and ice is formed. The maximum density point of sea water is considerably lower than that of fresh water, and varies with the quantities of the salts contained in it. The expansion of water is about the same for any number of degrees above or below the maximum density point. Thus, if we heat water 5° above 39.2°, it occupies the same bulk as it does when cooled down to 5° below 39.2°: and the density of water at 32° and at 53° is very nearly the same. The force with which water expands in the act of freezing is shown when glass bottles are filled with water and sealed; the glass is broken in pieces when the water freezes. A brass globe, whose cavity is an inch in diameter, may be burst by filling it with water and freezing it; and the force necessary for this effect is 27,720 pounds weight. The expansive force of freezing water may be explained by supposing it the consequence of a tendency which water in consolidating is observed to have to arrange its particles in one determinate manner, so as to form prismatic crystals, crossing each other at angles of 60° and 120°. The force with which they arrange themselves in this manner must be enormous, since it enables small quantities of water to overcome so great mechanical pressures. This observation is conspicuously illustrated by observing the crystals of ice on a piece of water exposed to the action of the air in frosty weather; or upon a pane of glass in a window of a room without a fire at the same season. Various methods have been tried to ascertain the specific gravity of ice at 32°; that which succeeded best was to dilute spirits of wine with water till a mass of solid ice put into it remained in any part of the liquid without either sinking or rising. The specific gravity of such a liquid is 0.92, which, of course, is the specific gravity of ice, supposing the specific gravity of water at 60° to be 1. This is an expansion much greater than water experiences even when heated to 212°, its boiling-point. We see from this that water at the instant of solidification receives a sudden and considerable augmentation of bulk. See HEAT.

Expatria'tion, the voluntary renunciation of the rights and liabilities of citizenship in one country, in order to become the citizen or subject of another. The right of a citizen of one country to renounce his allegiance in order to adopt another country as his own, has and is still much disputed. It seems most reasonable that the mother country and not the individual should decide the question. In the early part of the 19th century the United States was almost the only nation that claimed for individuals the right of expatriation without the consent of the government of which they were citizens or subjects. The European nations, as a rule, maintained that the permission of the sovereign was necessary; and the enforcement by England of this claim was one of the causes of the War of 1812. The right of voluntary renunciation of allegiance to the United States by one of our citizens was unsettled, so far as legislation was concerned, till the Act of Congress of 27 July 1868, asserted that expatriation "is a natural and inherent right of all people," but the action of the department of State had previously seemed practically to admit the right. The first formal recognition of this principle was secured in an expatriation treaty with the North German Confederation, signed 22 Feb. 1868. England first recognized the right of voluntary expatriation by act of Parliament in 1870, and immediately concluded an expatriation treaty with the United States. All the leading nations of Europe now recognize the right, including besides those just mentioned, France, Austria, Russia, Italy, and Spain. The laws of the various nations upon this subject have been published by the United States government, under the title 'Opinions of the Principal Officers of the Executive Department and other Papers, Relating to Expatriation, Naturalization and Change of Allegiance' (Washington 1873). See also CITIZEN.

Expecta'tion. See PSYCHOLOGY.

Expectation Sunday, the Sunday before Whitsunday. Acts i. 4, Christ commanded the disciples "that they should not depart from Jerusalem, but wait for the promise of the Father." They waited till the day of Pentecost and the promise was fulfilled.

Expectation Week, the week, or rather the nine days, which elapsed between the ascension of Jesus and the Pentecostal effusion of the Spirit, because during that interval the apostles and early Church waited in expectation that the promised Comforter would come.

Expectorant, a remedy used to increase the amount of secretion of the lower respiratory tract — the trachea and bronchi. Such remedies act: (1) Through nervous influences, like those of ipecac, antimony, senega; or (2) they increase the amount of blood flowing around the bronchi; or else (3) they stimulate the mucous membranes of the bronchi as they are excreted. To this latter class potassium iodide, chloride of ammonium, the aromatic balsams, and squills belong. They are useful in chronic stages of catarrhal bronchitis. See BRONCHITIS.

Expectoration, technically termed sputum, is a physiological secretion, but when there is an excess of secretion of mucus in the bronchi and trachea, which is expelled by hawking or coughing, it becomes a diseased condition. Excessive expectoration is found in bronchitis, in pneumonia, in tuberculosis, in gangrene of the lung, and in influenza. In all of these conditions the sputum carries the germ of the disease and should be disinfected. Miscellaneous expectoration in the street and public places should be prohibited by law. To properly disinfect the sputum, it should be received in a paper spitcup or appropriate pocket-flask, and later destroyed. A mixture of carbolic acid, 1 to 25 of water, or of chlorinated lime, a teaspoonful to a pint of water, should be used in spittoons if these are essential. In cases of tuberculosis and influenza particularly, great care should be taken of the sputum and of all handkerchiefs, towels, napkins, and other linen that come in contact with the patient. See DISINFECTION; INFLUENZA; TUBERCULOSIS.

Expeditions to Latin America. See DISCOVERIES OF AMERICA.

Experiment, an operation designed to discover some truth, principle, or effect, or to establish or illustrate it when discovered. It differs from observation in the fact that the phenomena observed are, to a greater or less extent, controlled by human agency. Experiment distinguishes the modern method of investigating nature, and we owe to it the rapid strides made in chemistry, physics, and other sciences.

Experiment Stations, Work of. The agricultural experiment stations of the United States government now form the most complete system of agricultural research in the world. Over 1,000 trained and practical men are now employed in the 60 stations, which are now in operation in every State and Territory, including Alaska, Hawaii, Porto Rico and the Philippines. The annual income of these stations in 1902 was $1,328,847, of which sum $720,000 came from the Federal government, and $608,847 from State appropriations and other sources. The stations have existed as a national enterprise for 14 years, and the outlay for agricultural investigation in that time has been at the rate of $1 for nearly $3,000 worth of farm products, which cannot be considered an extravagant outlay.

Our farmers spend over $50,000,000 a year for fertilizers, and the stations have given particular attention to this subject. Fraud and extravagant assertions about fertilizers have been largely eliminated from the business and thousands of farmers are buying fertilizers more intelligently and economically. The annual loss to farmers from waste of barnyard manure is estimated at $7,000,000. Many of the stations have given special attention to the economic use of manure on the farm, with the result that better methods for its care and use are being employed. The successful introduction of Mansury barley, for which the Wisconsin station is mainly responsible, has increased the yield of barley over a wide region, with results worth millions of dollars. Kaffir corn was introduced about 15 years ago by the stations in California, Kansas and Oklahoma. It has been found specially suited to regions of scanty rainfall. The crop in Kansas alone in 1899 was valued at over $6,000,000.

The various macaroni wheats which have been tested under varying conditions by a number of the stations, have proved so successful that the United States will probably produce all the macaroni it consumes in the course of a few years. The investigations of the experiment stations in the southern States have convinced farmers that many varieties of forage plants may be more successfully grown in the South than was supposed and have laid the foundation for a wide development of the live stock and dairy industries of that region. The department of agriculture and the Connecticut State station, co-operating with local tobacco growers, have within the last three years demonstrated that a fine grade of Sumatra wrapper tobacco may be grown under shade in the Connecticut valley. Prof. Whitney says that this discovery will increase the value of the light lands of the Connecticut valley over 200 per cent. The stations of the northwestern States have extended the limits of corn culture by proving, by careful selections of varieties and modified methods of culture, that this crop may be grown in regions heretofore believed to be unsuited to corn culture. The stations have been prominent in the investigations which have led to the new system of forcing vegetables in the field and under glass for supplying the markets with fresh vegetables at all seasons of the year. For example, the winter culture of lettuce in eastern North Carolina is now yielding over $100,000 a year. The Ohio station discovered that onions started in the greenhouse or under frames from seed and then transplanted to the open field produce larger onions and earlier and heavier crops than by the usual methods of tillage and seeding. This discovery is changing the methods of onion culture.

These are only a few of the many ways in which the experiment stations are helping agriculture. Their investigations relating to protective measures against plant diseases and injurious insects, the storage and utilization of fodder crops, breeding and dairying, the protection of farmers against fraud, and many other topics have been of the utmost value. See AGRICULTURE; AGRICULTURAL EXPERIMENT STATION.

Expert. See EVIDENCE.

Expert Testimony. A branch of the law of legal evidence which may be defined as testimony in the form of an opinion, based upon facts proved in an action by other witnesses, or upon facts assumed to have been proved, concerning matters involving scientific or technical knowledge.

The value of expert testimony was recognized in the Roman law and was incorporated in that system of jurisprudence. In the law of some continental countries the system has always been firmly established. Indeed, in those countries, all forms of opinion evidence was and still is freely accepted: the courts giving it such weight as it seems entitled.

In the very earliest period of the English law, however, expert testimony was unknown. At that time a jury was selected from among persons already possessing knowledge of the facts of the case to be tried. In other words, during the early development of English law, the witnesses composed the jury and their verdict was based upon the facts within their own knowledge, and no effort was made to assist them. Gradually, however, the practice of taking testimony in open court came into vogue, and it was later seen, in order that an impartial verdict might be rendered, that the jury should be composed of unbiased persons, whose minds were not hampered by conclusions theretofore formed.

As a general rule in the English common law, which is, with slight modifications, the law of the United States, testimony of opinions has never been admitted as evidence. Our courts require and allow testimony as to facts only, and consider it the province of the court and jury to draw conclusions and form opinions from the facts proved. An exception to this rule is found in expert testimony. Since a jury represents only the average intelligence of the community, cases were early encountered where it was difficult or impossible for the jury to reach a reasonable conclusion from the facts proved before them, and to obviate the defect in the trial system, the courts gradually brought to its assistance expert witnesses, to aid in correctly determining questions presented. At that stage expert testimony was confined almost entirely to that of physicians. Causes of death or effects of physical injuries were then and still are the most common questions with which juries must deal, and the determination of such issues is dependent largely upon the opinions of skilled physicians, familiar with the conditions, testifying as experts. In later years in England and in the United States, expert testimony has been availed of to assist juries in various other classes of cases. The theory of the courts in allowing such testimony is, that the jury, or where the action is tried without a jury, the trial judge, is not competent to draw its own conclusion from the facts proved, without the aid of such testimony. In that event witnesses possessing technical or peculiar knowledge upon the subject are allowed to give their opinions as evidence for the enlightenment of judge or jury.

Within the last few years, the practice of employing expert testimony has grown rapidly and has resulted in the creation of a class of witnesses who might be termed professional experts, and who command large fees for their services. This has conduced to a result which has brought about much criticism, adverse to the system, based largely upon the fact that the testimony of expert witnesses involving lengthy technical discussions is one if not the principal cause of the unreasonable length of modern trials; upon the further fact that the testimony of the modern expert, with its technicalities and extreme length, tends rather to obscure than to enlighten the minds of a jury; but principally upon the fact that such testimony has proved in a great many cases to be so partisan as to be wholly unreliable. This criticism is not unmerited.

The creation of the class of so-called professional experts whose services demand large compensation has resulted in a condition where opposite opinions may be obtained in any number. Some of the recent prominent murder trials have hence afforded an interesting spectacle of arrays of experts with conflicting opinions retained by the respective parties, at great expense, whose examination and cross-examination has consumed days and even weeks, exhausting the patience of the judge, consuming the time of the courts, perplexing instead of clearing the issues, and weakening the confidence of the public in its system of justice.

Before the testimony of an expert witness is admitted, he must be qualified as an expert; in other words it must be shown by his own testimony that he has a knowledge derived from experience or study not possessed by the ordinary person in regard to the particular subject to which he intends to testify. Whether or not the witness has proved himself an expert is determined by the trial judge in his discretion.

The method usually adopted to get the testimony of an expert witness before the jury, after his qualification, is through the form of a hypothetical question. A question is put to the witness by the counsel of the party calling him, the question containing in detail the facts which the counsel believes have been proved and the witness is asked his opinion upon the assumption that the facts assumed are true. Such hypothetical question is often of great length, containing, as it does, a statement of facts that may have required days to prove. After the question is answered by the expert, he is usually subjected to a long cross-examination by the opposing counsel to test his skill and knowledge and the correctness of his conclusion. That the ordinary jury places little weight upon the conclusions of an expert based upon the facts contained in a hypothetical question, may be inferred from the fact that the counsel putting the question may assume facts which have not been proved to the satisfaction of the jury. Again the question is often so long involved that its meaning is soon lost.

In other cases, however, where the witness has knowledge of the facts, the hypothetical question is not necessary. For instance, the opinion of an expert in handwriting may be given after his comparison of the disputed writing with an admitted sample of handwriting used as a standard of comparison; and the physician who has examined a physical injury, or the alienist who has examined a person claimed to be insane, may testify as to his opinion based upon the knowledge acquired by him through such examination without the medium of a hypothetical question.

The courts do not consider expert testimony of great importance, or in any sense binding on the jury. It is allowed solely for the purpose of assisting the jury, and the courts take occasion to instruct a jury to attach such weight to expert testimony as in their minds it seems entitled or to disregard it altogether if they deem fit so to do. Such an instruction will be upheld even if there is no conflict in the expert testimony introduced.

In spite of the just criticism to which the modern development of expert testimony has been subjected, the doctrine has its uses and is necessary to our system of jurisprudence.

Thus, such testimony is absolutely indispensable to prove the custom in a trade; to prove the tensile strength of materials; the probable cost of buildings or works; the chemical composition of materials; the presence of disease and the cause and effects of disease or physical injury, and the cause of death; the seaworthiness of vessels and other nautical matters; and to assist the jury in various other matters not within the knowledge of the average judge or juryman.

Various remedies through legislation have been suggested to remedy the abuses to which expert testimony has been subjected, such as limiting the number of such witnesses to be called upon a trial; limiting the length of the testimony, forbidding an expert witness receiving any compensation beyond the ordinary fees of witnesses and even to the extent of forbidding expert testimony in some classes of cases, the most recent suggestion in connection with criminai cases being the creation of a board of experts retained and compensated solely by the state whose services may be invoked by either the people or the accused.

It may be suggested that the evil will, in time, work its own remedy through the agency of the courts without the aid of legislation. The judge presiding at the trial of an action has a wide discretion in allowing or disallowing the testimony of experts, and it may be said that a too liberal policy of allowing expert testimony without limit is largely the cause of the abuse.

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Exploration in America. As the routes followed by explorers of North America were determined by its physical contour, a brief geographical survey is necessary to understand the progress of its exploration. Thus considered, the continent divides itself into four geographic provinces: the Atlantic coast region, the eastern mountains, the central region, and the western mountains. The first embraces the coastal plain and Piedmont plateau lying east of the Appalachians; the second the Appalachian Mountains and their northern extension to the Gulf of St. Lawrence; the third the whole Mississippi Basin, the Great Lake region, and the Hudson Bay drainage. The last province is the great cordillera of western North America, which lies west of the Mississippi Basin and includes the Rocky Mountain system, Pacific Mountain system, and the Great Basin region lying in between.

The Atlantic seaboard, which was the scene of the earliest exploration and settlement, is separated from the central region by the Appalachian barrier. Hence the St. Lawrence, lying beyond the northern terminus of this barrier, is the only easterly flowing river which drains any part of the central province; and as in an unexplored wilderness watercourses naturally offer the easiest routes of travel, it was by its valley that explorers first penetrated the continent. A way through the barrier was found by following the Hudson and its westerly tributary, the Mohawk, which is connected with Lake Ontario by a lowland area.

The central province is covered by a network of waterways extending nearly two thirds of the distance across the continent, from the inland margin of the Appalachians on the east to the front of the Rocky Mountains on the west. It is separated by low divides into three distinct drainage systems: the rivers emptying into the Gulf of Mexico through the Mississippi; the waters which feed the St. Lawrence; and the rivers tributary to Hudson Bay.

The western mountain belt stretches northward from Mexico through the United States and Canada to the Arctic Ocean. Its southern section is interlaced by a series of rivers tributary in part to the Rio Grande, flowing into the Gulf of Mexico; and in part to the Colorado River, flowing into the Gulf of California.

The easiest route across the continent lay near the present northern boundary of the United States, where the head waters of the Missouri reach far into the western mountains, only 500 miles from the Pacific, and separated by but one divide from the Columbia River basin, which leads directly to the Pacific. Geographically, then, the explorations of our country fall into four groups: (1) those along the Atlantic seaboard, made by colonists of various nationalities; (2) those along the Mississippi, made by the

Spaniards from the south, the French from the north, and pioneers breaking through the passes of the Appalachians from the Atlantic seaboard; (3) those made by the Spaniards northward from the Mexican border; and (4) those of the western mountains, made by Americans and of comparatively recent date.

Though the Cabots discovered North America in 1497 and claimed it for England, it was Spain who first attempted its exploration. Ponce de Leon, who had sailed with Columbus on his second voyage and subsequently become governor of Porto Rico, set out in 1513 in search of the "Fountain of Youth." Sighting an unknown coast at latitude 30° 8', he named the land "Florida," and turning south explored both sides of the peninsula. When he attempted nine years later to plant a colony on these shores, he was driven off by Indians.

But Spanish interest was aroused. In 1519 Cortes achieved his infamous conquest of Mexico, and the fame of its wealth inspired others to seek the New World. Pánfilo de Narvaez obtained a grant to conquer and govern Florida, by which was meant all the rest of the continent, stretching indefinitely northward from the Gulf of Mexico. With 300 men he landed at Tampa Bay in 1528, and marched northward, suffering terrible hardships. Disappointed at not finding the gold they sought, they returned to the coast near Appalachee Bay and set out for Mexico in improvised boats, but were wrecked by the way. Of the whole party, Cabeza de Vaca and three others were the only survivors. For six years they wandered: up through Mississippi across the Mississippi River near Memphis, along the Arkansas and Red rivers to New Mexico and Chihuahua; at last reaching Sinaloa on the Gulf of California, where they were found by Spaniards and taken to Mexico (1536).

Cabeza's written account of their experiences, published after his return to Spain, falsely attributed great wealth to Florida. So when Hernando de Soto, fresh from the conquests in South America, which had given him riches and fame, obtained permission to conquer Florida, many flocked to join him. He sailed in nine ships with 620 men, maintaining great display. Landing at Tampa Bay in 1539, the procession wandered westward, ill-treating the natives, for three years in pursuit of gold through the wilderness of the present Georgia, Alabama, Tennessee, and Mississippi to the banks of the Mississippi River. They crossed above the Arkansas, penetrated westward until frightened back by the roving prairie tribes, and returned to the Mississippi, where De Soto died and was buried in its waters at the mouth of the Red River (1542). His followers under Moscoso built seven brigantines, descended to the Gulf, and reached the Spanish settlement on the River Panuco, 311 survivors all told. Thus it was De Soto who first attracted attention to the Mississippi. Alonso de Pineda had discovered its mouth in 1519, and named it "Espiritu Santo," and Cabeza de Vaca crossed it about 1530; but neither of them recognized its importance.

The fate of this expedition discouraged coastal exploration for a time. But the Spaniards in Mexico were already pushing their way up into the heart of the continent. In 1539 Marcos de Niza, a priest, penetrated New Mexico and came back with reports of the wealth of Cibola, a name which he applied to seven cities somewhere to the north. These were long supposed to be mythical, but have since been identified as the seven Zuñi villages in New Mexico.

The tale led Vasquez de Coronado to set out in 1540. Part of his expedition he sent by water up the Gulf of California under Hernando d'Alarçon, who discovered the Colorado River and ascended it for 85 leagues. The other part he led overland in the direction of Cibola, which he found and conquered (about lat. 35°); and then on into Kansas to about lat. 40°.

The belt of country bounding Mexico on the north received the name "New Mexico" from Antonio Espejo, an explorer who started north in 1582 with Indian guides to the rescue of three missionaries who had been deserted the previous year. Following the Rio Grande del Norte, he came to Cibola and, after learning that the missionaries had been killed, continued to explore the region, and returned by the river Pecos.

The colonizer of New Mexico was Juan de Oñate. He entered the country in 1597 with 130 families and founded the first capital, San Gabriel (second oldest town in the United States), near Santa Fé. In succeeding years he carried his explorations westward through Arizona, in 1604 following the Gila River to the Gulf of California. The following year he founded Santa Fé.

While this was going on in the interior, other nations were interested in the coast. It must be remembered that Columbus was in search of a western passage to Asia when he came upon America. But the idea did not die. A similar quest brought the Cabots to the shores of North America; and later, as the vast extent of the new country began to be realized, one explorer after another searched the coast for a water route by which to pierce the continent. When at last the waters of the St. Lawrence were found to lead no farther than the Great Lakes, explorers still pushed westward along the tributaries of the Mississippi or attempted to round the continent on the north through the ice-blocked seas.

In 1524 Giovanni da Verrazzano, sent by Francis I. of France, examined the shores from South Carolina to Newfoundland, and wrote to the king the first known description of them. He brought back a theory of an inland sea approaching the Atlantic coast about the middle of the continent; and it was to find this "Sea of Verrazzano," as a possible route to Asia, that the king sent Jacques Cartier in 1534 to the Gulf of St. Lawrence (previously discovered by Jean Denys of Honfleur). In the course of three voyages he explored the St. Lawrence as far as Montreal, believing that he had found the western passage.

Cartier attempted to plant a colony near the site of Quebec; but for many years France's efforts in that line were doomed to failure. Equally unsuccessful were Jean Ribaut, who in 1562 brought over a band of Huguenot colonists to the site of Beaufort, S. C.; and René de Laudonnière, who founded Fort Caroline two years later at the mouth of the St. John's River, Florida. In 1565 Pedro Menendez de Avilés came to colonize Florida for Spain, and massacred the inhabitants of Fort Caroline. Laudonnière escaped to France, but Ribaut (who had just arrived from his second voyage with reinforcements for the colony) was killed while attempting to escape along the coast.

Menendez was the first to establish Spanish rule firmly in Florida. He founded St. Augustine (oldest town in the United States) in 1565, sent a mission to the Rappahannock in 1570, and explored Chesapeake Bay and the Potomac.

England sent out her first colonists to Jamestown, Va., in 1607. Among the number was Capt. John Smith, an indefatigable explorer of the neighboring rivers and Chesapeake Bay.

Another Englishman, Henry Hudson, sent out in 1609 by the Dutch East India Company, explored the coast from Nova Scotia to Chesapeake Bay, and then ascended the Hudson River to Albany. It was during the following year that, in the search for a northwest passage, he discovered the strait and bay that bear his name.

France first gained a foothold in North America through the efforts of Samuel de Champlain. The years 1603–7 he spent in exploring the St. Lawrence and the shores of New England, making the first accurate map of that coast. After he founded Quebec in 1608, he became interested in inland exploration, which twice led him into the United States: In 1609 he set out with 11 men to aid the Hurons against the Iroquois, descended the Richelieu in canoes, portaging part of the way, and pushed on through Lake Champlain to about Crown Point; and again in 1615 he accompanied a great war party of Indians by way of the New York lakes into the heart of the Iroquois country, south of Lake Oneida.

From this time fur-traders and missionaries spread over the country bordering the St. Lawrence and its tributaries, gradually approaching the Mississippi. The Spaniards had not followed up their discovery, failing to understand its importance. Nearly a century after De Soto's journey the French at the north began to have an interest in the Indian traditions regarding the "Great River." About 1635 a trader, Jean Nicollet, was sent to a tribe near the head of Green Bay, Wisconsin. From there he went with Indian guides up the Fox River, portaged to the Wisconsin, and descended that until he came "near the sea," as he reported; probably mistaking the "Great Water" described by the Indians for the sea. By 1658 two other French traders, Radisson and Groseilliers, reached the head of Lake Superior and explored the surrounding country.

When these rumors of a great river to the west reached Frontenac, the governor of Canada, he sent Louis Joliet to explore it in company with Jacques Marquette, a Jesuit. Meeting at St. Ignace, they set out with five men and two canoes, skirted the north shore of Lake Michigan and Green Bay, and ascending the Fox River, were guided by Indians across the portage to the Wisconsin, down which they passed, reaching the Mississippi 17 June. For one month they floated down the great stream, noting the mouths of its tributaries as they passed, until they came to an Indian village opposite the mouth of the Arkansas. By this time they knew that the river emptied into the Gulf of Mexico, and supposing themselves nearer the mouth than they actually were, they turned back through fear of Spaniards, returning by way of the Illinois and the western shore of Lake Michigan, which they reached by portage. Two years later Marquette met his death while attempting to establish a mission on the Illinois. His work among the Indians was taken up by Father Claude Allouez, also a Jesuit, who established several missions and traversed much of the country around lakes Superior and Michigan between 1665 and 1680.

Already another explorer was searching for the Mississippi. Robert Cavalier de La Salle was one of those who had come to Canada in pursuit of the passage to China, and guessed that it lay by way of the Mississippi, which he supposed emptied into the Gulf of California. In 1669 he crossed from Lake Ontario to a branch of the Ohio, and followed that river as far as Louisville. The next year he reached the Illinois from the end of Lake Michigan and explored it for some distance. For years he went back and forth through the region and established trade with the western Indians. In 1680 he sent Louis Hennepin, another Jesuit, with two men down the Illinois to ascend the Mississippi. On the way they were taken prisoners by the Sioux and carried up the great river to the Falls of St. Anthony, which Hennepin named. There they were joined by the famous trader Daniel Greysolon Du Lhut, who for two years had fearlessly explored the region around the end of Lake Superior and the head of the Mississippi. He had just come by way of the St. Croix River from his fort on the site of Duluth, and now joined Hennepin on his return journey by the Wisconsin.

At last, in 1682, La Salle attained his goal. With Henri de Tonty and a large party he reached the Mississippi from the foot of Lake Michigan by way of the Chicago and the Illinois, and descended to its mouth. On 9 April La Salle took possession in the name of King Louis of France and gave the name Louisiana to all territory drained by the Mississippi. After his return he sailed for France and obtained permission to transport colonists to the new province. He reached the Gulf of Mexico, but was unable to find the mouth of the river, and put in at Matagorda Bay. There he built Fort St. Louis, and then started overland to find the Mississippi and reach Canada to obtain supplies for the colonists, but was murdered by one of his men near a fork of Trinity River, Texas.

Where La Salle had failed, Pierre Le Moyne d'Iberville was to succeed. In 1699 he entered the Gulf of Mexico and explored the region around the mouth of the Mississippi, leaving a colony at Biloxi, which was afterward transferred to Mobile. With him was one already known as an explorer of the northern region, Pierre Le Sueur. He in 1695 had discovered and named the St. Peter (the Minnesota) River and observed a quantity of green earth near it; and now, in the belief that it was copper, he led a party of men up the river to work it and established a fort on the Blue Earth (Green) River.

Just at this time (1703) Baron La Hontan, a man who participated in many explorations in the north of the Valley, published an account of his wanderings which contains some valuable information with much that is false. He claimed to have discovered a river (La Rivière Longue) entering the Mississippi from the west near Lake Pepin, and to have followed it to its source in a large lake at the foot of mountains, on the other side of which was another river which emptied into the Pacific. This figured on maps for years before it was found to be fictitious.

The right to "farm out" this great country of Louisiana was granted to Antoine Crozat in 1714, and agents were immediately despatched to explore the tributaries of the Mississippi. Before the year was out St. Denis followed the Red River and crossed to the Rio Grande, where he came upon a Spanish mission and was imprisoned, sent to Mexico, and ordered to return. La Harpe in 1719 pushed up the Red River and across to the Arkansas, reaching lat. 37° 21′. He established a post among the Indians, claimed all this country for France, and defied the Spaniards in a letter to the Spanish governor. The exploration of the Missouri was attempted in 1719 by Du Tisné and followed up to six leagues above Grand River, at the peril of his life among hostile Indians, who attempted in vain to bar his passage.

In this southwestern section of the Valley French intrusion was resented by the Spaniards. Their claim to Texas rested on the exploration of its rivers by Francisco de Urdinola in 1575, and an expedition led across its borders by Hernando del Bisque in 1675. Farther west their control was assured by the work of missionaries. Father Kino, a Jesuit, had entered Arizona as early as 1658, and by 1679 had established five missions and become well acquainted with the country. On one of his expeditions he reached the mouth of the Colorado and discovered that Lower California was a peninsula, not an island, as was supposed.

With the expulsion of the Jesuits in 1767 the missions passed into the hands of the Franciscans, who inaugurated the era of Spanish exploration and settlement in California by a colony at San Diego in 1769. Years before pioneers from the east broke through the mountains and seized upon the country, these missionaries had permeated it and stamped their influence upon it.

Meanwhile the French at the north were every year sending traders and explorers into the interior. For some time they continued to use the routes followed by Marquette through Green Bay and by La Salle up the Chicago, but in 1716 they opened a new one by way of the Wabash, and another in 1720 by way of the Miami. A dispute over boundaries arose between the English and the French. Gov. Spotswood of Virginia urged upon the English the necessity of colonizing the Ohio Valley, and in 1716 made his fantastic ride with the "Knights of the Golden Horseshoe" to see if a way through the mountains could be found. He crossed the Blue Ridge and the Shenandoah Valley, but it was not until 1732 that the first settler, Joist Hite, entered the region.

Other efforts were being made to cross the mountains. When it was learned that the French were winning the allegiance of the Cherokees from the English, Sir Alexander Cuming, a Scotchman, set out in 1730 with a party from Charleston and made a circuit of 500 miles across the mountains, bringing back several Indians in token of renewed faith. In 1736 Col. William Mayo and a party of surveyors followed the Potomac to its springs and discovered a portage to waters flowing into the Monongahela. Another route was opened to the Kanawha, an affluent of the Ohio, in 1744 by Col. James Wood, a well-known frontiersman and explorer. Dr. Thomas Walker in 1748 led an expedition across the Virginia mountains, named Cumberland Gap and River, and made a circuit through West Virginia.

As the country became better known public interest awakened, and in 1748 a number of Virginians formed themselves into the "Ohio Company" for the purpose of colonizing the Ohio Valley. To anticipate them, the governor of Montreal despatched Bienville de Céleron down the Ohio to bury at the mouths of its tributaries plates inscribed with the declaration that all territory drained by those waters belonged to France. In spite of this, the Ohio Company sent out Walker in 1750 to survey lands for settlement. He explored Kentucky, and built the first house in the region now comprised in that State. Christopher Gist was also sent to explore routes to the north, select lands for settlement, and investigate the Indian tribes. He made a circuit of 1,200 miles north to the Scioto and Miami, and then south of the Ohio, visiting all the Ohio tribes, and returning by way of the Licking, Kentucky, and Roanoke rivers. On a second mission in 1751 he discovered a new gap from the Potomac to the Monongahela, and explored the Kanawha.

The next year Gist acted as guide to George Washington when he went as emissary from the governor of Virginia to the French fort at the head of the Ohio to protest against the French occupation of the valley. His mission was fruitless, but he brought back a map of his route: up the Potomac, across the divide, and along the Monongahela and Allegheny to the French fort near Lake Erie.

A most prominent figure in English exploration was George Croghan. Sent out by Pennsylvania in 1750 with the half-breed Montour to win over the Indians through the Ohio valley to the English, he went far and wide, from tribe to tribe, attaining an influence over the Indians which was of invaluable service to the English during the French and Indian war. When peace was declared he was delegated to prepare the Indians for English occupation. Starting from Pittsburg, he followed the Ohio, Wabash and Maumee to Detroit, and reported that the way was open; whereupon the English troops, under Capt. Thomas Stirling, advanced to Fort Chartres and took possession of the country east of the Mississippi.

And now, with English control assured, settlement spread rapidly beyond the Appalachians. Much of the preliminary exploration was made by hunters, trappers, and traders too numerous to mention, were they known. North of the Ohio the country was first settled by Moravian missionaries. Among the southern pioneers, James Smith followed the Kentucky and Tennessee rivers in 1766 and John Finlay explored northern Kentucky in 1767; but most prominent was Daniel Boone. His first venture was made in 1769, when he crossed the Cumberland Gap with James Robertson and spent two years exploring eastern Kentucky and Tennessee. Subsequently these two men took a prominent part in the settlement of this region.

With the advent of the American Revolution exploration received a check; but the expeditions of troops led by George Rodgers Clark into the Ohio basin 1778–9, and by Gen. John Sullivan into western New York were not without geographical value. And in the Indian wars which followed (1790–4) the American expeditions under Harmar, Clark, St. Clair, and Wayne added to knowledge of the Ohio Valley.

During the 17th and 18th centuries, while exploration and settlement had been pushed westward from the Atlantic seaboard over half-way across the continent, the Pacific coast was almost unknown. Balboa had discovered the Pacific at the Isthmus of Panama in 1513, and Cortes had sent several expeditions to the west coast of Mexico (1522–24). The first white man to reach the coast of California was the Spaniard Juan Cabrillo, who in 1542 traced it north as far as Monterey; and after his death the following year his pilot continued to Cape Mendocino. In 1576 the English seaman Drake reached lat. 43° in his coastal exploration. To the north the coast was unknown until Vitus Bering (1741), commanding a Russian expedition, visited it in lat. 60°. His voyage was followed by a swarm of Russian fur-traders, who, following the chain of Aleutian Islands during the latter part of the 18th century, gradually worked their way eastward and eventually reached the mainland of what is now Alaska.

In 1778 came Capt. James Cook, the famous English navigator, surveying the coast from Vancouver Island to the Arctic Ocean in his search for a northeast passage. When the published account of this voyage called attention to the rich fur-trade in the northwest, Americans were among the first to take advantage of it. In 1789 Capt. Robert Gray, of Boston, in the ship Columbia, cruised around the Horn and visited the northwest coast, carried a cargo of furs to China, and returned to Boston by way of the Cape of Good Hope. Thus was the American flag first carried around the world. On a second voyage in 1792 he discovered and explored the lower reaches of the Columbia River. This all-important achievement, besides disclosing an easy route from the western mountains to the sea — thus paving the way for trans-continental exploration — formed the chief basis of our territorial claim to Oregon. When George Vancouver, who was exploring the west coast with two British vessels (1792), learned of the Columbia River through Gray, he sent a boat expedition to investigate it. Afterward he continued northward to extend Cook's explorations on the coast of Alaska and British Columbia.

As yet none had succeeded in finding an overland route to the Pacific north of Mexico. Cabeza de Vaca, in his transcontinental wanderings, had turned to the south when he reached the mountains. A Canadian, Varennes de la Vérendrye, spent many years (1731–49) in the search for a route: at his own expense, for his government refused to back him. With his sons he made extensive explorations west of Hudson Bay, in the course of which he discovered (1731) the Red River and Lake Winnipeg, and his son Pierre penetrated to the forks of the Saskatchewan River (1739). In 1742 the two sons made a perilous journey to the southwest, across the Missouri and on to the Big Horn Mountains.

In the struggle for the Ohio Valley the western route was forgotten for a time. But when that contest was settled the quest was renewed by Jonathan Carver of Connecticut. In 1766 he made his way westward by canoe through the Great Lakes, and by Marquette's route to the Mississippi, which he ascended to the Falls of St. Anthony. He explored the Minnesota River, spent a winter among the Sioux, and in 1767 returned by ascending the Chippewa River and reaching Lake Superior waters by portage. While his journey added little to geographical knowledge, yet it served to awaken interest, and led Richard Whitworth to join Carver in planning a transcontinental expedition, which was unfortunately prevented by the outbreak of the Revolution.

Meanwhile the English fur-trading companies, through the journeys of their agents, had contributed much to geographical knowledge, not only of Canada but of the United States. The Hudson Bay Company, since it obtained its charter in 1670 and established its first post (Fort Rupert) on the great bay from which it took its name, had, in spite of French interference, extended along the shores of the bay and its tributaries. After the English conquest of Canada in 1763 it had a clear field until the appearance in 1783 of a rival "Northwestern Company," made up of Canadian merchants, which operated by the direct route from Montreal to the Great Lakes, and rapidly pushed its control throughout the north and west. Its influence was extended to the west coast by Alexander Mackenzie in a journey (1792–3) from Lake Athabasca up the Peace River and across the Rocky Mountains, the head waters of the Fraser River, and the Coast Range to the coast of British Columbia in the latitude of Queen Charlotte Sound. This was the first time the continent was crossed north of Mexico.

Thomas Jefferson in 1803 induced Congress to make an appropriation for the expenses of a transcontinental exploring expedition, a project that he had entertained for some 20 years. Nominally, Capt. Meriwether Lewis was leader of the party, with Lieut. (generally known as Capt.) William Clark second in command; but in point of fact all action was taken jointly, and the expedition is always known as that of Lewis and Clark. While preparations were under way the purchase of the territory of Louisiana from France gave additional importance to the enterprise. Lewis and Clark, with 43 men, left St. Louis, then a frontier trading-post, in three large boats, pushed their way up the Missouri, and built a fort at the Mandan Village, about 50 miles above the present town of Bismarck, N. D. From this point some of the party were sent back, and in the spring of 1805 the rest continued their voyage up the Missouri with 32 men. At the falls the heavy boats were left, and canoes were constructed to continue the ascent of the river. Near the head of what they named the Jefferson (the western fork of the Missouri) they cached their canoes, and with horses secured from the Indians crossed the Rocky Mountains to the Columbia, which they descended to the mouth, reaching the Pacific in November, 1805. After wintering here the party retraced their steps to the east side of the Rocky Mountains, and there separated; Lewis following the Missouri, while Clark traced the course of the Yellowstone. At the junction the reunited forces continued their rapid down-stream journey, reaching St. Louis in September, 1806. This was not only the most notable exploration ever undertaken by the United States government, but its complete success led to the many others which have followed up to the present day.

The head waters of the Mississippi were explored by Lieut. Zebulon Montgomery Pike, who ascended the river with a party of 20 soldiers in 1805. He reached Leach Lake drainage system and found the region already occupied by the agents of the Northwestern Company. Upon his return in 1806 Pike set out again with 23 men, with the idea of winning the allegiance of the Indians from the Spaniards and establishing an American claim to the region which had long been in dispute between the French and Spaniards. He ascended the Osage River in boats, and crossed overland with horses to the Pawnee villages, where he took up the trail of the Spaniard Malgares, who in the previous year had made an excursion into this region from Mexico at the head of several hundred troops. At the Arkansas Pike detailed Lieut. James Wilkinson to explore that stream to the Mississippi, and continued west with the larger section of the party, arriving in November at that high peak of the Rockies which now bears his name. During the winter, after terrible suffering from cold and hunger, he reached the Rio Grande. The Spanish authorities sent out a large force to capture the little band of explorers, and they were conducted back through what is now known as Texas.

The roving fur-traders were quick to penetrate the regions pioneered by Lewis and Clark and Pike. During the years 1806–9 they extended their excursions well into the Rocky Mountains from the east. In Canada the Northwestern Company, ever active, pushed its outposts westward; and in 1808 one of its agents, Simon Fraser, reached the Pacific at the mouth of the Fraser River.

In 1810 John Jacob Astor, a New York fur-trader, organized a company for the purpose of exploiting the trade on the Pacific slope. A vessel was despatched to the mouth of the Columbia River to establish a post, and an expedition sent overland to follow the Lewis and Clark route. This was the second party to cross the United States to the Pacific. Numbering three boats and sixty men under the leadership of one of the partners, Wilson Price Hunt, it left St. Louis in the late summer of 1810, and pushed its way up the Missouri about 450 miles. Here the party wintered, and in the spring continued by boat to the big bend of the Missouri; then with horses purchased from the Sioux proceeded overland in a southwesterly direction, crossed the Rockies near the head of the Big Horn River, and followed the Snake River Valley to the Columbia. With only a fraction of his large party, and after the most terrible suffering, Hunt reached the mouth of the Columbia in February, 1812, and found Astoria, the post established by the party sent by sea. The American company was only just in time: the previous year David Thompson of the Northwestern Company had portaged across the Rockies from the Saskatchewan to the head waters of the Columbia and followed it to the Pacific, where, much to his disgust, he found the Americans already in possession.

In 1812 David Stuart, with a small party, started eastward from Astoria to make the difficult and hazardous journey to St. Louis. He chose a route to the head waters of the Snake, across the divide to the Green River, a tributary of the Colorado, and across a second divide to the Platte, which he followed to its junction with the Missouri, and continued down stream to St. Louis, arriving in April, 1813, after a journey full of peril and hardship.

In 1814 Astoria passed into the hands of the Northwestern Company, which extended its trade over the entire Columbia River basin, and established posts at various points. The eastern slope of the Rockies was occupied by American traders, with headquarters at St. Louis and posts on the upper Missouri in the Green River Valley.

The government began to realize the importance of exploration. In the hope of discovering the sources of the Red River, a large expedition under Maj. Stephen H. Long left Pittsburg on a small steamer in April, 1819, wintered on the lower Missouri and during the following year made explorations and surveys in the country now included in Arkansas and Missouri. Long was sent again in 1828 to explore the head waters of the Mississippi, which he approached through the wilderness from the Miami River to Lake Michigan, thence to the junction of the Wisconsin and Mississippi, and on to the Minnesota: a difficult route, but lying in a region which had been explored by French pioneers more than a century before.

Still the source of the Mississippi had not been discovered. The head water region, previously visited by Pike, and long the stamping-ground of the fur-trader, had been again explored in 1820 by Gen. Lewis Cass, governor of Michigan, in company with Henry R. Schoolcraft. It was not until 1832 that the source was finally discovered in Lake Itasca by Schoolcraft and Lieut. J. Allen.

Capt. B. L. E. Bonneville, an officer of the U. S. army, in 1832 organized a party of trappers and hunters for the ostensible purpose of taking part in the fur-trade, but more to gratify his own ambition to explore the Far West. He left Fort Osage on the Missouri with 110 men, transporting his supplies by means of wagons, instead of using pack-animals, as all previous parties had done. Following Stuart's route of 20 years before along the valley of the Platte River, he crossed the mountains with his wagon-train and established a post at the head of the Green River. From this point as rendezvous his party scattered out in various directions, he himself exploring the Big Horn and Wind River mountains and extending one journey to the English trading-post on the Columbia. A party sent out by him visited Salt Lake, and continued through to the Spanish settlement of Monterey on the Pacific.

During the years 1833–5 the Rev. Samuel Parker, a zealous missionary, made several hazardous journeys from the Mississippi waters to those of the Columbia. At this time the Hudson Bay Company, which had absorbed its rival, the Northwestern Company, controlled the entire Columbia River basin, and claimed it for England, in spite of the protest of the few American settlers. In 1842 it came to the knowledge of the Americans that the English were making preparations to colonize the region, and it was necessary that the authorities at Washington should be informed at once. For this purpose Dr. Marcus Whitman and A. L. Lovejoy set out in the dead of winter on a journey of 4,000 miles across the continent. They took a southerly route through New Mexico to the Arkansas, and Whitman reached Washington.

In 1841 Lieut. R. E. Johnson of the United States Exploring Expedition, commanded by Charles Wilkes, U. S. N., crossed the Cascade Mountains near Mt. Rainier and, after making an extended journey in the Columbia River Valley, recrossed the Cascades to the coast. A detachment ascended the Willamette and crossed to the Sacramento Valley, which they followed to San Francisco.

With the exception of the Lewis and Clark expedition, the most important exploration of the century was done by Lieut. John C. Frémont, who had gained his first experience while assisting J. N. Nicollet, a French geodesist, employed by the United States government 1836–40, for making surveys in the upper Mississippi basin. In 1842 Frémont, with 25 men, among whom was the famous scout, Kit Carson, made surveys of a region lying between the Missouri River and the Rocky Mountains, along the valleys of the Kansas and Great Platte rivers. In 1843 he was instructed to carry his surveys to the Pacific coast. With a party of 40 men he made his way westward from the junction of the Kansas and Missouri rivers to the head waters of the North Platte, crossed to Green River, and traversing a region long known through the explorations of Bonneville and others, crossed another divide and descended Bear River to Salt Lake, which he explored. From there he went westward to the Snake River, and on to the mouth of the Columbia. After renewing the supply of provisions, Frémont retraced his steps to the Dalles of the Columbia, then turned southward to Klamath Lake, and made a hazardous journey through the Sierras which brought him into California along the valley of the American River, an eastern branch of the Sacramento. Traveling southward, he once more crossed the Sierras in lat. 35°, and returned to St. Louis across the Great Basin region and the Rockies. On his third journey Frémont crossed the Rockies from the head of the Arkansas to the Green River Valley, then continued westward around the southern end of Salt Lake across the Sierras, near where he previously traversed them, and then turned northward along the Sacramento Valley and across the mountains to Klamath Lake. Here he was impelled to turn back by the news of the uprising in California, and converted his exploring party into a military expedition.

The southwest became better known through military operations during the Mexican War, and after its close many expeditions were sent out by the government, under both military and civilian leadership, most of them, however, in regions already explored.

Public interest in the construction of a transcontinental railway led to five extensive expeditions during the years 1852–7: the first exploring along the 32d parallel; the second near the 35th; the third near the 38th and 39th; the fourth near the 41st and 42d; and the fifth near the 47th and 49th. Various military explorations and surveys were carried on west of the Mississippi up to the outbreak of the Civil War.

In 1869 Maj. J. W. Powell made a daring exploration of the Grand Cañon of the Colorado. With only a few men, in small boats, he followed the Green and Colorado rivers from Green River Station to the mouth of the Virgin River. In the next two years he extended this exploration in the Colorado basin under government auspices.

The Pacific railroad surveys practically completed the purely exploratory work of the United States; subsequent investigation was directed to minor details. During the years 1867–79 this work was carried on by various organizations which were created for both geographic and geologic research. Four of them were of especial note: "The Geological Exploration of the 40th Parallel," under Clarence King (King Survey); "United States Geographical and Geological Survey West of the 100th Meridian," under Capt. Geo. M. Wheeler, U. S. A. (Wheeler Survey); "United States Geological and Geographical Survey of Territories," under F. V. Hayden (Hayden Survey); "Geological and Geographical Survey of the Rocky Mountain Region," under J. W. Powell. In 1879 the United States Geological Survey was created for this purpose and the other organizations discontinued.

The acquisition of Alaska in 1867 gave American explorers a new field. This territory, occupying the northwest corner of the continent, is peninsular in form, its southern seaboard fronting on the Pacific. An almost unbroken system of mountains lies near the southern coast, forming a barrier which long prevented inland exploration. The broad, depressed interior area behind this mountain system is also cut off on the north and east by another range (the Rockies), which interposed a barrier between the interior of Alaska and that extensive system of waterways of northern Canada which was used by the explorer and fur-trader from the Atlantic coast. The central region opens out to Bering Sea, into which it pours most of its drainage through two great rivers, the Yukon and Kuskokwim: both navigable and affording easy access to the interior.

Alaska had been known to Russians since Bering's discoveries (1724 and 1741) and its coast-line had been explored by Russian fur-traders and naval officers, but more effectively by the English navigators, Cook (1778) and Vancouver (1793). The general shore-survey was continued by Otto von Kotzebue (German in Russian employ) in 1815, and by the English explorers, Sir John Franklin and Capt. F. W. Beechey (1826), Peter Warren Dease and Thomas Simpson (1837). The years 1849–53 saw a confirmation of the coastal exploration by Capts. Thomas E. L. Moore, Henry Kellett, Richard Collinson, and Commander Robert S. McClure, all H. M. S., and belonging to vessels of the Franklin relief expeditions.

In 1864–6 Robert Kennicott, Wm. H. Dall, and others of the Western Union Telegraph Survey, which had for its purpose the establishment of a telegraph line from the United States to Asia via Bering Strait, made explorations in the lower Yukon basin and ascended the full length of the river, about 1,800 miles. It had been traced from the sea for about 1,000 miles (1842–3) by Lieut. Zagoskin, and the Hudson Bay traders had reached it from the east in 1848 and established posts.

At the time of Alaska's transfer to the United States the coast-line had been explored practically throughout, but little was known of the interior; and for many years thereafter no official exploration was undertaken. Capt. R. W. Raymond, U. S. A., ascended the Yukon for 1,200 miles in 1869, but his journey was of no geographic importance. The pioneer fur-traders, among whom may be mentioned Jack McQueston, Arthur Harper, Fred Hunt, Joe Ladue, and Frank Densmore, made many hazardous journeys by which they extended geographic knowledge. Some time in the early seventies George Holt, a prospector, the forerunner of the great multitude to follow, made his way inland by way of the Chilkoot Pass and Lewes River; and by 1883, when Lieut. Frederick Schwatka, U. S. A., followed the same route, it had already become well established among miners and prospectors. In 1885 Lieut. Henry T. Allen made an exploration of the Copper, Tanana, and Koyukuk Rivers. Northern Alaska was explored (1883–6) by Lieut. George M. Stoney, U. S. N., and Lieut. John C. Cantwell and S. B. McLenigan, R. M. S. These expeditions mapped the Noatak, Kobuk, and upper Colville rivers, and Ensign W. L. Howard of the Stoney party extended the work through to the north Arctic coast. The journey of J. H. Turner, U. S. Coast and Geodetic Survey, in 1890 from the Porcupine River to the Arctic coast added to knowledge of northern Alaska. In 1890 E. J. Glave and Jack Dalton explored the Alsek River, which finds its way to the sea through the St. Elias Range. An exploration from the Yukon up the White River Valley to the Copper River was made in 1891 by Lieut. Schwatka in company with C. Willard Hayes, U. S. Geological Survey.

In 1898 the U. S. Geological Survey took up systematic surveys and explorations in Alaska. The first year George H. Eldridge and Robert Muldrow explored the Sushitna Valley; J. E. Spurr and W. S. Post the Kuskokwim Valley; and Alfred H. Brooks and W. J. Peters the White and Tanana river valleys. In the same year Capt. E. F. Glenn, U. S. A., and W. C. Mendenhall, U. S. G. S., penetrated overland from the head of Cook Inlet to the Tanana River. In 1899 F. C. Schrader and T. G. Gerdine explored the Chandler and Koyukuk valleys, while Peters and Brooks made a journey from Lynn Canal to the Yukon, exploring the northern front of the St. Elias Range. The same year Lieut. J. S. Herron, U. S. A., made an exploration in the upper Kuskokwim basin. Two years later the work in northern Alaska was extended by Schrader and Peters northward from the Koyukuk through to the mouth of the Colville, and by W. C. Mendenhall and D. L. Reaburn from the Yukon to Kotzebue Sound by way of the Kobuk River. In 1902 Brooks and Reaburn made an exploration from Cook Inlet through the Alaskan Range, along its northern base by the foot of Mt. McKinley, to the Yukon River.

In spite of all this activity, there are large areas of Alaska which have yet to be explored.

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Exploration in the 19th Century. Two phases of geographic research distinguished the 19th century from its predecessors. The largest discoveries of the 18th century were made by sailors — Cook, Carteret, Bougainville, Vancouver, and many others — who brought to light the myriad islands of the oceans or delineated unexplored parts of coast-lines. The largest discoveries of the 19th century, on the other hand, were made in the interior of the great land masses. It was the era of the study of the continents. The Cossack pioneers, in Russia's service, had crossed Siberia, but with this exception not a line of exploration had been run across Asia since Marco Polo in the 13th century till the second half of the 19th century brought forth its scores of Asian explorers. Nearly all our knowledge of the interior of Africa, Australia, and the larger part of North America is also the work of that century.

When Alexander von Humboldt described the travels which he began in South America in July 1799, he ushered in a new era of exploration; for he taught geographers that exploration does not consist merely of topographic delineation of mountains, rivers, plains, and settlements, but that it includes many other factors that have a bearing upon human interests — such as meteorology, climatology, the distribution of plants, and the nature of soils. He was the main pioneer influence in substituting scientific for superficial and unskilled exploration. Thus the 19th century was not only the greatest century in the study of the land surface of the earth, but also in scientific discovery.

South America, Africa, and Australia.— In their exploration, South America is the anomaly and Africa the wonder among the continents. South America is the only great region whose exploration on a large scale quickly followed European occupancy. The Amazon was known almost from its sources to its mouth, in the middle of the 16th century. Nearly all the coast cities on our maps were founded at that time, and a little later the Jesuits established their almost independent states in the heart of the continent; but to-day South America lags behind them all. Inner Africa, the geographical enigma 50 years ago, is better known. No railroad in Brazil penetrates so far inland as the African railroad to Matabeleland. South America is the part of the habitable world where most pioneer exploration remains to be done.

These facts are mainly the result of one potent influence that enabled the 19th century to contribute most largely to detailed geographical knowledge. It was the desire of the European powers to acquire more lands, widen commerce, and spread civilization that, in the past 50 years, has placed in the field scores of very costly exploring enterprises, many on a military basis, and fitted for really scientific work on a scale far beyond the scope of private achievement. South America has been outside this field of rivalry. Her days of largest exploration were when Spain and Portugal were great colonial powers. But early in the 19th century they lost that continent; and the republics which succeeded them, poor in purse and involved in many civil and external wars, have scarcely made the exploration of their own territories a state affair until within the past few years. The world knows far more of inner Africa to-day than the government at Bogota knows of the southeastern third of Colombia. Dr. Sievers has mentioned the fact that long series of meteorological observations in inner Africa are now available, while in large parts of South America — as in the llanos of Venezuela and most of the Amazon basin — there are no records of value for scientific deductions with regard to climate. .

But the European nations did not enter upon this great task of studying the undeveloped continents till they received the impulse from the humble pioneers of discovery. Stanley says he thought Livingstone was an enthusiast and a visionary when they stood together on the shore of Tanganyika, and the great missionary-explorer, with uplifted hand trembling with weakness, told him the day was coming when the civilized nations would see the good in Africa and set about the reclamation of the continent. It was Livingstone, first of all, and his successors, who started the movement, which gathered volume and momentum till we see a continent one third larger than our own parceled out among the European powers, which have practically completed exploration on broad lines, and are studying it in detail.

Twenty years ago the country back of the west coast of Australia was an unknown Sahara, through which only three or four travelers, at the risk of their lives, had pushed their way. Then it was discovered that this frightful waste was the treasure-house of western Australia, guarded from all intruders by thirst and famine. The entire topography of this spinifex-covered desert has now been revealed. This exploration was made possible by the fact that the great modern agent of civilization, the railroad, was pushed out into the desert at various points, so that thousands of men, with supplies daily replenished from the coast, may live there and find and develop the gold resources. This illustrates the fact that many inventions of the 19th century which facilitate the development of little-known lands have stimulated the work of discovery because they have made it easier to obtain substantial results for business as well as for science by exploratory enterprises.

Better Knowledge of Our Own Country.— The text-books which our school children used 100 years ago told them nothing of the Rocky Mountains or of the ranges of the Pacific slope. The exploration of three fourths of our vast domain has been the work of our government and private citizens. In a broad sense, it has been well done; and in the past 25 years it has been succeeded by detailed studies and surveys which should be specially mentioned, for they are a phase of exploration never carried out on a large scale till the 19th century, and which is essential to the production of the most accurate maps. No topographic feature or town or distribution of economic resources can be mapped with the greatest attainable accuracy till these surveys are made. They involve, (1) The preparation of a topographic map showing the relief or inequalities of the surface, the drainage, and the works of man, such as roads, railroads, boundaries, and towns; (2) the geologic map, printed in colors upon the topographic base map, showing the distribution of the rock formations, soils, useful minerals, artesian waters, etc. These surveys and the resulting maps are one of the most scientific developments of geographic research in the 19th century. They have been completed in all countries of Europe except in Norway, Spain, Turkey, and some of the Balkan states. The great survey of India is one of the monuments of cartography, and similar surveys are far advanced in Algeria and Tunis. The topographic work has been carried by our general government, with the assistance of a few states, into all the States and Territories, and about a third of our entire area has now been completed. The labor is enormous and costly, and many years will elapse before the whole country can be mapped with the refinement and accuracy that characterize the map sheets of the most of Europe.

Mapping the Ocean.— Oceanography, one of the largest departments of geographic science, may be said to be wholly a development of the 19th century. It was not known before that the sea-bottom, like the land, has its mountains, valleys, and plateaus. It was believed that life could not exist at depths below 1,500 feet; but we now know there are forms of life at the bottom of the deepest oceans. Ingenious appliances have been invented for exploring the depths of the sea, and the world has to-day a general idea of the contour of the ocean floor, and of the conditions of movement, temperature, salinity, and life that prevail at different sea-depths. Nearly all these additions to knowledge have been made in the last 50 years. The science of limnology is not 30 years old. This is the study of lakes, their depths, color, transparency, life, and other characteristics. It has been widely pursued in Switzerland, France, and Germany, and, to some extent, in other countries.

Blank Spaces on the Map.— The whole of North America south of subarctic latitudes has now been carefully explored, and the 13 large areas in northern British America, to which Dr. Dawson referred as unknown, not many years ago, have passed out of that category or been greatly reduced in size by such work as Ogilvie has done on the upper Yukon, Low in Labrador, and the Tyrrell brothers in the Barren Lands. Next to Europe, North America is the best-explored part of the world, though 60 years ago more than half the continent was not so well known as most of Africa is to-day. It is only a question of time when all the habitable territory of the United States and Canada will be as thoroughly studied and mapped as that of the European states.

Central America still offers a large field to the explorer. The long, gentle slopes from the central mountains to the eastern coasts, continually drenched by the trade-wind rains, have a luxuriant and almost impenetrable vegetation, and are still very little known. It is on the drier Pacific side of these little states that development is mainly centred.

Most of the additions the 19th century made to South American exploration were the work of European and North American explorers, many of them poorly equipped and paying their own way. Their most conspicuous service has been the mapping of the drainage and explorations in the northern and central parts of the

Cordilleras. The Spaniards long ago revealed the courses of the Amazon and La Plata-Paraguay, but they paid little attention to smaller streams and tributaries. It was left to the 19th century, and particularly to its last three decades, to explore these rivers, and we now have an excellent idea of all the large features of the drainage system. European explorers have made Ecuador better known than Colombia simply because they have been attracted to the Ecuadorian Andes as a specially inviting field. Political or military influences have mainly incited exploration so far as the states have participated in it. Thus the important wars that Argentina waged in 1879–80 with the Indians of the south, and in 1884–5 with those of the north, had the incidental result of making large parts of Patagonia and the Gran Chaco fairly well known.

Explorations in South America.— When Chile and Argentina based their boundary treaty of 1881 upon inaccurate geographical knowledge they sowed the seeds of an international quarrel. The result was that both began to survey the Cordilleran regions in dispute, and the resulting maps of the entire Andean Territory between Cape Horn and lat. 39° S. are specimens of excellent survey work, and have revealed a hitherto unknown region. Explorations in South America are of very uneven merit. Many are only crude route surveys. Argentina is by far the best-mapped country for its geological and meteorological departments, and the staff of foreign professors in the higher schools placed exploration and mapping, after 1882, on a high plane. The Brazilian government has never promoted scientific exploration, and all official work in that line has been done by a few states, mainly by Minas Geraes, São Paulo, and Pará. Most of the far interior, away from the rivers, is still unknown. The Amazon basin is one of the largest unexplored areas in the world; for, though steamers sail regularly on the main stream and many tributaries, the stretches between the rivers have not been visited. The inland parts of the Guianas and of the cordilleran countries from Venezuela to Bolivia are still in the crude and early stages of exploration.

What a contrast Africa presents! A hundred years ago the world had knowledge only of its coasts, Egypt, some of the Barbary Coast lands, bits of Senegambia, and the upper Niger, revealed by Mungo Park, and the Cape of Good Hope for 120 miles inland. All the rest was a blank on the maps. The last inhabited area of importance that was wholly unknown a few years ago, that between Lake Rudolf and the Nile, has been crossed by the American explorer, Dr. Donaldson Smith. The least-known part of Africa is now the Sahara and Libyan deserts, which have been neglected, on the whole, though a great deal has been done to reveal their character. This neglect is due partly to the small economic importance of these regions, but mainly to the hostility of the natives.

Pioneer Exploring in Asia.— Nearly three quarters of a century ago it was said before the British Association: «We have only a general knowledge of the geographical character of the Burman, Chinese, and Japanese empires; the innumerable islands of the latter are still, except occasionally, inaccessible to European navigators. Geographers hardly venture on the most loose description of Tibet, Mongolia, or Chinese Tartary, Siam and Cochin-China.» Since that time a swarm of explorers have overrun nearly every portion of Asia. India is as well mapped as any part of Europe, and that great survey is now being extended over Burma. Japan is mapping her own rugged islands by the most detailed and scientific methods. There are only two regions in that largest of all the continents where pioneer exploring may now be done. One of them is in central and southern Arabia, where there are still large areas, probably sandy desert, that are wholly unknown. The other is in Tibet, the highest of plateau regions, where there are large gaps to be visited between the lines of exploration run by many Russian, British, and French explorers and the American, Rockhill. Thus the era of running route surveys in Asia was closing with the end of the 19th century, and the work of detailed exploration, completed in India, is now rapidly extending.

Our knowledge of Australia, like that of Africa, is the gift of the 19th century. A number of explorers, of whom the best known was Dr. Leichardt, have perished in the waterless and repellent waste that covers the vast interior. But this sandy desert is now marked in all directions by the tracks of explorers; and one of the most practical features of their work was the discovery, around the desert margins, of wide areas of grazing lands that are making Australia one of the greatest of stock-raising countries. The interior of eastern New Guinea, the largest island except Greenland, has been opened to our knowledge within the past 20 years by the British and Germans, who wished to ascertain the nature of their new possessions. The fact that the western half of the island is still almost unknown seems to show that its masters, the Dutch, have lost the zeal that placed their fathers among the hardiest and most enthusiastic explorers.

Polar Explorations.— In Polar exploration, the 19th century scarcely excelled the splendid achievements of earlier ages, though it added many new islands to the maps, attained the farthest north, and, what is perhaps most important, perfected the art of living and traveling, in comparative safety, in the high latitudes. It may be that the archipelago north of this continent will be considerably extended by later explorations, but there are good reasons for believing that the still unknown Arctic area contains no great land masses. The unknown part of the Antarctic regions is twice as large as Europe, and contains the largest unexplored area in the world. Already the present century has entered upon explorations in that quarter which promise important results. Every Arctic expert now believes that the attainment of the North Pole is only a question of time; and it is probable that the 20th century will fully complete the pioneer exploration of the entire world, which the 19th century so wonderfully advanced.

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Explosion, a sudden bursting, generally due to the rapid production of gaseous matter from solids or liquids. Thus the explosion of gunpowder is due to the sudden formation and expansion of gases into which the powder is converted by chemical agency. Explosions are often caused by the elastic force of steam confined in boilers, and by spontaneous combustion. See EXPLOSIVES.

Explosive Gelatine, blasting gelatine or gum dynamite, an explosive material resembling wine jelly in appearance. It was invented by Nobel in 1878, and consists of soluble cellulose nitrate dissolved in nitroglycerin. Originally, the solution was effected by warming the nitroglycerin and adding the perfectly dry soluble cellulose nitrate, called nitro-cotton, little by little, with stirring, whereby the nitroglycerin was made to dissolve from 4 to 10 per cent of the nitro-cotton: Then the solution was effected by the aid of a solvent like acetone, which was afterward evaporated off. All of these processes of manufacture were dangerous. In 1889, Lundholm and Sayer discovered that if the nitroglycerin and nitro-cotton are mixed with warm water and stirred up by compressed air, gelatinization sets in, and may be completed by pressing out the water and working the mass in malaxating machines. Explosive gelatine is a gelatinous mass, looking something like new honey in color, and varying in consistency from a tough leather-like material to a soft jelly, in accordance with a variety of circumstances, such as the quantity and chemical composition of the nitro-cotton used, and the methods of manufacture. In general, the thinner the gelatine, the more sensitive it is to detonation; but, on the other hand, a thin gelatine is more subject to liquefaction and possibly also to exudation, which would make it dangerous in storage, transportation and use. Specially strong detonators are required to explode blasting gelatine; or else ordinary detonators together with primers of dynamite or gunpowder. In order that detonation should be transmitted through a mass of explosive gelatine it must be confined; for, unlike dynamite, a train of it cannot be exploded in the open, except by means of an extremely powerful initial detonation. The sensitiveness of the material is still further diminished by the solution in it of camphor, or other substances rich in carbon and hydrogen, like benzine or nitro-benzine. Explosive gelatine containing camphor has been proposed for use as a bursting charge for high explosive shell, under the name of "military explosive gelatine." While dynamite and nitroglycerin when frozen are much less liable to be exploded by a blow, such as that given by a rifle bullet, the reverse is true of frozen explosive gelatine. Though while in the unfrozen condition explosive gelatine is less sensitive to shock or blows than either nitroglycerin or nitrocellulose, it is, when exploded, a more powerful explosive than either of them. This is due to the fact that when nitroglycerin is detonated, there are unused oxidizing materials in the gaseous products; and when cellulose nitrate is detonated, there are unused combustible materials in the products. When, therefore, these bodies are mixed in the right proportions, the products will be those of complete combustion. Explosive gelatine has the advantage over dynamite in that it is practically unaffected by water and therefore can be stored in water. It is, on the whole, less liable to freeze than dynamite. It possesses an advantage over guncotton, in being plastic and can, therefore, better adapt itself to the irregularities of the bore-holes in loading. The specific gravity of explosive gelatine is from 1.5 to 1.6. If heated slowly, beginning at 60° C., it will explode at 204° C. (399.2° F.). On rapid heating it explodes at 240° C. (464° F.). If ignited when frozen even small quantities may explode. Pure explosive gelatine is never used excepting either for blasting in unusually tough rock or for blasting under water, or for military purposes. It is put up in cylindrical "sticks" in paper wrappers like dynamite. For general use in blasting it is too violent, and therefore "gelatine dynamites" are made by mixing this costly and powerful material with diluents. A great many different dopes are used, but a good example of a gelatine dynamite is "gelignite," which is made by mixing 65 per cent of explosive gelatine with 35 per cent of an explosive wood-pulp dope, giving a substance consisting of nitroglycerin 62.5 per cent, nitro-cotton 2.5 per cent, sodium nitrate 26.25 per cent, wood pulp 8.4 per cent, and sodium carbonate 0.35 per cent. It is interesting to note that "ballisti," which is a smokeless powder, is also made by dissolving nitro-cotton in nitroglycerin, but while explosive gelatine contains at the most but 10 per cent of nitro-cotton ballistite contains 40 per cent of this material.

Explosives (from Lat. *explosus,* p.p. of *explodere,* to drive out, to drive out a player with clapping, to explode; from *ex,* out + *plaudere, plodere,* to clap, strike, applaud), are substances which easily react at comparatively low temperatures with the formation of a considerable volume of highly expanded gas, the evolution of heat and light and the production of sound. At ordinary temperatures they may be solid bodies like gunpowder or liquid like nitroglycerin or gaseous like fire damp mixtures. They may consist wholly of a single chemical compound like mercuric fulminate, or of mixtures of combustible substances with supporters of combustion or oxidizing agents like blasting powder, which is a mixture of charcoal, sulphur, and sodium nitrate. Though the temperature is different for each explosive they can all be caused to explode if heated to the explosion temperature, which for nitrogen chloride is 93° C.; mercuric fulminate, 152° C.; emmensite, 165° C.; nitrostarch, 175° C.; dynamite, guncotton, and nitroglycerin each, 180° C.; blasting gelatine, 204° C.; blasting powder, 270° C.; picric powder, 273° C.; rifle powder, 275° C.; best sporting powder, 315° C.

History.— The inventor of gunpowder, the oldest of explosives, and the place where it originated, are not known. The invention has been ascribed by different authors to Marcus Græcus, Albertus Magnus, Roger Bacon, and Berthold Schwarz; to the Arabians, whose works were largely used by Marcus Græcus in his writings; to the Hindus, because of certain passages occurring in the code of Gentoo laws prepared by Indian savants by order of Warren Hastings in the 18th century; and to the Chinese because of certain statements made by Marco Polo. There seems to be little doubt that this confusion exists (1) because modern meanings have been given to words and phrases used in the old manuscripts; (2) because of the intentionally confusing methods employed by the writers of the Middle Ages; and (3) because gunpowder for use in guns was not the invention of any one person, but was really the result of a progressive development.

It is recorded that what moderns call "Greek fire," and the ancients called "naphtha," was employed in the defense of Constantinople in the 7th century and that these fiery compositions were propelled against the enemy by means of arrows from bows, or in hollow vessels of stone or iron thrown by war engines. Though consisting at first of pitch, rosin, sulphur, and similar easily inflammable and highly combustible substances, it is easy to imagine that in the tentative development of these materials of war nitre was added to the combustible substances and that there was thus produced a deflagrating composition for use as bursting charges in bombs and grenades and for the manufacture of devices analogous to modern firecrackers and rockets with which to frighten and confuse their foes.

The supposition that gunpowder was known before it was applied for use in guns is supported by the older historians. All the components and mixtures for Greek fire similar to gunpowder were already known in the time of Hassan-al-Rammah (1290). From an exhaustive search of the literature Guttmann arrives at the conclusion "that gunpowder was gradually developed from Greek fire, and that it was known for years before cannons and guns were thought of. The use of purer materials in making it developed its propulsive power, and led to the subsequent invention of cannons and guns. The Arabians were the first to make gunpowder-like mixtures, probably about 1280 A.D., while the idea of utilizing their propulsive force, that is, the invention of guns and cannons, belongs to the monk, Berthold Schwarz, of Freiburg, Saxony; the date of the latter invention being probably 1313 A.D." It is accepted as indisputable that gunpowder mills existed at Augsburg, Germany, 1340, and at Spandau, Germany, 1344, and that the English used gunpowder in guns at the battle of Crécy, 1346.

Though many improvements were made in the manufacture of gunpowder, such as in the preparation and purification of the raw materials from which it was produced; the methods of incorporation; and its granulation to adapt it to special uses, this substance remained unrivaled until the end of the 17th century, when the French chemist, Berthollet proposed the substitution of potassium chlorate for the potassium nitrate and produced by this means a much stronger and quicker powder, but one which was also much more dangerous than gunpowder. Beginning with the discovery of mercuric fulminate by Howard, an English chemist, 1880, there was added to the achievements of the 19th century the discovery of nitrogen chloride by the French chemist Dulong, 1812; nitrostarch by Braconnot, 1832; guncotton by Schoenbein of Basel, Switzerland, 1845; nitroglycerin by Sobrero at Turin, Italy, 1846; the invention of blasting powder by L. DuPont of Wilmington, Del., 1856; the discovery of diazo compounds by the German chemist, Griess, 1860; the invention of dynamite by A. Nobel of Sweden, 1866; smokeless sporting powder by Schultze of Potsdam, Germany, 1867; blasting gelatine by Nobel, 1878; military smokeless powder by Vieille of France, 1886; hard-grained smokeless sporting powder by Richard von Freeden of Walsrode, Germany, 1889; homogeneous smokeless powder composed of a single chemical substance in a state of chemical purity by Charles E. Munroe of Newport, R. I., 1890; and the discovery of triazoic acid by Curtius of Kiel, Germany, 1890, while in the meantime picric acid, which was discovered by Hausmann, 1788, was shown to possess explosive properties and adapted for use in shell, it having been pointed out by Sprengel, 1873, that it contains a sufficient amount of available oxygen to render it, without the help of foreign oxidizers, a powerful explosive when fired with a detonator.

This growth has been coincident with the development of the chemical and physical sciences and has been the more rapid, the more completely experimental methods of research have been perfected and applied. In addition to those enumerated above this advance in the science and art of explosives has been chiefly due to the labors and intelligence of Hess, Lauer, Trauzl, and von Lenk in Austria; Abel, Cundill, Debus, Dewar, Dixon, Dupré, Majendie, and Noble in England; Berthelot, Chalon, Daniel, Desortiaux, Gay-Lussac, Lavoisier, Le Chatelier, Mallard, Maurouard, Roux, Sarrau, Turpin, and Violette in France; Bunsen, Dittmar, Guttmann, Liebig, Meyer, Schischkoff, Upmann, Will, von Förster, and von Romocki in Germany; Abbot, Barnard, Craig, Emmens, Judson, Hill, Maxim (q.v.), Mixter, Mowbray, Quinan, Rodman, Count Rumford, and Woodbridge in the United States; Mendeléeff in Russia; Cronquist in Sweden, and Hebler and Lunge in Switzerland. Because of their prominence in this science Abel and Berthelot deserve special mention.

Sir Frederic Augustus Abel, K.C.B., D.C.L., chemist, was born in London 1827 and died 6 Sept. 1902. He was tutor to Edward VII., the present king of England; professor of chemistry at Woolwich 1851; chemist to the war office 1854–88; chairman Government Committee on Explosives 1888; member of Royal Commission on Accidents in Mines; president of the London Chemical Society, Society of Chemical Industry, Institute of Chemistry, Institute of Electrical Engineers, Iron and Steel Institute, and of the British Association for the Advancement of Science; he perfected the manufacture of guncotton, making it a valuable explosive; conducted with Capt. Nobel elaborate researches on fired gunpowder; together with Prof. Dewar invented the smokeless powder, known as cordite, which was adopted and used by the British government; and was the chief authority in the United Kingdom on explosives and explosions. Among his published works may be cited: 'Guncotton' (1866); 'The Modern History of Gunpowder' (1866); 'On Explosive Agents' (1872); 'Researches on Explosives' (1875); 'Electricity as Applied to Explosive Purposes' (1884).

Marcellin Pierre Eugène Berthelot, chemist, was born in Paris 25 Oct. 1827, and has been professor of chemistry in the Collège de France since 1865; member of the Institute 1873, perpetual secretary of the Academy of Sciences 1889; inspector-general of higher education 1876; life member of senate 1881; minister of public instruction 1886–7; minister of foreign affairs 1895–6; he has achieved equal fame for his researches, discoveries, and philosophical deductions in synthetic chemistry, thermochemistry, explosives, and historical chemistry. Among his published writings may be cited: 'Chimie Organique Fondée sur la Synthèse' (1860); 'Mecanique Chimique Fondée sur la Thermochimie' (1879); 'Les Origines de l'Alchimie' (1885); 'Sur la Force de la Poudre et les Matières Explosives' (1871, 1872, and 2 vols. 1879). The last was translated into English, 'Explosives and Their Power' (1892).

Theory of Explosives.— When wood or other combustible substances containing hydrogen and carbon are ignited in contact with air they burn, giving forth heat and light and are converted into water and carbon dioxide, which pass off as invisible and highly expanded gases. As the wood is subdivided so as to expose a continually increased surface to the air the rapidity of the combustion is increased until, when the wood is reduced to dust like sawdust and suspended in the air so as to be intimately mixed with it, the velocity of the combustion is so great and the evolution of the gases so rapid that the reaction becomes an explosive one and such a mixture of sawdust and air is an explosive. All inexplosive combustible substances can, when finely divided and intimately mixed with air, form explosives, and volatile liquids and gases are especially likely to do so. Many accidents have arisen from the ignition of mixtures of air with the dust of charcoal, coal, flour, malt, soap, starch, sugar, zinc, wood, and other solids; with the vapors of alcohol, ether, gasoline, and other naphthas, spirits of turpentine and other liquids, or gases like acetylene, coal gas, hydrogen, and marsh gas since each of these substances, though in themselves non-explosive, form explosive mixtures with air if they be mixed with it in the right proportions. The best proportions are those in which the volume of oxygen in the air present is just sufficient to convert all of the hydrogen in the combustible into water and all of the carbon into carbon dioxide, or, in other words, to produce complete combustion. Less violent explosions may occur when the proportion of air is greater or less than the "best proportion," the limit being fixed in each case by the character of the combustible substance, the quantity of the mixture, the temperature and pressure to which it is subjected and the manner in which it is ignited. Mixtures of these substances whose proportions are outside of these limits may be ignited and may burn, but do not explode.

If pure oxygen in the proper proportions be substituted for air in the above mixture the velocity of the reactions will be still greater, and the energy set free in unit of time and consequently the violence of the explosion will be greatly increased. Besides the proportions that determine the limits between explosion and combustion will be extended. Such mixtures if confined and out of contact with the air will still take fire and explode. Oxygen may be supplied either in the free state or in solid bodies which contain it and which give it up when heated to comparatively low temperatures. Among such solids are the nitrates of metallic radicles, like ammonium nitrate, potassium nitrate (India saltpetre), and sodium nitrate (Chile saltpetre); chlorates such as potassium chlorate; peroxides like sodium peroxide, and many others. If these solids be dried, finely divided, and intimately mixed with a combustible, in the right proportions, a solid explosive is produced. Often, as in the case of mixtures of charcoal and saltpetre the temperature to which they must be heated in order that combustion shall begin, called the point of ignition, is so high that they are difficult to ignite and in such cases a small portion of a substance like sulphur, which has a low point of ignition, is incorporated in the mixture.

Another method by which oxygen may be brought into intimate contact with combustible bodies so as to form an explosive is through the action of nitric acid upon them. Two cases present themselves. First when the combustible body is a simple or mixed primary alcohol and the nitric acid reacts with the acidic hydrogen. Second, when the combustible substance is a hydrocarbon or its derivative and the nitric acid reacts with the hydrogen of the hydrocarbon or the hydrocarbon nucleus. The products of the first case are organic nitrates called also nitric esters. The products of the second case are nitro-substitution compounds. Examples of the first case are ethyl nitrate from ethyl or grain alcohol, glycol nitrate from ethylene glycol, glyceryl nitrate (nitroglycerin) from glycerol (glycerin), mannitol nitrate from mannitol (mannite), starch nitrate (nitrostarch) from starch, and cellulose nitrates (guncotton and pyroxylin) from cotton. Examples of the second case are mono and di nitro benzene from benzene, tri nitro phenol (picric acid) from carbolic acid (phenol), and nitro-naphthalenes from naphthalene. These explosives differ markedly from mixtures like gunpowder, for, whereas in the mixtures the combustible substance and the oxidizing agents are in different masses, in the explosive compounds like nitroglycerin, they are both in the same molecule. Therefore in the latter the contact is more intimate and the reaction takes place with greater velocity.

In addition to the explosives of the characters lescribed above is another class of chemical compounds, of which mercuric fulminate, silver amine (fulminating silver) and diazo benzene nitrate are notable examples, whose explosive properties are due to a phenomenon (namely, a molecular disruption), which is quite unlike that of combustion ascribed to those of the previous classes. This case of disruption arises from the fact that these substances are endothermous compounds, or in other words, that they absorb heat during their formation and are therefore reservoirs of energy.

Classification of Explosives.— Following the foregoing theories of their constitution and behavior, explosives may be classed as

(1) *Nitrate mixtures.*— Amide powder (charcoal, potassium nitrate, and ammonium nitrate); amidogene (bran or starch, charcoal, magnesium sulphate, potassium nitrate, and sulphur); azotine (petroleum, charcoal, sodium nitrate, and sulphur); blasting powder (charcoal, sodium nitrate, and sulphur); carbazotine (bark or wood pulp, lampblack, ferrous sulphate, potassium nitrate, and sulphur); Courteille's triumph safety powder (charcoal, peat, coal, oleaginous matters [animal or vegetable], metallic sulphates, sodium nitrate, and sulphur); diorrexine (sawdust, sodium nitrate, potassium nitrate, and sulphur); fractorite (rosin, dextrine, potassium dichromate, ammonium nitrate); gunpowder (charcoal, potassium nitrate, and sulphur); haloxyline (charcoal, sawdust, potassium ferro-

cyanide, and potassium nitrate); Himly's powder (hydrocarbons and potassium nitrate); Nordenfeldt and Meurling's powder (hydrocellulose, potassium nitrate, and sulphur); pyrolithe (charcoal, sawdust, sodium carbonate or sulphate, potassium nitrate, sodium nitrate, and sulphur); saxifragine (charcoal, barium nitrate, and sulphur).

(2) *Chlorate mixtures.*— Asphaline (hydrocarbons, potassium sulphate, potassium nitrate, potassium chlorate); Berthollet's powder (charcoal, potassium chlorate, and sulphur); britainite (naphthalene, potassium nitrate, ammonium nitrate, potassium chlorate); Callow's powder (orpiment, potassium ferrocyanide, and potassium chlorate); carlsonites (naphthalene, or dinitrobenzene, and other combustible substances with ammonium perchlorate); comet powder (rosin and potassium chlorate); cycene (cane sugar, paraffin oil or coal dust, potassium nitrate, and potassium chlorate); Ehrhardt's powder (tannic acid, charcoal, rosin, potassium nitrate, and potassium chlorate); Hahn's powder (charcoal, spermaceti, antimony sulphide, and potassium chlorate); Himly and von Trutschler-Falkenstein's powder (coal tar, potassium nitrate, and potassium chlorate); Horsley's powder (nutgalls and potassium chlorate); Kellow and Short's safety powder (tanbark or sawdust, potassium nitrate, sodium nitrate, potassium chlorate, and sulphur); Knaffl's powder (ammonium ulmate, potassium nitrate, potassium chlorate and sulphur); Melland's paper powder (porous paper which has been soaked in a paste composed of starch, charcoal, potassium ferrocyanide, potassium chromate, potassium nitrate, potassium chlorate, and water and dried); Oriental powder (gum gambier and potassium chlorate); Parone's explosive (carbon disulphide and potassium chlorate); Pertuiset's powder (sulphur and potassium chlorate); pyrodialites (mixtures of coal tar with chlorates or perchlorates and with or without nitrates, nitrosubstitution compounds, charcoal, and oxidizing salts); pyronome (rye flour, charcoal, metallic antimony, sulphur, potassium chromate and potassium chlorate); rossellite (asphalt oil and potassium chlorate); Siemen's powder (a solid hydrocarbon, potassium nitrate, and potassium chlorate); thorite (cane sugar and potassium chlorate); tutonite (metallic sulphides, sulphur and potassium chlorate); and white powders of Augendre and Pohl (cane sugar, potassium ferrocyanide, and potassium chlorate).

(3) *Oxidizing mixtures.*—These are mixtures of combustible substances with oxidizers other than the nitrates, chlorates or perchlorates. Among such bodies may be named sodium peroxide, potassium permanganate, potassium dichromate, liquid air, and liquid nitrogen tetroxide. As examples we have mixtures of sodium thiosulphate with sodium peroxide; metallic aluminum with sodium peroxide; cotton wool with liquid air, and panclastite, which is a mixture of carbon disulphide with liquid nitrogen tetroxide.

(4) *Organic nitrates or nitric esters and mixtures containing them.*— Esters: Guncotton, which is a cellulose nitrate of high nitration and practically insoluble in a mixture of ether and alcohol at ordinary temperatures; nitrocellulose, a term applied to all cellulose nitrates; nitroelectrite (isomannitol nitrate); nitroerythrite (erythrol nitrate); nitroethyl (ethyl nitrate); nitroglucose, a nitrate produced from grape sugar; nitroglycerin, pyroglycerin or glonoin oil (glyceryl trinitrate); nitrolactose (nitrated sugar of milk); nitrolignin (nitrated wood); nitromannite (mannitol nitrate); nitromethyl (methyl nitrate); nitrostarch or xyloidine (starch nitrate); nitrosugar or nitrosaccharose, a nitrate produced from cane sugar; pyroxylin, collodion cotton, nitrocotton or pyrocellulose, are cellulose nitrates of medium nitration and practically completely soluble in a mixture of ether and alcohol at ordinary temperatures. In this class is also to be included the explosive mixtures into which these esters enter as essential components and of which the dynamites are conspicuous examples. These are classified, according to the nature of the *dope* or absorbent, into

A. *Dynamites with an inert base.*— Nobel's dynamite No. 1, giant powder No. 1; dynamite blanche de Paulilles; dynamite de Vonges; E. C. dynamite; S, 1, dynamite; Rutenberg's explosive; dynamite rouge, all consist of nitroglycerin with kieselguhr; Hill's powder (nitroglycerin with precipitated silica); Mowbray's mica powder (nitroglycerin with asbestos); Hercules powder (Extra No. 1); (magnesia powder, nitro-magnite; dynamagnite; fulgurite; nitroglycerin with magnesia alba); dynamite de boghead (nitroglycerin with ashes from Boghead coal); selenitic powder (nitroglycerin with plaster of Paris); Horsley's powder No. 1 (nitroglycerin, alum, and magnesium sulphate); metalline nitroleum (nitroglycerin, red lead, and plaster of Paris); renish dynamite (nitroglycerin, kieselguhr, and naphthalene); dynamite noire (nitroglycerin, sand, and coke); mataziette (nitroglycerin, sand, ochre, charcoal, and resinous matter); porifera nitroleum (nitroglycerin, sponge, or vegetable fibre, and plaster of Paris); Burstenbender's explosive (nitroglycerin, spongy vegetable substances with glycocoll or chondrin); Morse's explosive (nitroglycerin with rosin); Borland's carbo-dynamite (nitroglycerin with charcoal from cork); white dynamite (nitroglycerin with lime-guhr); boritine (nitroglycerin, kieselguhr and boric acid); fluorine (nitroglycerin, kieselguhr, and calcium fluoride).

B. *Dynamites with an active base.*— *a.* Consisting of nitroglycerin absorbed by a gunpowder like dope — Ammonia dynamite; ammonia krut; ammonia powder; Coad's explosive; Champion's powder; colonia powder; Dittmar's powder; dynamite No. 2; dynamite au charbon; dynamite d'ammoniaque; dynamite grieses de Paulilles; extra powder; Fowler's explosive; giant powder No. 2; Gotham's powder; Hercules powder; Horsley's powder No. 2; Judson's powder; Jupiter powder; lithofracteur; Monakay's explosive; miner's powder Co. dynamite; Neptune powder; potentia; petrolithe; sebastine; thunderbolt powder; Titan powder; virite powder; Vulcan powder.

b. Consisting of nitroglycerin absorbed by or gelatinized with a cellulose or ligno-cellulose nitrate — Blasting gelatine; cellulose dynamite; Clark's explosive; Dean's explosive; Dittmar's explosive; extra dynamite; explosive gelatine; glyoxyline; grisoutine; gum dynamite; nitrogelatine; paleine; Punshon's explosive; Schultze's dynamite; straw dynamite; Trauzl's dynamite.

c. Consisting of nitroglycerin or an explosive gelatine incorporated with wood pulp or sawdust and a nitrate, principally sodium nitrate. Such dynamites are styled lignin-dynamites — Ætna powder; amidogene; Atlas powder; Brain's powder; carbonite; diaspon; dualin; dynamite de Krummel; dynamite de Lanky; forcite; gelatine dynamite; gelignite; giant powder; Hecla powder; meganite; miner's friend powder; grisoutite; kadmite; petralithe; rendrock; rhexite; safety nitropowder; Schultze dynamite; stonite; stowite; vigorite.

d. Other dynamites.— Americanite (nitro glycerin and methyl alcohol); Castellano's powder (nitroglycerin, fibrous material, earth and nitrobenzene); cerberite (nitroglycerin, wood oil, nitrobenzene, wood pulp, and sodium nitrate); Engle's powder (nitroglycerin, ammoniacal salts, saltpetre, pyroxyline, nitrostarch, nitromannite, nitrobenzene, and water glass); glukodine (nitroglycerin and nitrosaccharose); perunite or terrorite (nitroglycerin, nitromethyl, nitroethyl, and pyroxylin); thunder powder (nitroglycerin and nitroglucose).

C. *Organic nitrate mixtures other than dynamites.*— Casteau's explosive (nitrodextrine and ammonium nitrate); Cooppal's powders (resinous bodies, barium nitrate, and nitrocellulose); diflamyr (metallic nitrates and nitrocellulose); flamminore (collodion cotton, ammonium sulphate, and ammonium nitrate); grenée powder (paraffin; agar-agar, nitrocellulose, potassium nitrate, and barium nitrate); explosive P, (nitrocellulose and ammonium nitrate); potentite and tonite (guncotton and barium nitrate).

5. *Nitrosubstitution compounds and mixtures containing them.*— Compounds: Nitrobenzenes; nitrocresols; nitrocumenes; nitronaphthalenes; nitronaphthols; nitrophenols; nitroresorcinols; nitrotoluenes; picric acid or cabazotic acid (trinitrophenol); picramic acid; styphnic acid or oxypicric acid (nitroresorcinol).

A. Mixtures containing nitrosubstitution compounds.— Abel's powder; ammonite; amvis; bellite; boritine; Borlinetto's powder; Boyd's powder; bronolithe; Brugere's powder; explosive A; explosive C; explosive N; cremonites; Du Bois-Raymond's powders; duplexite; ecrasite; emmensite; Faversham powders; Favier explosives; ferrifractor; Fontaine's powder; Gathhurst powder; gelbite; Geserick's powder; Girard's powder; hellhoffite; Hill's powder; Johnite; joveite; kinetite; lyddite; melinite; oxonite; rackarock; roburite; romite; securite; streetites; Volney powders.

(6) *Fulminates.*— Compounds: Copper acetylide; diazobenzene nitrate; fulminating gold (auramine); fulminating silver (argentamine); mercuric fulminate; mercuric triazotate; nitrogen chloride (chloramide); nitrogen iodide (iodamide); silver fulminate; and triazoic acid, also called hydrazoic acid and azoimide.

In addition to these classes there are four groups of explosives which have received such widespread notice as to merit especial mention here, though the members of each may all be and many of them are included in the classes given above. These groups are Sprengel explosives, safety or flameless explosives, permitted explosives, and smokeless powders.

Sprengel Explosives.— These explosives were invented by Dr. Hermann Sprengel, 1873, and he advocated their use because of their safety, as they are non-explosive during manufacture, storage, and transportation, but are very powerful explosives when prepared and detonated. His plan was to employ mixtures of combustible and oxidizing substances, which should be kept separate until needed for use, the bodies to be employed in the compounding of the explosives being either all liquid or part liquid and part solid, for by taking advantage of the liquid state speedy and intimate mixing could be realized and the explosives could be compounded on the spot and at the time they were wanted for use. Among the oxidizing agents proposed were the nitrates and chlorates, which are solids, and nitric acid and nitrogen tetroxide, which are liquids. Among the combustible substances were the nitrosubstitution bodies, carbon disulphide, and petroleum. A conspicuous example of a Sprengel explosive is rackarock, which was used in blowing up Flood Rock in Hell Gate, N. Y., and which may be made by pouring mononitrobenzene upon potassium chlorate crystals. Other examples are some forms of emmensite; explosive A; hellhoffite; oxonite; panclastite; and Parone's explosive.

Safety or Flameless Explosives.— These explosives are for use in fiery mines, particularly coal mines, where there is a chance of an accident arising through the ignition of the fire damp from the flame or incandescent particles given off by the explosive as the blast is fired. Among the earlier devices employed to prevent this was the mixing in the dope of the dynamite or with the powder of a quantity of washing soda, alum, Epsom salts or other salt containing a large amount of water of crystallization that would be set free when the mixture was fired. In 1883 Mallard and Le Chatelier discovered that when explosives were detonated unconfined in air containing 10 per cent of methane (marsh-gas), the fire damp could not be ignited if the temperature of detonation was below 2200° C., owing to the cooling of the gases due to their rapid expansion and to the retardation of the inflammation of the fire-damp. An investigation by the French Fire Damp Commission showed that, among others, certain salts of ammonia and especially ammonium nitrate, were capable of reducing the temperature of the gases produced by detonation very materially, the temperature of the gases from explosive gelatine being reduced from 3090° C., when detonated alone, to 1493° C., if detonated when mixed with 88 per cent of ammonium nitrate. In August 1890 the French government prohibited the use of black powder in fiery or dusty mines and permitted the use in them of explosives whose gases are not combustible and the detonation temperature of which does not exceed 1900° C., where blasting is to be done in the rock, nor 1500° C., where the work is to be done in the coal seam. Among the explosives designed to meet such conditions and styled abroad safety or flameless explosives are: Ammonite; amvis, aphosite; bellite; benedite; britainite; cambrite; Casteau's explosives; dahmenite; Favier's explosive; fractorite; Geserick's powder; grisoutine; grisoutite; nitroferrite; progressite; roburite; securite; westphalite; wetterdynamite.

Permitted Explosives are those which have passed the prescribed tests of the governmental authorities in Great Britain and whose sale and use is authorized under carefully prescribed conditions.

Smokeless Powders are high powdered propellents used as substitutes for gunpowder in firearms and cannon. They are formed of the highest grade of cellulose nitrate only, like indurite, or of the medium grade only, like pyrocellulose powder, or they may be mixtures of different grades together with metallic nitrates like the B. N. powders. Another class are mixtures of cellulose nitrates with nitroglycerin and a restrainer, like vaseline; ballistite, cordite, and filite being examples of this kind. In robin-hood, gold dust, and gelbite, we have examples of such powders made from nitrosubstitution compounds and oxidizing agents. Other smokeless powders are amberite; Brackett's powder; cannonite; Curtis and Andre's powder; Du Pont powder; E. C. powder; fulgor; granulite; hornite; J. B. powder; kolfite; poudre J; poudre S; pyrocollodion; rifleite; Schultze powder, and Walsrode powder.

Methods of Firing Explosives.— Explosives may be made to explode by heating them to their explosion temperatures. This may be accomplished by a flame, a spark, an incandescent body, friction, percussion, concussion, pressure, or chemical action, provided the resulting temperature is sufficiently high. Gunpowder was originally ignited in muskets, guns, and boreholes by the application of a torch, a glowing tinder, or a heated iron rod. Later muskets were fired by the sparks from a flint striking steel. Joseph Egg, an English gunmaker, 1815, invented percussion caps, and to-day all fixed ammunition is fired by percussion primers, while the charges in very large guns are fired by friction primers or by electric primers. In firing blasts a train of powder was laid from the mine to a safe distance by which to convey the inflammation. Later quills, straws, or paper or wooden tubes were used to hold the train and permit of the charge being tamped so as to secure the advantage which comes from confining an explosive. Bickford of Tuckingwall, England, 1831, invented the «running» or «tape» or «safety» fuse, in which a core of gunpowder is enclosed in a tube of jute yarn impregnated with a waterproof composition, and this is to-day largely used in firing blasts. Dr. Watson of England, 1745, succeeded in igniting gunpowder by means of electric sparks, and in 1749 a battery of 11 guns was fired by means of a frictional electric machine at Annapolis, Maryland. Dr. Robert Hare of Philadelphia, 1832, invented the method of firing gunpowder charges by means of the electric current, using low tension fuses, and he had for some time prior to this employed the voltaic battery, in eudiometrical experiments, for igniting explosive mixtures of gases. Sir Charles Wheatstone, 1856, introduced the magneto-exploder in blasting, and Moses G. Farmer, of Newport, R. I., 1871, invented the dynamo-electric machine with which to generate the current and applied it to firing electric ignitors or detonators, and to-day great guns, military and naval mines, and torpedoes and many blasts, especially those in which several charges are to be fired simultaneously or where the blast is under water, are fired by this means.

It has long been known that when a notable quantity of a mixture of two volumes of hydrogen with one volume of oxygen is ignited at any point, the inflammation extends almost instantaneously throughout the mass and a most violent explosion ensues. This phenomenon is called detonation, and this mixture has long been known under the name of detonating gas. Certain chemical compounds such as nitrogen chloride, nitrogen iodide, and mercuric fulminate undergo an almost instantaneous decomposition, giving rise to violent explosive effects, if heated, struck or rubbed, and they are known as detonating explosives. At first guncotton, nitroglycerin, and dynamite were fired by ignition as gunpowder had been, but Nobel, 1866, discovered that if a quantity of mercuric fulminate was detonated in contact with nitroglycerin or dynamite they then underwent a detonating explosion also. E. O. Brown of the chemical department at Woolwich, England, 1868, discovered that not only could dry compressed military guncotton be detonated in this way, but that if the dry charge, called a primer, was in contact with wet guncotton, the latter was detonated also, even though it was saturated with or submerged under and in contact with water. There are then two kinds of explosion, namely, explosion by simple combustion and explosion by detonation. Explosives of the gunpowder class undergo only the first kind of explosion. Explosives of the nitric ester or nitrosubstitution classes undergo both kinds of explosions. Explosives of the fulminate class practically undergo only the second kind of explosion. A marked difference between the two kinds of explosion is found in the velocity with which the explosive reaction is propagated within the mass of the explosive. Thus in detonating gas, which can undergo both kinds of explosion, Bunsen found, when using very narrow tubes where only combustion could take place, that the velocity of the reaction was 34 metres per second, while Berthelot, using long and wide tubes in which detonation could take place, found that the velocity of the reaction was 2,810 metres per second. Experiments made by laying trains of the materials and firing them showed that while the velocity of combustion of gunpowder in the open air is but from 1.5 to 3.4 metres per second, the velocity of detonation of dynamite and of guncotton is about 6,000 metres per second. Provided each explosive gave the same volume of gases, having the same temperature and that the conditions were in all other respects alike, it is evident that the explosion in which the reaction velocity was the greater would be the more violent one. But they are not alike since guncotton, nitroglycerin, and mercuric fulminate, besides being endothermous compounds, are completely resolved into gases, while gunpowder, besides being a mixture, yields but about 44 per cent of gaseous products. The pressure developed by gunpowder when fired in a space completely filled by it is, from Noble and Abel's experiments, 6,150 atmospheres. The theoretical pressures developed by guncotton, nitroglycerin, and mercuric fulminate when detonated in contact with bodies, are respectively 24,000 atmospheres, 25,000 atmospheres, and 28,000 atmospheres. Investigation has shown that no other explosive known will give in contact an instantaneous pressure at all comparable with that of mercuric fulminate.

Owing to these differences in behavior explosives have been distinguished as high explosives and low explosives. Gunpowder and explosives of the nitrate class, together with smokeless powder are low explosives. They act with comparative slowness and are used where it is desired to lift or push a load without cracking it or in propelling projectiles. Nitroglycerin and explosives of the class of nitric esters or nitrosubstitution bodies are high explosives. They are shattering and crushing in their effect. Detonators containing mercuric fulminate are used to fire high explosives, the detonators being themselves fired by means of a Bickford fuse or by an electric current. The high explosives are usually put up for use in paper cylinders, and, when loaded for shipment, these are called cartridges or «sticks.» Usually several sticks are required for one borehole. In this case the detonator is inserted in one of these sticks, usually the last one inserted in the hole, and this stick is then called the priming cartridge or «primer.»

Direction in Which Explosives Explode.— There is a very common but erroneous belief that gunpowder explodes upward and that high explosives explode downward. It arises from the fact that if a quantity of dynamite be laid unconfined upon the surface of the rock on detonating it the rock will often be fractured, whereas if gunpowder is thus placed and fired, it produces no effect whatever upon the rock. The facts are that each explosive tends to act in all directions about the centre of explosion. As exposed in air they are subjected to the weight of the air above them, and are to that extent under confinement. When the high explosive is detonated the gases are set free so fast that the air acts as a tamping agent; when the gunpowder explodes the gases are generated so slowly that they have time to move the air. Besides the «pressure in contact» exerted by the high explosives is enormously greater than that of the low explosives. That high explosives exert pressure in all directions may be easily demonstrated by fastening blocks of guncotton of equal size and weight on opposite sides of a plate of iron, but at some distance apart, by means of light cords or wires, suspending the plate in any position and detonating both charges simultaneously when holes will be blown through the plate away from each of the charges. Although high explosives usually produce a shattering effect when fired unconfined upon a body the effect is markedly increased by increasing the confinement. Thus in the method of breaking boulders and large masses of stone called «plastering,» after the charge is laid upon the stone and fused, one or two shovelfuls of earth are placed over it before firing. In «blockholing,» when it is desired to break the rock into fragments of definite size, a small hole is bored in the rock and the explosive inserted in this cavity whereby the gases obtain a greater leverage.

Explosions by Influence.—In detonating explosive substances it has been found that the influence of the detonation is exerted to a distance all about the mass depending on the kind and the amount of the explosive used and its environment and that a second charge of explosive within the sphere of influence may be detonated by the detonation of the first charge without being in contact with it. Thus in accidental explosions in explosive works the initial explosion occurring in one building may detonate the explosives in other buildings unless care is taken in the construction of the works to separate the buildings by a safe distance from one another. Care, too, must be taken in forming fixed ammunition that the primers are not heavily charged with fulminate, and that the cartridges are so packed that the accidental explosion of one cannot explode the others by influence. Application of this principle is made in military engineering in the operation of countermining, the enemy's submarine mines being blown up by firing a heavy torpedo charged with guncotton in the vicinity of them. To-day large quantities of explosives are frequently used in big blasts. According to Eissler, it is an almost daily occurrence in California for 20,000, 30,000, and even 50,000 pounds of explosives to be used in a single charge. The system of large blasts has even become common in hard rock excavations, such as quarries and railroad cuttings, and in these large blasts it is common practice to dispose the larger part of the mass of explosive so that it may be exploded by influence and not by contact or by propagation of flame or fire.

The largest single blast ever fired was that used in the blowing up of Flood Rock at Hell Gate in the East River, N. Y., 10 Oct. 1885. There was used in the blast 240,399 pounds of rackarock and 42,331 pounds of dynamite, or 283,000 pounds of explosive. There were 13,000 separate charges of rackarock embedded in drill holes with a dynamite cartridge on top of each, and there were 591 primary charges of dynamite placed on timbers 25 feet apart within the mine. When all the charges had been placed in the excavation and the primary charges connected with the firing batteries, the mine was filled with water, the primary charges were exploded by the electric current and these exploded the 13,000 other charges by influence through the intervening water. Munroe founded on this principle a method of testing the relative sensitiveness of explosive substances.

Uses of Explosives.— The uses of explosives as propellents in war and in the chase; as rupturing agents in mining, quarrying, and engineering operations; and as an essential component of fireworks is well known. It is not so generally known that they are employed for saving life and property in signal lights, rockets, and guns; in projecting lines from the shore to stranded ships, and, in case of fire, to the upper stories of high buildings; in casting oil upon the water to quell a raging sea; and in railroad torpedoes to prevent collisions. Gunpowder guns are also used in bridge building to project a line across a chasm which is to be bridged, and they are used in the whale fishery to project the harpoons, while the latter may carry an explosive charge with which to stun or destroy the whale. Detonating explosives have been improperly used in taking fish; in burglarious operations against safes and vaults and in anarchistic outrages. Dynamite has been used to knock the blocking from the ways when launching ships. Fired on an iron plate placed on the top of a pile and covered with a tamping of earth or clay, it has successfully replaced the pile driver. It has been found efficient in excavating holes in which to plant telegraph and telephone poles and fence posts; in driving water out of quicksands in which foundations are to be laid or shafts to be driven; in slaughtering cattle; in breaking down ice dams to prevent inundations; in blowing up buildings to prevent the spread of conflagrations; in razing unsafe walls of burned buildings; in destroying wrecks which endanger navigation, and in freeing vessels which are hard aground on shoals. The farmer uses them in breaking boulders, grubbing stumps, and felling trees; in shaking the soil to fit it for deep-soil cultivation, and, in wine growing districts, to free the soils from the phylloxera: while their aid has been sought in breaking droughts and diverting hailstorms from their courses. The iron founder uses them in breaking large castings. The iron smelter employs them to clear out obstructions in blast furnaces while the latter are still in operation. Munroe proposed using detonating explosives as a means of testing the integrity of large masses of metal and their resistance to shock.

Explosives Industry in the United States.— From the reports of the Twelfth Census of the United States it appears that in the year ending 30 June 1900 there was produced 25,638,804 pounds of gunpowder; 977,442,237 pounds of blasting powder; 35,482,947 pounds of nitroglycerin; 3,662,633 pounds of cellulose nitrates; 85,846,456 pounds of dynamite, and 3,053,126 pounds of smokeless powder. The comparative condition of the industry from 1840 to 1900 is shown in the following table:

TOTAL PRODUCTION AND VALUE OF EXPLOSIVES IN THE UNITED STATES BY DECADES, 1840–1900.

	No. of establishments	Capital	Average No. of wage earners	Products	
				Pounds	Value
1840....	137	$ 875,875	496	8,977,348	....
1850....	54	1,179,223	579	....	$ 1,590,332
1860....	58	2,305,700	747	....	3,223,090
1870....	36	4,099,900	973	....	4,237,539
1880 ...	54	6,585,185	1,340	....	5,802,029
1890....	69	13,539,478	2,353	98,645,912	10,993,131
1900....	97	19,465,846	4,502	215,590,719	*16,950,976

* This value is for the explosive substances only. When materials of all kinds produced in these establishments are included, the value is $17,125,418.

The establishments reported for 1900 were most numerous in the sections where mining or engineering operations were carried on most extensively. Though Pennsylvania had 36 factories and the largest output was in the Middle Atlantic States, yet California alone manufactured over one fourth of the entire annual output, and was the largest producer in the United States. See DYNAMITE; FIRE-DAMP; GUNPOWDER; NITROGLYCERIN; MAXIMITE; STABILITE.

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Exports and Imports, American. The interchange of commodities among nations, a process now seen in its highest and most elaborate forms of development in the commercial relations between manufacturers, merchants, and financiers of the United States and those of other countries, owes its origin to the brave, enterprising adventurers of Southern Europe, France, Holland, and England, who, during the 14th, 15th, and 16th centuries, scoured the seas in quest of territory for occupation and the exploitation of trifling commercial ventures.

The motives of these men were not primarily patriotic as a rule, but they were, in the hands of Providence, to be the foundation-layers of a gigantic, world-wide commercial, political, and social structure such as now exists and is forever expanding.

The discovery and occupation of the Canary Islands, Madeira and the Azores; the doubling of the Cape of Good Hope by Vasco de Gama; the finding of Zanzibar and penetration eastward to the mainland of India; the crossing, thrice, of the Atlantic by Columbus; his landings at Jamaica and Porto Rico; the finding, by Cabot, of Newfoundland, Labrador, Nova Scotia, Virginia, and the present Canadian territory — these events, and such as these, gave an impetus to adventurous navigation that has continued without intermission and still dominates among expert sailors and explorers. Arctic and Antarctic expeditions are among the most modern illustrations of the Caucasian tendency to seek a further knowledge of the world's resources and hidden treasures.

The establishments, by Portuguese traders, of the first European factory in India, soon after the results of de Gama's expedition became known; the founding of the English East India Company and the explorations of Spain in Mexico and Peru were among the most important events leading, directly or indirectly, to a magnitude of commercial operations such as is now illustrated in the grand aggregates of United States exports and imports.

Portugal, figuring but little in 20th century commerce, at that time led the way in discoveries of subsequently profitable markets on the coast of Africa, in India, and in the Indian archipelago. Spain, now so trifling in stature among nations, in those days pervaded what might be termed the atmosphere of adventure and by her mining work in Central and South America greatly increased the world's available stock of precious metals. French activity in the East and West Indies, in Canada and in the Mississippi region helped to swell the tide of commercial progress. Dutch aggressiveness in New Amsterdam and English colonial development also contributed substantially to the general advance.

Conspicuous among events connected with the beginnings of New World commerce, which consisted principally of dealings in foodstuffs, metals, dyes, tissues, and chemical substances, was the importation of negroes, begun by Spain, in the early part of the 16th century. The employment of this class of forced-servitude workers into the West Indies was started by England in 1652. Then followed their introduction by landowners and others in New England and the Southern States.

The declaration of peace in 1783 found the United States occupying, as their only territory, the strip bordering the Atlantic from Maine to Florida. This territory was bounded on the west by the Mississippi River. Seven years later, with a total settled area of 240,000 miles and an aggregate population estimated at four millions, the principal commercial products were as follows:

Tobacco, grown in Virginia and Maryland and sent abroad to all countries.

Rice and indigo, grown in the Carolinas and highly esteemed in European markets.

Fish and lumber, products of New England and sold extensively in the West Indies, then European colonial possessions.

Furs. New York was the centre of the fur trade.

Agriculture. Agricultural industries were developing in the Northwest.

Commercial extension in the United States, from 1790, was brought about by annexation of territory west of the Mississippi and to the southward, including Florida and Texas. From the start, agriculture has furnished, and still furnishes, the bulk of United States exports, cotton, hog products, wheat flour, wood, animals, beef products, and wheat figuring as leading items, with an aggregate value of $786,000,000. Manufacturing, as a recognized feature of United States commerce and, consequently, an important division in the consideration of increasing exports and decreasing imports, began in 1816. The inventive genius of Americans, ever since that time, has aided and encouraged capital and enterprise in bringing American-manufactured products to the prominence now so universally accorded them. The Federal census returns of 1900, recently issued, report, in their completed form, 641,000 manufacturing establishments in the United States, employing $10,000,000,000 of capital owned by 709,000 proprietors. The number of wage-earners is given as 5,400,000, receiving $2,400,000,000 in wages. The total cost of materials is reported as nearly $7,400,000,000 and the value of products as over $13,000,000,000.

The American export trade, in spite of many fluctuations in financial, commercial, and political conditions, has shown a steady growth, unmarked by any startling decreases such as might reasonably have been expected as a result of panics, wars, labor troubles, and other disturbances, local, State, National, and international. During the past 27 years the total of merchandise exports from the United States has remained above $600,000,000. During 1879, 1882, 1884, 1885, 1887, and 1889 the total was between $700,000,000 and $800,000,000; during 1880, 1883, 1890, 1891, 1893–1896, it was between $800,000,000 and $900,000,000; during nine other years the total of exports has exceeded $1,000,000,000.

Exports from United States — Merchandise and Specie.— The grand total of merchandise and specie exports, domestic and foreign, from the United States during the fiscal year 1904 amounted in value to $1,600,000,000. The 10 largest aggregates, in their order of value, were: Cotton (unmanufactured), $371,000,000; iron and steel (manufactures of), $112,000,000; hog products, $105,000,000; mineral oils (refined or manufactured), $72,000,000; wheat flour, $69,000,000; wood (and manufactures of), $65,000,000; copper (manufactures of), $57,000,000; animals, $48,000,000; beef products, $40,000,000, and wheat, $36,000,000. The aggregate for the 10 industries, 1904, as shown above, is $975,000,000.

For the fiscal year ending June 30, 1905, the same ten export aggregates as shown above were: Cotton (unmanufactured), $381,000,000; iron and steel (manufactures of), $135,000,000; hog products, $106,000,000; mineral oils (refined or manufactured), $73,000,000; wheat flour, $40,000,000; wood (and manufactures of), $58,000,000; copper (manufactures of), $86,000,000; animals, $47,000,000; beef products, $35,000,000, and wheat, $4,000,000.

Imports to United States — Merchandise and Specie.— The grand total of merchandise and specie imports into the United States during the fiscal year 1904 amounted in value to $1,125,000,000. The 10 largest aggregates, in their order, were: Sugar, $72,000,000; coffee, $70,000,000; chemicals, $65,000,000; hides and skins, other than fur, $52,000,000; manufactures of cotton, $50,000,000; silk (unmanufactured), $46,000,000; india rubber and gutta percha (crude), $41,000,000; fibres, vegetable (manufactures of), $40,000,000; fibres, vegetable (unmanufactured), $38,000,000, and silk (manufactures of), $32,000,000. The aggregate for the 10 industries, 1904, as shown above, is $506,000,000. Considering only the 10 classes of products outgoing and incoming, the excess of outgoing over incoming products, 1904, was, in round numbers, $469,000,000. A remarkable feature of the aggregate showing for 1904 under the two general headings shown above, including all industries and products, is that almost exactly the same proportion of excess in exports over imports as revealed in 10 products appears. (See table following.)

For the fiscal year ending June 30, 1905, the same ten import aggregates as shown above were: Sugar, $98,000,000; coffee, $85,000,000; chemicals, $65,000,000; hides and skins, other than fur, $65,000,000; manufactures of cotton, $49,000,000; silk (unmanufactured), $61,000,000; india rubber and gutta percha (crude), $51,000,000; fibres, vegetable (manufactures of), $40,000,000; fibres, vegetable (unmanufactured), $38,000,000; silks (manufactures of), $33,000,000.

Exports and Imports, 1791–1904, with Excesses of Each.— The following table presents a compact view of United States exports and imports covering a period of 113 years. It will be noted that there has been a substantial excess of exports over imports each year since 1893.

TOTAL VALUES OF ALL EXPORTS AND IMPORTS, EXCEPT GOLD AND SILVER,† FROM 1791 TO 1905.

Year	Exports	Imports	Excess
1791........	$19,012,041	$29,200,000	Imp. $10,187,959
1800........	70,971,780	91,252,768	Imp. 20,280,988
1810........	66,757,970	85 400,000	Imp. 18,642,030
1820........	69,691,669	74,450,000	Imp. 4,758,331
1830........	71,670,735	62,7[illegible]9,956	Exp. 8,940,779
1840........	123,668,932	98,258,706	Exp. 25,410,220
1850........	144,375,726	173,509,526	Imp. 29,133,800
1860........	333,576,057	353,616,119	Imp. 20,040,062
1870........	392,771,768	435,958,408	Imp. 43,186,640
1880........	835,638,658	667,954,746	Exp. 167,683,912
1885........	742,189,755	577,527,329	Exp. 164,662,426
1890........	85[illegible],828,684	789,310,409	Exp. 68,518,275
1892*.......	1,030,278,148	827,402,462	Exp. 202,876,686
1893**......	847,665,194	866,400,922	Imp. 18,737,728
1895........	807,538,165	731,969,965	Exp. 75,568,200
1897*.......	1,050,993,556	764,730,412	Exp. 286,263,144
1900........	1,394,483,082	849,941,184	Exp. 544,541,898
1901........	1,487,764,991	823,172,165	Exp. 664,592,826
1902........	1,381,719,401	903,320,948	Exp. 478,398,453
1903........	1,419,991,290	1,025,619,127	Exp. 394,372,163
1904........	1,460,868,185	991,090,978	Exp. 469,777,207
1905........	1,518,561,666	1,117,513,071	Exp. 401,048,595

*Given because exports here passed the billion mark.
**Given because last year of excess of imports.
†Gold specie exported, 1904, $81,000,000; silver specie, $50,000,000.

Exports, Merchandise, 1904; *Value, by Principal Countries.*— The ten greatest values in merchandise sent from the United States during the fiscal year 1904 went to the following countries: Great Britain and Ireland, $538,000,000; Germany, $213,000,000; British North America, $134,000,000; France, $85,000,0000; Netherland, $72,000,000; Mexico, $46,000,000; West Indies, $44,000,000; Belgium, $41,000,000; Italy, $36,000,000, and British Australasia, $27,000,000. The aggregate value of merchandise sent to the ten countries given above is $1,250,000,000.

1905. Great Britain and Ireland, $523,000,000; Germany, $194,000,000; British North America, $143,000,000; France, $76,000,000; Netherlands, $73,000,000; Mexico, $46,000,000; West Indies, $55,000,000; Belgium, $38,000,000, and British Australasia, $26,000,000. The aggregate value of merchandise sent to the ten countries given above during the year ending June 30, 1905, was $1,174,000,000.

EXPORTS FROM THE UNITED STATES TO OTHER COUNTRIES.

Divisions	Value, 1800	Value, 1850	Value, 1905
Europe..........	$41,000,000	$114,000,000	$1,021,000,000
North America..	27,000,000	25,000,000	261,000,000
South America ..	*1,000,000	9,000,000	57,000,000
Asia	1,000,000	3,000,000	} 162,000,000
Oceanica.........	14,000	208,000	
Africa..........	1,000,000	977,000	19,000,000

*1810.

Imports, Merchandise, 1904; *Value by Principal Countries.*— The ten greatest values in merchandise received in the United States from other countries, in their order, during the fiscal year 1904 were: From Great Britain and Ireland, $164,000,000; Germany, $109,000,000; France, $81,000,000; Cuba, $77,000,000; Brazil, $76,000,000; East Indies, $58,000,000; British North America, $50,000,000; Japan, $47,000,000; Mexico, $44,000,000 and Italy, $34,000,000. The aggregate value of merchandise sent to the United States from the ten countries given above is $740,000,000.

1905. Great Britain and Ireland, $176,000,000; Germany, $118,000,000; France, $89,000,000; Cuba, $86,000,000; Brazil, $100,000,000; East Indies, $72,000,000; British North America, $63,000,000; Japan, $52,000,000; Mexico, $46,000,000, and Italy, $39,000,000. The aggregate value of merchandise sent to the United States from the ten countries given above during the year ending June 30, 1905, was $841,000,000.

THE WORLD'S EXPORTS TO THE UNITED STATES.

Grand Divisions	Value, 1800	Value, 1850	Value, 1904
Europe	$47,000,000	$125,000,000	$499,000,000
North America..	32,000,000	24,000,000	199,000,000
South America...	*6,000,000	17,000,000	120,000,000
Asia	12,000,000	10,000,000	144,000,000
Oceanica	143,000	1,500,000	20,000,000
Africa	551,000	682,000	9,500,000

*1830.

Exports from United States, from Principal Ports.— In their order of value, the principal ports of the United States shipped to other countries, during the fiscal year 1904, as follows: New York, $507,000,000; New Orleans, $149,000,000; Galveston, $145,000,000; Boston and Charlestown, $90,000,000; Baltimore, $83,000,000; Philadelphia, $71,000,000; Savannah, $54,000,000; San Francisco, $33,000,000; Puget Sound, $23,000,000, and Wilmington, N. C., $19,000,000. The increase for the above ports over 1903 were: New York, $1,000,000; Galveston, $40,000,000; Boston and Charlestown, $1,750,000; Baltimore, $1,000,000; Puget Sound, $250,000; Wilmington, N. C., $4,000,000.

Imports Received at Principal Ports of United States.— In their order of value of imports the record shows the following amounts: New York, $600,000,000; Boston and Charlestown, $81,000,000; Philadelphia, $54,000,000; San Francisco, $38,000,000; New Orleans, $34,000,000; Baltimore, $20,000,000; Puget Sound, $11,000,000; Detroit, $4,000,000; Mobile, $4,000,000; Newport News, $2,000,000; Galveston, $1,800,000; Charleston, $1,700,000, and Portland, Me., $1,400,000. The increase in imports received for the above ports over 1903 were: San Francisco, $1,000,000; New Orleans, $5,000,000; Detroit, $165,000; Mobile, $100,000; Galveston, $300,000. The decreases were: New York, $18,400,000; Boston and Charlestown, $6,000,000; Philadelphia, $6,000,000; Baltimore $7,500,000; Puget Sound, $1,000,000; Newport News, $2,000,000; Charleston, $400,000, and Portland, Me., $1,000,000.

Exports from United States by Classes.— The aggregates under several great headings in 1860 and 1904, respectively, are given below. They make a remarkable showing of national development.

Agricultural exports.....	1860, valued at.....	$257,000,000
	1904, " "	854,000,000
Mining exports..........	1860, " "	1,000,000
	1904, " "	46,000,000
Forest exports...........	1860, " "	10,000,000
	1904, " "	69,000,000

Fisheries exports........	1860, valued at	$4,000,000
	1904, " "	9,000,000
Total value of domestic manufactures exported	1860, " "	40,000 000
	1904, " "	452,000,000

Exports and Imports, Cuba, Porto Rico, Hawaii, and the Philippines.— The following tabular exhibit is interesting as an example of progress through close commercial and political contact with the United States:

Years	Cuba	Porto Rico	Hawaii	Philippines
1888				
Exports from U. S.	$10,000,000	$2,000,000	$2,000,000	$166,000
Imports to U. S...	49,000,000	4,000,000	11,000,000	10,000,000
1899				
Exports from U. S.	$19,000,000	$3,000,000	$9,000,000	$400,000
Imports to U. S...	25,000,000	3,000,000	18,000,000	4,000,000
1905				
Exports from U. S.	$38,000,000	$14,000,000	$12,000,000	$6,000,000
Imports to U. S...	86,000,000	16,000,000	36,000,000	13,000,000

Exports from United States, Increase during Decade.— The increase in total value of exports from the United States to Europe 1893–1904, as shown by comparison of totals for 1893 and 1904, was $396,000,000; to North America, $115,000,000; to South America, $18,000,000; to Asia and Oceanica, $66,000,000; Africa and other countries, $18,000,000. The total increase in volume of outward trade of the United States to the geographical divisions shown above is $613,000,000.

Exports and Imports, 1904, *Compared by Same Principal Classes of Products.*— The value of provisions exported from the United States, 1904, was $175,000,000; imported to the United States, $4,000,000; iron and steel (manufactures of), exported, $112,000,000; imported, $27,000,000; oils, exported, $109,000,000; imported, $11,000,000; animals, exported, $48,000,000; imported, $3,000,000; leather (and manufactures of), exported, $34,000,000; imported, $11,000,000; cotton (no manufactures of), exported, $22,000,000; imported, $50,000,000; coal (bituminous), exported, $18,000,000; imported, $5,000,000.

Exports, American Vessels.— The value of exports carried from the United States in American vessels 75 years ago (1830) aggregated $64,000,000. Twenty years later the records show $100,000,000. The official reports for 1904 give a total of $97,000,000.

Exports, Foreign Vessels.—Foreign merchantmen, in 1830, took from United States ports commodities valued at $10,000,000. The amount reached, 1850, exceeded $52,000,000. The aggregate of exportations in foreign bottoms, 1904, showed values totaling $1,211,000,000.

Imports, American Vessels.—American vessels, in 1830, brought to the United States goods worth $66,000,000. This, after two decades, increased to $140,000,000. The latest official reports (1904), indicate $132,000,000 as the value, in that year, of imports arriving in American vessels.

Imports, Foreign Vessels.— The aggregate value of such imports, 1830, was over $4,000,000. In 1850, a grand total of more than $38,000,000 had been reached. The figures for 1904 under this heading show $791,000,000 as the amount represented for that year in imports brought in foreign ships.

Summary of Statistics.— The statements of fact, taken from official reports, following the introductory part of this article, show:

Exports from United States, merchandise and specie.

Imports to United States, merchandise and specie.

Exports and imports from 1791, with excesses of each.

Exports, merchandise, value of, by principal countries.

Imports, merchandise, value of, by principal countries.

Exports from United States, from principal ports.

Imports received at principal ports.

Exports from United States by classes.

Exports and imports, *Cuba,* Porto Rico, Hawaii, and the Philippines.

Exports from United States, increase during decade.

Exports and imports, compared by principal classes of products.

Exports, past and present, in American and foreign vessels.

Imports, past and present, in American and foreign vessels.

Comparison of United States Exports (1902–3) *with Those of Principal Nations.*— The ten countries showing the greatest value of exports (1904–5) from their own territory are: United States, $1,492,000,000; United Kingdom, $1,463,000,000; Germany, $1,243,000,000; France, $864,000,000; Netherlands, $797,000,000; Russia, $516,000,000; British India, $500,000,000; Austria-Hungary, $424,000,000; Belgium, $421,000,000; Italy, $312,000,000.

Comparison of United States Imports (1904–5) *with Those of Principal Nations.*— United Kingdom, $2,682,000,000; Germany, $1,515,000,000; United States, $991,000,000; Netherlands, $1,118,000,000; France, $876,000,000; Belgium, $537,000,000; Austria-Hungary, $416,000,000; Italy, $359,000,000; Russia (1903), $351,000,000; British India, $314,000,000.

Conclusion.— The exports of any country furnish a reliable indication of its productive capacity. The three countries having the greatest productive capacity are, in their order, the United States, the United Kingdom (Great Britain and Ireland) and Germany, with France and the Netherland holding creditable fourth and fifth places.

Imports show, approximately, the ability and necessity of a nation to buy. In the figures it will be noted that Great Britain and Ireland are the largest buyers, Germany being second, and the United States third.

THOMAS C. COPELAND,
Expert Statistician.

Exports and Imports of the Latin-American Republics. *Argentina.*—The total value of exports from the Argentine Republic to all other countries during the year 1902 was $179,486,727 gold; an increase of $11,760,625, as compared with the exports in 1901; and the imports aggregated only $103,039,256 gold; a decrease of $10,920,493, as compared with those of 1901. Imports during 1902 from the United States into the Argentine Republic were: Agricultural implements, valued at $2,381,735; carriages, $412,033; cycles, $10,710; cotton cloths, $77,821; wearing apparel, $214,853; electric and scientific apparatus, $110,915; builders' hardware, $232,464; sewing-machines, $129,600; steam-engines, $8,380; typewriting-machines, $24,940; leather, $56,901; rosin, tar, etc., $136,958; turpentine, $124,161; oils, $1,132,402; lard, $5,040; tobacco, $17,213; wood, $54,098; lumber, $858,888; furniture, $98,220. Imports into the Argentine Republic from Great Britain during 1902 were: Cotton manufactures, valued at $5,776,336.22; jute manufactures, $229,104.28; linen piece goods, $269,452.23; woolen tissues, $601,887.91; worsted tissues, $798,908.89; carpets, $158,440.58; cutlery, $74,126.21; hardware, $99,830.13; iron (bar, bolt, etc.), $131,548.44; railroad iron, $1,956,566.33; wire (of iron or steel), $298,516.23; galvanized sheets, $1,354,663.55; tin plates and sheets, $3,669.54; wrought and cast iron, $1,044,020.86; cement, $147,483.08; earthen- and china-ware, $163,391.48. The distribution of exports and imports is shown in the following table:

Exports from Argentina to	Value in Argentine gold	Imports into Argentina from	Value in Argentine gold
Great Britain..	$35,084,066	Great Britain..	$36,995,460
France	29,587,457	France	9,243,071
Germany	22,939,881	Germany	13,229,275
Belgium	13,760,219	Belgium	5,484,233
United States ..	10,037,576	United States..	13,303,504
Brazil	8,368,742	Brazil	4,583,645
Africa	8,285,387	Africa	
Italy	4,215,756	Italy	12,265,003
Uruguay	3,673,633	Uruguay	744,694
Netherlands ...	2,834,288	Netherlands ...	622,359
Spain	2,025,428	Spain	3,166,902
Chile	684,113	Chile	213,189
Bolivia	600,368	Bolivia	122,015
Cuba	470,991	Cuba	106,781
Paraguay	212,212	Paraguay	1,469,510
Other countries	10,196,675	Other countries.	1,485,124
Orders	26,509,935		

Among the articles exported to the United States in 1902 were: 224 tons of tasajo (jerked beef); 800,000 pounds of bone and bone ash; 11,020 tons of wool; 966 tons of wheat; and 14,113 tons of linseed. Exports to Great Britain during that year were: Wheat, valued at $7,129,589.47; maize, $17,287,180.23; fresh beef, $8,414,574.84; fresh mutton, $11,069,641.49; unrefined sugar, $1,483,634.44; wet hides, including shipments from Uruguay, $737,975.45; linseed, $8,681,643.18; tallow and stearin, $3,290,318.10. The total shipments of wheat from Argentina in 1902 were estimated at 700,000 tons, and the exports of butter (5,837,282 pounds) were nearly four times as large as those of 1901.

Bolivia.— The exports during 1902 were valued at $13,566,734, against $13,621,237.56 in the year 1901. Importations from all countries into Bolivia, according to consular invoices (values as given to the customs officers), amounted to $6,120,113, and to 16,953,223.75 *bolivianos*, or $6,476,131.47 United States currency, in 1901 and 1902. Exports from Bolivia consisted chiefly of silver, rubber, tin, and copper. Imported articles were bought principally from Germany, England, France, and the United States.

Brazil.— During the year 1902 Brazil exported to the United States coffee to the value of $47,004,453; india rubber, $15,209,295; sugar, $2,534,760; and cocoa, $1,302,493. Her imports from the United States in the same year were: Agricultural implements, valued at $35,702; wheat flour, $2,209,881; carriages, $54,266; cycles, etc., $6,799; cotton cloths, $603,161; wearing apparel, $81,143; electric and scientific apparatus, $323,941; builders' hardware, $188,404; sewing-machines, $74,114; steam-engines, $133,759; typewriting-machines, $12,428; leather, $155,119; rosin, tar, etc., $226,676; turpentine, $79,804; oils, $2,568,684; beef, $9,926; tallow, $26,905; bacon, $167,981; hams, $2,612; pork, $13,021; lard, $924,582; butter, $116,410; lumber, $353,175; and furniture, $16,639. Exports from Brazil to Great Britain in 1902 were: Raw cotton, valued at $5,299,665.49; coffee, $2,290,862.61; unrefined sugar, $932,001.12; wet hides, $271,850.49. Imports from Great Britain were: Coal and coke, valued at $3,687,880.53; cotton manufactures, $6,845,427.84; jute yarn, $1,787,220.33; jute manufactures, $93,148.49; linen piece goods, 246,509.66; woolen tissues, $401,940.58; worsted tissues, $490,652.50; cutlery, $147,826.77; hardware, $135,634.37; iron (bar, angle, bolt, and rod), $155,933.05; railroad iron, $597,315.24; iron- or steel-wire, $60,329.56; galvanized sheets, $205,820.55; tin plates and sheets, $372,900.77; wrought and cast iron, $890,377.75; cement, $55,513.13; earthen- and china-ware, $307,160.64; and seed oil, $295,657.70. There was a marked increase in exports to Spain and France. The aggregate of exports to all countries during the first six months of 1902 was $84,291,922.61; while the imports from all countries during the same period amounted only to 219,886 *contos*, or $52,971,457.52.

Chile.— Exports to all countries during the first half of the year 1902 had an aggregate value of $93,955,450, including gold and silver specie; or $79,745,933, excluding specie. In the corresponding period of 1901 the value of the exports was $78,682,883, including gold and silver specie, amounting to $203,119. The total value of imports in the first half of 1902 was $63,158,537; that sum being less by $2,608,044 than the imports during the corresponding period of 1901. It is stated that the diminution is due to the following causes: "In the first place, there are the rectifications made in the valuations of sugar, coffee, and tea. In the statistics for 1901 these articles figured with an excess of $3,652,000 over their real value. In the second place, the last harvest sufficed for the wants of the country, and consequently there were no heavy imports of wheat and flour, which articles in 1901 represented a value of $8,578,000. In the third place, there was the higher premium on gold, and transitory circumstances which perturbed trade and reduced personal consumption." Instead of importing wheat, as in 1901, Chile sent more than 15,000 tons of that product to Peru. Imports from the United States during the entire year 1902 were: Agricultural implements, valued at $132,242; carriages, cars, etc., $115,276; cotton cloth, $520,642; wearing apparel, $29,311; electric and scientific apparatus, $52,979; builders' hardware, $123,116; leather, $28,398; rosin, tar, etc., $15,593; turpentine, $34,105; oils, $554,080; beef, $7,493; tallow, $3,020; lard, $42,681; wood, $5,371; lumber, $199,183; and furniture, $14,844. Imports into Chile from Great Britain during 1902 were: Cotton manufactures, valued at $3,065,788.29; woolen tissues, $520,422.81; worsted tissues, $810,723.76; carpets, $121,409.10; cutlery, $65,384.62; hardware, $102,771.61; iron (angle, bar, bolt, and rod), $166,554.00; railroad iron, $181,173.74; galvanized sheets, $378,598.67; and wrought and cast iron, $171,163.62. Exports from Chile to Great Britain in 1902 were principally nitrate of soda and copper (namely, copper ore, $1,419,224.76; regulus and precipitate, $1,226,558.20; and wrought and unwrought copper, $4,452,300.10). British importations of nitrate of soda during 1902 had a total value of $5,122,606.90, most of which came from Chile. The British empire (on account of the business done with India) heads the list of importers, and Germany stands next in order.

Colombia.— According to official statistics of the United States, Colombia imported from this country in 1902: Agricultural implements, $3,553; wheat flour, $231,828; carriages, $21,675; cycles, $937; cotton cloths, $1,286,535; wearing apparel, $76,398; builders' hardware, $55,667; sewing-machines, $19,129; steam-engines, $21,400; typewriting machines, $3,227; leather, $14,297; boots and shoes, $80,514; rosin, tar, etc., $11,705; turpentine, $5,802; oils, $115,884; beef, $27,310; tallow, $3,880; bacon, $2,971; hams, $15,444; pork, $14,133; lard, $109,952; butter, $13,626; cheese, $10,960; tobacco, $70,869; wood, $12,718; lumber, $36,992; and furniture, $24,327. Imports into Colombia from Great Britain during the same year were: Cotton manufactures, $3,129,788.29; and linen piece goods, $60,595.52. The only available commercial statistics of a Colombian source are those of the port of Cartagena. The total value of imports there during 1902 is given as $1,601,159.28 United States gold. Reliable statistics of exports in 1902 cannot be obtained.

Costa Rica.— Exports of coffee (1 Oct. 1901 to 30 Sept. 1902) amounted to 236,057 sacks. Exports of bananas in 1902 were greater than in any preceding year — 4,174,199 bunches, worth, approximately, $1,878,389.55. Other exports in 1902: cocobola logs, valued at $7,187.04; fustic (*palo mora*), $43,514.28; mahogany, $2,487.60; cedar timber, $117,007.80; cacao, $24,051.20; sundry merchandise by parcels-post, $8,934.67; gold by parcels-post, $11,630.63; total gold and silver coin and bullion, $147,340.59; not enumerated, $41,184.44. Imports into Costa Rica from the United States in 1902 were valued at $2,048,809; that sum being 54 per cent of the total value of Costa Rica's imports, which was $3,794,642. Great Britain furnished 24 per cent of the imports, Germany 12½ per cent, and France a little over 5 per cent. The chief imports from the United States were foodstuffs, machinery, and tools, cotton prints, dynamite, drugs, paints, and oils. Foodstuffs of European origin were imported to the value of $118,329 in 1901, but only $87,675 in 1902, while similar imports from the United States increased from $493,078 in 1901 to $554,251 in 1902. This increase is due to frequent and easy maritime communication with the ports of New York, New Orleans, and Mobile, which has also "raised the percentage of Costa Rican products shipped to the United States, such as gold bullion, rubber, hides, and coffee." From Nicaragua 14,587 head of cattle were imported. Imports of gold coin in 1902 amounted to $250,000, of which $150,000 was consigned to the government and $100,000 to the Bank of Costa Rica.

Cuba.— The principal exports from Cuba to the United States in 1902 were sugar, tobacco, bananas, mahogany, and logwood. Imports into Cuba from the United States were: Wheat flour, valued at $2,059,876; agricultural implements, $45,304; corn, $827,538; carriages, $457,217; cycles, $12,320; cotton cloths, $208,039; wearing apparel, $158,313; builders' hardware, $322,500; sewing-machines, $97,355; steam-engines, $125,730; typewriting machines, $33,982; leather, $68,348; rosin, tar, etc., $28,576; turpentine, $30,154; oils, $586,946; beef, $9,105; tallow, $7,276; bacon, $379,188; hams, $505,757; pork, $316,383; lard, $2,197,928; butter, $26,624; cheese, $14,593; tobacco, $137,339; wood, $151,614; lumber, $877,880; and furniture, $261,683. Cuba's exports to all countries in 1902 were valued at $64,329,000, an increase of $1,051,000, as compared with those of 1901. The United States took 76 per cent of the exports, $49,498,000, an increase of $1,431,000 over 1901; England 9 per cent, $5,087,000, a decrease of $134,000; Germany 6 per cent, $3,967,000, a decrease of $272,000; Spain 2 per cent, and France 1 per cent. The island produced 880,000 tons of sugar in 1902–3; or nearly 30,000 tons more than in 1901–2; yet the value of the sugar exported in 1902 was less by $1,391,000 than in the preceding year. Tobacco exported in 1902 was valued at $25,404,000, an increase of $77,000. See CUBA.

Dominican Republic.— During the year ending 30 June 1902, exports to all countries amounted to $3,095,691.43. Those to the United States were valued at $2,500,000, and imports from the United States at $1,500,000. See DOMINICAN REPUBLIC.

Ecuador.— For the year ending 30 June 1902 trade with the United States was represented by exports valued at $1,500,000, and imports $1,400,000. See ECUADOR.

Guatemala.— Exports to the United States during the fiscal year ending 30 June 1902 were valued at $2,600,000; imports from the United States, $1,680,000. See GUATEMALA.

Haiti.— The value of exports to the United States during 1902 is given as $1,200,000; of imports from the United States, $2,700,000. The principal articles exported were coffee, cocoa, and logwood. Haiti imports from Great Britain considerable quantities of cotton and linen goods and hardware.

Honduras.— The total value of exports from this republic in 1902 was $6,170,353.27, a decrease of $12,670.10 as compared with 1901. But during the past four years Honduras has increased the value of her exports by $1,387,666.69, and the value of her imports by $2,777,161.42. The total value of imports during 1902 was $4,377,161.42. The United States took two thirds of the exports ($4,077,108.89), and supplied three fifths of the imports ($2,841,484.10). Other countries to which exports were sent: Great Britain, $778,293.60; Central American republics, $775,473.90; Cuba, $303,509; Germany, $136,214.54. Metals valued at $938,976 (23,235 ounces of gold, 1,010,204 ounces of silver, and 25,198 ounces of copper) were exported during the year. (In this paragraph the dollar mark means *peso*, standard "dollar" of Honduras; value $0.39 in 1892.)

Mexico.— The exports from Mexico for the fiscal year ending 30 June 1902 were valued at $156,168,145.66 silver. In the preceding year the amount was $148,659,001.71 silver. The largest items were precious metals, to the value of $68,897,126.17 in 1901–2; and of $81,376,319.78 in 1900–1. The imports form a study of special interest to American business men, as indicated in the following table:

IMPORTS OF MEXICO (VALUES GIVEN IN GOLD).

Source	Fiscal Year 1900–1901	Fiscal Year 1901–1902
North America	$35,201,400.35	$37,450,613.84
Europe	28,956,971.89	26,380,111.76
Asia	545,410.29	514,309.08
Africa	26,938.62	25,030.06
Central America	70,044.75	41,091.93
South America	140,212.27	156,101.38
West Indies	58,009.00	53,851.65
Oceania	84,466.12	35,239.73
Total	$65,083,453.29	$64,656,349.43

But Mexico's imports from the United States were valued at $35,189,955.85, in 1900–1; and at $37,435,099.29, in 1901–2, being nearly the entire amount credited in the table to North America: this statement may, therefore, be regarded as evidence of a decided improvement in the commercial relations of the United States with Mexico. European countries which supplied Mexican imports in the fiscal year 1901–2 were: Germany, to the value of $6,451,099.24; Austria-Hungary, $354,401.75; Belgium, $1,074,743.17; Spain, $2,719,909.77; France, $6,296,001.72; Great Britain, $8,266,096.33; Holland, $235,246.35; Italy, $397,450.06; Norway, $79,056; Portugal, $41,265.45; Russia, $3,062.83; Sweden, $49,789.77; Switzerland, $405,811.53; other countries, $16,177.25. Imports during the last six months of 1902 from all countries were valued at $36,973,133 gold; against $29,586,547 for the same period of 1901. Exports also increased, being valued at $93,254,675 silver for the last six months of 1902; or $19,990,745 silver more than for the corresponding period of 1901. Exports from Mexico to the United States during the calendar year 1902 were: copper, value in United States gold or silver, $14,373,820; coffee, $2,785,633; coal, $25,022; logwood, $18,206; sisal grass, $12,907,629; oranges, $90,534; hides and skins, $3,611,628; india rubber, $97,534; lead, $3,884,285; sugar, $8,624; tobacco leaf, $61,595; and mahogany, $394,720. Imports from the United States during the calendar year 1902: agricultural implements, value in United States gold or silver, $340,514; corn, $4,275; wheat, $59,551; wheat flour, $217,485; carriages, $1,429,573; cycles, $27,052; copper, $829,035; cotton, $3,142,223; cotton cloths, $219,476; wearing apparel, $439,032; electric and scientific apparatus, $852,373; iron and steel, $427,192; builders' hardware, saws and tools, $765,317; sewing-machines, $422,845; steam-engines, $1,099,806; typewriting machines, $163,521; leather, $13,573; boots and shoes, $680,607; rosin, tar, etc., $16,558; turpentine, $3,415; oils, $1,543,776; beef, $20,566; tallow, $30,990; bacon, $32,754; hams, $61,932; lard, $533,365; butter, $86,160; cheese, $50,288; tobacco, $242,666; wood, $611,161; lumber, $1,509,983; and furniture, $613,608. Imports into Mexico from Great Britain in 1902 were: cotton manufactures valued at $1,506,379.24; linen piece goods, $70,595.52; railroad iron, $1,556,008.83; and galvanized sheets, $405,695.35. Importations of textiles and woven goods were less in value by $843,755.48, as a result of the increased manufacture of such goods in the Mexican mills.

Nicaragua.—Exports to the United States for the year ending 30 June 1902 were valued at $1,900,000; imports from the United States during the same year, $1,300,000. The total amount of foreign merchandise imported into Nicaragua during 1902 was said to be considerably less in quantity and value than that of any of the preceding 10 years. British trade with this republic has declined, or has been transferred to the United States or Germany. Mahogany logs, shipped from the port of Bluefields in 1902, represented 6,759,325 feet of lumber, valued at $337,966 United States currency.

Paraguay.— Exports, during 1902, were valued at $3,252,650 gold; imports at $2,050,000 gold, 35 per cent less than in 1901. Exports to the Argentine Republic in 1902 amounted to $1,469,510, and imports from that country to $1,681,722. See PARAGUAY.

Peru.—In the first half of the year 1902 imports amounted to $7,391,681. Ores to the value of $8,526,632 were exported; the value of such exports in the previous year having been $8,259,319. Exports to the United States in the year ending 30 June 1902 were valued at $3,200,000; imports from the United States at $2,500,000. Exports to Great Britain in 1902 were: unrefined sugar, valued at $278,276.34; alpaca, vicuña, and llama, $1,266,144.49; copper regulus and precipitate, $661,399.57. Imports into Peru from Great Britain during 1902 were: Cotton manufactures to the value of $1,785,751.08; woolen tissues, $356,985.61; worsted tissues, $125,285.62; railroad iron, $225,541.01; and wrought and cast iron, $171,063.62.

Salvador.— Exports in 1902 were valued at 10,278,151.98 *pesos,* and imports at 2,747,385.08 *pesos;* value of a *peso* in United States gold or silver being $0.384. The imports were chiefly from Great Britain, the United States, and Germany. In the fiscal year ending 30 June 1902, exports to the United States amounted to $600,000; and imports from the United States to $890,000. Coffee was exported to Austria, Holland, and Norway; sole leather to Cuba; manufactured tobacco to Curaçao; indigo to Chile; Ecuador, and Peru; and to Spain, Salvador sent indigo, coffee, and manufactured silk.

Uruguay.— The exports in 1902 were valued at $32,549,483; and the imports at $23,757,471. During the six years from 1897 to 1902, the exports of this republic exceeded the imports by $44,485,150. Exports to the United States, during the fiscal year ending 30 June 1902, were valued at $2,500,000; and imports from the United States at $1,500,000. Imports into Uruguay from Great Britain during 1902 were: Cotton manufactures, to the value of $2,097,426.21; woolen tissues, $128,105.35; worsted tissues, $213,843.11; iron (bar, angle, bolt, and rod), $48,641.56; railroad iron, $16,071; and galvanized sheets, $215,770.22.

Venezuela.— Exports through Puerto Cabello in 1902 were: 374,786 cattle hides; 11,205 deerskins, and 70,053 goatskins; the United States being the principal purchaser. Imports into Venezuela from the United States in 1902 were: Agricultural implements, valued at $1,694; carriages, $13,620; cycles, $462; cotton cloths, $460,888; wearing apparel, $17,328; electric and scientific apparatus, $28,320; builders' hardware, $22,682; leather, $27,406; rosin, tar, etc., $20,341;

turpentine, $3,488; oils, $108,870; hams, $31,154; lard, $298,888; butter, $84,363; lumber, $1,946; and furniture, $8,555. Cotton manufactures to the value of $911,440 were imported during 1902 from Great Britain. Complete statistics were not prepared owing to the disturbances in the country. A statement of the foreign commerce during other years will be found in the article VENEZUELA.

Consult: 'Monthly Bulletins' of the International Bureau of the American Republics from July 1902 to July 1903, inclusive.

MARRION WILCOX.

Express Service. The creation and development of express service in the United States, and the extension of the American express system, under American control, throughout the length and breadth of the civilized world, and beyond, offers positive, convincing proof of unique native constructive and administrative genius along the lines of greatest utility to mankind.

One of the most prominent, successful, and progressive express companies, now operating on every continent, began, some sixty years ago, with a simple service for delivery of packages between a few eastern and western points. To-day, the same organization has, in addition to traffic in the United States, British North America, and the Latin-American republics, at least a dozen agencies with commodious quarters on leading thoroughfares in principal European cities, each fully equipped with men, wagons, and horses for the most rapid and effective express service.

As part of its routine business, the company is in touch with thirty of the world's largest banking institutions and has shipping and banking correspondents at all large cities and ports in both hemispheres. As a means of comparison with express conditions of half a century ago, when the system was merely an adjunct to the railroads, a brief outline of the work now being carried on in progressive express companies will be of interest. Since the express plan first began, in 1838, the situation of the railroads toward the express companies has, by mutual consent, and to meet ever-growing demands, been entirely reversed. The railroads, in their own interests, so far as carriage of express freight is concerned, are now adjuncts of the express companies.

The most modern American express service, when conducted on a large scale, usually includes, in addition to conveyance of ordinary merchandise packages, the following special features:

Travelers' cheques, letters of credit, sight drafts, money orders, money transfer by cable and telegraph, payment of taxes, dues, etc., for nonresidents, conveyance of valuables and securities, collection of accounts, collection of notes, drafts, and C. O. D. parcels, purchase of goods, household supplies, books, articles, or commodities, rare or otherwise, and the performance of every other legitimate commercial, financial, or other transaction requiring the service of a personal representative of intelligence and discretion.

The "cheque" system has been so perfected that travelers in foreign countries save time and avoid delay by their use, as they are promptly recognized and cheerfully cashed or accepted by the principal hotels, steamship and sleeping-car companies, by many railroad companies, and by merchants, shopkeepers, and others, in settlement of accounts. Travelers often avoid loss of time in specially visiting banks to obtain funds for such expenses, as well as the delays resulting from inability to obtain money on Sundays, holidays, or fête days, or before or after business hours.

For those traveling in the United States, Canada, Mexico, Central and South America, these cheques afford the advantages of a secure and convenient means of carrying funds immediately available, combined with the avoidance of delays, of the risk of loss of money by fire or destruction, and of the annoyance of negotiating personal checks in places where such may be unacceptable. Being cashed by agents of the companies and by banks in all the principal cities and pleasure resorts of the United States, the Canadas, Mexico, Cuba, Central and South America, accepted in payment of fares by the principal steamship companies and many railroad companies throughout the United States, and received by agents and conductors of the Pullman Palace Car Company and by many hotels in settlement of account, travelers cheques are found to be a most satisfactory form of credit for use during a tour.

"Letters of Credit" now form a usual express office specialty. These documents are drawn in sterling and are available in all parts of the world. Through the Letters of Credit system, cheques may be obtained from express agencies at all important points. Every foreign express correspondent has a cable address, also every express agency.

The "C. O. D" system and bank of account collection are among the useful developments of express service. "C. O. D." shipments are subject to collection of bill or invoice for the goods, with prompt return of proceeds made at a small charge for such service. C. O. D. shipments to foreign countries are usually made under the same system as applied to domestic points.

Several of the big express companies attend to the collection of accounts, bills, notes, drafts, etc., in any part of the commercial world. Collections in United States and Canada are effected with unusual promptness and at less risk and cost to payee than by other methods. Collections in foreign countries of drafts or deposits, or by powers of attorney, are undertaken by express companies through their own organizations in Europe or through banking correspondents. The proceeds of C. O. D.'s or collections are transferred by cable when patrons desire, with a charge for collecting, plus only the cost of cablegrams.

The transfer of money is another useful and much appreciated feature of express service. Purchases are made and commissions executed for patrons, in the quickest possible time, at places in United States, Canada, and Europe, by a special department. Besides attending to orders for the purchase or sale of goods and property, including household supplies, this department pays tax bills, redeems articles pawned, collects baggage at railroad stations, secures seats at theatres, berths on sleeping cars, staterooms on steamboats, passage and staterooms on European steamers. Rare goods or books or articles requiring exact matching, or the maker or seller of which is unknown, are obtained without annoyance or loss of time to patrons.

Imports and exports of every class and size are handled by express companies now, as a rule, this work being deemed part of their regular business. Bills of lading, bills of exchange and all other documents of that character are prepared and attended to from first to last.

Money orders and drafts are issued by several express companies for any amount, at the posted rate of exchange, in sterling, francs, lire, lei, marks, kroner, rubles, kronen, gulden, finmarks, Turkish pounds, Mexican dollars, local dollars, pesos, rupees, yen, and U. S. dollars on all parts of the commercial world.

The regular transportation service of express companies includes merchandise, parcels, produce, money, bonds, valuables, and baggage. The routes extend over 50,000 miles of railroads in the United States alone. Shipments are frequently made in through express cars, with burglar and fire-proof safes for valuables and iron express trunks for parcels, all in charge of special messengers, fully armed. The swiftest trains are almost invariably used for express service. The aim of the companies is to cover the ground in the least time at the lowest rates. They accept entire responsibility for loss or damage. Some express companies run special express trains to facilitate business during very busy seasons. Other companies have this feature as a permanent arrangement.

Novel and highly useful features of the most modern express service are the securing of ocean passages, European railroad tickets, and passports for patrons at a nominal charge. It is only necessary for those who desire to utilize express companies in this way to state their wishes — the companies do the rest rapidly, perfectly, and inexpensively.

So much for the work-scope of express companies to-day as compared with that of earlier periods. Before reviewing briefly the evolutionary processes connected with express service developments it may be well to mention what has been brought about through the use of express enterprise and by such methods as are peculiar to the service.

1. The creation of wagon service, and, in connection with this, special cars and trains for transportation of express matter at high speed.

2. The creation of transportation business for carriage to and from all advantageous producing points of game, poultry, fish, oysters, and fruit to localities where these commodities are not easily obtainable.

3. The creation of a novel method of selling goods for merchants by collecting on delivery the amount of invoice and returning cash to the shipper.

4. The creation of a method of collecting the proceeds of negotiable paper and assuming, for the time being, responsibility of indorsees.

5. The creation of an efficient means of safe transportation of moneys and valuables shipped by individual citizens and by firms, banks, railroads, and the government. In one year $4,000,000,000 have been shipped in the United States through the express companies in this manner.

6. The creation of a vast and perfect network of money-order agencies. The present number of these agencies is estimated at 40,000.

The creation of improved facilities for immediate transportation of foreign goods from ports of entry to destination. Heavy bonds are demanded by the government and given for proper execution of this service.

Origin and Evolution of the Express Idea.— The "Express" idea sprang from the system of sending parcels in care of coach-drivers, by stage-coach, and from the shipping of such parcels in care of captains, by coasting vessels.

When the railroads took the place, gradually, of the coaches, much parcel traffic was performed by means of the steam-cars. Then the conductors of these cars had to assume responsibility for safe-keeping. Eventually, this transfer overcrowded them with work. A division of duties naturally followed. Finally, the railroads insisted that their employes should chose between railroad and the supplemental delivery traffic.

The principal events following this decision were:

1838–9. The starting of an express company to operate in New England. Alvin Adams, who later began business for himself in New York, was with this company.

1839. "Harnden's Express" started between New York and Boston.

1840. "Adams' Express" began operations between the same points.

1840–45. Other expresses opened up business, extending service to Philadelphia, Baltimore, Washington, Buffalo, Pittsburg, Detroit, Chicago, Cincinnati, Louisville, St. Louis, and New Orleans.

The men most active in the new field at this time were William F. Harnden, William B. Dunsmore, Henry Wells, Edward P. Sanford, Samuel M. Shoemaker, Johnston Livingston, and William G. Fargo.

Almost all of the western transportation was carried on over the Ohio, Mississippi, and Missouri rivers, with their tributaries, which included canals then recently completed in several of the States to connect those rivers with the lakes.

From 1840 the construction of railroads continued uninterruptedly, express business expanding in proportion. Then came the inauguration of express "continuous lines," enabling goods to be carried quickly between many points without transfers.

At this period people sent their letters by express as being safer than the government's mail service. In course of time the authorities at Washington protested, and finally prohibited by law the private conveyance, without United States contract, of private letters.

1848. The stampede of gold-seekers, 1848–9, to California, brought out a great extension of the express system. Money and gold-dust were transmitted direct from the coast to eastern points through the express companies, many new agencies being established for the purpose.

1854. In this year a consolidation of express interests took place. "Adams & Co." bought up and worked several minor eastern routes and secured the right to much southern traffic.

During the same year the "American Express Co.," first established in 1841, was formally organized, to operate from the east to the far west.

The "United States" express also came into existence in 1854 to operate along the New York & Erie railroad and the route running westward.

1854–5. About this time "Wells, Fargo & Co." were organized. They started the famous "Pony Express" and several stage lines. Other firms competed in these special forms of rapid transportation.

1855. The "National" Express Co. began operations in this year, with routes between New York, Albany, Troy, Saratoga, Whitehall, Rutland, and Montreal.

1858. Wells, Fargo & Co. and the Pony Express lines organized the "Overland Mail Co.," which, until the completion of the Union Pacific railroad, carried the whole of the United States mails between the Missouri river and the Pacific coast. By this time the express had become a recognized necessity in the commercial and individual transactions of the country. Its lines had amplified in every direction. It had attracted to itself sufficient capital to place it on a firm financial basis. Obligations to insure the safe and speedy transmission of merchandise, valuables, and money were readily assumed. When loss or damage occurred, due reparation was promptly made. Thieves were and are, to-day, followed up by them until caught and punished.

1861. Henry S. Plant and associates organized the "Southern Express Co.," which operated principally in the southern States.

1861–5. Upon the breaking out of hostilities, the express was the only means of communication between soldiers in the field and their friends at home. Government securities, being purchased largely by the people, were sent by government through the express, it being officially recognized that, during that critical period, the express was much safer than the official mail service.

After the war a contract was made by the United States government with the Adams Express Co., acting for itself and other companies, to transmit all securities and moneys of the government by express.

1865–1905. This period represents a phenomenal growth of the express movement. The present organization of the great companies, each with the experience of half a century to guide it, is practically perfect in its workings and labors continuously at high tension to keep even pace with calls which increase day by day. As railroad and steamship facilities become more and more complete the pressure becomes greater.

The routes now aggregate over 250,000 miles. The total number of packages handled per annum has reached nearly 150,000,000. The estimated total of men employed is 75,000, with 20,000 horses and 10,000 vehicles. The capital represented in this line of commercial activity is now at least $100,000,000.

Expressed Oils, in chemistry, oils obtainable from bodies by pressing, to distinguish them from mineral and essential oils, which last are obtained by distillation.

Expulsion. Usually this word is used to describe the act of depriving one or more members of a political or corporate organization, or of a society, of their right of membership. The act is frequently brought about by a vote of the organization or society after the submission of a committee report, for some violation of duty or some other offense rendering such member or members, in the opinion of their associates, unfit or unworthy.

It is provided in the Constitution of the United States that the members of the Senate or House of Representatives may expel members of their respective bodies, by a two-thirds vote, for disorderly conduct.

Corporations have the right of expulsion in cases where good order and proper control make the exercise of such power essential as, for example, (1) when the offense is not within corporate duties, but nevertheless disgraceful or infamous, or (2) when the offense is against his duty as a corporation member or officer or director, or (3) when the offense is of such a character as to infringe corporation rules and the statutes at the same time.

Before a person can be expelled from a corporation or society for disgraceful conduct outside of the jurisdiction of such organizations, a previous conviction by jury is necessary before expulsion. If the offense is against or in violation of corporation or society rules or duties, a trial and conviction may be had before the authorities of the organization.

The word "expulsion" is also used to describe the ejection of people from meetings when they create a disturbance or otherwise make their presence obnoxious. Those who convene meetings have, in the eyes of the law, the right to expel objectionable persons, providing they only use as much force as is necessary for the purpose.

Club members are not liable to expulsion for striking fellow members, refusing to submit to arbitration, refusing to pay awards of arbitration, or refusal to pay dues after illegal suspension.

Non-members of any organization, if present at any meeting of such organizations, are liable to expulsion.

The Constitution of the United States provides that Federal judges cannot be expelled from their posts during good behavior. See DISFRANCHISEMENT.

Expunging Resolution. See CENSURE, CONGRESSIONAL.

Extension, in physics and metaphysics, that property of a body by which it occupies a portion of space. Extension is an essential as well as a general property of matter, for it is impossible to form a conception of matter, however minute may be the particle, without connecting with it the idea of its having a certain bulk and occupying a certain quantity of space. Every body, however small, must have length, breadth, and thickness; that is, it must possess the property of extension. Figure or form is the result of extension, for we cannot conceive that a body has length, breadth, and thickness without its having some kind of figure, however irregular. In logic, extension is the extent of the application of a general term, that is, the objects collectively which are included under it; thus European is more extensive than French, Frenchman, German, etc. Matter and mind are the most extensive terms of which any definite conception can be formed. Extension is contrasted with comprehension or intension. See PHYSICS.

Extension, University. See EDUCATION; UNIVERSITY EXTENSION.

Extension Teaching. See HOME EDUCATION; UNIVERSITY EXTENSION.

Extenuating Circumstances, in legal practice, those circumstances, in connection either with the position of the prisoner or with the act alone, which are taken into consideration by the court in mitigation of the punishment. The previous good character of the person convicted may always be proved as a circumstance giving him some claim to leniency of punishment. Besides character, there are other circumstances, the presence of which in a case sometimes serves to mitigate the sentence, sometimes to take the act done out of the category of crime altogether. One is youth. Thus, no act done by any person under seven years of age is a crime. Defective mental power in the person convicted will always be considered in determining the severity of his sentence. Such disease of mind as prevents a man from knowing that the act he does is wrong will excuse him from the consequences of an act otherwise criminal. Drunkenness, when voluntary, is not held an extenuating circumstance, but if a man is made drunk by the fraudulent administration of drugs, and while under their influence kills another, not knowing what he does, the act is not a crime. It is a good excuse for persons charged with crime that they have been compelled by others by threats of death or great violence to do the criminal act; and the acts of a married woman in presence of her husband are presumed to be done under his coercion, and so, unless the presumption is rebutted, will be excused. Ignorance of the law is no excuse for an offense. Nor, in general, will ignorance of facts be a good excuse, though in particular circumstances it might form a valid defense. Sir James Fitzjames Stephen states, in language purposely vague, to represent the vagueness of the law, a principle under which the stress of necessity is held to excuse acts otherwise criminal. He says: «An act which would otherwise be a crime may in some cases be excused if the person accused can show that it was done only in order to avoid consequences which could not otherwise be avoided, and which, if they had followed, would have inflicted on him or on others whom he was bound to protect inevitable and irreparable evil, that no more was done than was reasonably necessary for that purpose, and that the evil inflicted by it was not disproportionate to the evil avoided.»

Extinct Animals. Many animals which inhabited the earth in bygone periods have entirely disappeared, leaving not even a modern representative of their race. Others, no doubt, were known to pre-historic peoples, concerning which no record has come down to us. But, within the period of recorded observations, many animals have lived and died out; various causes contributing to their extermination, not least among these being the presence of mankind. Man reconstructs the face of the earth to suit his needs: he cuts down forests, plows or burns over prairie lands, changes the course of rivers, drains the swamps, and thus destroys the natural environment of many of nature's wild children. Then, too, he destroys creatures directly; he kills them for food, for clothing, or for other utilitarian purposes; he hunts them because he fears them, as dangerous foes to himself, or to his agricultural pursuits; he destroys them for his sport; and, finally, he draws them from feral conditions by domestication. Not only thus does man directly injure the wild creatures; but his coming, accompanied by exterminating influences, kills out certain other creatures. These, when man has destroyed their natural prey, practically die of starvation before they can adapt themselves to changed conditions. Then the domestic dogs, cats, etc., help on the work of slaughter in certain ways, by preying upon wild life.

That pre-historic man was partially responsible for the extinction of certain animals, scientists are agreed; but they are also assured that except in the cases of the horse, the camel, and perhaps the domestic dog, the extinction was due more to their inability to adapt themselves readily to the changes of climate of that remote time, than to human agency. The wild progenitors of the horse and camel have not been known in historic times. That aboriginal man in Europe aided the elemental forces in their work of destruction, by hunting to death the mastodon, and the great cave-haunting lions, bears and hyenas, and other huge creatures of his time, is most probable; but in America this is not at all likely to have been the case.

Since the earliest records were made, however, various species have been eliminated from the European fauna; many from that of the other continents as well. In the days when the Romans fought the Dacians, various members of the cat family were common along the Rhine-Danube frontier, among them, lions, tigers, leopards, and wild-cats. They found also the great herds of wild cattle, which have entirely vanished. The ibex, too, is gone, and, but for the protective legislation, the chamois and the deer would have been exterminated, as well. The bear, the beaver, the wolf, and the wild boar, have all gone, within the last 10 centuries, from Britain, the wild-boar, which was hunted by royal cavalcades, disappearing at the close of the 17th century.

Records concerning Asiatic animals show few cases of extinction except those of a few cases of a species of sea-cow native to the Commander Islands, off the Kamchatkan coast. This animal, the rhytina, was pursued for its flesh, chiefly, and, so far as is known, the last survivor was killed in 1768. Among the same islands lived the now extinct Pallas's cormorant, a great bird also exterminated because of its edible quality.

Animals which are restricted in habitat to small islands seem liable to suffer from the inroads of man, more surely and swiftly, because they have no adequate means of escape, many such examples being furnished of birds whose power of flight is limited. Such species, especially in the Australasian and South Sea islands, have been in almost all cases, destroyed; notably several representatives of the moa tribe in New Zealand, the dodo, the solitaire, and certain parrots, rails, and fowls. The disappearance of the gigantic edible tortoises from the islands of the Indian Ocean and from the Galapagos, presents another striking instance of the extermination of animals owing to man's depredations.

Both Africa and America have presented fields for indiscriminate slaughter. In the former continent, where once there roamed great herds of antelopes, countless buffaloes and elephants, the slaughter has been so great since the middle of the 19th century as to make many of these denizens of plain and forest extremely rare, if not altogether extinct. The search for hides was perhaps the strongest destructive force; but the European hunters for "big game," and their followers, have done much in the same direction. The mountain zebra, the quagga, and various species of antelopes are examples of this; while the giraffe, to escape entire extinction, has retired to almost inaccessible regions in the Kalahari Desert and northward.

As for America, with her long list of lost species, most people are more or less acquainted with the efforts that have been made (and sometimes with signal success), within the past few years, to save, by protective legislation, such of her native birds as are still found; and to prevent the wholesale slaughter of her wild denizens of field and forest. The best-known example of extinction is furnished by the bison (q.v.), which roamed in vast herds over the grass lands, until it was destroyed by hide-gatherers; so that now there are no wild bison except one small herd, carefully protected by law, dwelling beyond the North Saskatchewan River. The American sea-elephant and the monk-seal are also practically gone; and the long lists of birds, from the great auk and the "passenger pigeon" to the California condor, give evidence how much this continent has been depleted as to its wild life. Many fishes, too, have decreased or wholly disappeared; and there is no doubt that, but for timely protection, many species, now small, would soon follow these vanished representatives of the earlier fauna, and swell the already lamentably long list of extinct animals. See SPECIES, EXTINCTION OF. L. H. HELLER,
Dewitt Clinton High School, New York City.

Extinction of Species. See SPECIES.

Extra-uterine Gestation. See PREGNANCY.

Extract, a term to denote all that can be dissolved out of a substance by a specified menstruum, such as water, alcohol, ether, etc. In modern pharmacy the term is applied to two kinds of preparation from vegetables. One is obtained by digesting the plant in water or other solvent, and evaporating or distilling away the excess of solvent till the extracted matter is sufficiently inspissated. The other is obtained by bruising the plant in a mortar, separating the juice, warming it till the green coloring matter separates, and filtering it off. The juice is next heated till the albumen coagulates, and again filtered. The juice is now evaporated to a syrup, the green coloring matter added and well mixed, and the evaporation is thereafter continued till the required concentration is attained. Extracts must be capable of being redissolved, so as to form a solution like that from which they were derived. Extracts are used in cookery, medicine, and the manufacture of perfumery.

Extract of Meat is a soft, yellowish-brown, solid or very thick syrup, which is employed as a portable soup. It is now manufactured on the large scale by processes proposed by Liebig. Finely chopped flesh is exhausted with water, the extract is heated, when, at 133° F., albumen coagulates; afterward the blood coloring matter also separates, and when these are removed and the clear liquid is evaporated at a low temperature, the extract is ready. This substance has a characteristic odor of roast meat, has a strong taste, dissolves in water, and forms a not unpalatable soup. It contains no fibrin, gelatine, albumen, or fat, but creatine, inosic acid, and other organic bodies are present, and it is especially rich in potassic salts and in phosphoric acid. It has the invaluable property of not spoiling by keeping; and it has been strongly recommended for its nutritious qualities; but its price limits the sale, and there is, besides, a dislike to food from other sources than perfectly fresh and new meat. It is very useful, however, for travelers, for troops, and for all persons who have to carry supplies of food about with them, or to prepare it rapidly.

Extradi'tion is the surrender of a criminal who has escaped from a territory under one government and taken refuge in a territory under another government. Extradition has two specific meanings in the United States. In the first place it refers to the surrender by one State government of a criminal who seeks asylum from another State of the Union in which he is held to be guilty of a heinous crime. (See EXTRADITION, INTERSTATE.) In the second place, it refers to the surrender of a criminal by one nation to another. The demand for extradition made by one nation of another is a matter of international law, and implies merely the control to be exercised by one nation over the right of affording asylum claimed by another. The Jay Treaty of 19 Nov. 1794 with Great Britain specified for powers of extradition during a period of 12 years. After its expiration in 1807 no provisions for international extradition were renewed until 1842 when the Ashburton treaty of 9 August of that year with Great Britain was concluded, in which extraditable offenses were enumerated. France on 9 November was the next country to enter into a treaty of extradition with the United States, since when treaties have been arranged with some 24 foreign governments providing for the mutual extradition of criminals, fugitives from justice, charged with heinous crimes, among which are enumerated robbery, burglary, arson, rape, embezzlement and the making and circulation of counterfeit money. In order to justify a claim for extradition, it is necessary to establish that the supreme political authority in the country where the crime has been committed has made a demand for the criminal's surrender; that an inquiry has been made into the facts of the case by a judge or United States commissioner, under direction of the President, in cases where the demand comes to the United States government from abroad; that a complaint be made on oath before the judge or commissioner; that a warrant be issued by the judge or commissioner for the apprehension of the party charged; that the charge be supported by suitable evidence; that a certificate be sent to the President of the United States signed by the commissioner, and stating that the charges are sufficiently well grounded to warrant a surrender; that such certificate so satisfy the President that he grant the writ of surrender.

The British extradition act of 1870 makes special provision that no criminal shall be surrendered for a political offense, and that the criminal shall not be tried for any but the crime of which he was demanded. In 1890 an extradition treaty was ratified between Great Britain and the United States extending somewhat the list of extraditable offenses in the direction of the commercial crimes of fraud and embezzlement. Consult: Moore's 'Treatise on Extradition and Interstate Rendition' (1891).

Extradition, Interstate. The New England Confederation of 1643 provided for mutual extradition of criminals between the different provinces; the Articles of Confederation did likewise; and the Constitution provides for it between the States, which are independent countries in all save the functions they have resigned to the general government. But the wording of the provision, though as definite as it can safely be made, leaves room for the widest difference in construction, and the evasion of the mandate in a large share of the cases that arise. It is: "A person charged in any State with treason, felony, *or other crime*, who shall flee from justice, and be found in another State, shall, on demand of the executive authority of the State from which he fled, be delivered up, to be removed to the State having jurisdiction of the crime." But must the offense be a crime by the law of the State requisitioned as well as of the State demanding? The judicial decisions say decidedly no — that "the obligation to surrender the fugitive . . . is the same as if the alleged act was a crime by the laws of both." On the other hand, the State executives, for obvious reasons, have stubbornly refused to tie their hands from exercising discretion, and have again and again acted on the theory that the offense must be a crime by the law of their own State. Thus, in the Dorr Rebellion (q.v.), Gov. Cleveland of Connecticut refused to extradite Dorr — though Dorr was actually using Connecticut soil to organize an attack on Rhode Island — on the ground that the latter's treason laws were not valid outside itself; and Gov. Seward of New York refused to surrender persons charged with stealing slaves (though his predecessors had done so), on the ground that it was not a crime by New York law, by common law, or the common consent of civilized nations. Even the principles of decision are not agreed upon. In some States the courts hold that the courts of the State making the demand are entitled to decide as to the sufficiency of the cause; in others their own courts make their own law without regard to that of the other States. Still another question is, whether the governor has any discretion in the matter, supposing his State law to demand extradition. The answer is somewhat startling; it is, that the governor legally has no discretion, that he is imperatively bound to issue the warrant, but if he does refuse, there is no power to compel him and no punishment for the refusal. The Constitution, in other words, has issued an imperative mandate with no provision for its enforcement. Indeed, it is difficult to see how there could be any; the only remedy being a State impeachment of its executive for malfeasance, which is out of the question in such cases. The forms of interstate extradition are provided in the act of 1793. The accused must be indicted in the State where the offense is committed; if the magistrate before whom the charge is brought is satisfied of its truth, he issues a warrant for the arrest of the criminal, and a copy is forwarded to the executive of the State, who makes requisition for the fugitive's surrender on the executive of the State to which he has fled. If the latter is satisfied of the legality of the process and the sufficiency of the evidence of guilt, he is to issue a warrant for surrender; but habeas corpus proceedings may always be interposed. The expense of the proceedings and transportation is borne by the State making the demand.

Extraordinary Ray. See LIGHT.

Extravagan'tes, two collections of decretals and constitutions of popes which were made up subsequent to 1317. Before the *Extravagantes* the Canon Law comprised the *Decretum* of Gratian (1234), the *Liber Sextus* (1298), and the *Clementinæ* (1317). No further collections were made by papal command, nor were any further collections officially promulgated; nevertheless, two collections were made by jurists, the *Extravagantes* of John XXII., and the *Extravagantes Communes;* and these, though lacking official promulgation, came in time to be recognized as part of the Canon Law. The *Extravagantes* of John XXII. consist of constitutions of that Pope only; the *E. Communes* comprise decretals of several popes between 1298 and 1484. The *Extravagantes* are so called because they wander out beyond (*extravagantur*) the limits of previous collections.

Extravaganza, ěks-trăv-ạ-găn'zạ, in music and the drama, a species of composition designed to produce effect by its wild irregularity and incoherence; differing from a burlesque in being an original composition and not a mere travesty. See DRAMA; STAGE.

Extravasa'tion, in contusions and other accidents, occurs when blood vessels are ruptured by the injury, and the blood finds its way into the neighboring tissues. A good illustration may be found in an ordinary bruise, when the part becomes blue in consequence of the vessels having been ruptured, and blood having escaped into the tissues. Extravasation in the cranium is a most serious accident, as the pressure on the brain which is the result often produces death very rapidly. The term is, however, applied to the escape of any fluid into the tissues from the vessels or cavity containing it.

Extreme Unction, a sacrament of the Roman Catholic Church for the bodily and spiritual comfort of the sick whose death is deemed to be imminent. The words of the apostle St. James in his epistle, ch. v., "Is any among you sick," etc., relate to this sacrament. The unction therefore is administered to the sick, and to those only who are in danger of death from sickness or from injury or accident; hence, it is not administered to persons under sentence of death, nor to those about to undergo a dangerous surgical operation, or the like; neither is it administered to children who have not reached the age of reason; for the principal end of this sacrament is, not restoration of bodily health, but forgiveness of sins. "If he has committed sins they shall be forgiven him." In the passage from St. James are found all the essential conditions of a sacrament, namely, the "outward sign," to wit: the anointing and the prayer of faith; and the "inward grace," typified by the outward sign, namely, forgiveness of sins. The divine institution of this sacrament is implied in the words of the gospel of St. James where it recommends its use and declares its efficacy for the remission of sins. Nevertheless extreme unction is not administered save after the person has made confession of his sins and received absolution in the sacrament of penance. In administering extreme unction the priest, with olive oil that has been blessed by the bishop, anoints the organs of the sense, pronouncing at each anointing the words, "By this holy unction and by his most tender mercy may the Lord forgive thee whatsoever sin thou hast commited by sight" (*per visum*), or "by hearing" (*per auditum*), etc.

Exuma, ĕks-oo'mä, **Great** and **Little,** two of the Bahama Islands. The Great Exuma is 30 miles long and 3 miles wide, and has a good harbor. Little Exuma has also a good harbor. The two islands together with Exuma Keys have an area of about 110 square miles. Pop. 2,374.

Eyas, ī'as, in falconry (q.v.), a hawk reared from the nest.

Eyck, īk, **Hubert van,** Flemish painter: b. Maaseyck, near Liège, Belgium, 1366; d. Ghent 18 Sept. 1426. It has been claimed that he and his brother Jan were the inventors of oil painting. For transparent and brilliant coloring and minute finish their works have never been surpassed. Their masterpieces are for the most part in Ghent, Bruges, Antwerp, Berlin, Munich, and Paris. The only painting that can now certainly be assigned to Hubert is the altarpiece with folding doors, 'The Adoration of the Lamb,' begun by him and finished by Jan, and afterward presented to the Cathedral of St. Bavon, Ghent, where only the two central divisions now remain, the wings being in the Gallery at Berlin, with the exception of those representing Adam and Eve, which are in the Brussels Museum.

Eyck, Jan van (also called **Jan van Brugge,** or **John of Bruges**), Flemish painter: b. Maaseyck about 1381; d. Bruges 9 July 1440. Hubert (q.v.) gave him his first instruction in the principles of the art, and his talents were so rapidly and vigorously developed that he soon surpassed his brother. The two resided at Bruges, then much frequented by the noble and the wealthy on account of its flourishing commerce. About 1420, or soon after, they went to Ghent for a considerable time, to execute together a work which Jodocus Vydt, a Flemish noble, had engaged them to do. This is the celebrated 'Adoration of the Lamb' for the cathedral of Ghent; a painting which contains above 300 figures, and is a masterpiece. It is painted on wood, with side panels which contain the portraits of the two artists and of their sister Margaret (q.v.), likewise a painter.

The reputation of this celebrated painter became very notable, even during his lifetime, by his great share in the introduction of oil painting; the original invention of which has been incorrectly ascribed to him by many. It was a general custom, before his time, to have for the background of the picture a flat gold ground, from which the figure stood out without perspective, as may still be seen in numberless works of earlier date. Van Eyck followed this practice in his earlier efforts, but, as he made further advances in his art, conceived the idea toward which there had been hitherto only some distant advances of giving a more natural grouping and perspective to his figures by a natural background. In this he succeeded so eminently, as many of his still remaining works prove, that he may be called in this respect the father of modern painting, since he gave the art a new turn and impulse, and laid the foundation of that high degree of improvement which it afterward attained in the brightest era of the great masters who succeeded him in the Netherlands and in Italy. In the art of painting on glass he is considered as the author of the mode of painting with colors delicately blended and yet so firmly fixed that obliteration was impossible — an object before attained only by joining together (in mosaic) several small panes of different colors. The school of which he was, in some measure, the founder, does not yield in celebrity to the best contemporary or succeeding artists, although it must be allowed to be often defective in the representation of the extremities of the human body — a fault occasioned by that excessive delicacy which prevented the study of naked forms, and of anatomy in general. On the other hand, the face, dresses, grouping, distribution of light and shade, are always superior, and the color brilliant and splendid, in the works of this painter and most of his scholars. Many of his paintings are still preserved, either in churches and museums, or in private collections.

Eyck, Margaret van, Flemish painter, sister of Hubert and Jan van Eyck: d. about 1430. A 'Virgin and Child,' in the National Gallery, London, was formerly assigned to her, but in the catalogue of 1889 is attributed to an unknown painter of the Early Flemish school; and she is believed to have executed the miniatures in the missal of the Duke of Bedford.

Eye, August von, ow'goost fōn ī'ĕ, German historian and critic: b. Fürstenau, Hannöverschen, 24 May 1825. His 'The Kingdom of the Beautiful' (1878); 'The Life and Work of Albert Dürer' (1860), together with his studies in art developments and tendencies, have been widely read.

Eye, the peripheral organ of vision by which light and images from the outer world are received and from which these images are transmitted to the visual centres in the brain or its equivalent by means of nerve fibres.

Anatomy and Physiology of the Human Eye. — The human eye is situated within a quadrilateral pyramidal cavity, surrounded by bony walls, called the *orbit.* The bony walls separate the orbit from the neighboring cavities, namely, the intracranial, the frontal, the nasal, and the Highmorean antrum. The anterior open-

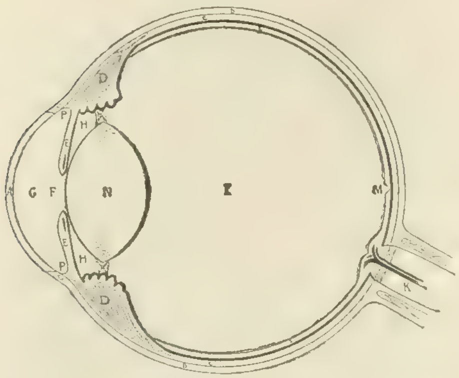

FIG. 1.

ing of the orbit forms the base of the pyramidal cavity; the apex lies in the depth and is penetrated by a number of openings for the passage of blood vessels and nerves. The bony rim of the anterior opening of the orbit is called the orbital margin. It is made up of very hard bone-tissue. Its upper, outer, and lower parts are more or less sharp and overhang the interior of the orbit slightly. The nasal part is rounded off toward the nose.

The walls of the orbit are formed by the union of seven bones of the skull and face. The upper wall consists of the frontal and sphenoid bones; behind its margin temporally it has a depression for the orbital lacrimal gland, near its nasal end there is a depression for the supraorbital artery and nerve and for the pulley through which the superior oblique muscle goes to the eyeball. The outer wall consists of the zygomatic and sphenoid bones. The lower wall, which is higher on its nasal than on its temporal side, consists of the supramaxillary, zygomatic, and palatine bones. The inner wall consists of the ethnoid, lacrimal, and sphenoid bones. All of the walls have openings and grooves for the passage of blood vessels and nerves. Where the supramaxillary and the lacrimal bones join together they form a bony canal for the lacrimal nasal duct.

At the apex of the orbit lies a round or oval funnel-shaped opening, the optic canal or foramen, through which the optic nerve comes from the brain; it runs slightly inward and upward. With this nerve, and underneath it, the ophthalmic artery enters the orbit. At the junctions of the outer wall with the upper and lower ones two fissures are formed, the upper one the sphenoid and the lower one the sphenomaxillary fissure. The ophthalmic nerve and vein, and the motor-nerves for the eye pass through the former.

The nasal walls of the two orbits run nearly parallel with each other, while the temporal walls converge toward each other. Therefore, the axes of the two orbits diverge towards their bases. The conformation and situation of the orbits and of their walls differ within certain limits very much in different individuals. They are sometimes so misshaped as to displace their contents and to interfere materially with comfortable binocular vision.

The periosteum of the orbital walls, which comes from the dura mater of the brain, besides covering the bones, furnishes numerous trabeculæ which hold the contents of the orbit in place, a sheath for the optic nerve, a serous capsule in which the posterior four fifths of the eyeball are encased and rotate (Tenon's capsule), and an anterior fascia-like diaphragm pierced by the anterior fifth of the eyeball. The posterior part of the orbit, besides blood vessels, nerves, and muscles, contains the orbital fat, which forms an elastic cushion on which the eyeball rests. Fig. 2.

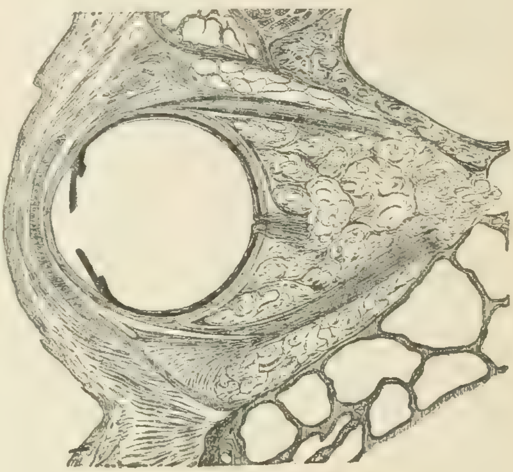

FIG. 2.

The eyeball itself consists of three membranes and several additional organs. The outer membrane, by which the shape of the eyeball is retained, has two parts of the cornea (horny membrane) (A, Fig. 1) and the sclerotic (hard membrane) (B, Fig. 1). The shape of the eyeball is nearly that of a sphere with the segment of a smaller sphere superadded anteriorly. The former (sclerotic) makes up about four fifths, the latter (cornea) one fifth of the eyeball. The former appears white, is very tough but elastic and translucent. The latter is, also, very tough and elastic, but perfectly transparent with a refractive index like that of water. The sclerotic consists of very dense connective tissue, similar to tendon-tissue, the fibres of which are interwoven in an irregular manner and form bundles. In a general way these bundles run in a meridional direction, but equatorial ones are always to be found anteriorly at the junction between cornea and sclerotic, and posteriorly where the optic nerve enters the eyeball. These fibres and bundles are held together by a cementing substance in which lie lymphatic canals and stationary cells. The sclerotic has but few and small blood vessels and nerves of its own, but gives passage to all the blood vessels and nerves which enter the interior of the eyeball or come from it. The former are the ciliary nerves, the optic nerve, and the ciliary arteries, the latter are the vorticous veins of which from four to six carry the blood away from the interior of the eyeball at or near its equator. Where the optic nerve enters the eyeball there is not one large opening for its admittance in the sclerotic, but the optic nerve fibre bundles pierce the sclerotic tissue separately. Thus this part of the sclerotic has a sieve-like appearance (*lamina cribrosa*). The tendons of the muscles of the eyeball are inserted into the sclerotic after having pierced Tenon's capsule.

The cornea is joined to the sclerotic anteriorly very much like a watch-crystal to its rim, that is the translucent tissue of the sclerotic slightly overlaps the transparent corneal tissue on the outer surface. The tissue of the cornea proper is a modified, perfectly transparent, dense connective tissue which consists of finest fibres united together by a cementing substance into bundles and these again into layers (*lamellæ*) which run more or less parallel with its surface. The layers are thicker in the posterior part and grow thinner toward the surface and finally form one perfectly compact layer, Bowman's or Reichert's membrane, on the outer surface. This may be looked upon as the basal membrane on which rests the outermost coating of several layers of epithelial cells. The inmost layer of these is single and is formed of cylindrical cells, then follow flatter and flatter cells outwardly, the outermost layer being true pavement epithelium, the cells of which never undergo a horny metamorphosis like those of the epidermis. The posterior surface of the corneal tissue proper is lined with a thin elastic vitreous membrane, Descemet's membrane, on which rests posteriorly a single layer of endothelial cells. In the cementing substance of the cornea lie very numerous lymph canals, von Recklinghausen's canals, which contain the fixed corneal cells (corneal corpuscles) in lacunæ-like enlargements. The cornea proper has no blood vessels; a ring of vascular loops enters its periphery only to the distance of one millimetre. Where cornea and sclerotic are joined the fibres and lymph canals of the one membrane pass over into those of the other. Here, also, a larger ring — like venous plexus, Leber's venous plexus or Schlemen's canal, is embedded, by which fluids from the anterior chamber are carried off. A large number of ciliary nerves enter the cornea at its periphery, are at first distributed in the corneal tissue proper, then having been divided into branches and just under Bowman's membrane into terminal fibres, they pierce this membrane and are lost in the epithelial cells.

Inside the sclerotic and loosely connected with it except at two points (the nerve entrance and the tendon of the ciliary muscle) lies the uveal tract, the vascular membrane of the eye. This membrane is divided into three distinct parts with distinct functions. The posterior one is the *chorioid* (C, Fig. 1); forward from it lies the *ciliary body* (D, Fig. 1); and in front of this the *iris* (E, Fig. 1). The chorioid begins around the entrance of the optic nerve and reaches forward beyond the equator of the eye. Inwardly it is lined by a very thin elastic membrane, the *lamina vitrea;* outwardly fibres of its tissue mingle with those of the sclerotic, leaving lymph spaces between them, *lamina suprachorioidea* and *fusca*. The tissue proper of the chorioid is made up of very loose connective tissue in which are embedded innumerable stellate pigmented cells and endothelial cells. The pigment in the stellate cells varies from almost no tint in the albino to jet black in the negro. In the loose connective tissue lie, furthermore, the innumerable blood vessels of the chorioid. The arteries coming from the short posteriociliary arteries and the veins, forming together the vorticous veins, lie in the outer two, the capillary blood vessels in the inner third of the membrane (Fig. 3). In the suprachorioideal tissue the long posterior ciliary arteries and the ciliary nerves run forward to the ciliary body. The function of the chorioid is the nutrition of the interior of the eyeball, especially of the outer layers of the retina, and the absorption of light.

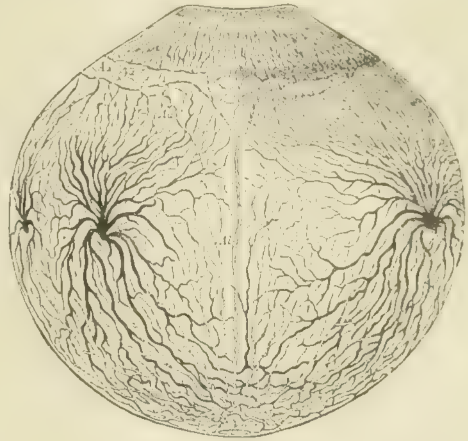

FIG. 3.

On the inside of the *lamina vitrea* lies a single layer of mostly hexagonal epithelial cells filled with pigment, the *pigment epithelium,* which though genetically belonging to the retina, must be looked upon as a gland-like organ interposed between retina and chorioid. Its cells send pigmented offshoots in between the outer parts of the rods and cones of the retina and by their secretion give the rods a slightly purplish tint, the retinal purple. This purple is continually bleached by the action of light and regenerated in the dark. Thus photochemic changes are produced, the exact value of which for the function of vision is as yet unknown.

Somewhat in front of the equator the chorioid becomes thicker, at first slowly and then more abruptly, and wrinkled, and thus the second part of the uveal tract in the ciliary body is formed (*pars non-plicata* and *plicata*). The thickening of the tissues is due to the addition of muscular tissue on the outside of the chorioideal tissue proper. This is the ciliary muscle or muscle of accommodation. Its anterior tendon is inserted into the corneo-scleral tissue inward of Leber's plexus, its posterior tendinous fibres are lost in the fibrous tissue of the chorioid. We recognize in this muscle two sets of fibres, one running meridionally on the outside, the other lying inward and forward running in an equatorial direction. The two act, however, together. In nearsighted eyes the former is more developed, in farsighted eyes the latter. The inner surface of the ciliary body which is represented by the chorioideal tissue shows about 70 meridional folds, the ciliary processes, on which microscopically a great many smaller wrinkles can be recognized and by which means the surface is immensely increased. These are covered by the continuation of the pigment epithelium and a layer of cylindrical unpigmented cells, the continuation of the retina, the retinal part of the ciliary body. The function of the ciliary body is twofold. Its muscular tissue governs the accommodation of the eye; the wrinkled inner surface is an immense secreting surface for the production of the aqueous and probably also, the anterior part of the vitreous body.

At the apex of the ciliary body and just inward from the tendon of the ciliary muscle, the third part of the uveal tract begins, the *iris*. This membrane lies in a plane almost at right angles with the one of the ciliary body. It has a round central opening, the pupil, which is the hole through which light reaches the interior of the eye and which is smaller when much light falls into the eye and larger under the reverse conditions. The tissue of the iris resembles that of the chorioid. It consists of a very loose, sponge-like connective tissue, richly supplied with stellate pigmented cells, and containing innumerable blood vessels. These come from the larger arterial circle at the periphery of the iris formed by the anastomosis of the branches of the long posterior and anterior ciliary arteries. They form a capillary network near the pupillary edge of the iris, the small iris circle. Both the anterior and the posterior surfaces of the iris show later in life circular folds and wrinkles, especially near the periphery, which result from the play of the pupil. Moreover, the anterior surface is studded with smaller and larger openings leading into small pouches, crypts of the iris. Posteriorly the iris is covered by the continuations of the two cell layers which cover the inner surface of the ciliary body. On the iris both of them are deeply pigmented so that without bleaching it is impossible to recognize the single cells. This pigmented layer reaches inward to the pupillary edge. The anterior surface of the iris is covered by endothelial cells. At its periphery the iris tissue receives fibres which come from Descemet's membrane and the innermost layers of the cornea, and which together form a network lying inside of the tendon of the ciliary body. This network of fibres which are partly covered by endothelial cells is called the pectinate ligament; the openings in it are called Fontana's spaces. Through this tissue the fluids passing out of the eye are filtered. The angle formed by the iris and corneo-scleral tissue is, therefore, usually termed the filtration angle of the eye. Around the pupillary opening and lying near the posterior surface of the iris a ring muscle is situated by the contraction of which the pupil is made smaller. A layer of spindle cells in front of the pigmented layer seems to represent an antagonistic pupil-dilating muscle. The function of the iris is that of a movable screen with a central opening, the size of which by reflex action regulates the amount of light which is to fall into the eye, the pupil contracting in strong and dilating in weak light. The pupil also contracts during the acts of accommodation and convergence.

Inward from the chorioid and closely applied to it lies the nervous membrane which receives the images, the expansion of the optic nerve, the *retina* (L, Fig. 1). This membrane consists of the optic nerve fibres to which are added nerve cells and neuro-epithelial cells, the whole held together by connective tissue, Mueller's fibres. The optic nerve (K, Fig. 1) having entered the orbit through the *foramen opticum*, and on its way to the eyeball, has three sheaths, the *dura mater* and *arachnoid* together forming the outer and the *pia mater* an inner sheath which closely invests the whole nerve and sends numerous trabeculæ into it which hold its fibre bundles together and in place. Between the sheaths lies the intervaginal space, a lymph-space communicating with the intracranial cavity and with the lymph-spaces in the eyeball. The dura mater and arachnoid together join the sclerotic where the nerve enters through this membrane, the pia mater ends where the nerve passes through the chorioid, unless we can look upon Mueller's fibres as its continuation. The double contoured nerve fibres coming from the chiasma lose their Schwann's sheath just before the nerve reaches the eyeball. Having reached the inner surface of the chorioid the fibres turn abruptly so as to cover the interior. This manner of distribution causes the nerve fibres at first to form a roundish elevation with a central depression, the optic papilla. This part consisting of conducting fibres only, does not perceive images and is known as Mariotte's blind spot.

The optic nerve fibres form the inner layer of the retina. The retina proper getting thinner and thinner reaches forward to the ciliary body where it ends with a serrated edge, *ora serrata*. It has a very complicated structure and including the pigment epithelium, has 10 distinct layers. The other nine are the rods and cones, the outer limiting membrane, the outer granular layer, the outer molecular layer, the inner granular layer, the inner molecular layer, the ganglion cell layer, the nerve fibre layer and the inner limiting membrane. The impressions received in the rod and cone layer are carried from neuron to neuron and finally back to the brain centres. The point of most acute perception lies opposite the center of the cornea, about 15° outward from and a little above the optic papilla. It is called the yellow spot (*macula lutea*) and has a central depression, the *fovea centralis*. Here the retina gets thinner on both surfaces till it consists but of a few nerve cells and conducting fibres, the rods have disappeared and the outer layer is formed of cones alone. The cones must, therefore, be considered as the organs of greatest importance in the act of distinct vision. From the neighborhood of the macula lutea to the ora serrata the proportion between rods and cones increases continually in favor of the rods. The retina is supplied with blood vessels in its inner layers only. They come from the central retinal artery and supply the retina only.

Close behind the iris lies the crystalline lens (N, Fig. 1), a lentil-shaped transparent body enclosed in a transparent capsule, the anterior half of which is thicker than the posterior one. The anterior capsule is lined with a single layer of cuboid epithelial cells which a little behind the equator of the lens grow longer and longer and form the lens fibres, long prismatic bands, of which the bulk of the lens tissue consists. These bands are arranged concentrically, new ones being added from the surface to the older ones which form a dense nucleus in the centre of the lens. With advancing age this nucleus grows larger, harder and less and less elastic. The lens is held in position by a ring of glassy tough fibres, the zonule of Zinn (O, Fig. 1) or suspensory ligament, which being firmly attached to the ciliary body and its processes, insert themselves on the anterior and posterior capsules near the equator. The origin of these fibres is still doubtful. The function of the lens is to focus images on the retina.

Behind the lens and supporting it in a cup-shaped depression, *fossa patellaris,* lies the *vitreous body* (I, Fig. 1). It fills the large posterior cavity of the eyeball. It is a perfectly transparent gelatine-like substance in which fine fibrillæ and a few wandering cells are found.

The space bounded by the inner surface of the cornea, *ligamentum pectinatum*, anterior surface of iris and anterior lens capsule, as far as it lies in the pupil, is called the *anterior chamber* (G, Fig. 1). The prismatic ring bounded by the posterior surface of the iris, the anterior part of the ciliary body, the zonule of Zinn and the peripheral part of the anterior lens capsule, is called the *posterior chamber* (H, Fig. 1). These two chambers are filled with a watery fluid, the *aqueous humor.*

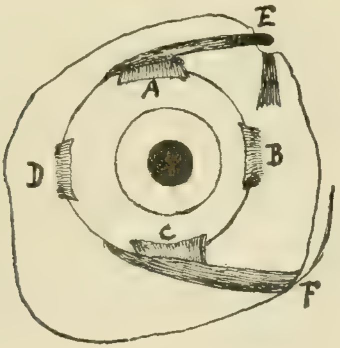

Fig. 4.

The eyeball within certain limits, can be moved in all directions around a centre of rotation by means of six *muscles* (Fig. 4). Five of these come from the apex of the orbit (Fig.

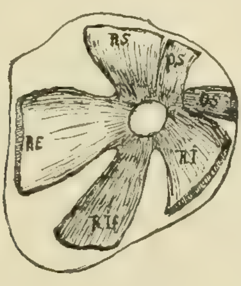

Fig. 5.

5). Four of these five, the recti muscles, run almost straight forward to their insertion on the sclerotic, namely, the superior, inferior, inner (nasal) and outer (temporal) rectus muscle. The fifth one, the trochlearis or superior oblique muscle, runs forward to the upper orbital margin, there passes over a pulley and returns to the eyeball from above in an oblique direction. The sixth muscle, the inferior oblique, springs from the lacrimal bone and running backward inserts itself on the eyeball in an oblique direction from below. The recti muscles turn the eye, the oblique ones roll it. By the single or combined action of these muscles the eye can be turned in all directions.

The *eyelids* are formed by two duplicatures of the skin, an upper and a lower one. The inner skin lying close to the eyeball assumes the character of a mucous membrane, the palpebral conjunctiva. It is folded over on the anterior third of the eyeball which it covers to the corneal periphery, bulbar or ocular conjunctiva. The fold of reversion, fornix or cul-de-sac, is very loose, so that the motions of the eyeball are not interfered with. When the lids are closed, the parts of the conjunctiva form with the cornea a closed sac, the conjunctival sac.

At the free margin of the lids, skin and conjunctiva merge into each other. This free margin has two edges, an inner sharp one and an outer rounded one; between them lies the intermarginal space, in which lie the eyelashes and the orifices of numerous glands. The stiffness of the lids is due to the very dense tarsal tissue plates which, semilunar in shape, form the inner layers of the lids, to which the palpebral conjunctiva is closely adherent. In this tissue and near its posterior surface lie the Meibomian glands which secrete a fatty substance the presence of which prevents the tears from running over the edges of the lids. In front of these the eyelashes, *cilia,* spring forth, short, strong, curved hair which interlock when the lids are closed. They live only about 100 days, and then fall out to be replaced by new ones. The lashes have the usual sebaceous glands and between them lie the so-called modified sweat glands of Moll. Between the outer skin and the tarsal tissue the fibres of the orbicularis muscle are embedded which when contracting closes the lids. The upper lid is rolled backward on the eyewall in the act of opening by means of its levator muscle which coming from the apex of the orbit is inserted on the upper edge and anterior surface of the tarsal tissue. From the orbital edge of each tarsal plate a non-striated muscular layer goes backward into the orbital tissue, Mueller's muscle. The opening between the lids is called the palpebral fissure. Where they join each other the lids form an outer, sharp angle, outer canthus, and an inner rounded angle, the inner canthus.

The eye, as far as it is exposed to the air, is kept moist and lubricated by the tear-fluid. The glands secreting it and the means of carrying the surplus away together are called the *lacrimal apparatus.* The tears are secreted by a number of acinous glands. The largest one lies in the orbit in the lacrimal fossa of the upper orbital wall. Right underneath it in the upper eyelid itself and down beneath the canthus in the lower lid smaller glands are situated, and still smaller ones are found all along the upper edge of the tarsal tissue of the upper lid, clear over to the inner canthus. All of these glands empty their secretion into the conjunctival sac by means of ducts. The fluid flows over the anterior surface of the eyeball and towards the inner canthus where the drainage apparatus is situated. Behind the inner canthus of the lids lies a round, dermoid body supplied with sebaceous glands and hair, the lacrimal caruncle, and in front of it a semilunar fold of conjunctiva, the remnant of the third lid in animals. When the stream of tears reaches the fatty caruncle it is held back and thus more easily sucked up. This is done by means of two capillary lacrimal canaliculi, which have their orifices (*lacrimal puncta*) in little papillæ at the edge of each lid near the caruncle. The sucking up of the tears is materially aided by a special muscle, Horner's muscle. The canaliculus in the upper lid runs in a slight curve downward toward the nose, the one in the lower lid upward. They meet behind the junction of the lids, the internal palpebral ligament, and empty their contents either singly or together into a larger receptacle, the lacrimal sac, from which in turn the tear-fluid is drained by the nasal lacrimal duct which opens on the lower floor of the nose.

The blood supply of the eye comes from a branch of the internal carotid artery, the ophthalmic artery, which gives off branches to the optic nerve sheaths, the orbital fat, the muscles of the eyeball, the lacrimal gland, besides the supraorbital, posterior, ethmoidal, and naso-frontal branches. From the muscular branches of the four recti muscles the anterior ciliary arteries pass through the sclerotic to the ciliary body and iris. Fom the ophthalmic artery directly or from one of its larger branches spring about 6 arteries which in turn split into about 20 branches and enter the sclerotic and the chorioid directly in a ring around the optic nerve entrance, called the short posterior ciliary arteries. Usually two of these branches run very obliquely forward through the sclerotic before reaching the uveal tract, the long posterior ciliary arteries.

The central retinal artery, which supplies the retina alone, comes from the ophthalmic artery, or one of its larger branches, enters the optic nerve near its entrance into the eyeball and then lies in its central canal together with the central retina vein.

The venous blood coming from the eye and orbit is collected into a superior and an inferior ophthalmic vein, both of which carry it to the cavernous sinus; a small portion is carried off by the temporal and facial veins.

The *nerves* of the eye, aside from the optic nerve, are motor, sensitive and sympathetic nerves and enter the orbit through the sphenoid fissure. The trochlearis nerve goes to the superior oblique muscle, the abduceus nerve to the external rectus muscle. The oculo-motor nerve, soon after its entry into the orbit, forms two branches. The upper one of these goes to the superior rectus muscle and to the levator of the upper lid. The lower one splits into three smaller branches for the internal and inferior rectus and for the inferior oblique muscle. This last branch forms the short root of the ciliary ganglion. The ophthalmic nerve (the sensitive nerve) a branch of the trigeminus gives off the supraorbital, naso-ciliary and lacrimal nerves. The naso-ciliary nerve forms the long root of the ciliary ganglion. Thus this ganglion from which originate the short ciliary nerves which go to the eyeball, contains motor, sensory and sympathetic fibres, the latter from the carotid plexus. The short ciliary nerves reach the sclerotic in a ring around the optic nerve entrance. The long ciliary nerves come from the naso-ciliary nerve (Fig. 6).

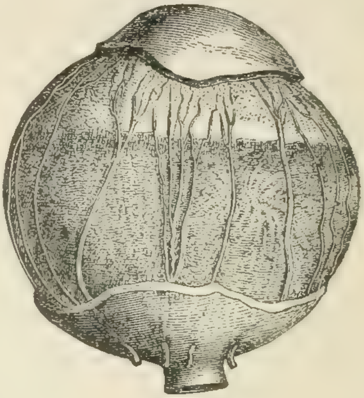

Fig. 6.

The optic nerve proper comes from the optic chiasma, the anterior commissure of the brain. The centres of vision are at present thought to lie in the occipital lobe of the brain in the cuneus and the region of the angular gyrus. From here fibres eradiate forward in the internal capsule to the pulvinar of the optic thalamus and are joined by fibres from the *corpora geniculata* and *quadrigemina*. These fibres together form the optic tract of each half of the brain. In the chiasma the two tracts join and partially cross each other, the smaller portion remaining uncrossed and going to the eye of the same side, the larger portion going to the eye of the opposite side.

Physiology.—As an optical instrument the eye has several refractive media. The main ones are the cornea and the crystalline lens. The curvature of the cornea, which is altered under special circumstances only, is not ideally spherical, but rather as if curved over a revolving ellipsoid. Therefore, most corneæ are asymmetrical in curvature, a condition which is called astigmatism. Rays of light impinging on the cornea are refracted so as to pass through the pupil; where they impinge on the crystalline lens by which they are farther refracted in such a manner as to come to a focus on the retina, on which an inverted image results. In order to change the focus of the lens so as to give clear images as well of distant objects, as of near ones, the eye is provided with the apparatus of accommodation. That is, it is enabled through the contraction of the ciliary muscle and the consequent increase in convexity of the lens to increase its refracting power and to shorten its focus or by relaxation to lengthen it. This faculty is gradually lost as age advances and at about 45 years of age accommodation for near objects can no longer be accomplished, *presbyopia.*

When an eye, perfectly at rest, focuses parallel rays on its retina it is called emmetropic. When in an eye, perfectly at rest, parallel rays are focused behind the retina, it is called hypermetropic or farsighted. When in an eye, perfectly at rest, parallel rays come to a focus in front of the retina, it is called a myopic or nearsighted eye. These differences depend chiefly on the axial length.

In astigmatism the asymmetry of the curvature of the cornea (or the lens) prevents rays of light from being focused in one point. As we can in this case usually recognize a principal meridian of lowest and one of highest curvature which generally lie at right angles to each other, we may find a number of combinations, as for instance the focus of the one principal meridian emmetropic and the other hypermetropic, or the one hypermetropic and the other myopic, etc. In consequence of astigmatism no clear images can be perceived by the retina of such an eye.

The whole area in which an eye, when steadily gazing at one point, can perceive objects, is called its field of vision. This has an irregular round outline and for white reaches upward and inward to between 60° and 70°, downward between 50° and 60°, and outward to 90° and more. The fields for colors are smaller in the following order: Blue, red, green. The binocular field is not as large as twice the monocular one, since the fields overlap at the nasal side to quite a considerable extent.

In binocular single vision the images must fall on the so-called identical spots in the two retinæ. When they do not, double vision, *diplopia*, results.

The perception of colors, a faculty which in man is congenitally wanting in about four pro mille (sometimes in one eye only), has been explained by a number of theories. That of Young-Helmholtz and the one of Hering assume special nerve cells for the perception of different colors. Oliver and others believe in the central location of color perception. Others believe in a combination of the two arrangements.

Comparative Anatomy.— The eye of man is a comparatively perfect visual organ and optic instrument. The farther we go down the scale of the animal kingdom the less perfect, the simpler does the eye become. In a general way we may distinguish between eyes which can differentiate between light and dark only, and eyes which perceive more or less perfect images of objects. The former are those of the lowest animals which have barely light perception and perhaps orientation. The latter are those of the higher classes, especially the vertebrata. The eyes of this group are so arranged that they can perceive a number of impressions at the same time and independently of each other, or in other words, images perceived by such eyes are composed of a large number of single impressions arranged like mosaic-work. The finer the parts of this mosaic, the more detail is perceived. This arrangement has reached its highest development in the eye of man.

In this second group we may recognize three forms of eyes. The *composite eye* (see article on COMPARATIVE ANATOMY), that of insects and crustaceans, is a hemispherical body composed of a varying number of single eyes of which from 20 to many thousands have been counted in different insects. Covered by a common transparent membrane, the cornea, these eyes form little prismatic boxes with from four to six angles, which lie close to each other arranged like radii. Their walls are usually pigmented, and thus virtually a vertical ray only can enter each of them. Sometimes the inner end of these boxes is convex, forming something like a lens, sometimes a lens-like transparent body lies in front, or the cornea is thickened so as to act like a lens. Others have a crystal cone going from each box to the nerve fibre connected with it. Such eyes cannot change their focal power. A higher form of eye is found in the nautilus. It forms a small camera obscura with a narrow pupil through which the light is admitted. This eye is supplied with a retina covering the wall opposite the pupil, with no arrangements of adjustment. The highest form of the eye, as found in the vertebrata, is a camera obscura, with a collective lens, capable of different degrees of focal adjustment. In the lower vertebrates this adjustment is made by bringing the retina nearer to the lens, in the higher ones the refraction of the lens is changed by an apparatus of accommodation. The former eyes are particularly adapted for seeing near objects.

There is a close relation between the eye and the mode of life and habitat of its possessor. Animals living in the water, or being most active at dusk, have a large flat cornea and a large pupil which admit much light. Some have, even, a reflecting apparatus behind the retina. The mode of locomotion has something to do with the position of the eye. Thus in the vertebrates, arthropods and cephalopods the eyes are situated at the head, while in the sea star, for instance, they lie at the tip of each of the five rays, in the worms on their gills, etc.

Man and the higher animals have two eyes. Most insects and some crustaceans have two composite eyes and a number of single supernumerary ones. Spiders have eight, some worms four or more supernumerary eyes. Some mollusks have up to several hundred eyes which lie along their mantle.

The eyes of the vertebrates, cephalopods and some snails have an external muscular apparatus. Those of the crabs lie at the end of a movable stem.

The shape of the eyeball is more or less spherical with a difference in the radius of curvature of the cornea and sclerotic. No eye seems to be perfectly spherical. That of aquatic birds is flatter than that of birds living in the air. The fishes have the flattest eyes.

The tissues of which the eye is composed show interesting differences in different species. The cornea is thickest in mammals; in the bat it is even much thicker than the sclerotic. In the terrestrial animals the radius of the corneal curvature is smaller than that of the sclerotic, in the animals living in the water the reverse obtains. In the mammalia the sclerotic consists of dense connective tissue, in the remaining vertebrata cartilage and even bone is added to this. In a large number of fishes we find on the outer surface of the chorioid a layer of iridescent crystals, the so-called argentea, which acts as a light reflector. In other fishes a cellular or fibrous membrane is found near the inner surface of the chorioid, called tapetum. The mammals, also, have a tapetum, hence their shining eyes.

The osseous fishes have a voluminous separate vascular tissue, improperly called chorioideal gland, interposed between the outer and inner layers of the chorioid. In birds a fan-shaped membrane, containing bloodvessels and being pigmented, springs from the optic papilla and its neighborhood and reaches into the vitreous body almost or altogether to the lens, the pecten or fan. It is less developed in nocturnal birds. A similar rudimentary appendage is found, also, in the eyes of some lizards.

The ciliary body and muscle, so well developed in man, is less and less developed the lower the animal. In the fishes its function seems to be reduced to the support of the lens and the nutrition of the anterior parts of the vitreous body. The lower the animal and the less accommodative function, the more spherical is the lens. The more developed the apparatus of accommodation, the more lentil-shaped is this organ.

The optic nerves in the lower animals seem to be as a rule totally crossed in the chiasma. The retina in a general way is very similarly constructed in all vertebrates. While man and the higher animals have one fovea centralis only, a great many birds have two foveæ centrales. One seems to serve for monocular and the other for binocular vision.

Diseases of the Eye.— The eye is subject to a great many diseases, which may originate in the eye itself or be symptoms and consequences of some systemic disease. The lids, conjunctiva and cornea being in an exposed position are very apt to become injured and diseased by direct infection from the outside. Infection from within and attacking the inner coats of the eye at first is, also, observed frequently. Certain toxins circulating in the blood produce characteristic diseases in the eye, like the neuro-retinitis of Bright's disease and the retinitis in diabetes. Certain diseases of the eye can be brought in connection with its refractive condition, thus glaucoma is more frequently seen in farsighted, detachment of the retina in nearsighted eyes. Many internal eye diseases may be traced to uncorrected errors of refraction. Thus, perhaps, this plays a decided role in the production of cataract. Errors of refraction and unequal visual acuity cause the parallelism of the eyes to be lost, farsightedness leading to convergent and nearsightedness to divergent squint. Some eye diseases are due to poisons ingested; the best known examples of this are, perhaps, the amblyopia from the abuse of nicotine and alcohol and the optic neuritis due to lead poisoning. Systemic diseases, like syphilis, rheumatism, gout, tuberculosis, are apt to cause diseases of the uveal tract, especially iritis and chorioiditis or of the retina and optic nerve. Brain diseases may lead to inflammation or atrophy of the optic nerve and to paresis or paralysis of the external and internal ocular muscles. Diseases of the vascular system are apt to produce hemorrhages in the eye or plugging of the central retinal artery and vein. Diseases of the nose are apt to produce stoppage of the drainage apparatus of the tears.

Injuries to the eyeballs are very frequent and may cause very serious results, especially iridochorioiditis with shrinkage of the eyeball, and such eyes are particularly prone to affect the fellow-eye by sympathetic inflammation, an almost incurable disease.

The most frequent eye diseases are those of the conjunctiva and lids, as stated above. The very situation of the conjunctiva and its being moist and warm renders it especially liable to infection from without and favorable to the propagation of germs. Thus blennorrhœa neonatorum, gonorrhœa, diphtheria, trachoma, let alone the milder forms of conjunctivitis, are due to such extraneous infection, as are also ulcers of the cornea.

Any dimness in the transparent media of the eye must of necessity interfere with vision, thus scars on the cornea, cataract, opacities in the vitreous body, etc., render the eye nearly or totally useless.

The eye is, furthermore, not infrequently the site of malignant tumors, as epithelioma, sarcoma and glioma of the retina.

Unlike other organs the eye is very often subject to important congenital malformations and anomalies.

Bibliography. — Graefe-Saemisch, 'Handbuch der gesammte Augenheilkunde'; Alt, 'Lectures on the Human Eye'; Alt, 'Original contributions concerning the glandular structures appertaining to the human eye and its appendages'; Norris and Oliver, 'System of diseases of the human eye.'

A. Alt, M. D.,

Eyebright, a common name for the plants of the genus *Euphrasia* (q.v.).

Ey'erman, John, American geologist: b. Easton, Pa., 15 Jan. 1867. He studied at Lafayette College, Harvard, and Princeton, 1889–95, and was instructor in blow-piping at Lafayette 1888–93, and lecturer on determinative mineralogy. He has been an associate editor of the 'American Geologist' since 1890, and is a member of many English and American scientific societies. He has published: 'Notes on Geology and Mineralogy' (1889); 'Mineralogy of Pennsylvania' (1891); 'Course in Determinative Mineralogy' (1892); 'Bibliography of North American Vertebrate Palæontology' (1889–93); 'The Genus Temnœyon' (1895); 'A Study of Genealogy' (1898); 'General Index to the Wills of Northampton County, 1752–1802' (1898); 'The Old Grave Yards of Northampton' (1899–1901).

Eylau, ī'low, or **Prussian Eylau,** Germany, town, on the Pasmar River and the lake of Arschen; 22 miles south of Königsberg. It was the scene of a battle fought 7–8 Feb. 1807, between the French under Napoleon (q.v.) on the one side and the allied Russians and Prussians on the other side. (See Ney.) The French force numbered about 70,000, of whom fully 18,000 were killed. The allied forces were about the same in number with a loss of more than 18,000. Pop. 3,546.

Eyma, Louis Xavier, loo-ē ksăv-ē-ā ī-mä, French writer: b. Saint Pierre, Martinique, West Indies, 16 Oct. 1816; d. Paris 29 March 1876. After a tour through the United States, he returned to France and published several works, of which the best known are: 'The Women of the New World' (1853); 'The Red Skins' (1854); 'The Black Skins' (1856); 'The American Republic' (1861); 'The Slave Hunt' (1866); and many novels.

Eyra, ī'rä, in Scandinavian mythology, the physician of gods. See Mythology.

Eyra, a species of cat (*Felis eyra*) native to the western hemisphere from Mexico to Paraguay. It is rufous or chestnut in color, entirely without the spots found on other cats, except the puma, of which it seems almost a miniature. It has white spots on the face, is about the size of the domestic cat, and has rounded ears. The pupil of the eye also is round. The body and head are slender, and the tail is unusually long and thick. The legs are shorter than those of the domestic cat. The eyra is easily tamed, but never seems, even in domestication, to relinquish its fondness for preying upon poultry. In the feral state it hunts small animals and birds for food.

Eyre, ār, **Edward John,** English explorer and colonial governor: b. Yorkshire 5 Aug. 1815; d. Tavistock, Devonshire, 21 Dec. 1901. He went to Australia in 1833; in 1839 discovered Lake Torrens, and in 1840 explored its eastern shores and the adjacent Flinders Range. He then commenced his perilous journey along the shores of the Great Australian Bight, and reached King George's Sound, in western Australia, a distance of 1,200 miles, with a single native boy, having left Adelaide more than a year before. In 1845 he published 'Discoveries in Central Australia.' After filling several governorships he was appointed governor of Jamaica in 1862. In 1865 he was confronted with a negro rebellion which he crushed with some severity, and was recalled. On his return to England John Stuart Mill and others took measures to have him tried for murder, but failed. In regard to this question Carlyle was one of his most strenuous defenders.

Eyre, Lake, a salt lake of South Australia, lying due north of Spencer Gulf, at an altitude of 79 feet, and with an area of 3,706 square miles. Except in the season of rains, this lake is generally a mere salt marsh, and has no apparent outlet. It was discovered in 1840 by Eyre.

Eyre-Todd, George, Scottish miscellaneous writer: b. Govan, Scotland, 2 June 1862. He was educated at Glasgow University. He has published: 'The Lady of Ranza' (1884); 'The Sage of Thebes' (1885); 'Ossian' in Canterbury Poets Series (1888); 'Sketch Book of the North' (1890); 'Byways of the Scottish Border' (1892); 'Scotland; Picturesque and Traditional' (1895); 'Vignettes of the North' (1895); 'Anne of Argyle' (1895); 'The Book of Glasgow Cathedral' (1898); 'Bohemian Papers' (1898); 'Byways of Scottish Story' (1900); 'Songs of Caledonia' (1900); 'The Glasgow Poets' (1902).

Eyria (ī'rĭ-a) **Peninsula,** on the south coast of South Australia, triangular in shape, its base being formed by the Gawler Range, while its sides are washed on the southeast by Spencer Gulf, and on the southwest by the Great Australian Bight. It constitutes a rich pastoral country.

Eyster, Nellie Blessing, American writer: b. Frederick, Md., 7 Dec. 1831. She was married to A. S. Eyster 1853. She has published: 'Sunny Hours' (1865); 'On the Wing' (1860); 'Robert Brent's Three Christmas Days'; 'Lionel Wintour's Diary' (1882); 'A Colonial Boy' (1895); 'The Bright Side of Chinese Life' (1901); 'Opportunity and I' (1901); etc.

Eyth, Eduard, ĕd'oo-ärd īt, German poet: b. Heilbronn, Würtemberg, 2 July 1809; d. New Ulm 28 April 1884. He was author of a volume of 'Poems' (1843); 'Pictures in Frames' (1856); and a version of the 'Odyssey.'

Eytinge, ĕt'tĭng, **Rose,** American actress: b. Philadelphia 21 Nov. 1838. She made her début as an amateur in Brooklyn, N. Y., 1852, and the following year played through the West in a stock company. She has created many parts, including Rose Michel, Amande Chandoce in 'Led Astray,' and Felicia in the play of that name, but has been especially successful in her playing of Shakespearean roles, notably Cleopatra, Lady Macbeth, and Hermione (in the 'Winter's Tale'). She has written: 'It Happened This Way,' a novel; 'Golden Chains,' a play; and has dramatized Browning's 'Colombe's Birthday,' and Dickens' 'Dombey and Son'; 'David Copperfield'; 'Oliver Twist'; 'Tale of Two Cities,' and other works.

Eze'kiel, one of the greater Hebrew prophets. To him is attributed one of the larger prophetic books of the Old Testament, the visions and utterances which it contains being expressly attributed, in the work itself, to Ezekiel. He was the son of Buzi, a priest, and was carried captive, in the time of Jehoiachin, 595 B.C., about 11 years before the destruction of Jerusalem under Zedekiah. His prophecies are mostly in chronological order, those excepted which are launched against foreign nations. There is no direct quotation from Ezekiel in the New Testament, but there are a few allusions to his utterances, especially in the Book of Revelations, which, in the concluding portion, distinctly looks back to the temple arrangements prophesied in the last chapter of Ezekiel. The genuineness and authenticity of the prophecies of Ezekiel have not been seriously impugned either in the Jewish or Christian Church, and nearly universal suffrage has been given in favor of their canonicity.

Ezekiel, Book of, a series of prophecies, intended to warn and encourage the Hebrews during their captivity at Babylon in the 7th century B.C. The central point of the prophet's message is the destruction of Jerusalem, and his object is to call the people to repentance, to warn them against trusting in the help of Egypt (Ezek. xvii. 15-17), as a deliverance from the Babylonian yoke, and to assure them that the downfall of their city and temple was inevitable. At the same time, a future restoration is promised, and messages of consolation are mingled with denunciation and menace.

The whole book may be divided into nine main sections, as follows:

1. Ezekiel's call to the prophetic office.

2. The fulfilment of the commission symbolically outlined. Particular predictions of Jerusalem's destruction form the ground work of this vivid symbolism (Ezek. iii. 16.-vii.).

3. In a series of visions is revealed to the prophet the rejection of the people, because of their idolatrous worship. In these tableaux the temple is seen polluted by the worship of Adonis. But the denunciation of idolatrous priests and people is followed by promises of prosperity under a purer worship (Ezek. viii-xi.).

4. The sins, errors and prejudices of his contemporaries are rebuked in detail by the prophet (Ezek. xii.-xix.).

5. The especial and particular nature of the judgment, and the guilt that caused it, are unfolded in a series of thrilling denunciations, delivered about a twelvemonth later. The prophet announces that the judgment of God is drawing very near (Ezek. xx.-xxiii.).

6. He explains the significance of the now no longer impending, but actually commencing judgment. Jerusalem is being besieged, and the day when the siege began is announced to the captives. The city's complete overthrow is predicted (Ezek. xxiv.).

7. God's judgment against seven heathen nations is threatened (Ammon, xxv. 1-17; Moab, 8-11; Edom, 12-14; the Philistines, 15-17; Tyre, xxvi.-xxviii., 19; Sidon, 20-24; Egypt, xxix.-xxxii.).

8. A prophetic representation of the triumph of Israel and of the Kingdom of God on earth (Ezek. xxxiii.-xxxix.).

9. A symbolic representation, in whose glowing imagery the Messianic reign, and the establishment of God's Kingdom in power and prosperity are revealed (Ezek. xl.-xlviii.). Consult: 'Encyclopedia Biblica' (1903); also Cornill, 'Der Prophet Ezechiel Geschildert.'

Ezekiel, Moses Jacob, American sculptor: b. Richmond, Va., 28 Oct. 1844. He was graduated at the Virginia Military Institute 1866, having served in the Confederate army during the last year of his course. He studied art in Richmond and Cincinnati 1866-70, and Berlin, Germany, 1870-4, where he was the first foreigner to win the Michael Beer prize (1873). While there he studied under Prof. Albert Wolf, and was admitted to the Berlin Society of Artists on the merits of his colossal bust of Washington, now in Cincinnati. Later he went to Rome, Italy, where he has chiefly resided save for frequent visits to America. He has exhibited in the chief American and European expositions. Large and small, including statues, portrait-busts, ideal groups, and relievos. His works number several hundred of which the best known are: 'Cain, or the Offering Rejected,' an early ideal bust that showed considerable dramatic talent; 'Schiller and Goethe,' Berlin (1870); 'Religious Liberty,' Fairmount Park, Philadelphia (1874-6); bas-relief portraits of Farragut (1872), and Robert E. Lee (1873); 12 marble statues of artists for the Corcoran Art Museum, Washington (1880-2); marble busts of Beethoven (1884), and of Cardinal Hohenlohe (1888); bronze statue of Columbus in the Columbian Memorial building, Chicago, Ill.; statue of Mrs. Andrew D. White for Cornell University; bust of Lord Sherbrooke for Westminster Abbey; the fountain of Neptune for the town of Neptune, Italy, etc. In June 1903 the sculptor presented a bronze monument, 'Virginia Mourning Her Dead,' to the Virginia Military Institute.

Ez'ra, Jewish scribe and priest. Under his guidance the second expedition of the Jews set out from Babylon to Palestine under the reign of Artaxerxes I., about 458 B.C. The important services rendered by Ezra to his countrymen on that occasion, and also in arranging, and in some measure, it is believed, settling the canon of Scripture, are specially acknowledged by the Jews, and he has even been regarded as the second founder of the nation. Josephus states that he died in Jerusalem, and was buried there with great pomp; others assert that he returned to Babylon, and died there at the age of 120 years.

Ezra, The Book of, an Old Testament book, arranged in the English Bible between 2 Chronicles and Nehemiah. In the Thirty Nine Articles it is styled 'The First Book of Esdras.' The name Ezra, though commonly held to denote that he was the author of the book, however signifies no more than that the doings of Ezra are the main theme of the book, which is certainly the case. The period which the book spans is about 80 years, namely, from the first of Cyrus, 536 B.C., to the eighth of Artaxerxes Longimanus, 456 B.C.; the reigns embraced are those of Cyrus, Cambyses, Smerdis, Darius Hystaspis, Xerxes, and part of that of Artaxerxes. Both Jews and Christians consider the work part of the Scripture canon. It is written partly in Hebrew and partly in Chaldee, a fact which has led some to conclude that it is the work of different hands.

Ezra Church (Atlanta), **Battle of.** On 20 July 1864 the Confederate army under Gen. Hood was defeated at Peach Tree Creek, and driven into the inner defenses of Atlanta. On the 22d Hood attacked the Army of the Tennessee, and was again defeated, and Gen. Sherman began the investment of Atlanta. He began to force Hood from Atlanta by moving upon his communciations leading south from the city. The Army of the Tennessee was transferred from the extreme left of the investing line to the right, near Ezra Church, and Hood took measures to check its further extension and drive it back. On the night of the 27th he marched out of Atlanta with the greater part of his force, and on the 28th Gen. J. C. Brown's division was ordered to attack Logan's corps, then advancing on the right, and drive it back to and beyond Ezra Church. Brown drove in Logan's skirmishers, followed them 500 to 600 yards, and struck Logan's right, carried it at some points, but was quickly repulsed with great slaughter. He made a second attempt with no success and fell back. He had lost 694 killed and wounded and 113 missing. During Brown's attack four regiments from Dodge's and Blair's corps extended Logan's right, and took part in the action. Clayton's division attacked on Brown's right, but not until after Brown's first repulse, and by a misunderstanding his three brigades made isolated attacks upon Harrow's division, all of which were repulsed with great loss, some of the regiments losing 50 per cent. Walthall had led out his division while Brown and Clayton were engaged, and at 2 P.M., after they had been withdrawn, he was ordered to attack over the ground of Brown's fight. Walthall made several persistent efforts, but failed, although some parts of his force got within 50 yards of Logan's line. After more than an hour's severe fighting, in which he reports the loss of 152 officers and nearly 1,000 men, he fell back. At night Hood withdrew his troops to the works around Atlanta. The Federals in this battle numbered about 13,000 men; the Confederates about 18,000. The Union loss was 559 killed and wounded, 73 missing. The aggregate Confederate losses were apparently about 2,636 killed and wounded, and 200 missing. The estimates of Gens. Sherman, Howard, and Logan that the Confederate loss was from 5,000 to 7,000 are excessive. Consult: 'Official Records,' Vol. XXXVIII.; Cox, 'Atlanta'; Sherman, 'Personal Memoirs,' Vol. II.; The Century Company's 'Battles and Leaders of the Civil War,' Vol. IV.

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F

F the sixth letter of the English and Latin alphabets and all alphabets derived from the Latin. The character F, though it does not appear in the Greek alphabet of the classic period, had a place in the earlier Greek alphabet, and is believed to have there represented the sound of *v* or of *w*. It is called by Greek grammarians, digamma or double-gamma, being formed of two gammas (g hard, Γ) written one above the other (F). From the Greek it came into Latin and, finally, was used to express the sound which it has for us. That the sound of F in Latin was the same as in English, we know from what Quintilian says of the mode of uttering it. The Greek letter Φ (phi) represented in Latin and English by *ph*, appears to have been very different in sound from the F of the Latins; and that in the pronunciation of F Greeks found great difficulty is known on the authority of Cicero; their difficulty was like that which people of other speech than ours find in pronouncing th in then, this, and in thin, think. A like difficulty in pronunciation of the F of Latin must have presented itself to the inhabitants of the Spanish peninsula, if not in the time of Roman domination, then after; else the initial F of words from the Latin would not have been so generally changed by them into a mere breathing, represented by the letter h. Examples: Lat. *faba* (bean), Span. *haba; fabulari* (to talk), *hablar; facere* (to make), *hacer.* In other languages, whether derived from one another or springing independently from a common original stem, as German, Anglo-Saxon, Greek, Latin, Celtic, etc., we see a different interchange as between F and P: thus to the English word fish answers the Latin *pisc* (*piscis*); to Eng. fire the Gr. *pyr*; to Eng. plow the Ger. *pflug.* In the local dialect of the English county of Somerset, F usually becomes V: fair becomes vair, friar vrier, five vive. As the Latin alphabet had but one character, V, to represent both the vowel U and the consonant V (or W) the Emperor Claudius ordered that in public inscriptions and state documents this consonant V should be represented by the F inverted, Ⅎ, and hence in monuments of that reign we find AMPLIAℲIT, TERMINAℲIT, OCTAℲIA, etc., for Ampliavit, Terminavit, Octavia, etc.

F. F. V.'s (First Family of Virginias), a jocular term applied in the North, before and during the war, to the Southern aristocracy in general.

Fa, fä, the name given by Guido to the fourth note of the natural diatonic scale of C, that is, the subdominant. In the major scale of C this tone is F.

Fabbri, fäb'rē, **Cora Randall,** American poet: b. New York 1871; d. there 1892. She was of Italian descent. A volume of her 'Lyrics' appeared but a few days before her death.

Fabens, Joseph Warren, American miscellaneous writer: b. Salem, Mass., 1821; d. 1875. Among his works are: 'The Camel Hunt,' a narrative of personal adventure; 'Facts about Santo Domingo'; and 'The Last Cigar,' a book of poems.

Faber, Frederick William, D.D., English theologian and hymn writer: b. Calverley, Yorkshire, 28 June 1814; d. Brompton, London, 26 Sept. 1863. He was a nephew of G. S. Faber (q.v.). He was educated at Balliol College, Oxford, where he came under the influence of John Henry Newman (q.v.), whom in 1845 he followed into the Roman Catholic Church. On becoming a Roman Catholic he founded a small community called Brothers of the Will of God, who three years later joined the oratory of St. Philip Neri. He afterward established a branch of this oratory at Brompton, with which he was connected till his death. His prose writings are numerous, but it is by his beautiful hymns that he is best known. Of these: 'Pilgrims of the Night,' and 'The Land Beyond the Sea,' are the most noted. See 'Life and Letters,' edited by Bowden (1869).

Faber, George Stanley, English theologian: b. Calverley, near Bradford, Yorkshire, 25 Oct. 1773; d. near Durham 27 Jan. 1854. Having been Bampton lecturer in 1801, he shortly after published his lectures under the title of 'Horæ Mosaicæ.' From the first he adopted evangelical views, and soon began to aid them by his pen, particularly by 'The Doctrine of Regeneration in the Case of Infant Baptism.' He was vicar successively of Stockton-upon-Tees, Redmanshall, and Longnewton, holding the last appointment 21 years, when he resigned it to become master of Sherburn Hospital. His principal writings, in addition to those already mentioned, are: 'A Dissertation on the Prophecies,' the most popular of all his works, having in 1818, only four years from its first appearance, reached a fifth edition; and the 'Difficulties of Romanism,' of which a third edition appeared in 1853.

Faber, Johann Lothar, German manufacturer: b. Stein, near Nuremberg, 12 June 1817; d. 1896. In 1760 he founded in his native town a manufactory of lead pencils, with only 20 hands employed. He made so many improvements in the manufacture that his factory gradually became the centre of that particular industry, and absorbed the trade of Germany and Austria. Particularly successful and profitable was the making of pencils of different grades, while his business capacity in distributing his goods did much to promote their popularity. He opened branches in great cities of Europe and the United States. In his factory at Noisy-le-Sec near Paris are employed more than a thousand operatives, and the Faber pencils are considered the best in the market.

Fabian, fā'bi-an, belonging or relating to the famous Roman family, or clan, the Fabian, used especially in the military phrase Fabian tactics, to denote tactics the chief point of which is to weary and exhaust the enemy. By such measures Quintus Fabius Maximus greatly harassed Hannibal in the Second Punic war.

Fabian Society, an English socialistic organization, having its headquarters in London, and with affiliated branches in most of the principal cities and towns of Great Britain and Ireland. The society includes in its ranks some very prominent writers on social economy, including Sidney Webb, and publishes 'Fabian Essays,' and 'Fabian Tracts.' In 1888 they began to hold public meetings. Above 700 lectures have been given in one year by members of the society. The Fabians aim to bring about the "emancipation of land and industrial capital from individual and class ownership and the vesting of them in the community for the general benefit"; "the extinction of rent"; and "the transfer to the community of the administration of such industrial capital as can be conveniently managed socially." They also advocate female suffrage. There is a society of the same name in the United States, which issues a periodical called the 'American Fabian.'

Fabié, François Joseph, frän-swä zhō-zef fä-byā, French poet: b. Durenque, France, 3 Nov. 1846. He filled important chairs in different colleges, attaining distinction as the author of 'The Poetry of the Foolish Ones' (1879); 'The Belfry'; etc., and by 'Roupeyrac's Mill,' a rustic drama, and other plays.

Fabii, fā'bi-ī, **Arch of the,** a commemorative arch in ancient Rome at the entrance of the Sacred Way (Via Sacra) to the Forum Romanum. It was constructed about 120 B.C. by Quintus Fabius Maximus Allobrogicus in celebration of his victories over the Allobroges and Arverni. Its material was the calcareous Italian rock called travertin, and its design simple. Some few of the travertin blocks were excavated in 1882 not far from the site of the arch.

Fabius, fā'bi-us, the name of one of the oldest and most famous families of Rome, every member of which was massacred at Cremera 478 B.C., except QUINTUS FABIUS VIBULANUS, who became one of the decemvirate. Among the most noted of the family in later times are: FABIUS AMBUSTUS, dictator, 350 B.C.; FABIUS RULLIANUS, to whose name MAXIMUS was added, twice dictator, conqueror of the Samnites and Etruscans, 323–280 B.C.; FABIUS GURGES, son of the preceding, consul of Rome; FABIUS PICTOR, the first writer of Roman history, 3d century B.C.; FABIUS MAXIMUS VERRUCOSUS, considered the greatest of his family, surnamed "Cunctator," "the Delayer" (see FABIAN), from his system of warfare. Died 203 B.C.; FABIUS MAXIMUS QUINTUS, son and next in office to the preceding, afterward consul; FABIUS MAXIMUS ÆMILIANUS, distinguished in the war of Persia and in Spain, consul 147 B.C.; FABIUS MAXIMUS SERVILIANUS, pro-consul for Spain, censor 126 B.C.; FABIUS MAXIMUS ALLOBROGICUS, consul 122 B.C.

Fable (Lat. *fabula*, a narrative, especially a fictitious one), in literature, a term applied originally to every imaginative tale, but confined in modern use to short stories, either in prose or verse, which are meant to inculcate a moral lesson in a pleasant garb. Imaginary persons, animals, and inanimate objects are introduced as the actors and speakers. The fables consist properly of two parts — the symbolical representation, and the application, or the instruction intended to be deduced from it, which latter is called the moral of the tale, and is indispensable to it.

Herder divides fables into (1) Theoretic, intended to form the understanding; thus a phenomenon of nature, as illustrative of the laws of the universe, is used to exercise the understanding. (2) Moral, which contain rules for the regulation of the will. We do not learn morality from the brutes, but view the great family of nature, and observe that she has connected the happiness of all living creatures with the unchangeable, eternal law of effort, and take example from the observance of this law by the lower orders of creation. (3) Fables of fate or destiny. It cannot always be made evident how one thing follows as a necessary consequence from another; here then comes in play that connection of events which we call fate, or chance, and which shows that things follow, at least after, if not from one another, by an order from above. Thus the eagle carries with her plunder a coal from the altar, which sets fire to her nest, and thus her unfledged brood becomes the prey of animals which she has already robbed of their young.

The oldest fables are supposed to be the Oriental; among these the Indian fables of Pilpay or Bidpai, and the fables of the Arabian Lokman, are celebrated. Æsop is well known among the Greeks, and was imitated by Phædrus among the Latin writers. Bodmer has published German fables of the time of the Minnesingers. The first known German fabulist is Stricker, who belongs to the first half of the 13th century, but the famous mediæval beast-epic of 'Reinecke Fuchs' (see REYNARD THE FOX) has a much more remote origin. Boner, who lived at the close of the 14th century, shows in his 'Edelstein' the true spirit of fable. Burkard Waldis may be mentioned in the 16th century. The most successful of German fable writers is undoubtedly Lessing. In the 17th century Gay among the English, and La Fontaine among the French, were distinguished. The writer last named made fable the vehicle of wit, and carried it to its highest stage of perfection. Among the most interesting modern productions in this department of literature the fables of the Russian, Ivan Kriloff, deserve special mention. See ALLEGORY; MYTH; PROVERB.

Fabliaux, fä-bli-ō (Fr. from the Lat. *fabula*, a narrative, particularly a fictitious narrative), in French literature, the short metrical tales of the Trouvères (q.v.), belonging for the most part in the 12th and 13th centuries. These productions were intended merely for recitation, not for singing, had as their principal subjects the current gossip and news of the day, and were epigrammatic and ironical in style.

Fabre, Amant Joseph, ä-mäṅ zhō-zef fäbr, a French author: b. Rodez, France, 10 Dec. 1842 (or 1843). A drama, 'Joan of Arc' (1890), made his name most widely known; his other works being largely represented by such books as: 'A Course in Philosophy' (1870); 'Washington, the Liberator of America' (1882).

Fabre, Ferdinand, fār-dē-näṅ, French novelist: b. Bédarieux, France, 1830; d. Paris 11 Feb. 1898. He published: 'Ivy Leaves,' poems (1853); then the novels: 'The Courbezons' (1861); 'Julien Savignac' (1863); 'My Uncle Célestin' (1881); 'King Ramiro' (1884); and 'Mr. John' (1886). The remarkable novel, 'Abbé Tigrane' (1873), first won him great distinction; 'Lucifer' (1884); portraying the struggle among the clergy between Gallicanism and Ultramontanism, is doubtless his greatest work. Among his shorter stories are: 'The Abbé Riotelet' (1891); 'Norine' (1890); 'Germany' (1891), etc. 'Ma Vocation' (1889) is a volume of leaves from his student diary.

Fabre, François Xavier Pascal, fräṅ-swä zäv-yā päs-cäl, French painter: b. Montpellier 1 April 1766; d. there 16 March 1837. He was a pupil of David, and produced in 1787 a painting representing the 'Execution of the Children of Zedekiah by order of Nebuchadnezzar,' for which he received the great prize of the academy, and was sent as a pensionary to Rome. He was believed to have been secretly married to the countess of Albany, who on her death in 1824 made him her sole heir, and bequeathed to him valuable MSS. which had been left to her by Alfieri. Fabre gave them to the city of Florence.

Fabre, Jean Raymond Auguste, zhŏṅ rā-mōṅ ōgüst, French poet, brother of Ferdinand Fabre (q.v.): b. Jaujac, France, 24 June 1792; d. Paris 23 Oct. 1839. He was prominent in journalism and wrote: 'Caledonia, or the Patriotic War' (1823); 'Histoire du Siège de Missolonghi' (1827); 'La révolution de 1830' (1833).

Fabre D'Eglantine, Philippe François Nazaire, fē-lēp fräṅ-swä nä-zār fäbr dā-glōṅ-tēn, French dramatic poet: b. Carcassonne 28 Dec. 1755; d. Paris 5 April 1794. Having gained the prize of the Eglantine in the Floreal games at Toulouse, he assumed the name of that flower as a surname. He now wrote several theatrical pieces, of which however only two, 'L'Intrigue épistolaire' and the 'Philinte de Molière,' were successful. The latter is still considered one of the best character-pieces of the modern French stage. He engaged with ardor in the Revolution, acting with Danton, Lacroix, and Camille Desmoulins. As deputy from Paris to the National Convention, he at first supported moderate principles, but afterward voted for the death of Louis XVI. without appeal, and was chosen a member of the committee of public safety. He afterward became suspected by the Jacobins, and being condemned to death was executed along with his colleague Danton (q.v.).

Fabretti, Raffaele, rä-fä-el'ā fä-bret'tē, Italian antiquarian: b. Urbino 1619; d. Rome 7 Jan. 1700. He was made papal treasurer by Alexander VII., and finally superintendent of the archives in the castle of San Angelo, which office he held till his death. Among his writings may be mentioned: 'De Aquæductibus veteris Romæ'; 'De Columna Trajani'; and 'Inscriptionum Antiquarum Explicatio,' in the last of which much light is thrown on the discoveries made by himself in the Catacombs.

Fabriano, Gentile da, jen-tē'lā dä fä-brē-ä'nō, Italian painter: b. Fabriano about 1370; d. Rome about 1450. His earliest work was perhaps the decoration of a chapel for Pandolfo Malatesta at Brescia. In 1423 he painted one of his best extant pictures, an 'Adoration of the Kings,' for the church of the Holy Trinity in Florence. To the same period belongs a Madonna with Saints (now in the Berlin Museum). A picture of the naval engagement between the fleet of Venice and that of the Emperor Barbarossa, which Fabriano painted for the Venetian senate, so pleased them that they conferred on him the dignity of a patrician and a pension of a ducat *per diem* for life. Fabriano next worked at Orvieto, but was called thence by Pope Martin V., who employed him in adorning the church of St. John Lateran with frescoes from the life of John the Baptist. Fabriano's pictures indicate a cheerful and joyous nature. He had a childlike love of splendor and rich ornamentation, but his coloring is never extravagant or meretricious.

Fabriano, Italy, city 20 miles northeast of Perugia. It is in the midst of mountain scenery, and in a fruit-growing region. This is the native place of the artist, Gentile da Fabriano (q.v.), a large number of whose paintings are preserved here in churches and in the city hall. Paper, parchment, gunpowder, glue, and felt-cloth are the chief manufactures. The paper and parchment factories were established in 1564. Pop. of the commune 21,000.

Fabricius, Hieronymus, hī-ĕr-ŏn'i-mus fā-brish'i-us (Ital. Fabrizio, Girolamo), Italian physician: b. Aquapendente 1537; d. Padua 23 May 1617. He studied at Padua under the celebrated Fallopius, whom he afterward succeeded in the anatomical chair, and had Harvey, the discoverer of the circulation of the blood, for a pupil. Harvey acknowledged that the discovery of the valves in the veins made by his master put him on the way of his discovery. During the lifetime of Fabricius his merit was fully recognized by the public and the state. His works were collected and published by Bohnius (1687).

Fabricius, Johann Albrecht, yō'hän äl'-breнt fä-brēt'se-ōs, German scholar: b. Leipsic 11 Nov. 1688; d. Hamburg 30 April 1736. He was versed in almost every department of human knowledge, particularly in philology and ancient literature, and understood the art of using these stores of erudition to the greatest advantage. He was professor of rhetoric and moral philosophy in the gymnasium at Hamburg. He published a 'Bibliotheca Græca' (1705–28); 'Bibliotheca Latina' (1697); 'Bibliotheca mediæ et infimæ Ætatis' (1734); 'Bibliotheca Ecclesiastica'; 'Bibliotheca Antiquaria' (1713).

Fabricius, Johann Christian, Danish entomologist: b. Tundern in the duchy of Schleswig 7 Jan. 1743; d. Kiel 3 March 1808. He pursued his studies at Leyden, Edinburgh, and Freiburg, in Saxony, and under Linnæus at Upsal. Few scholars of that great man profited more by his instructions. His works upon entomology show the principles, the method, and even the forms of expression, peculiar to Linnæus, applied to the development of a new, happy, and fruitful train of ideas. From his intercourse with him he derived his first notions of his system of arranging insects according to the organs of the mouth; and he endeavored to persuade Linnæus to make use of it in the new edition of his 'Systema Naturæ.' Fabricius obtained the professorship of natural history in the University of Kiel, and in 1775 appeared his 'System of Entomology,' which gave to this science an entirely new form. Two years afterward he developed in a second work the characters of the classes and orders, and demonstrated in the *prolegomena* the advantages of his method. In 1778 he published his 'Philosophia Entomologica,' written upon the plan of the well-known 'Philosophia Botanica.' From this time till his death he was constantly occupied in extending his system, and in publishing it, under various forms, in works of different titles. He was appointed counselor to the king of Denmark, and professor of political and rural economy.

Fabricius, Gaius Luscinus, kā'yus fā-brish'us lū-sī'nus, Roman general: d. after 275 B.C. He was twice consul, and gained several victories over the Samnites and Lucanians and was famed for his integrity and contempt of riches. This was shown on the occasion of his embassy to Pyrrhus in 280 B.C., when he firmly withstood all the attempts of Pyrrhus to allure him into his service. When consul, he discovered to Pyrrhus a plot formed to poison him by his physician; and in gratitude Pyrrhus released the Roman prisoners without ransom. Fabricius was afterward censor, and endeavored to check the growing passion for luxury. He lived a simple life and died poor.

Fabrics, Names of. The names given to most fabrics are derived from cities, towns, and persons. Damask is from Damascus; satins from Zay in China; calico from Calicut, India; muslin from Mosul; drugget is from Drogheda, Ireland; cambric from Cambral; taffeta from a street in Bagdad; gauze from Caza; dimity from Damietta; jeans from Jean; duck from Torque in Normandy; serge from Xerga, a Spanish name for a peculiar woolen blanket; velvet from the Italian *vellute;* chintz from the Indian *chott;* blanket is called after Thomas Blanket, a famous clothier who lived in England in 1340.

Fabroni, or **Fabbroni,** fä-brō'nē, **Giovanni Valentino Mathias,** Italian scientist: b. Florence 13 Feb. 1752; d. Pisa 17 Dec. 1822. He left behind him a considerable number of valuable memoirs and treatises on matters relating to chemistry, agriculture, physiology, etc., of which the best known are 'Provvedimenti Annonarj'; his 'Discourses on National Prosperity'; on 'The Equilibrium of Commerce, and the Establishment of Custom-houses'; on the 'Effects of the Free Traffic in Raw Material'; on 'Rewards for the Encouragement of Trade'; on the 'Chemical Action of Metals'; on the 'Value and Reciprocal Proportion of Coins'; on the 'Scales and Steelyards of the Chinese'; on the 'Palaces of Spain'; and on the 'Ancient Hebrew People.'

Façade, fa-sad' (Fr. "the front of a building"), the face or front of any building, particularly its principal face or faces; generally used of a building of magnitude or importance. A back elevation is termed a rear façade. See ARCHITECTURE.

Facciolati, or **Facciolato, Jacopo,** yä'kō-pō fä-chō-lä'tē or -tō, Italian philologist: b. Toregia, near Padua, 4 Jan. 1682; d. Padua 26 Aug. 1769. He devoted the greatest attention to reviving the study of ancient literature; and, accordingly, undertook a new edition of a dictionary in seven languages, which was called the 'Calepin,' from the name of its author, the monk Ambrosius Calepinus. His pupil, Forcellini, assisted him, and the work was completed between 1715 and 1719. He now, in company with his industrious disciple, conceived the idea of a Latin lexicon, in which every word, with all its significations, should be contained and illustrated by examples from the classical writers, after the manner of the dictionary of the Cruscan Academy. This immense undertaking occupied them both for nearly 40 years. Facciolati directed the work, which was almost entirely executed by Forcellini. He left many Latin discourses which are characterized by Ciceronian elegances of style, but differ from their model by a precise brevity.

Face. See SKULL.

Face Wheel, called also **Contrate Wheel** and **Crown Wheel,** a wheel which has cogs projecting from the periphery at right angles to the plane of motion; as, in watches, the wheel situated nearest the crown and driving the balance.

Facetiæ, fa-sē'shĭ-ē (Lat. "witticisms"), a collection of humorous sayings or tales, witticisms, and jests. Among the earliest such is that known as 'Asteia,' generally attributed to Hierocles. Latin collections were common in the later Middle Ages, the most notable being the 'Liber Facetiarum' (1470) of Poggio Bracciolini. See JEST-BOOK.

Fachan, or **Fatshan,** China, in the province of Kwang-Tung; on the Tu-Kiang, about 20 miles west by south of Canton. Its chief manufactures are iron and steel products, bamboo, and rattan articles, embroideries, and porcelain. Its trade is in manufactured articles and the agricultural products of the surrounding country. Pop. 500,000.

Fachingen-water (Ger. *Fachinger Wasser*), a mineral water, from a spring near Fachingen, a village of the governmental district of Wiesbaden, Prussia. It is reckoned among the strongest alkaline acidulous waters of Germany, being marked by a large content of carbonic acid and bicarbonate of soda. It is transparent, with a temperature of 10° C., and is used in cases of bronchial catarrh, catarrh of the stomach, gout, and other troubles.

Facial Angle, an anatomical term for the angle contained between two imaginary lines, one from the most prominent part of the forehead to the anterior extremity of the alveolar process of the upper jaw, opposite to the incisor teeth; the other from the external auditory foramen to the same point, serving to measure the elevation of the forehead. The angle is of great service in ethnology, but its magnitude is not an infallible criterion of the intellectual capacity of an individual. It is sometimes called Camper's angle, because the celebrated Dutch anatomist Camper was the first to draw attention to the importance of this method of skull measurement.

Facial Nerve. The seventh cranial nerve in the cerebro-spinal axis forms the chief motor nerve of the face. It originates in a group of ganglion cells lying in the floor of the fourth ventricle in the medulla. The fibres pass out through the temporal-bone lying by the side of the auditory nerve in the middle of the ear canal, and are finally distributed to the chief muscles of the face. Affections of this nerve cause partial or total loss of power of the muscles of the face. See Facial Paralysis.

Facial Nerve Paralysis, paralysis of the motor nerve which controls the muscles of the face. The paralysis may extend to one or both cheeks; but, in most cases, when the cause has been treated recovery follows.

Facial Neuralgia, a painful affection involving the chief sensory nerve of the face; the trigeminal or fifth nerve. This neuralgia may involve any of the branches and, because of their wide distribution over the shoulder, back of the neck, scalp, and face may be felt in a number of locations. Very frequently the pain is in the jaw and is due to diseased teeth, toothache being a form of neuralgia of this nerve.

The pain may radiate from over the orbit, constituting supra-orbital neuralgia, or it may be distributed over the back of the head, constituting occipital neuralgia. Occasionally neuralgia of the fifth nerve gives rise to typical attacks of sick-headache. A particular variety which is extremely severe, and is supposably due to disease of the sensory ganglia of the fifth nerve, is known as tic-douloureux. Characteristic features of neuralgias of the face are the sudden shooting, darting pains, usually one-sided, unaccompanied with other constitutional disturbances. The cause is most frequently exposure to cold. From riding on the tops of omnibuses, sitting by the open windows of railroad-cars, or by any open window with a draft blowing through, persons are very frequently affected. At times anæmia, gout, and infection from bad teeth occasion facial neuralgia.

Treatment will depend largely upon the exciting cause. Heat, gentle massage, simple diet, and free movements of the bowels are general measures to be carried out. Occasional surgical intervention is necessary to cure tic-douloureux. The medical treatment of neuralgias of the face is technical and involves the use of remedies that are dangerous in the hands of laymen.

Facial Paralysis, a partial or total loss of power in the muscles of the face. One side of the face alone is usually affected. Paralysis may result from any disease of or injury to the facial nerve, either inside of the skull proper, or in its external distribution. Paralysis of the face very frequently occurs in apoplexies. Here the disease results from a disturbance of the nerve in its intracranial portion. It also is occasioned by disease in the middle ear, but is most frequent following exposure to cold, during which the external branches are involved. This latter form is termed Bell's palsy (q.v.). The symptoms of facial paralysis may vary according to the number of branches of the nerve that may be involved. In a complete case the paralyzed side is flat and expressionless, the mouth is drawn toward the well side, making the well side look as though it were contorted and diseased. The patient is unable to whistle, and may not be able to talk very clearly. The tongue may be protruded toward the well side. There may be inability to close the eyelids. Sensation is not involved. When the patient eats he may not be able to move the tongue on the paralyzed side of the mouth, and he cannot fill out his cheeks on the flat side. The electrical reactions of the muscles at first may not be affected, but later what is known as the reaction of degeneration sets in. Most cases of facial paralysis due to peripheral trouble, as well as Bell's palsy, recover of themselves; others, due to hemiplegia or to inflammation of the middle ear or to fracture of the skull, recover less frequently.

Treatment is by means of tonics — iron, strychnine, arsenic, and electricity. In intractable cases surgical anastomosis with other motor nerves may prove of service.

Facial Spasm. See Tics.

Factor (Lat. "a maker"). (1) An agent or substitute, especially a steward or agent of an estate, appointed by a landowner to manage the estate, collect rents, let lands, etc.; also an agent employed by merchants to transact business for them in other places, as to buy and sell, to negotiate bills of exchange, etc. He differs from a broker in that he is entrusted with the possession and disposal of the goods, property, etc., and may buy and sell in his own name. See Agent. (2) In arithmetic any one of the integers the product of which is a given number. A prime factor is a factor which is also a prime number. (3) In algebra, any one of the quantities which, when multiplied, produce a given algebraic expression.

Factor of Safety. See Strength of Materials.

Factories and Factory Inspection. During the reign of Edward III., the making of woolen cloths became an industry, and some of the phases of the factory system began to appear. This industry was fostered by Edward, and at the suggestion of Queen Philippa he invited one John Kempe, a Flemish manufacturer of textiles, to come to England with his skilled workmen, and promised them protection and assistance. Accordingly by act of Parliament, the woolen manufacturers were first established in England, in the town of Kendal, manufacturing the cloth that was known as Kendal-green. Previous to the time of Edward III., English wool was largely in demand on the continent, and now, the better to protect this new industry, Edward forbade the export of wool under the penalty of death, and obliged his people to wear, as he himself wore, only the natural cloth. From this time on by legislation and protection, England took care of its woolen industries, until the time of Elizabeth, when free importation of wool was permitted, and some historians point to the fact that during her reign the manufacturers made most rapid progress; charity schools and poorhouses were established, which in after years were to form a strong factor in the factory system, and ultimately to improve factory conditions. About this time improvements had been made in the stocking loom, a great demand for yarns springing up, and new materials were sought. The cotton wool, a new material in weaving, which was to be the most important in the modern factory system, was given its impetus. The iron manufacture by the middle of the 18th century had almost come to a stand-still, owing to the destruction of the forest woods, which were used for coal. In 1756, making iron by the use of pit coal was successful, and the manufacture of iron again began to be one of the principal industries. By the middle of the 18th century the first factory, in the present sense of the word, was built by Lombe Brothers. It was a silk-mill, and the first in which the motive power was supplied from the outside, and machinery did the work heretofore supplied by human hands. The power used was a water wheel. This naturally set inventive minds to work with a view to supplying like mechanism to other grades, and many inventions sprang up, particularly for using the cotton wool. Arkwright came to the front with his water-frame, so-called, because water was the motive power. There began a rapid development in spinning machines, which were first applied to cotton, and in this industry we have the explanation how the earlier triumphs of the factory system were won. In the beginning of the 19th century, the modern factory system became established and the child-labor question arose. As the mills were first established by the streams, so that wheels might be moved by water power, it often happened that labor could not be had in the vicinity. Application was made to the almshouse for children who were indentured or bound out at a fixed rate, and for a certain length of time. Forced to work whether sick or well, often 16 hours a day, and given nothing for breakfast but water porridge, these children were visited with serious epidemics, and the attention of the public was thus aroused. In 1802 the first factory act for the "Preservation of the health and morals of apprentices in cotton mills" was introduced by Sir Edward Peel, one of the large manufacturers of that time. All mills employing 3 or more apprentices, or 20 other persons, were subject to this act. The most important clause was that which fixed 12 hours as a working day, and prohibited work altogether from 9 P.M. to 6 A.M.

In the earlier years of the factory in the United States, each home had its spindles and loom to fill the needs of its own members, the flax and cotton being grown, spun, and wove by the individual householder, or the slaves on the plantations. England frowned upon all manufactures in her colonies, and would allow no machinery or parts of machinery to be brought to this country, but could not fetter the brain, nor forbid the inventive genius, and Slatter and his associates, who coming to this country in the latter part of 1700, brought with them the knowledge which in 1803 built in Massachusetts the first cotton-mill in America. The first mill to take cotton in its crude state and pass it through the different processes to the woven cloth, was erected in Waltham, Mass., in 1813. The first type foundry was built in Philadelphia in 1794. The first glass-house was constructed in Pittsburg in 1796. Other factories followed in rapid succession between 1796 and 1810.

The first factory inspection law was adopted in England about the beginning of the 19th century, as a result of the agitation caused by epidemics among children and women in factories, but it was not until 1819 that the law was made effective. The abuses became so great that the government was at last compelled to interfere in the interests of humanity. This began by asserting the right of the state to control industrial establishments, where women and children were employed, but this necessarily involved the freedom of men in making contracts. The law was intended more particularly to meet the evils of the apprentice system, but it did not extend to factories, where children residing in the neighborhood were employed. From time to time this act has been amended, and the authority of government extended, so as to make it generally effective for the protection of all labor. It was thus in England that the value of factory inspection was first determined by experience. Subsequently it was introduced into this country. Massachusetts was the first American State to adopt a law of that character.

To-day there are factory laws in the United States based on the Massachusetts laws, for the examination and approval of plans of factories, apartment and tenement houses, also for proper fire-fighting, means of egress, and sanitary provisions; regulating the employment of labor of women and minors in manufacturing, mechanical and mercantile establishments and workshops; guarding of machinery; the construction of safety appliances of elevators; ventilation of factories and workshops; provision of water-closets for the use of each sex employed in factories and workshops, and various other sanitary regulations; uniform hours for meals for women and young persons; communication between the engineer's room and each room where machinery is run by steam; proper safeguards at hatchways, elevator openings and well-holes in public buildings, factories and mercantile establishments; competent watchmen and red lights in hotels; prohibiting during working hours the locking of any inside or outside door of any building where operatives are employed; weekly payment of wages; and sundry other matters; the granting of licenses to make, alter, repair, or finish coats, vests, trousers or wearing apparel of any description in a room or apartment in a tenement or dwelling house; the examination of engineers and firemen, and the inspection of boilers, granting of licenses, and steam power to be used. Women are protected by law from overwork by their employers and children are excluded from factories until of proper age, and Massachusetts has been from the first, and continues to be, in the advance in factory inspection, and under this system her industrial establishments have become models for all the other States. It is a marked illustration of what such a law accomplishes for a community.

International Association of Factory Inspection.— The International Association of Factory Inspection was organized at Philadelphia in 1886, and includes Canada, and the States of Massachusetts, New York, New Jersey, Pennsylvania, Rhode Island, Connecticut, Maine, Michigan, Ohio, Minnesota, Illinois, Wisconsin, Missouri, and Indiana. Each of these several States holds an annual convention of its inspectors, who meet to compare notes of their work for the year, and as their proceedings are made public, each State may know the advancement the other is making in its labor laws.

The inspection laws of Massachusetts are enforced by the inspection department, comprising 35 members, assigned to the duty of the examination and approval of plans for the construction of school, and other public buildings coming under the provisions of the law, relative to means of egress and to prevent the spread of fire; the proper heating and ventilating of school and other public buildings and examination of buildings reported to be unsafe to life or limb. Relative to the employment of children under the laws of the Commonwealth of Massachusetts, Inspector-in-Chief Rufus R. Wade says, in his last report: "During my service as chief of this department, I have seen the gradual rise and progress of legislation relative to the employment of child labor. The development of the labor question brought to the attention of successive legislatures, facts in relation to the employment of children, and whether from motives of humanity, or from other considerations, the legislatures have from 1874, when the so-called 10-hour law was enacted, down to the session of the present year, thrown the safeguard of law around the child-workers, and protected them from the evils and dangers to which they were exposed by the cupidity or thoughtlessness of others."

In 1876 an act was passed in Massachusetts prohibiting the employment of children under 10 years of age. In 1883 the limit was extended by providing that no child under 12 years of age should be employed during the hours in which the public schools were in session. Again in 1885 another change was made, which provided that no child under 12 years of age should be employed at any time during the day in which the public schools were in session. In 1888 these several statutes were repealed, and provisions were made that no child under 13 years of age should be employed at any time in any factory, workshop, or mercantile establishment, thereby raising the limit without any qualification to 13 years; the statute also providing that no such child should be employed except during the vacation of the public schools in the city or town where he resides, unless the person or corporation employing him, procured and kept on file a certificate and an employment ticket for such child as prescribed by law. Again in 1898 the limit was raised to 14 years, and providing that no child under 14 years of age can be employed at any time in a factory, workshop, or mercantile establishment, and no child under 16 years of age can be employed in a factory, workshop, or mercantile establishment unless the employer procures and keeps on file a certificate, and posts near the principal entrance a list of all such children employed. States that have adopted the factory inspection system have similar child labor laws, differing as to their age, to the age limit when they can be employed. In some kinds of manufacturing, especially in the textile- and cotton-mills, young children can be employed to advantage. The children enter the mills when very young and soon become experts in certain parts of the business, and by the time they become men and women are able to command very good wages. This custom is now practised to some extent by foreigners in mill districts, who make every attempt to get their children employed, not seeming to care as to age or education, and as soon as their children begin to earn good wages, the parents stop work and live upon what their children earn. The laws of the State of Massachusetts are very good in some respects as to child labor, but when a child lives in a town where there are no evening schools, and the child comes from a foreign country, and has attained the age of 14 years, the parents can procure a certificate for them, and they can be employed, not being able to read at sight and write legibly simple sentences in the English language. Evening schools are now maintained by law only in towns where there are 10,000 or more inhabitants. These children should be made to attend the public day school, but at the present time they cannot legally be compelled to attend school.

The Fifty-Eight-Hour Law.— In the State of Massachusetts children under 18 years and women cannot be legally employed more than 58 hours in a week in a factory, workshop, or mercantile establishment, and every employer must post in a conspicuous place the number of working hours each day of the week, the hours allowed for meals, the hours when starting and stopping work, and it becomes a part of the inspector's business to see that this is faithfully complied with. This has been the law of the State since 1894. Previous to that time, a week's work for children and women in factories and workshops was 60 hours a week, and still at an earlier time there was scarcely any limit to the hours of labor. From 1874 to 1894 10 hours a day, or 60 hours a week was the limit. In 1900 a law was enacted by the legislature prohibiting the employment of children under 18 and women over 58 hours per week in a mercantile establishment, and obliging the employer to post a notice stating the hours of work required of them for each day of the week, and the hours allowed for dinner or other meals. Before this date there was no limit to the hours required of a female after she was 18 years of age, and 60 hours a week was required of females under 18 years of age.

Employment of Illiterate Minors.— The definition of an illiterate minor in the Massachusetts laws is one who cannot read at sight and write simple sentences in the English language, no matter how well he can read or write in any foreign language. The law provides that every minor over 14 years of age, who resides in a city or town where there is an evening school maintained, and who cannot read at sight and write legibly simple sentences in the English language, must attend day or evening school, or he or she cannot be employed while the evening school is in session.

Pure Drinking Water to be Provided.— All manufacturing establishments in Massachusetts shall provide fresh and pure drinking water, to which their employees shall have access during working hours.

The Care and Custody of Elevators.— The carelessness of those who operate elevators, and who have the safety of human life in their care, seems to be the source of many accidents. In Massachusetts all elevators for the carrying of freight or passengers, running at a speed of more than 100 feet a minute, must be operated by competent persons not less than 18 years of age, and no other person shall operate, or have the care or charge of such elevator, and no elevator shall be operated by, or placed in charge of any person under 16 years of age, whatever less than 100 feet a minute may be its speed.

Sanitary Provisions in Factories and Workshops.— The laws of Massachusetts and other States that have factory inspection laws have the most rigid sanitary regulations, and are provided in the interest of comfort, decency, and health. These relate to factories, workshops, mercantile establishments, offices, school-houses, and public buildings. It is required that these buildings shall be kept free from all effluvia arising from drains and that they shall have a proper number of water-closets provided for persons of each sex. It is also provided that during working hours these buildings shall be ventilated, that the air may not become injurious to the health of the persons employed therein. It also provides that all dust from the grinding or polishing of metals be carried away through suction pipes.

The Inspection of Boilers and Engineers' Licenses.— The Massachusetts law as now enforced reads as follows: "It shall be unlawful for any person to have charge of, or to operate a steam-boiler or engine, except boilers and engines of locomotive motor-road vehicles, boilers in private residences, in apartment houses of less than five flats, boilers under the jurisdiction of the United States, boilers used for agricultural purposes exclusively, boilers of less than 8 horsepower, and boilers used for heating purposes, limiting the pressure to 15 pounds to the square inch, other than these boilers above excepted; the person in charge must hold a license granted after a thorough examination by the inspectors appointed for this duty, who are expert engineers."

The Sweatshop System.— With the introduction of the sweating system in the United States came a revolution in the clothing industry which has left in its wake destruction and poverty; for prior to the introduction of this system there was not, as a class, a better-paid people than those engaged in the ready-made clothing trade. Looking backward only a few years we have the recollection of a movement in sympathy with a people who were being driven from Russia and other European countries. The first duty upon arrival was to procure means to provide food and shelter for themselves and families, and, being without funds, the task became a very complicated one. The inducement to learn a good trade was freely offered them, provided they would work cheap enough to warrant a sufficient return for the knowledge bestowed upon them. The custom in vogue was that the apprentice should give from one to three months at very small pay, giving from 12 to 16 hours as a day's work. The profits to contractors employing this class of help was, of course, enormous. The immense amount of available labor, of this class, to a new method of employment which is called the task system, and to which the term "sweating" system was aptly applied. The sweating system, if conducted in workshops located in buildings devoted exclusively to manufacturing purposes, would never have obtained its present prominence in the public mind; but the competition between the employers of labor under this system resulted in a complete revision of conditions; cheaper shops were secured; large quantities of work per day were imposed upon the employed, until finally the tenement of the contractor was made to answer the double purpose of home and shop. The crowded condition of these tenements, hardly sufficiently large for the accommodation of the family, was increased by the addition of the help to be employed. All traces of home privacy were obliterated, sanitary conditions became unmentionable, filth and disease abounded, and the health of the public became endangered. When these conditions were made plain to the people, fear overcame them and appeals to the State legislature for the prevention of this system of manufacture were made. These appeals led to the enactment of laws tending to restrict the manufacture of clothing in tenement houses. The first law enacted, like most which tend to elevate the conditions of those who are obliged to labor for their living, emanated from the legislature of Massachusetts. This law provided that any house, room or place, used as a dwelling, and also used for the purpose of manufacturing, should within the meaning of the law, be deemed a workshop. The law defines a workshop as meaning any premises, room, or place wherein manual labor is exercised by way of trade, or for purposes of gain, but the exercise of such labor in a private house by the family, if a majority of the persons therein employed are members of such family, shall not constitute a workshop. The law also contained a provision which was intended to prevent the importation into the State of garments which had been made under unhealthful conditions, and this was enforced until similar laws were enacted in other States, particularly in the State of New York, from which the majority of this class of clothing was produced. The law also provides that any family desiring to do the work of making, repairing, or finishing any coats, vests, trousers, or wearing apparel of any description, in any room or apartment, in any tenement or dwelling house, shall first procure a license, approved by the chief of the inspection department. Every room or apartment in which any garments are made, shall be subject to the inspection and examination of the inspectors, for the purpose of ascertaining whether the rooms or apartments are clean and free from any contagious nature. If the inspector finds evidence of infectious disease present he shall report to the local board of health.

The laws of Massachusetts require that no building which is designed to be used above the second story as a factory, or workshop, or mercantile, or other establishment, and has accommodations for 10 or more above the second story, and no building more than two stories in height shall be erected until a copy of the plans thereof has been deposited with the inspectors. Such buildings shall not be erected without sufficient egress and other means of escape from fire, properly located and constructed. Such inspector may require that proper appliances shall be provided in the floors, walls, and partitions of such buildings to prevent the spread of fire.

Charles E. Burfitt,
State Factory Inspector, Boston.

Factory Acts. See Child-labor; Labor Legislation.

Factory Economics. From the primitive condition where each man must shift for himself, evolution leads to a state of society where the individual expends his energy upon some congenial occupation and exchanges his product for the diverse results of the work of others. The concentration of interest and skill on special trades enables the development of tools and machinery of a degree of complication which places them beyond the power of the workman to own or operate individually. Almost every form of constructive work is now carried on by groups of specialized workers, each proficient in but one task and requiring for the best results a large investment in buildings, machinery, and other equipments. Each man receives a daily wage depending remotely upon the momentary condition of trade in the product he assists to make, and generally reduced or cut off only after a protracted period of business stagnation. To successfully provide for a comparatively regular outlay for pay-roll, material, and factory expense from the irregular receipts from sales is the problem of factory management.

Expectation of Profit.—The promoter of a manufacturing enterprise must first demonstrate a prospective profit to the capital invested. Monopoly, as by patent, franchise, or arbitrary conditions; natural advantages of location, affording cheap power or raw materials, low cost of land with corresponding low rental or interest charge, convenient transportation facilities, a good labor market, proximity to place of principal sales, and superior design backed by persistent effort to keep the advantage, are all factors in the problem of expected profits. The cost of product is made up of the value of material and labor. In factory accounting this sum is known as the net or "prime" cost. In addition to this, factory work is done with the aid of a force of laborers, sweeps, stock handlers, crane men, power plant employees, pattern-makers, draftsmen, office men, and salaried officials whose work cannot generally be determined to be upon this or that particular "job," though quite as much part of the cost of product as is the direct labor. Equally undistributable are the general expense account, and the cost of marketing, made up of advertising, salesmen's salaries, and collection expenses. If the estimated selling price affords a probable margin of profit above the total cost made up of all these items, the enterprise has a chance of success, which may be increased by the ability of the sales department to raise prices, and of the constructing department to reduce costs.

Factory Construction and Equipment.—Essentials for economical production are abundance of daylight, preferably from overhead and the north side, ample space for unfinished work convenient to machines where it is handled, "routing" arranged so that as nearly as possible all articles are carried in one direction from the place of entrance successively to the proper machines and rooms for storage of finished product, and suitable transportation facilities, such as traveling cranes, trolley conveyors, and industrial railways. Tools and supplies are stored in central locations, cared for by attendants, and issued under restrictions which will prevent waste and loss. Machines must be selected of such dimensions and capacities that they may be usually worked to their maximum. Modern practice drives all machinery at maximum rates, in order to earn its cost before better tools are invented. With reference to the working force, comfortable, clean, and pleasant surroundings are of actual cash value to the management in increased quantity and quality of product. A sufficiency of unskilled labor must be supplied to save the time and steps of the skilled men. The most expensive item about the factory, generally speaking, is labor; which should be economized by labor-saving devices wherever possible, except where the cost of the daily operation of improvements is greater than the amount paid for labor that might be so saved.

Starting the Plant.—A new factory is merely an aggregation of men and machines, and until this condition is passed the financial results will be disappointing. The intangible something that puts the balance on the right side of the old factory's ledger comes with the better acquaintance of the various heads and their individual employees, the gradual elimination of weak points in the equipment, the construction and adaptation of "jigs" for quickly and conveniently handling work, and the gathering of records of past performances which measure the progress or backsliding of each repetition job. The books of the general office show the results of the transactions of the company with stockholders and others. The records of the cost department account for pay-roll and merchandise expenditures in such detail as to show accurately the cost of operating the machines, discover petty losses, suggest promising opportunities for cost reduction, and compare recent work with previous jobs or with the work of other factories.

Direct and Indirect Expense.—To this end distinctive order numbers or symbols are assigned to each piece or class of work, and accounts opened with each, to which labor and material are charged, thus giving "prime" or "direct" costs; to these amounts are added charges determined by arbitrarily fixed rules designed to indicate that proportion of the general operating expense fairly borne by each particular order, and known as "burden" charges. The burden rate may be laid out to cover the total of expense outside of material and direct labor; or preferably separated, the first addition covering only that portion belonging to factory operation, in which case the cost so far found is the manufacturing cost, and is a proper charge against an outsider bringing shop work of a familiar kind and taking it away when done. In most cases further expense is incurred for royalties, freight, and insurance on shipments to purchasers, and with large machinery, erecting expense; also for the shipping and billing force. The addition of this total in the form of a second burden charge gives the cost of the completed and delivered goods. Finally, there is the selling expense, which advances the total cost of product so that a very short profit may bridge the gap to the total income from sales.

Classification of Indirect Expense.— A fundamental principle is to charge direct to the order whatever can be determined to have been used thereon. The indistributable items will form some or all of the following accounts:

Manufacturing Expense, a general division comprising the following: *Rent,* or charges such as interest on bonds or fixed dividends on preferred stock representing the actual value of the property occupied; *Shop Salaries*, foremen's and clerks' wages; *General Labor*, all unskilled or skilled men not directly employed in manufacturing, such as helpers, watchmen, crane tenders and teamsters; *Supplies*, as oils, waste, files, paint, etc.; *Power, Heat and Light*, comprising fuel, water rent, power plant labor and supplies, belt renewals, pipe repairs and kindred items; *Defective Work*, expenses due to replacing incorrect, defective and spoiled work, which chance alone causes to fall on one job rather than another. *Repairs*, conveniently divided among the four heads, Buildings, Machinery, Small Tools, and General.

Administrative Expense.— Salaries, of draftsmen, office force and cost clerks; *Office Expense; General Expense*, not otherwise assigned; *Interest and Discount; Legal Expenses; Traveling.*

Selling Expense.— Commissions, and salaries; *Advertising; Traveling; Reclamation.* All these accounts should be defined in writing so that charges may be made consistently. Often further subdivisions are desirable; or heads different from those given, which pertain more particularly to machine construction. Each invoice when approved for entry is posted to the proper account, together with amounts paid for work and materials where such pertain to these accounts, and general totals are taken off at the end of each month.

Three Ways to Distribute Indirect Expense.— The problem is to determine the amount to add to the prime cost of each production order, so that the sum of all the amounts so added will approximate the total of the manufacturing expense accounts to date. The easiest, but generally the most inaccurate way is to add a percentage to the direct labor cost. A better way is to base the addition on the time taken to do the job. The best is a combination of the two.

To explain: Suppose wages actually paid for productive work — "direct" labor — amounts to $10,000, and manufacturing expense to $12,500. By adding to the cost of each order a sum equal to 125 per cent of wages paid for direct labor the problem is solved. But by this method, a job done in two hours by a 30-cent man on an expensive machine tool would appear to cost the same as if done in six hours by a 10-cent boy, ignoring the fact that the boy used the tool three times as long as the man, during which time the interest on first cost, depreciation, rent and heating expense went on at the usual rate, while the power used was probably no less, and the wear and tear perhaps more than with the more experienced man. The method is correct only for manufacturing operations done by men at equal wages on tools of equal value. By the second method, assuming that the $10,000 was paid to 180 men working 250 hours each, or 45,000 hours; the expense total of $12,500 being therefore equal to about 28 cents per hour, the job just instanced would be estimated to cost by the man $1.16, and by the boy $2.28. This method is correct where men earning various wages use tools all alike, but inaccurate where, as is usually the case, different employees use apparatus varying from a few hand tools to a $10,000 machine. The exact method is to divide the expense accounts into two classes, and apportion those which like light, heat, superintendence and clerk's wages belong equally to all the workmen, by a man-hour-rate found by the second method, and those which like power, repairs, rent and depreciation, etc., belong properly to the machines, by special tool-hour-rates based on careful study of the expense of operating each tool. Thus, suppose with the same hypothetical figures that $2,500 is found to be the total of the first class of expenses, or an hour-rate of 5½ cents for the 45,000 hours; while a large chucking machine carries as its monthly burden the value of space occupied at $30, interest and depreciation at 15 per cent on its cost of $2,000, making $25, 10 horse-power for its operation, costing $25, and other charges similarly determined to be $30, or a total of $110, distributed over a month averaging 150 hours running time, consequently at an hour rate of 73 cents. Rates being similarly determined for each machine or hand-work equipment, the cost of a one-hour job by a 30-cent man on this hypothetical chucking machine would be $30 + 73 + 5\frac{1}{2}$ cents, or $1.08½, while the same piece, if it could be made by a 10-cent boy in three hours on an engine-lathe with an hour-rate of 20 cents, would cost $30 + 60 + 16\frac{1}{2}$ cents, or $1.06½. The exact method here reveals that the expensive tool on this particular piece is saving nothing, and must show up better on other work or be arranged for use on more jobs. If run for the full shop time of 250 hours per month, its burden-rate would fall to 44 cents, and the supposed job would become profitable.

Convenient Simplification of Burden-charge.—In practice it is entirely satisfactory, after working out the man-hour and tool-hour rates, to combine and modify such as fall close together into two, three, or at most four class-rates; thus deciding that all work by hand on certain small machines shall carry Class A burden of, say, 10 cents per hour, another lot of larger tools Class B rate of, say 25 cents, and so on. This compromise gives good results, enabling the management to say definitely whether any particular job or class of product is paying for its real cost. Manufacturers using flat burden rates bid too low on work which, by reason of using their heaviest equipment, is unprofitable at the prices secured, and too high on work which employs mostly cheap labor and tools and would pay well at a lower figure. To determine truly the relative profits of different kinds of work it is advisable to apportion selling expense in a similar way, estimating the cost of selling each class and size of products and charging in the form of a percentage burden-rate on the gross cost of the goods.

Cost, Profit, and Selling Price.—Sub-totals of the cost of the month's completed work are credited on the general ledger, labor to "pay-roll," material to "merchandise," and burden to "distribution," while the corresponding charge is made to "manufacturing account." On the other side of the latter appears the total price received from or charged to customers for completed work. If the burden rates are modified, as is necessary from time to time to keep the distribution account approximately equal to the total expense account, the excess of the credit side of the "manufacturing account" shows the profit made by the sale of the product.

S. H. Bunnell,
Works Manager, Watertown Engine Company, Watertown, N. Y.

Faculties, Court of, an English ecclesiastical court, under the archbishop, which creates rights to pews, monuments, and particular places and modes of burial, and has also various powers in granting licenses of different descriptions, as a license to marry, a faculty to erect an organ in a parish church, or to remove bodies previously buried.

Faculty, in ecclesiastical law, a privilege or license granted to any person by favor, and not as a right to do any act which by law he may not do. In the Roman Catholic Church, permission granted by an ecclesiastical superior to a duly qualified subject to hear confessions. Such permission only extends to the district over which the superior has jurisdiction. Thus, faculties are granted by bishops to the priests in their dioceses, and by the heads of religious houses to such of their subjects as they judge qualified to hear the confessions of the community. In the United States, the term faculty indicates the body of persons who are entrusted with the government and instruction of a university or college as a whole, comprising the president, professors, and tutors. It is also used for the body of masters and professors of each of the several departments of instruction in a university; as, the law faculty, etc.

Fadeyev, Rostislav Andreievitch, Russian military writer: b. 1824; d. Odessa 12 Jan. 1884. He made more than one campaign in the Caucasus; achieving a reputation as a scientific soldier that commands respect for his 'Russian Military Power' (1868); 'My Opinions of the Oriental Problem' (1870); 'Letters on Russia's Present Position' (1881); and many similar writings.

Fadienskoi, a Russian island of the Arctic Ocean, in the province of Yakatsk. It is 100 miles long by about 40 broad. The climate is very cold the greater part of the year; but the island is inhabited.

Fæces, the residue of food, combined with the intestinal secretions, as it passes from the body. After chyme has passed into the large intestine it is then termed fæces. During health fæces consist largely of the undigested portions of the food taken into the body. They contain microscopically many epithelial cells from different parts of the intestinal canal; shreds of mucus, bits of meat-fibre, the character of which depends upon the ingested food, and which can be determined by the microscope; vegetable detritus consisting largely of parenchymatous and vascular tissues, plant-hairs, etc.; fat-globules; bacteria of many kinds; bile pigments; and other organic residues. As the chemistry of the fæces will vary widely according to the diet, charts of chemical composition are worthless. The consistency of the fæces also widely varies. Normally, fæces should be semi-solid; if too hard, constipation is probable; if too soft and watery, indigestion may be present, or some degree of colitis (q.v.). Large quantities of mucus indicate a colitis. The color of the fæces is of much importance in determining whether the normal functions of the intestine are being carried on. In health the fæces should vary from a light to an umber brown, white to yellow fæces indicating lack of bile-excretion or loss of fat-digestion. Very black fæces often result from excessive bile-elimination, but such are more likely to be present when the drinking-water contains small amounts of mineral constituents, notably iron. Many drugs modify the color of the fæces. In children, green to greenish stools indicate either the presence of certain pigment forming bacteria, or they mean that there is excessive fermentation or putrefaction of the intestinal contents, leading to excess of oxidation of the bile-pigments: In either case castor oil is an excellent corrective. Tarry fæces, resembling coffee-grounds in color, usually indicate the presence of blood high up in the intestinal canal. If bleeding occurs in the large intestine or rectum, red is the prevailing tinge. Small quantities of blood color the fæces orange, like paprika. Cocoa and huckleberries cause a coloration of the fæces that may be mistaken for blood. Colorless or gray-colored stools usually indicate some form of biliary obstruction; or, perhaps from fatty indigestion, an excess of fat passed either from lack of bile-emulsion action or from loss of fat-absorption. Children taking cod-liver oil often have light-colored stools. These should be carefully studied to determine if digestion of the oil is taking place. Disturbance of the functions of the pancreas may also cause light-colored or fatty stools. The study of the color of the stools is of immense practical importance in medicine, and careful observation of this matter by the patient may be of immense service to the physician. See INTESTINES. Consult Conner, 'Medical News' 30 Aug. 1902.

Faed, fād, **John,** R.S.A., Scottish artist: b. Burley Mill, Kirkcudbrightshire, 1820; d. Gatehouse-of-Fleet, Scotland, 22 Oct. 1902. In 1841 he went to Edinburgh to study, soon won a considerable reputation, and was elected associate of the Royal Scottish Academy in 1847, becoming full academician four years afterward. In 1851 he exhibited a work entitled 'The Cruel Sisters,' and this was followed by 'The Cotter's Saturday Night' (1854); 'The Philosopher' (1855); 'The Household Gods in Danger' (1856); 'Job and his Friends' (1858); and 'Boaz and Ruth' (1860). Going to London in 1862, he began to exhibit in the Royal Academy also, some of his pictures shown since that date being: 'Catherine Seyton' (1864); 'Old Age' (1867); 'John Anderson, my Jo' (1869); 'After the Victory' (1873); 'The Morning before Flodden' (1874); 'Blenheim' (1875); 'In Memoriam' (1876); 'The Old Basket-Maker' (1878); and 'The Poet's Dream' (1882). His work invariably displays careful drawing, but his coloring is somewhat hard.

Faed, Thomas, Scottish artist: b. Burley Mill, Kirkcudbrightshire, 8 June 1826; d. London, 22 Aug. 1900. He was a brother of John Faed (q.v.), and at an early age became known as a clever painter of rustic subjects. The subjects of his brush are for the most part domestic or pathetic, and in these he has attained a success that emulates that of Wilkie. Among his principal works are: 'Sir Walter Scott and his Friends' (1849); 'The Mitherless Bairn' (1855); 'The First Break in the Family' (1857); 'Sunday in the Backwoods' (1859); 'His Only Pair' (1860); 'From Dawn to Sunset' (1861); 'The Last o' the Clan' (1865); 'Pot Luck' (1866); 'Worn Out' (1868); 'Homeless' (1869); 'The Highland Mother'

(1870); 'Winter' (1872); 'Violets and Primroses' (1874); 'She Never Told her Love' (1876); and 'Maggie and her Friends' (1878).

Faenza, fä-en'zä (ancient Faventia), Italy, city, in the province of Ravenna, 19 miles from the city of Ravenna. It is noted for its glazed earthenware, called Faience (q.v.), the manufacture of which has flourished here for centuries. Others of its manufactures are majolica, silk goods, and refined sulphur. In the neighborhood are ferruginous and saline springs of considerable repute. Faenza is connected with the Adriatic by the Zanelli Canal, opened in 1782. It claims to be the birthplace of Torricelli. Its history extends into the times before the Christian era, and many changes in government took place before 1509, when it was annexed by Julius II. to the States of the Church. In 1860 it became a part of the Kingdom of Italy. Pop. 13,998; of the commune, 40,400.

Faerie Queene, The, a famous metrical romance by Edmund Spenser, dedicated to Queen Elizabeth, and published in 1590. The poet was already known by his 'Shepherd's Calendar,' but the appearance of the first three books of the 'Faerie Queene' brought him fame. The last three books appeared in 1595–6. The poem is an allegory, founded on the manners and customs of chivalry, with the aim of portraying a perfect knight.

Faeroe Islands. See Faroe Islands.

Fafnir, fäf'nēr, in the mythology of the Nibelungenlied, a son of the magician Hreidmar. In the form of a dragon he guarded the gold which was paid in atonement for the death of Otr, and was slain by Siegfried.

Fagel, fä'hĕl, **Frans Nicolaas,** Dutch soldier: b. Nimwegen 1645; d. Shiys 23 Feb. 1718. He was a nephew of Gaspar Fagel (q.v.), entered the military service in 1672. He distinguished himself in the battle of Fleurus 1690, and the famous defence of Mons 1691 was directed by him. He also displayed great military talent at the siege of Namur, at the capture of Bonn, and in Portugal 1703, in Flanders 1711 and 1712, at the battles of Ramillies (1706) and Malplaquet (1709).

Fagel, Gaspar, Dutch statesman: b. The Hague 1629; d. there 15 Dec. 1688. He was one of the negotiators on the part of Holland in the Peace of Nimwegen (1678), to the conclusion of which he appears to have been personally opposed. He contributed, as much as his position enabled him to do, to the enterprise of William of Orange upon England, and prepared the expedition by which he was enabled to take possession of the crown of that country, although he did not live to witness the success of the undertaking.

Fagerlin, fä'gėr-lēn, **Ferdinand Julius:** b. Stockholm 5 Feb. 1825. In 1854 he began his art studies and entered the Academy of Stockholm; thence he passed to Düsseldorf, and finally became a pupil of Couture at Paris. From Düsseldorf he started on a professional journey northward, for the purpose of studying sea and coast life in Holland. The pictures he then painted are true to nature, subtile in characterization, and abound in wholesome humor.

Fagin, fā'gin, a despicable Jew in Dickens' 'Oliver Twist.' He is represented as training up children in crime in order to profit by their thievish practices, and condemned to be hanged for receiving stolen goods.

Fagnani, fän-yä'nē, **Joseph,** Italian painter: b. Naples, Italy, 1819; d. 1873. He studied at Vienna and Paris, and came to the United States with Sir Henry Bulwer in 1849; here he painted 'The Nine Muses' (portraits of New York women), now in the Metropolitan Museum. He also painted many European celebrities.

Fagot, a bundle of sticks or small branches of trees bound together. In times of religious persecution, the fagot was a badge worn on the sleeve of the upper garment of such persons as had abjured heresy, being put on after the person had publicly carried a fagot to some appointed place, by way of penance. Among military men in England, fagots were persons hired by officers whose companies were not full, to muster and hide the deficiencies of the company, and thus cheat the government.

Fagot-vote, in Great Britain, is a vote procured by the purchase of property under mortgage, or otherwise, so as to constitute a nominal qualification without a substantial basis. Fagot-votes are chiefly used in county elections. The way in which they are usually manufactured, namely, by the purchase of a property which is divided into as many lots as will constitute separate votes, and given to different persons, has given rise to the name. Sometimes properties are bought in this way, and held for the sake of the vote.

Fagot-worm, a caterpillar of a moth of the genus *Eumeta,* which in Ceylon is common on the coffee-trees. It forms a pupa case of silk covered with small sticks, so that it looks like a bundle of fagots; and local folk-lore explains that these worms are the abode of the souls of persons who in their lifetime were thieves of firewood. These moths are related to the bag-worm moths (q.v.).

Fagotto, fa-got'tō, a brass wind instrument, blown with a reed, which can be taken in pieces and carried like a bundle of fagots, hence the name; a bassoon (q.v.).

Faguet, Emile, ā-mēl' fä-gā', French critic: b. La Roche-sur-Yon, France, 17 Dec. 1847. He has published 'French Tragedy of the 16th Century' (1883); 'Corneille' (1888); 'The Great Masters of the 17th Century' (1885); 'Madame de Maintenon as a Teacher,' etc.

Fagus, the typical genus of the Beech family (*Fagaceæ*). The genus has four species, natives of the Northern hemisphere, only one of which, the common beech (*F. americana*), is native of the United States. All the species are trees with smooth gray bark and serrate leaves, the flowers and leaves appearing together. The name is from the Greek, to eat, referring to the edible nuts. See Beech.

Fahaka, an edible globe-fish (*Tetiaodon fahaka*), singular in inhabiting the fresh waters of the Nile. See Globe-fish.

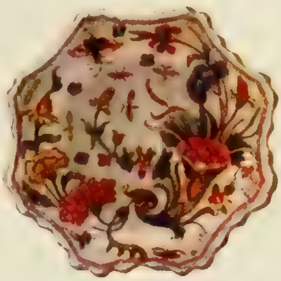
Fahlcranz, fäl'kränts, **Karl Johann,** Swedish landscape-painter: b. Sprengel, Stora-Tuna, in the län of Falun, 29 Nov. 1774; d. Stockholm 1 Jan. 1861. Studying nature diligently, he became a self-educated artist. He was acquainted only with northern scenery, but has given it with great fidelity and spirit. His

FAIENCE

From Strassburg

Persian Faience

Old German Jug



From Rouen

Hirschvogel Pitcher

Delft Ware

Modern English Faience

Modern French Faience

principal productions are in the possession of the king of Sweden.

Fahrenheit, fä'ren-hīt, **Gabriel Daniel,** German physicist: b. Dantzic 14 May 1686; d. Amsterdam 16 Sept. 1736. He settled in Holland, where in 1720 he first conceived the idea of using quicksilver instead of alcohol in thermometers — a discovery by which the accuracy of the instrument was very much improved. He took, as the limit of the greatest cold, that which he had observed at Dantzic in the winter of 1709. The space between the point to which the quicksilver fell at this temperature, and that to which it rose in boiling water, he divided into 212 parts. About 1724 he discovered the fluctuation of the boiling point of water, which he had made one of the fixed points of his thermometer. Fahrenheit's thermometer owed its beginnings to the invention of a thermometer by Newton, described in the 'Philosophical Transactions' for 1701. Newton's instrument was a tube filled with linseed oil, and the starting-point of the scale was the temperature of the human body, which Newton called 12. Newton divided the space between his datum and the freezing-point of water into 12 equal parts, and stated that the boiling-point of water would be about 30 of these degrees on the scale. Fahrenheit, when he began to work with Newton's thermometer, did not find the scale minute enough for his purposes. He therefore first doubled the number of degrees, making the scale number 24 instead of 12. Finding he could, by mixing ice and salt, obtain a temperature below freezing, Fahrenheit next adopted this for his starting-point and counted 24 degrees up to body heat, making the freezing-point 8 and calling boiling water 53. Later on he again divided his degrees into four. It will be seen that if the above figures are multiplied by four, the result is the thermometric scale called after him which is still in use.

Faidherbe, Louis Léon César, loo-ē lā-ôn sā-zär fā-dārb, French general and author: b. Lille 3 June 1818; d. Paris 29 Sept. 1889. Entering the army in 1840, he became lieutenant in 1842. From 1854 till 1861, and again from 1863 till 1865, he was governor of Senegal, in which capacity he considerably extended the French possessions there. After the fall of Napoleon III. he was summoned by the government of National Defense to France and appointed commander of the army of the north. In the latter part of his life he went on a mission to Egypt to study the monuments and hieroglyphics. He wrote valuable monographs on Senegal, the Sudan, and other parts of Africa, including 'L'Avenir du Sahara et du Sudan' (1863); 'Collection Complète des Inscriptions Numidiques' (1870); 'Nouvelles Inscriptions Numidiques' (1872); 'Langues Sénégalaises' (1887); and 'Le Sénégal: la France dans l'Afrique Occidentale' (1889). On the Franco-German war he published 'Campagne de l'Armée du Nord en 1870–1' (1872).

Faïence, fā-äns, glazed pottery. The name is derived from the town of Faënza in Italy and was applied to pottery by the French under the following circumstances. About the year 1578 the Duke of Nevers in France was desirous of establishing an atelier for the production of glazed pottery and he secured a skilled workman named Gambyn. This man was an Italian and had learned his art in Faënza. When, therefore, he produced similar pottery at Nevers it was known as Faënza ware and, subsequently, as faïence, a Gallicized form of the word. The term is now generally applied to ornamental pottery of which the glaze forms a marked feature. Faïence is distinguished from porcelain by the fact that it is produced at a much lower temperature, being made, for the most part, of common and often colored clays. Most of the decorative pottery produced in America falls within this class, as for instance the Rookwood, Grueby, Merrimac, and Volkmar wares. The term faïence is not usually applied to any form of tableware though there seems to be no good reason why plates should be classed apart from vases if they are similar in technical quality. See Ceramics; Pottery.

Faillon, Michel Etienne, mē-shel ā-tē-en fä-yôn', French historical writer: b. Tarascon, France, 1799; d. Paris 25 Oct. 1870. He was a Sulpician and visited Canada in 1854 to investigate the houses of that order. He wrote lives of noted French Canadian religionists, and a comprehensive history of the French in Canada, three volumes of which appeared before his death.

Failure. See Bankrupt.

Fainéants, fā-nā-än, or **Do-nothing Kings,** the name given in French history to some of the Merovingian sovereigns, who were the puppets of the mayors of the palace. The last of these kings was Childeric III.

Faint (syncope), a peculiar form of sudden loss of consciousness. Impoverishment of the blood, lowered vitality from any cause, an overwrought nervous system, and disease of the circulatory system predispose to such attacks. The immediate cause is an anæmia of the brain. This sudden cerebral anæmia is most frequently due to shocking sights, sickening smells, pains, or fears. The attack may be ushered in by a period of nausea, sighing respiration, or "faint feeling." Immediate lowering of the head below the rest of the body will frequently ward off further trouble. Most commonly the attack is very sudden, the face becoming absolutely bloodless and having a deathlike calm; the pulse is weak or imperceptible, the breathing very shallow. In true syncope spasms are not present, neither is voiding of the urine or fæces. Fatal termination is rare, consciousness ordinarily being restored in a few moments if prompt measures are taken. The patient must be placed in a recumbent position, with the head as low or lower than the rest of the body; constricting clothing should be loosened; and water may be slapped on exposed parts. Smelling-salts held to the nose are of value. Later mild stimulants may be used to restore normal condition; but resumption of vertical position should be postponed as long as practicable.

Faioum, or **Fayoum.** See Fayum.

Fair, James Graham, American capitalist: b. near Belfast, Ireland, 1831; d. San Francisco 1894. He emigrated to America in 1843 and went to California in the famous '49 year. He amassed great wealth by mining in Nevada, to which he went in 1860. He was elected in 1881 as a Democrat to the United States Senate in which he served one term.

Fair God, The, a romance by Lew Wallace 1873. It is a story of the conquest of Mexico by the Spaniards, its scene laid upon Aztec soil, in the early part of the 16th century. The title is derived from Quetzalcoatl, "the fair god," the Aztec deity of the air.

Fair Haven, Mass., town in Bristol County on Buzzard's Bay, at the mouth of the Acushnet River, and on the New York, N. H. & H. R.R.; 60 miles south of Boston, and opposite New Bedford, with which it is connected by bridges. Here are the Millicent Public Library, several banks, churches, and other public buildings. It has manufactories of glass, castings, nails, and tacks. Many buildings of architectural merit, which render Fair Haven one of the most attractive towns of the State, were erected by Henry H. Rogers (q.v.) as memorials to members of his family. One architectural group, a fine example of Tudor architecture, consisting of a church and two other buildings, is considered a model of beauty. Pop. (1900) 3,567.

Fair Havens (Gr. Καλοὶ Λιμένες, *Kaloi Limenes*), an anchorage on the southern coast of Crete, five miles east of Cape Litino. It is of small size and amply sheltered from western winds. The only mention of it by ancient writers is that by Paul (Acts xxvii. 8), whose well-known shipwreck occurred after departure from Fair Havens for Phenice or Phœnix. It is probable that there was no town at that point, although, as stated in Acts, Lasea was but a short distance away.

Fair Head, or **Benmore,** a precipitous promontory of the north coast of county Antrim, Ireland, opposite Rathlin Isle. It rises 636 feet above the sea, and consists of carboniferous strata, overlaid by greenstone columns, 20 to 30 feet thick, and 280 to 300 feet high.

Fair Isle, a solitary Shetland island lying midway between Shetland and Orkney, and 30 miles southwest of Lerwick. It is three miles long and two miles broad. The men employ themselves chiefly in fishing, and the women in knitting the well-known Shetland hosiery. They are said to have acquired this art from the Spanish seamen whose ship, belonging to the Armada, was wrecked here in 1588. Pop. 223.

Fair Maid of Perth, The, a novel by Sir Walter Scott, published 1831. The time is the reign of King Robert III. of Scotland; whose scapegrace son David, the crown prince, is the connecting link in the story between the nobility and the burgher-folk of the city of Perth. Like all Scott's novels, 'The Fair Maid of Perth' contains fine descriptions of scenery, and stirring accounts of battle; and unlike many of his plots, this one allows the "course of true love" to run comparatively smooth.

Fair Oaks and Darbytown Road, Engagement at (SECOND BATTLE OF FAIR OAKS)—On 27 Oct. 1864, Gen. Grant began a movement on the Petersburg lines, to seize the South-side railroad, and as a support to the movement, had ordered Gen. Butler to make a demonstration north of James River on Richmond. Parts of three divisions of the Tenth corps, under Gen. Terry, six brigades of the Eighteenth corps, under Gen. Weitzel and Gen. Kautz's cavalry division were designated for the movement. Terry was to make a demonstration along the Darbytown road, under cover of which Weitzel was to push through White Oak Swamp to reach the Williamsburg road and seriously threaten Richmond. The columns started from camps, near Chaffin's farm, very early on 27 October. Terry reached the Darbytown road, a part of his command crossed over to the Charles City road and advancing on both roads, a little before 8 A.M. engaged the Confederates in their entrenchments from the New Market road to the Charles City road. Weitzel, after a march of 16 miles, crossing both the Darbytown road and Charles City road and at 1 P. M. reached the Williamsburg road at Heintzelman's old works, on the battle-field of 31 May 1862, and pushed at once down the road one and a half miles toward Richmond, and came upon the Confederate works, which appeared to be feebly held by a small body of dismounted cavalry and three guns. Weitzel prepared to attack, first sending a brigade of colored troops across the York River railroad to find and turn the Confederates' left near the New Bridge road. The defenses north of the James were held by Gen. Longstreet, with the divisions of Gens. Hoke and Field, some "local defense" troops, under Gen. Ewell, and Gen. Gary's cavalry brigade. These were posted with reference to defense along the river roads. As soon as Longstreet detected Weitzel's movement he ordered Field's division to move to the left and it formed on either side of the Williamsburg road. It was 3.30 P.M. when Weitzel, with two brigades, and others in support, advanced on either side of the road, over open ground, and was met with an unexpected heavy fire of musketry and artillery. His troops almost reached the works, but were repulsed with a severe loss, in killed, wounded, and missing. Soon after dark Weitzel withdrew after losing over 1,000 men. While Weitzel was engaged, Terry, at 4 P. M., was ordered to press his demonstration and carry the entrenchments. He made the attempt and was repulsed. On the next day the expedition returned to camp. The Union loss was 905 killed and wounded, and 698 missing. The Confederate loss was comparatively small; Field's division and Gary's brigade reported 64 killed, wounded and missing. The entire loss probably did not exceed 100. See Humphrey, 'The Virginia Campaign of 1864–5.' E. A. CARMAN.

Fair Oaks (Seven Pines), Battle of. After the battle of Williamsburg (5 May 1862) the Army of the Potomac, under Gen. McClellan, advanced cautiously up the Peninsula, established a base at White House, and 20 May his advance crossed the Chickahominy at Bottom's Bridge, and the entire Fourth corps under Gen. E. D. Keyes crossed on 23, taking position 25 May at Seven Pines, on the main road to Richmond, about five miles distant. The Third corps, under Gen. S. P. Heintzelman, crossed 25 May. This left on the north bank, the Second, Fifth and Sixth corps, commanded respectively by Gens. E. V. Sumner, Fitz John Porter, and Wm. B. Franklin. McClellan began to rebuild destroyed bridges and to perfect communication between the two wings of his army, astride the Chickahominy. The movements of McClellan north of the Chickahominy and information from his cavalry, convinced Gen. Joseph E. Johnston, the Confederate commander, that Gen. McDowell with a strong corps was about to join McClellan from Fredericksburg, upon which, 28 May, he ordered up Gen. Huger's division from Petersburg and Drewry's Bluff and suggested to Gen. Lee that every available command should be concentrated at Richmond. On 25 May Gen. Casey's division of the Fourth corps advanced from Seven Pines to Fair Oaks, about three fourths of a mile and threw up works covering the road, and on 30 May two brigades of Kearny's division, Third corps, were advanced about a fourth of a mile in front of Savage Station to within supporting distance of Casey. Gen. Couch's division, Fourth corps, was at Seven Pines, and Gen. Hooker's division, Third corps, on the border of White Oak Swamp. Johnston, from his works, three miles in front of Richmond, watched McClellan's cautious advance. A reconnoissance 30 May developed the fact that Keyes had advanced his lines to Fair Oaks; Johnston saw his opportunity and issued orders for an attack next day. The Army of the Potomac, 31 May, had 127,166 officers and men, of whom 98,008 were present for duty, and it had 280 guns. Johnston had about 63,000 effectives and was not well supplied with artillery. Johnston purposed to throw 23 of his 27 brigades against Keyes and Heintzelman and with four brigades along the line of the river from New Bridge to Meadow Bridge prevent the rest of McClellan's army from crossing the stream. He purposed to move the 23 brigades by the Charles City, Williamsburg, and Nine Mile roads, crush Keyes' corps and drive it back in disorder on Heintzelman, and capture or destroy those two corps before any assistance could reach them from the north bank of the stream. There was some misunderstanding of orders on the morning of the 31 and much consequent delay but, at noon, Gen. D. H. Hill's division of four brigades, deployed in double line on either side of the Williamsburg road, advanced on Casey's division at Fair Oaks and after a severe fight of two hours drove it back upon Couch's division at Seven Pines. Hill now received a reinforcement of one brigade, and two brigades of Kearny's division came to the assistance of Couch and Keyes, and the struggle was renewed at Seven Pines, with the result that the entire Union force was driven back to a line of entrenchments about a mile in the rear, which position was held. Three Union divisions had been engaged and suffered severely, and a part of Couch's division had been cut off. Gen. G. W. Smith, with several Confederate brigades, was observing the Chickahominy, under orders to engage any troops that might cross the stream to assist Keyes and Heintzelman, or, if none came, he was to fall upon the right flanks of the Union lines engaged. After waiting some time and believing that no Union troops would cross to the south bank of the stream, Smith put some of his troops in motion to make the flank attack, but it miscarried from the timely arrival of Sumner on the south bank of the Chickahominy. Sumner, who was nearest Keyes and Heintzelman, heard the sound of battle at 1 o'clock and was at once in the saddle, and ordered his troops under arms. A little later orders came from McClellan that he should be prepared to march at a moment's notice. Without waiting another moment he marched his two divisions to the Chickahominy and paused upon the two bridges, waiting orders to cross them. At 2.30 P. M. the order came to cross. Richardson could get but one brigade of his division over the lower bridge and was obliged to move up and follow Sedgwick's division over the Grapevine Bridge, which swayed and tossed in the river. But the solid column of Sedgwick's infantry, loading it with a weight with which even the angry Chickahominy could not trifle, soon pressed and held it down among the stumps of the trees, which in turn prevented its lateral motion. Once across, Sumner pressed forward on the road, deep with mud, toward Fair Oaks, and came up to Couch, who with four regiments and a battery had been cut off from his division and was holding ground about a half mile from Fair Oaks, with Smith approaching to make his flank attack. But four of Sumner's regiments had formed on Couch when Smith attacked, two more soon followed, and these six regiments, with Couch's, checked all efforts of Smith's four brigades to dislodge them and saved the day at Fair Oaks. Richardson's division came up at nightfall and formed on Sedgwick's left, extending toward a brigade of Heintzelman's corps, while Hooker, coming to the support of the defeated troops on the Williamsburg road, filled vacant spaces in the line. There were now three corps across the Chickahominy in continuous order, ready for action when day should dawn. Near the close of the day Gen. Johnston, the Confederate commander, was severely wounded and relinquished command to Gen. G. W. Smith. On the morning of 1 June, the Union army awaited attack, which was delivered by the Confederates and, on some parts of the line, the fighting was severe, but the advantage remained with the Union troops, who regained most of the ground lost the previous day. On 1 June, Gen. R. E. Lee was placed in command of the Army of Northern Virginia, but did not take direction of affairs on the field until the fighting was over, and 2 June withdrew to the fortifications around Richmond from which Johnston had advanced 31 May. The Union forces engaged at Fair Oaks numbered about 36,000; the Confederates about 32,000. The Union loss was 4,384 killed and wounded, and 647 missing; the Confederate loss was 5,729 killed and wounded, and 405 missing.

Consult: Allan, 'The Army of Northern Virginia in 1862'; 'Battles and Leaders of the Civil War,' Vol II.; McClellan, 'My Own Story'; Michie, 'Life of Gen. McClellan'; 'Official Records,' Vol. XI.; Walker, 'History of the Second Army Corps'; Webb, 'The Peninsula.'

E. A. CARMAN.

Fair Trade, an expression used in Great Britain by certain persons who, professing to be free traders, would still tax goods imported from any country which refuses to accept the principles of free trade. Free traders consider this view as protectionist. They hold that if they can import goods cheaper from a protectionist country than elsewhere, they should be free to reap that advantage even if they cannot export their own goods to that country free of duty. See FREE-TRADE.

Fairbairn, Andrew Martin, English theologian: b. near Edinburgh 4 Nov. 1838. Having qualified for the ministry of the Evangelical Union, he was appointed to a church of that denomination at Bathgate in 1860. Accepting a similar charge in Aberdeen in 1872, he ministered there till appointed in 1877 to the principalship of Airedale Independent College, Bradford. On the foundation of Mansfield College, the Congregational Theological College at Oxford, in 1886, he was appointed principal, a post which he still occupies. He delivered the Aberdeen Gifford Lectures of 1892–4, and the Lyman Beecher Lectures at Yale in 1892. His most important works are: 'Studies in the Philosophy of Religion and History' (1876); 'Studies in the Life of Christ' (1881); 'The City of God' (1882); 'Religion in History and in Modern Life' (1884, revised and enlarged edition 1893); 'Christ in the Centuries' (1892); 'The Place of Christ in Modern Theology' (1893); 'Catholicism, Roman and Anglican' (1899).

Fairbairn, Sir **William,** Scottish civil engineer: b. Kelso, Scotland, 19 Feb. 1789; d. 18 Aug. 1874. He entered business in Manchester, England, in 1817. He constructed the first iron ship in England and afterward his firm built over 100 iron vessels. He was associated with Robert Stephenson in designing and building the great tubular bridge over Menai Strait. He was the author of 'Mills and Millwork'; 'Iron, Its History and Manufacture'; 'Application of Iron to Building Purposes'; 'Iron Shipbuilding'; 'Useful Information for Engineers'; 'An Experimental Inquiry into the Strength, Elasticity, Ductility, and other Properties of Steel' (1869); etc.

Fairbank, Calvin, American clergyman: b. Pike, N. Y., 3 Nov. 1816; d. Angelica, N. Y., 12 Oct. 1898. He was an ardent abolitionist, and during 1837–9, aided 23 slaves to escape across the Ohio River. In 1843 he raised $2,275 to secure the liberty of a nearly white slave girl who was to be sold at auction at Lexington, Ky. In 1844 he opened the way for the escape of the Hayden family, for which offense he suffered five years' imprisonment. Later he was again detected in violation of the Fugitive Slave Law, and sentenced to 15 years' imprisonment at Frankfort, where he was cruelly treated, receiving about 35,000 lashes on his naked body. In 1864 he was set at liberty after spending more than 17 years in jail. He published 'How the Way Was Prepared' (in which he told the story of his own life).

Fairbanks, Arthur, American teacher and author: b. Hanover, N. H., 1864. He was graduated at Dartmouth College in 1886, and received a doctorate from Freiburg, Germany. He has taught at Dartmouth, Yale, and Cornell, and since 1900 has been professor of Greek literature in the State University of Iowa. Among his writings is an 'Introduction to Sociology' (1901) which has been translated into Japanese.

Fairbanks, Charles Warren, American lawyer and senator: b. near Unionville Centre, Union County, Ohio, 11 May 1852. His father, Lorison M. Fairbanks, was a Vermonter, and was one of the early pioneers who settled in the west in 1836 and helped to hew out of the wilderness the great Buckeye State. The son's earliest life was spent in toil on the farm, from sunrise to sunset, and in quiet hours of study during the evening. He was naturally studious, and early destined himself to the career of a lawyer. After passing through the district school he attended classes in the Ohio Wesleyan University, where he was graduated with distinction in 1872. During his senior years at college he edited the 'Western Collegian,' the college journal. After leaving the Wesleyan University he went to Cleveland, as Associated Press agent; meanwhile studying law. In 1874 he was admitted to the bar of the supreme court of Ohio at Columbus, and in the same year removed to Indianapolis, Ind. In this city he has lived ever since, as a practising lawyer. While never holding public office until elected to the Senate, he was chairman of the Indiana State Convention in 1892 and again in 1898. In 1893 he was unanimously chosen as the nominee of the Republican party for United States senator, but was defeated at the polls by the Democratic candidate, David Turpie, although receiving his entire party vote. He was delegate-at-large to the Republican National Convention at St. Louis in 1896, and was temporary chairman of the convention. He was appointed a member of the United States and British Joint High Commission, which met in Quebec in 1898 for the adjustment of Canadian questions, especially relating to the seal-fisheries of Alaska. He was elected to the United States Senate 30 Jan. 1897, and at the expiration of his term was re-elected. In Nov. 1904 he was elected Vice-President on the Republican ticket. Since 1885 he has been a trustee of the Ohio Wesleyan University.

Fairbanks, Henry, American inventor: b. St. Johnsbury, Vt., 6 May 1830. He is a son of Thaddeus Fairbanks (q.v.), and was graduated at Dartmouth College in 1853, and at Andover Theological Seminary in 1857. He was ordained in 1858; held pastorates in Burke and Barnet, Vt., and in 1859 was professor of physics, and later of history, at Dartmouth. He became identified with the manufacturing firm of E. & T. Fairbanks & Co., in 1868; and subsequently gave much of his time to mechanical experiments, and patented several inventions relating to the manufacture of scales.

Fairbanks, Thaddeus, American inventor: b. Brimfield, Mass., 17 Jan. 1796; d. St. Johnsbury, Vt., 12 April 1886. He settled in St. Johnsbury in 1815, and there worked with his father in a saw and grist mill, and also in the manufacture of carriages. In June 1831 he patented the platform scales bearing his name. Afterward about 50 different improvements were made on these scales, which have been sold in all parts of the world.

Fairbury, Nebr., city, county-seat of Jefferson County; on the Little Blue River, the St. Joseph and other branches of the Chicago, R. I. & P. System; about 60 miles southwest of Lincoln. It is situated in a good agricultural region, and its chief manufactures are flour and dairy products. A large nursery is just outside the city limits. Pop. (1900) 3,140.

Fairchild, Ashbel Green, American clergyman; b. Hanover, N. J., 1 May 1795; d. Smithfield, Pa., 1864. He wrote many contributions to the religious press. His most popular work, 'The Great Supper,' was translated into German and had an immense sale. He also published 'Baptism'; 'Faith and Works'; and 'Confession of Faith.'

Fairchild, Charles Stebbins, American financier; b. Cazenovia, N. Y., 30 April 1842. He was graduated at Harvard University in 1863; admitted to the bar in 1865; became deputy attorney-general of New York in 1874, and attorney-general in 1876. After spending some time in Europe he settled in New York city in

1880, where he practised law till 1885. He was assistant secretary of the treasury 1885–7, and secretary 1887–9. Subsequently he became president of the New York Security and Trust Company.

Fairchild, George Thompson, American educator: b. Brownhelm, Ohio, 6 Oct. 1838. He was graduated from Oberlin College 1862, and from Oberlin Theological School 1865; was professor of English literature Michigan Agricultural College 1879–97; and has been vice-president of Berea College since 1898. He entered the Congregational ministry in 1871 and has published 'Rural Wealth and Welfare: Economic Principles Illustrated and Applied in Farm Life' (1900).

Fairchild, Herman Le Roy, American educator; b. Montrose, Pa., 29 April 1850. He was graduated at Cornell University in 1874; was secretary of the New York Academy of Science in 1885–88; became president of the Rochester Academy of Science in 1889, secretary of the Geological Society of America in 1890, and vice-president in 1898. He has been professor of geology at the University of Rochester from 1888, and has published a 'History of the New York Academy of Sciences' (1887).

Fairchild, James Harris, American educator: b. Stockbridge, Mass., 25 Nov. 1817. He was elected president of Oberlin College in 1866, after a service of 26 years as tutor, professor of languages, professor of mathematics, and professor of moral philosophy and theology. Besides editing the 'Memoirs of Charles G. Finney' (1876) and Finney's 'Systematic Theology' (1878), he was the author of 'Moral Philosophy' (1869); 'Oberlin, the Colony and the College' (1883); 'Elements of Theology, Natural and Revealed'; and 'Woman's Right to the Ballot' (1870). He resigned the presidency of Oberlin in 1889.

Fairchild, Lucius, American military officer: b. Kent, Ohio, 27 Dec. 1831; d. Madison, Wis., 23 May 1896. At the beginning of the Civil War he enlisted as a private in the Federal army, and in August 1861, was appointed a captain in the regular army, and major in the volunteer army. He took part in the battles of Bull Run and Antietam, and led the charge up Seminary Hill at Gettysburg, where he lost his left arm. He was promoted brigadier-general in 1863, but resigned to serve as secretary of state of Wisconsin. He was afterward elected governor, and served six consecutive terms. In 1886 he was chosen commander-in-chief of the Grand Army of the Republic.

Fairfax, Donald McNeill, American naval officer: b. Virginia 19 March 1821; d. Hagerstown, Md., 10 Jan. 1894. During the Mexican war he participated in the capture of Mazatlan and Lower California. In 1861 he had personal charge of the transfer of Messrs. Mason and Slidell and their secretaries from the «Trent,» a British mail ship, to the «San Jacinto.» He later took part in the chief naval operations in Charleston harbor; was promoted rear-admiral 11 July 1880; and retired 30 Sept. 1881.

Fairfax, Edward, English poet: b. Denton, England, about 1580; d. near Otley, England, January 1635. He made a metrical translation 'Godfrey of Boulogne' (1600), of Tasso's 'Jerusalem Delivered,' and dedicated it to Queen Elizabeth; it was highly esteemed by James I., and is still highly valued; and on this rather than on his own «Eclogues» the fame of Fairfax as a poet rests. He is also author of a 'Discourse on Witchcraft,' first published in 1858.

Fairfax, Thomas, Lord, English general: b. Denton, Yorkshire, 17 Jan. 1611; d. Nun Appleton, Yorkshire, 12 Nov. 1671. Fairfax warmly espoused the cause of Parliament, and in April 1642, presented to Charles a petition of the people imploring him to be reconciled to his subjects. The same year he was appointed general of the horse, and in 1644, together with Essex, Waller, and Manchester, he held a chief command in the English army sent to co-operate with the Scots. The credit of the battle of Marston Moor has, by some authorities, been divided between Leslie and Cromwell, but, according to others, Fairfax is also entitled to share in it. On the Earl of Essex resigning the command of the parliamentary army in 1645, Fairfax was made general-in-chief in his room. He insisted on the command of the horse being given to Cromwell. When he took Oxford the first thing he did was to set a guard upon the Bodleian Library, an act for which he deserves the gratitude of posterity. He subsequently, in November 1647, was engaged with Cromwell in putting down the levellers in the army, and in the following year captured Colchester, and caused Sir Charles Lucas and Sir George Lisle to be tried by court-martial and shot. Being ordered to march against the Scottish Presbyterians, he positively declined the command and Cromwell was appointed (June 26, 1650) to succeed him. He was appointed one of the lay church commissioners in 1654, and was a member of Cromwell's first Parliament. He assisted Monk against Gen. Lambert, and co-operated in the restoration of Charles II., being one of the committee charged to secure his return.

Fairfax, Thomas, 6th Baron of Cameron: b. England 1691; d. Greenway Court, Frederick County, Va., 12 Dec. 1782. He was educated at Oxford and was a contributor to Addison's 'Spectator.' He came to America and settled on a vast landed estate in Virginia inherited from his mother, a daughter of Lord Culpeper. It was there, at Greenway Court, that Washington first met him, and between the two there sprang up a warm friendship.

The 11th Lord Fairfax and baron of Cameron who succeeded his brother to the baronetcy in 1869, and who died in Northampton, Md., 28 Sept. 1900, like his American predecessors, made no claim to the title.

Fairfield, Sumner Lincoln, American author: b. Warwick, Mass., 25 June 1803; d. New Orleans, La., 6 March 1844. He began the publication of the 'North American Magazine' in 1833; and continued to edit and publish it for five years. His published volumes include: 'Lays of Melpomene' (1824); 'Cities of the Plain' (1828); 'Poems and Prose Writings' (1840), and 'Select Poems' (1860).

Fairfield, Conn., town, port of entry, in Fairfield County; three miles southwest of Bridgeport; on the Long Island Sound, the New York, N. H. & H. R.R. The chief manufactures are paper, rubber goods, and machinery. It has good public buildings, two libraries, and four buildings which date from Revolutionary times. The first settlement was made in 1869 and the town was incorporated the same year. It was the scene of several Indian and Revolutionary battles, and in 1779 was almost wholly burned by the Hessians and Tories. Pop. (1900) 4,489. Consult: Osgood, 'Centennial Commemoration of the Burning of Fairfield.'

Fairfield, Ill., city, county-seat of Wayne County; 123 miles southeast of Springfield; on the Louisville, E. & St. L. and the B. & O. Southwestern R.R.'s. The manufactures are chiefly flour, lumber, and dairy products. The trade is in agricultural products. It is the site of the Hayward Collegiate Institute. Pop. (1900) 2,338.

Fairfield, Iowa, city, county-seat of Jefferson County; 48 miles northwest of Burlington; on the Chicago, R. I. & P. and the C., B. & Q. R.R.'s. The principal manufactures are brooms, tile, agricultural implements, machinery, furniture, carriages, flour, and dairy products. The electric-light plant and the water-works are owned by the city. The Parsons College, under the auspices of the Presbyterian Church, was founded here in 1875. The first settlement was made in 1839. Pop. (1900) 4,689.

Fairhaven, Wash., city in Whatcom County; on an arm of Puget Sound; 42 miles northeast of Victoria, in Canada, and 88 miles north of Seattle; on the Northern P. and the G. N. R.R.'s. It is near a good agricultural region; its principal manufactures are canned salmon, tin cans, flour, and lumber. Fairhaven was first settled in 1888. Its natural advantages combined with its opportunities for railroad transportation make its outlook most promising. Pop. (1900) 4,228.

Fairholt, Frederick William, English artist and author: b. London 1814; d. there 3 April 1866. He published: 'Costume in England: a History of Dress to the Close of the 18th Century' (1846); 'The Home of Shakespeare Illustrated and Described' (1847); 'Remarkable and Scientific Characters' (1849); 'Dictionary of Terms in Art' (1854); etc.

Fairmont, W. Va., city, county-seat of Marion County; on the Monongahela River and the Baltimore & O. R.R.; 75 miles southeast of Wheeling. It is the site of a State Normal School; its principal manufactures are glass, machinery, cigars, lumber, and iron products. It has considerable trade in coal, coke, and manufactured articles. Pop. (1900) 5,655.

Fairmount College, a coeducational preparatory school and college, under the auspices of the Congregationalist Church. It was established in 1892, with assistance from the Boston Education Society. A collegiate department was added in 1895. In 1901 there were 23 professors and instructors, 238 pupils, and 23,000 volumes in the library.

Fairmount Park. See PHILADELPHIA.

Fairs and Periodical Markets. A fair is a periodical meeting of merchants in an open market held at a particular place, and generally for the transaction of a particular class of business. The origin of fairs is obviously to be traced to the convenience of bringing together at stated times the buyers and sellers of the stock-produce of a district. Fairs are generally held in or near towns, but from their nature are specially adapted to the convenience of country dealers and their customers. Two curious facts are to be noted in the history of fairs. In Europe the numerous festivals of the church afforded the most favorable opportunity for the establishment of these markets. This association is indicated in the German name of a fair, which is identical with that used for the ceremony of the mass. A fair generally brings a concourse of people into the town in which it is held, and gives it something of a holiday appearance. Advantage has frequently been taken of this concourse, either by the persons assembled themselves or by the purveyors of various amusements, to add entertainment to business, and as the business of a particular fair declined it has often, instead of being abandoned, been gradually converted into a periodical opportunity for a saturnalia of amusement. Thus religion, business, and diversion have come to be associated in the idea of a fair.

In the Middle Ages fairs were specially privileged and chartered by princes and magistrates, special temporary tribunals were even established for their use. It was then the custom, which in some places still remains, to make a public proclamation of the commencement and duration of the fair. The goods sold at fairs were then of much greater value, as well as variety, than at present, embracing fabrics of all kinds, as well as jewelry. In some parts of the Continent the practice still prevails of purchasing clothing at fairs. Fairs existed in ancient as well as modern times, and are to be found in all parts of the world. In the East they are of great magnitude and importance. At Mecca, during the annual pilgrimages, and at Hardwar in Ajmir, a resort of pilgrims in Hindustan, two of the greatest fairs of the East, we find again the association between commerce and religion. According to Prescott fairs were regularly held in the principal cities of Mexico every fifth day, being the recognized substitute for shops. A fair for the sale of slaves was held at Azcapozales, near the capital. At the principal fair, held at the City of Mexico, the number of visitors reached 40,000 to 50,000. Here the same arrangement prevailed as in the European fairs of the Middle Ages. A court of 12 judges, clothed with absolute authority, maintained perfect order in this great concourse.

The Easter and Michaelmas fairs at Leipsic, the fairs of Frankfort-on-the-Main, of Lyons in France, and Nijnei-Novgorod in Russia, are among the most important fairs of the present day in Europe. The fairs of Great Britain now mostly consist of the weekly market-days of country towns, and certain great agricultural meetings, or trysts, as they are called in Scotland, chiefly for the sale of cattle and horses, such as the Falkirk Tryst. There are also, especially in Scotland, a considerable number of the hiring fairs. Among the most celebrated of the fairs which have been turned into saturnalia are the celebrated Donnybrook fair in the county of Dublin; Bartholomew and Greenwich fairs, London; and Glasgow fair. The day of these fairs is, however, already past; the tide of modern improvement has long since reached the amusements of the people, and better means of entertainment are now available. In the United States the State fair and county fair, as well as the church fair, are established institutions. See EXHIBITIONS.

Fairweather, Mount, in Alaska, 35 miles northeast of Cape Fairweather. According to accurate observations its height is 14,900 feet above the level of the sea. It is covered with perpetual snow.

Fairy, an imaginary being or spirit of diminutive size, supposed generally to assume a human form, but appearing also in others, and represented as both beneficent and malevolent toward mankind. In the latter case diseases of cattle were frequently attributed to their mischievous operations; and cattle that died suddenly without any apparent cause were commonly said to be elf-shot. Among the Irish peasantry they are termed "the good people" by way of placation. In Poole's 'Parnassus' are given the names of the fairy court: "Oberon, the emperor; Mab, th empress; Perriwiggin, Perriwinkle, Puck, Hobgoblin, Tomalin, Tom Thumb, courtiers; Hop Mop, Drop, Pip, Drip, Skip, Tub, Tib, Tick, Pink, Pin, Quick, Gill, Ion, Tit, Wap, Wim, Nit, the maids of honor; Nymphidia, the mother of the maids." Croker, in his 'Fairy Legends and Traditions of the south of Ireland,' describes them as beings "a few inches high, airy, and almost transparent in body; so delicate in their form that a dewdrop, when they chance to dance on it, trembles, indeed, but never breaks." They are supposed to live in a distinct domain known as Fairyland, and their character and habits as represented in literature may best be learned from the Irish lore and such works as the 'Märchen of the Grimms'; Spenser's 'Faerie Queene,' and Shakespeare's 'Mid-summer Night's Dream.' Belief in fairies has existed from earliest times, and formed part of the superstition of nearly all peoples. Consult: Keightley, 'The Fairy Mythology' (1850). See FOLK-LORE; MYTHOLOGY; PARACELSUS; also such titles as ELVES, KOBOLD, and the like.

Fairy Bluebird, one of the bulbuls (q.v.) of the East Indian family *Pycnonotidæ* and genus *Irena,* familiar in Indian gardens, and justly admired. The commonest species is brilliant turquoise, with black wings, tail and under parts, and coral-red legs and beak. They make a rather rough little nest in a bush and lay two or three speckled eggs.

Fairy Ring, or **Circle**, a ring occasionally observed in pastures, distinguished from surrounding vegetation by being either barer or more luxuriant, and attributed by the peasantry of western Europe to the dancing of the fairies. They are now known to be occasioned by the growth of certain kinds of fungi, which, proceeding outward from a centre, render the soil for a time unfitted for the nourishment of grass, but later fertilize it by their decay.

Fairy Shrimp, a phyllopodous crustacean (*Chirocephalus diaphanus*), occasionally found in fresh-water ponds in Europe. It is about one inch in length, and nearly transparent.

Fairy-tales, stories in which fairies play a part, or which contain other supernatural or magical elements such as mark the folk-tales of 'Puss in Boots'; 'Beauty and the Beast'; 'Hop o' My Thumb'; 'Sleeping Beauty'; and others. Actual fairies seldom appear in traditional fairy-tales so called. Grimm and his successors showed by the study of comparative mythology that these tales are not restricted to Europe alone, but are to be found, in varying forms, among almost all nations. The survival of popular tales is due to their being unconscious growths, to the strict adherence to form shown by illiterate and savage people in recitals, and to the laws of the permanence of culture. There are several theories in regard to the origin of folk-tales. The oldest is the Oriental theory, which traces all back to a common origin in the Vedas. It is true that the germs of most tales are found in the Vedas, but proofs of the Indian origin of stories are lacking; the discovery of tales in Egypt which were written down in the period of the early empire are objections to its acceptance, and the idea of diffusion will not account for similar tales found in Australia, New Zealand, and America. The Aryan theory, supported by Max Müller, Grimm, and others, gives as their origin the explanation of natural phenomena. These nature-myths must not be regarded as originally metaphors; they were primitive man's philosophy of nature, in the days when every object was endowed with a personal life. The tales have enough likeness to show that they come from the same source, and enough difference to show they were not copied from each other. Müller says, "Nursery tales are generally the last things to be adopted by one nation from another." Another theory, supported by Tylor and Lang, traces the origin of folk-lore to a far earlier source than the Aryan,— the customs and practices of early man: such as totemism, descent from animals or things, which were at last worshipped; and curious taboos or prohibitions, which can be explained by similar savage customs of the present. But late authorities declare that it is useless to seek any common origin of folk-tales; since the incidents, which are few, and the persons, who are types, are based on ideas that might occur to uncivilized races anywhere.

Our popular fairy-tales, or *contes,* have been, in the main, handed down orally. However, some of their elements or variants at least have come down through ancient Oriental literature. The 'Syntipas,' a Greek version, belongs to the 11th century. Then followed translations into several European languages. The earliest collection of European tales was made by Straparola, who published at Venice in 1550 his 'Notti Piacevola,' which was translated into French, and was probably the origin of the 'Contes des Fées.' The best early collection is Basile's, the 'Pentamerone,' published at Naples in 1637. In 1696 there appeared in the 'Recueil' a magazine published by Moetjens at The Hague, the story 'La Belle au Bois Dormant' (our 'Sleeping Beauty'), by Charles Perrault; and in 1697 appeared seven others: 'Little Red Riding Hood'; 'Bluebeard'; 'Puss in Boots'; 'The Fairy); 'Cinderella'; 'Riquet of the Tuft'; and 'Hop o' My Thumb.' These were published in 1697 under the title 'Contes du Temps Passé Avec des Moralités,' by P. Darmancour, Perrault's son, for whom he wrote them down from a nurse's stories. Within this century the investigations of Jacob and William Grimm, and their successors in this field, have reduced to written form the tales of nearly all nations. We must include in the comparison of stories the Greek myths; as the Odyssey is now conceded to be a mass of popular tales. To these we must add the tales of ancient Egypt; those narrated by Herodotus, and other travelers and historians; the beautiful story of 'Cupid and Psyche,' given by Apuleius in his 'Metamorphoses' of the 2d century A.D., which also was taken from a popular myth. See BEAUTY AND THE BEAST; BLUEBEARD; CINDERELLA; ELVES; FAIRY; FOLK-LORE, etc.

Faith, in Christian theology, a term used in conformity with its New Testament signification, to express ordinary belief or conviction, based upon reasonable evidence; also signifying confidence or trust in God, in Christ, and in the objects, seen or unseen, of religious regard. It likewise means the whole body of beliefs held by the Christian Church; hence, the Christian religion itself.

As understood by Roman Catholic divines, and as defined in the Catechism of the Council of Trent, faith is "that profound conviction of the mind by which we give firm and unhesitating assent to God when he reveals his mysterious truths"; or, in the words of John Henry Newman, it is "belief in certain doctrines because God has revealed them." In the Roman Catholic system dogmas are a fundamental part of the Christian religion, no less essential than piety, love, and obedience: "Religion," says Newman ('Grammar of Assent,' chap. V.), "cannot maintain its ground without theology"; hence that "war-song of faith," the Athanasian Creed, is to the Catholic believer "a psalm or hymn of praise, of confession, and of profound, self-prostrating homage, parallel to the canticles of the elect in the Apocalypse." The Roman Catholic Church requires from all the faithful that they accept as of faith all the dogmatic canons of ecumenical councils and all the dogmatic definitions of Popes; but to accept these with "implicit" faith suffices. This faith is professed when one professes *ex animo* his belief in the one Holy Roman Catholic and Apostolic Church.

In the Protestant interpretation of faith, great emphasis is laid upon the willing surrender of the believer to the requirements of Christianity as understood by the various sects. The will itself is the chief organ of saving faith, through the action of which, in accepting the terms of salvation, the individual is brought into a state of forgiveness, justification (q.v.), and peace in his relations with God, with Christ, and with the spiritual world. The operations of the Holy Spirit are an incalculable factor with the individual, but can avail for salvation through the act of faith only with complete assent of his own will and all his being.

Faith-cure, the practice of curing or attempting to cure disease by appealing to the patient's faith, whether specifically religious in its nature or not; also any cure effected or supposed to have been effected by such means. (See CHRISTIAN SCIENCE; HYPNOTISM; SUGGESTION; THERAPEUTICS.) Questions concerning the legal status of practitioners of faith-cure under one or another name — sometimes "divine healing," "faith-healing," "mental science," "prayer-cure," etc.— have in recent years arisen in different States, but thus far no final determination of them has been reached. In view of present phases of these questions, in this and other countries, the following abstract of an opinion handed down 13 Oct. 1903 by the New York State Court of Appeals has a timely interest, especially as dealing with what many regard as a test case.

In 1901 a citizen of the State of New York, a member of the Christian Catholic Church, organized by John Alexander Dowie (q.v.), with which avoidance of drugs is a cardinal principle, was found guilty in a court of that State of violating the Penal Code by omitting to perform a duty imposed by the law — the furnishing of medical attendance for his sick child, who died of her illness. He was fined $500. The judgment was reversed by the Appellate Division, and the state appealed. In the opinion handed down by the Court of Appeals, affirming the verdict of the trial court, the main points presented are as follows:

After the adoption of Christianity by Rome and the conversion of the greater part of Europe, there commenced a growth of legends of miracles connected with the lives of great men who became benefactors of humanity. The great majority of miracles recorded had reference to the healing of the sick through divine intervention, and so extensively was this belief rooted in the minds of the people that for 1,000 years or more it was considered dishonorable to practise physic or surgery. At the Lateran Council of the Church, held at the beginning of the 13th century, physicians were forbidden, under pain of expulsion from the Church, to undertake medical treatment without calling in a priest; and as late as 250 years thereafter Pope Pius V. renewed the command of Pope Innocent by enforcing the penalties. The curing by miracles, or by interposition of divine power, continued throughout Christian Europe during the entire period of the Middle Ages, and was the mode of treating sickness recognized by the Church. This power to heal was not confined to the Catholics alone, but was also in later years invoked by Protestants and by rulers.

With the commencement of the 18th century a number of important discoveries were made in medicine and surgery, which effected a great change in public sentiment, and these have been followed by numerous discoveries of specifics in drugs and compounds. These discoveries have resulted in the establishment of schools and colleges throughout the civilized world for the special education of those who have chosen the practice of medicine for their profession. These schools and colleges have gone a long way in establishing medicine as a science, and as such it has come to be recognized in the law of our land. By the middle of the 18th century the custom of calling upon practitioners of medicine in case of serious illness had become quite general in England, France and Germany, and indeed, to a considerable extent throughout Europe and in this country. From that time the practice among the people of engaging physicians has continued to increase until it has come to be regarded as a duty devolving upon persons having the care of others to call upon medical assistance in case of serious illness.

Formerly no license or certificate was required of a person who undertook the practice of medicine. A certificate or diploma of an incorporated medical college was looked upon by the public as furnishing the necessary qualification. The result was that many persons engaged in the practice of medicine who had acquired no scientific knowledge with reference to the character of diseases or of the ingredients of drugs that they administered, some of whom imposed upon the public by purchasing diplomas from fraudulent concerns and advertising them as real. This resulted in the adoption of several statutes upon the subject. The provision of the Penal Code [of New York State] under consideration was first adopted in 1881, following the statute of 1880 prohibiting the practice of medicine by other than a physician duly qualified in accordance with the provisions of the act. This, we think, is significant. The legislature first limits the right to practice medicine to those who have been licensed and registered, or have received a diploma from some incorporated college conferring upon them the degree of doctor of medicine; and then the following year it enacts the provision of the Penal Code under consideration, in which it requires the procurement of medical attendance under the circumstances to which we have called attention.

We think, therefore, that the medical attendance required by the Code is the authorized medical attendance prescribed by the statute, and this view is strengthened from the fact that the third subdivision of this section of the Code requires nurses to report certain conditions

FALCONS.

1. Goshawk 2. Marsh Hawk. 3. Pigeon Hawk or Merlin.
4. Fish Hawk. 5. Saker Falcon.

of infants under two weeks of age "to a legally qualified practitioner of medicine of the city, town or place where such child is being cared for," thus particularly specifying the kind of practitioner recognized by the statute as a medical attendant.

The peace and safety of the State involves the protection of the lives and health of its children, as well as the obedience of its laws. Full and free enjoyment of religious profession and worship is guaranteed, but acts which are not worship are not. Children when born into the world are utterly helpless, having neither the power to care for, protect nor maintain themselves. They are exposed to all the ills to which flesh is heir, and require careful nursing, and at times when danger is present the help of an experienced physician. But the law of nature, as well as the common law, devolves upon the parents the duty of caring for their young in sickness and in health, and of doing whatever may be necessary for their care, maintenance and preservation, including medical attendance if necessary, and an omission to do this is a public wrong which the State, under its police powers, may prevent.

We are aware that there are people who believe that the divine power may be invoked to heal the sick, and that faith is all that is required. There are others who believe that the Creator has supplied the earth, nature's storehouse, with everything that man may want for his support and maintenance, including the restoration and preservation of his health, and that he is left to work out his own salvation, under fixed natural laws. There are still others who believe that Christianity and science go hand in hand, both proceeding from the Creator; that science is but the agent of the Almighty, through which he accomplishes results; and that both science and divine power may be invoked together to restore diseased and suffering humanity. But, sitting as a court of law for the purpose of construing and determining the meaning of statutes, we have nothing to do with these variances in religious beliefs, and have no power to determine which is correct.

We place no limitations upon the power of the mind over the body, the power of faith to dispel disease, or the power of the Supreme Being to heal the sick. We merely declare the law as given us by the legislature. We have considered the legal proposition raised by the record, and have found no error on the part of the trial court that called for a reversal.

Faithful Shepherdess, The, a pastoral drama by John Fletcher, published in 1609, and ranking with 'Comus,' which it partly inspired, as one of the finest specimens of this Italian form of poetry extant in English literature.

Faithfull, Emily, English philanthropist: b. Headley, Surrey, 1835; d. 31 May 1895. Out of pure philanthropy, she founded the Victoria *Press,* 1860, in which women alone were employed as operatives. Queen Victoria encouraged her by appointing her "publisher-in-ordinary to the queen." She started the 'Victoria Magazine' as an advocate of women's right to lucrative employment, and appeared in the United States as a lecturer in 1872–82. She was the author of 'Change Upon Change,' a novel (1868); 'Three Visits to America' (1884).

Falcon, a term broadly given to any of many birds of the family Falconidæ (q.v.), but more narrowly to the species of the typical subfamily Falconinæ, whence are derived most of the hawks used in falconry. The falcons proper for strength, symmetry and powers of flight, are the most perfectly developed of the feathered race. They are distinguished by having the beak hooked at the point, the upper mandible with a notch or tooth on its cutting edge. The wings are long and powerful, the second feather rather the longest; legs short and strong. The largest falcons are the three great arctic ones represented by the circumpolar jerfalcon (*Hierofalco, gyrfalco*), and its congeners the Greenland, Iceland and Labrador falcons (see JERFALCON). The type of its race, however, is the noble peregrine (*Falco peregrinus*), to the female of which the term "falcon" was alone given by falconers, and was most highly esteemed for the fierceness, dash and perfection with which she worked. The female is about 17 inches long and 3½ feet in extent of wing; the male is 2 or 3 inches less. The head, neck, a patch under the eye and the whole upper surface are dusky, with gray and brownish shades; the throat and under parts whitish or cream-colored, with dusky bars and arrowheads; legs and feet yellow, bill bluish. It chiefly inhabits wild districts, and preys on grouse, ducks, ptarmigans, pigeons, rabbits, seafowl, etc., pouncing upon them from above with terrific swiftness and force, and always betraying the greatest courage in its encounters with rivals or in defense of its nest, which is usually placed on a ledge of some lofty cliff. This species is to be found in nearly all quarters of the globe, for the North American duck-hawk (variety *anatum*) and certain tropical forms are only sub-species.

Other American true falcons are the pigeon-hawk, sparrow-hawk (qq.v.), and some closely allied western and northern forms. Many of the Old World falcons are famous, and are elsewhere individually described, such as the European hobby, kestrel, merlin, and lanner; the Asiatic shaheen, saker, luggur, turumti and other species trained by eastern falconers; the Australasian quail-hawk, and the large African genus Baza, which has the peculiarity of possessing two "teeth" on the edge of the beak. Another interesting genus is Microhierax, containing the finch-falcons (q.v.). Falcons attain to a great age. One is said to have been found in France, about 1790, with a collar of gold dated 1610, showing it to have belonged to James I. of England.

Falconer, fâk'nėr or fâ'kon-ėr, **Hugh,** Scottish botanist and palæontologist: b. Forres, Morayshire, 29 Feb. 1808; d. London 31 Jan. 1865. He was appointed assistant surgeon on the Bengal establishment of the East India Company. Arriving in India (1830) he examined and reported on a collection of fossil bones from Ava, and won scientific standing in India. In 1832 he was made superintendent of the botanic garden at Saharanpur. He discovered the geological character of the Sewalik Hills, and in order to study their ossiferous deposits he compared them with skeletons of extant species. For these researches he received the Wollaston medal of the Geological Society of England.

Falconer, William, English poet: b. Edinburgh, Scotland, 11 Feb. 1732; d. at sea off Mozambique 1769. Having early shipped before the mast, he became before 1750 second mate of a ship trading to the Levant. The experience of a shipwreck off Cape Colonna, Greece, furnished material for the poem of 'The Shipwreck' (1762), by which he is best known. He was later appointed purser of the frigate Aurora, royal navy, bound for India. The Aurora touched at the Cape of Good Hope in December 1869 and was shortly after lost with all hands. Falconer's 'Poetical Works,' with a biography by Gilfillan, appeared in 1854.

Falconet, Etienne Maurice, ā-tē en mō-rēs făl-cō-nā, French sculptor: b. Vevay, Switzerland, 1716; d. Paris 4 Jan. 1791. Catharine II. of Russia patronized him, and he was employed by her to execute the colossal statue of Peter the Great, erected at Petersburg.

Falconidæ, a family of raptorial birds, comprising the sub-families *Gypaetinæ* (lammergeiers), *Polyborinæ* (carrion-hawks), *Accipitrinæ* (hawks), *Buteoninæ* (buzzards), *Aquillinæ* (eagles), and *Falconinæ* (falcons). They are all remarkable for strong and sharply hooked bills, with a distinct cere, usually fleshy; and most of them have sharp and powerful talons, designed to seize, kill, and tear to pieces the living prey upon which most of them subsist. In the eagles and falcons these characters are developed in the highest degree. The tarsus is usually more or less feathered, in some cases down to the very toes, which are arranged three in front and one behind, and are exceedingly strong and tenacious. There is a projection over the eyebrows except in the ospreys, which gives an appearance to the eyes of being very deeply set in the orbits. These birds range in size from the mighty lammergeier to the falconets, hardly bigger than sparrows. The female is usually decidedly larger than the male, and upon her falls the burden of the support of the young. The tribe is represented in all climates, even to the remote north, but is most numerous in the tropics, while some species are nearly cosmopolitan. Many migrate, but few show any tendency toward flocking. The color of the plumage frequently differs much in the young from that of the full-grown birds, and as their first plumage is retained for some time, this has caused more species to be enumerated than really exist. Plain tints rule, but white and black are often strikingly displayed, and a few species present a considerable variety of colors. Their voice is limited as a rule to screaming cries, but a few utter somewhat melodious notes. The nests of all are rude structures, placed in trees, on rock-cliffs, on the ground, or in some hole. The eggs are few in number — one to five as a rule — and are laid much earlier in the year than is the case with birds generally; and they and the young are well cared for and ably defended by the parents. The sport of falconry (q.v.) took its name from employing certain of these birds in the chase.

Falconio Diomede, apostolic delegate to the United States: b. Pescocostanzo, Italy, 20 Sept. 1842. He entered the Franciscan Order 2 Sept. 1860, and upon completing his studies came to the United States as a missionary, reaching Allegany, N. Y., December 1865, and being ordained priest by Bishop Timon of Buffalo, 4 Jan. 1866. In 1868 he was named president of the College and Seminary of Saint Bonaventure, Allegany, N. Y., and on 29 Nov. 1871, was sent by his superiors to Harbor-Grace, Newfoundland, at the request of the bishop of that diocese, who appointed Father Falconio his secretary and chancellor and rector of the cathedral. In 1882 he came back to the United States, where he remained a year. Returning to Italy in 1883, he was elected Provincial of the Franciscans in the Abruzzi, and in 1889 he was chosen procurator-general and later visitor-general in various provinces. He was preconized bishop of Lacedonia 11 July 1892, and on the 17th of that month was consecrated at Rome by Cardinal Monaco La Valletta. On 2 Feb. 1893, Mgr. Falconio assumed charge of his diocese. He was elevated to the United Archiepiscopal See of Accerenza and Matera in Basilicata, 29 Nov. 1895, but was called thence by Leo. XIII., 3 Aug. 1899, and appointed first apostolic delegate to Canada, taking possession at Quebec, 1 Oct. 1899. On 30 Sept. 1902, he was nominated apostolic delegate to the United States and assumed possession at Washington, D. C., 21 November of the same year.

Falconry, or **Hawking,** the employment of falcons in the chase. This sport is of Oriental origin, and has been practised in the East since before the days of any record,— in China at least 2,000 years before Christ; and it was probably followed at that date all over Asia and down into the Nile valley, for falconers with their hawks are depicted in some of the oldest Egyptian mural paintings. The sport spread over Europe with the Roman domination, but seems not to have been introduced into England until the 9th century. Many laws and social customs regulated this pursuit in Great Britain, and many terms and phrases remain in the language as an inheritance from the art and etiquette of this most elegant form of the chase. Thus the square frame on which hawks were carried to the field was named a "cadge," and the servant who bore it a "cadger"; and a "cast" of hawks meant two taken on a chase together. To "man a hawk" was to tame it; and one so thoroughly trained as to be flown with young ones to show them how to work was called a "make hawk." A hawk was said to "mew," when molting; and to "plume" when she pulls off feathers. A female of any species, but especially of the peregrine, is a "falcon"; a male a "tiercel"; one caught wild a "haggard" or "passage hawk"; one reared from the nest an "eyas," and a young one is a "red hawk"; while a falcon's nest is an "eyry." All the actions of a hawk in its work are named. A hawk "stoops" when she descends upon the "quarry" (prey) with closed wings, to kill it by a stroke of the beak; she "binds" when she seizes large prey in the air and clings to it in its fall, or "trusses" when the prey is of small size. A hawk is said to "clutch" when (as do short-winged hawks) she seizes it in her feet; to "carry," when she tries to fly away with the prey; to "check" when she flies at a bird other than the one intended for her; to "foot well" when she kills successfully; to "make her point" when she rises and hovers over some quarry which has escaped to cover, as in a thick hedge; to "ring" when she rises spirally in the air; to "take the air" when she tries to get above the fleeing quarry; to "wait on" when she hovers above her master at a certain "pitch" (height), waiting for quarry to be flushed. "Seeling" is closing the eyes with a fine thread (no longer done); "imping," mending broken feathers; "mantling," stretching out the wings or one wing and a leg; and "jarak" means keen, or in good condition for work.

The extensive agricultural changes which occurred in England during the 17th century, causing the enclosure and improvement of waste lands; the growth of towns and industry; the altered temper of the people preceding and during the Protectorate; and most of all the introduction of firearms, followed by the sports of shooting and the consequent preserving of game,— all tended toward the decline of falconry, both in England and on the Continent; and game-keepers and peasants began to shoot as "vermin" the grand and valuable birds upon which their forefathers had doted. Nevertheless the sport is still followed by fanciers who keep alive its traditions.

The hawks used in falconry are all true falcons, and nearly or quite the whole list have at some time or place been regularly trained, except in the United States, although here the best of material exists, in our duck-hawk (the peregrine), pigeon, and sparrow-hawks, southwestern prairie-falcon and others. A few clubs here and there have flown their hawks, but the sport shows little sign of becoming general in North America. It is more frequent in Central and South America. In North Africa and the Orient the sport flourishes as much as formerly; and there eagles are often employed, and quarry as large as gazelles and bustards is struck down.

Falconers divide their birds into «long-winged» or «dark-eyed» hawks, and «short-winged» or «yellow-eyed» hawks. The first class contains the true falcons, of which the great jerfalcon (q.v.) was in old times reserved for royalty, the peregrine for an earl, and the others for the nobility; hence these were known as "noble," while the goshawk, kestrel, etc., on account of the inferiority of their masters as well as of their own powers, were styled "ignoble."

Hawks are taken for training either as nestlings or when full-grown. They are trained by being hooded, made to wear bands of leather («jesses») about the legs, to which are attached "varvels" (rings, sometimes carrying bells hung by «bewits»), and a swiveled "leash"; and gradually are accustomed, at first in complete darkness, to being fed and handled, and later to feeding in the light and among spectators, and finally to take first live birds thrown toward it and finally wild quarry. During this process young birds are much at liberty and are then said to be "flying at hack."

The sport was one in which women as well as men of all classes might indulge, going afield on foot and alone, or in mounted cavalcades, and often during mediæval times with royal pomp. The hawks, hooded, were carried by servants on frames suspended from their shoulders, but each sportsman was likely to hold a favorite bird upon his gauntleted wrist — in Europe on the left wrist, in the Orient on the right. Dogs, especially small greyhounds and pointers, were likely to accompany the falconer and were put to use in flushing birds, starting hares and the like. When the hunting scene was reached the hawks were prepared for flight, and some were freed to «wait on» until quarry was sighted; but others, trained differently, were kept hooded until the falconer himself started or perceived the game, when they were unhooded and sent after it. The sportsmen then followed, watched the chase, and recovered prey and hawk as well as they could. Good falcons show a keen interest and great intelligence in their work.

Many books describe both the sport and the falcons in great detail. One of the best of the early works is ‘The Booke of Faulconrie or Hawking,’ by Turberville (1575). Recent British authors of repute are Brodrick, Salvin, Freeman (‘Practical Falconry,’ 1869), and J. E. Harting (‘Hints on the Management of Hawks,’ 1884). The latest general work is ‘Coursing and Falconry,’ by Cox & Lascelles, in the Badminton Library, 1892.

Faldstool, or Foldstool, the name of various pieces of English church furniture, the principal being a portable folding seat, also called faldistory, similar to a camp-stool used by a bishop when officiating in other than his own cathedral church; and a small desk at which the litany is read, the name dating from a period when folding lecterns were used.

Falerii. See FALISCI.

Falernian Wine, one of the favorite wines of the Romans, so called from *Falernus Ager* (the Falernian Field), the district in which it was grown, in Campania, Italy. It is described by Horace as, in his time, surpassing all other wines then in repute. In the time of Pliny, however, as he himself informs us, Falernian wine had already, owing to a want of care in its cultivation, begun to decline in quality. See WINE.

Falguière, Jean Alexandre Joseph, zhŏṅ ä-lex-zäṅdr făl-gyăr, French sculptor and figure painter: b. Toulouse, France, 7 Sept. 1831. Both in sculpture and painting his work is of very notable excellence, and displays originality and vigor. The Luxembourg Gallery in Paris contains his sculptures: ‘Christian Martyr’ (1868); and ‘Victor in the Cock Fight’ (1870). Among his most noted paintings are: ‘The Wrestlers’ (1874); ‘Susanna’; and ‘Slaughter of a Bull’ (1881).

Falieri, Marino, mä-rē'nō fä-lē-ā'rē, Doge of Venice: b. 1278; d. Venice 17 April 1355. He commanded the troops of the republic at the siege of Zara in Dalmatia. He there gained a brilliant victory over the king of Hungary, and was afterward ambassador to Genoa and Rome. He was elected doge of Venice on 11 Sept. 1354, but in the following year dissatisfaction with the light punishment imposed upon a noble who had insulted Falieri's young wife caused him to conspire with the lower orders to overthrow th republic and make himself sovereign of the state. His plot was discovered on the night before it was to have been consummated, and he was beheaded 17 April 1355. The last scenes of his life are depicted in Byron's tragedy of ‘Marino Falieri.’ Plays have been written on the same subject by Casimir Delavigne and Swinburne.

Falisci, fȧ-lis'ī, a people of Etruria, said to have been originally a Macedonian colony. They occupied Falerii, one of the 12 Etruscan cities. When they were besieged by the Roman general Camillus, a schoolmaster offered to betray his pupils into the hands of the enemy, that, by such a possession, he might easily oblige the place to surrender. Camillus heard the proposal with indignation, and ordered the man whipped back to the town by the very pupils whom his perfidy would have betrayed. This instance of magnanimity operated upon the people so powerfully that they surrendered to the Romans.

Falk, Paul Ludwig Adalbert, powl lood'vĭH ä'däl-bĕrt fälk, Prussian statesman: b. Metschkau, Silesia, 10 Aug. 1827; d. 7 July 1900. He was appointed minister of public worship and education in 1872, and in this capacity was mainly instrumental in carrying the so-called May laws (because passed in May 1873–4–5), aimed at the restriction of the Roman Catholic

Church in Germany, by limiting the influence of the clergy in the schools, by reorganizing the seminaries for the training of teachers, and by defining in a stricter and more comprehensive manner the relations generally of the clergy to the state. When, however, Bismarck came to bid for the support of the clerical party, in order to carry out his later internal policy, Falk was compelled to resign.

Falk, fälk, **Johannes Daniel,** German author: b. Dantzic, Prussia, 28 Oct. 1768; d. 14 Feb. 1826. His capacity for satire was considerable. Among his works are: ‘A Pocket Book for Friends of Jest and Satire’ (1797); ‘Men and Heroes’ (1796), a satire in verse, and ‘Prometheus’ (1804), a dramatic poem.

Falke, Jacob von, yä'cōp fon fäl'kĕ, German connoisseur and historian of taste: b. Ratzeburg 21 June 1825. His administrative capacity has placed many art galleries and repositories of art treasures in Germany and Austria upon a successful basis. His writings, particularly ‘Knightly Society in the Days of Homage to Womanhood’ (1862); ‘History of Modern Taste’ (1866); ‘Art and Art Study’ (1878); ‘Hellas and Rome’ (1879); and ‘History of Taste in the Middle Ages’ (1893), are notable for both learning and judgment.

Falkirk, fâl'kėrk, **Battle of,** a contest in which Edward I. of England gained a victory over Wallace 22 July 1298. The king's army is said to have contained 7,000 to 8,000 mounted men and 80,000 footmen. Wallace's force amounted to about a third of the English army. His infantry was drawn up in circles, the men in the outer ring kneeling and holding their lances obliquely. The archers occupied the centre of the circles. The overwhelming superiority of the enemy's horse, however, decided the battle. Wallace retired with a small body to Stirling, but the bulk of his army was broken up and destroyed. See WALLACE, SIR WILLIAM.

Falkland, fâk'land, **Lucius Cary,** VISCOUNT, English statesman and soldier: b. probably at Burford, Oxfordshire, 1610; d. Newbury 20 Sept. 1643. In 1633 he succeeded his father in the peerage, and for some years after chiefly resided at his seat of Burford, which he made a kind of academy of learned men, being continually surrounded by the scholars from the neighboring universities, and visitors from London. Here it was that Chillingworth composed his famous work against «Popery»; and questions of morals, theology, and literature were discussed in a congenial circle with the utmost freedom. In 1640 he was chosen member of the House of Commons for Newport, Isle of Wight. At first he warmly supported the Parliament party, but a strong attachment, however, to established forms, and some doubts of the ultimate objects of the parliamentary leaders, caused him to retract, and he embraced the party of the king when hostilities commenced, and attended him at the battle of Edgehill and the siege of Gloucester. At the battle of Newbury he was struck from his horse by a musket-shot, and was found the next day dead upon the field.

Falkland Isles, two large islands, with a number of smaller ones surrounding them, in the South Atlantic Ocean; about 300 miles east of the Strait of Magellan. Area, 7,510 square miles. The soil is light, and but scanty crops are obtained. Sheep raising is the principal occupation. The capital is Stanley. These islands were discovered by Davis in 1592, and came into the possession of the British in 1771. Their appropriation has been at times disputed; but since 1833 the British have held uninterrupted occupancy of them. Pop. (1901) 2,043.

Falkner, fäk'nėr, **Roland Post,** American statistician: b. Bridgeport, Conn., 14 April 1866. He was graduated at the University of Pennsylvania in 1885; studied economics at Berlin, Leipsic, and Halle-on-Saale, Germany; was instructor in accounting and statistics in the University of Pennsylvania in 1888–91, and professor of statistics in 1891–1900. He served also as statistician of the United States Senate Committee of Finance in 1891; as secretary of the United States delegation to the International Monetary Conference; and as secretary of the conference in 1892. He is author of numerous essays on criminology, sociology, etc.; chief of the division of documents in the Library of Congress, and editor of ‘Annals’ of the American Academy of Political and Social Science.

Fall Army Worm, the caterpillar of a gregarious moth (*Laphygma frugiperda*). See GRASS-WORM.

Fall-fish, or **Silver Chub,** a cyprinodont fish, or «minnow» (*Semnotilus corporalis*) of the eastern United States. It is very common east of the Alleghanies in clear, swift streams and rocky pools, and reaches 18 inches in length. It is steel blue above, sides and belly silvery, but in the breeding season the fins and lower surface of the males are rosy. The fins are of moderate size and unspotted.

Fall of Man, a commonly received doctrine of Christianity, founded upon the historical narrative contained in the third chapter of the book of Genesis, together with the allusions to the same matter in other parts of Scripture. The history of the fall, as given in Genesis, contains the following particulars: God having placed Adam and Eve in the garden of Eden, and forbidden them under pain of death to eat of the fruit of the tree of the knowledge of good and evil, Eve, tempted by the serpent, first ate of the fruit herself, and afterward gave of it to her husband, who followed her example. Both were driven out of Eden. Punitive sentences were passed upon each of them, and upon the serpent, which is alluded to by St. Paul as representing the devil. In the subsequent narrative the consequences of the fall significantly appear. The first man born of the original pair is a murderer, and his descendants grow in wickedness until a flood is sent to carry them away. As might be expected, this most suggestive narrative has given rise to inexhaustible controversy. The opinions on the fall may be divided into three classes: those which reject the narrative altogether; those which accept it as a mythical or allegorical account of the origin of evil; those which regard it as in the main historical. As a mere matter of literary criticism, the uninterrupted flow of the narrative down to times and events evidently historical, together with the uniformity and sobriety of its style, leave little ground for the supposition that the writer himself supposed he was dealing in allegory. The historical view of the fall, besides the theoretical controversies to which it gives rise as to its account of the origin of evil, encounters difficulties from two sources — the modern sciences of chronology and ethnology. In the meantime these remain difficulties only, as these sciences are by no means in a state of sufficient maturity to allow their conclusions to be absolutely applied. It is remarkable that in most mythologies the serpent is worshipped as a beneficent being, though Tylor shows that Aji Dahaka of the Zarathustrians (Zoroastrians), which is a personification of evil, may have an historical connection with the serpent of Eden. With regard to the relation of man's fall to that of Adam, St. Paul says "by one man's disobedience many were made sinners" (Rom. v. 19), and "as by one man sin entered into the world, and death by sin, and so death passed upon all men for that all have sinned" (ver. 12). It seems impossible to reconcile the constant appeals made in Scripture to the moral nature of man with the notion that that nature is inherently and radically corrupt. It would also appear that the statements of Scripture with regard to the actual moral condition of man, strong as they are, do not absolutely require this mode of accounting for them. Without supposing any radical change of man's moral nature, or even any change of it whatsoever, it is only necessary to suppose a change in his relation to God to explain all that is said regarding him. It is supposed that man's moral nature consists of capabilities which are good or bad according as they are directed, and that God himself is the object of all its highest aspirations. The fall being supposed to consist in the alienation of man from God, it is easy to perceive that all these aspirations, being deprived of their proper objects, must apply themselves to improper ones, and become evil in their tendency; hence the sudden rise of pride, selfishness, ambition, and all evil passions. In as far also as man's nature is affected by the hereditary transmission of qualities it might become actually vitiated in its tendencies, and this, together with the accumulation of evil habits, would produce those climaxes of violence or corruption which have from time to time convulsed or disintegrated society, which have called forth the denunciations of prophets, and by their very excesses have produced a reaction, which, however, has left human nature as incompetent to guide itself as ever, and ready, after a period of repose, to progress toward another crisis. The fall, according to this view, consists in the moral inadequacy of man's nature when left to itself, and the actual evils flowing from this inadequacy. It is argued by theologians that in the original sentence pronounced on the transgressors there is contained the promise of a redemption, and they maintain that the whole scope of Scripture is directed to the development of this promise, and of the scheme of providence associated with it. It is from the New Testament, however, and not from the Old, that the whole doctrine of the fall has been built up. Milton seized on this as the groundwork of his two great poems. See ADAM; ORIGINAL SIN.

Fall Poison, the name given in the United States to the plant *Amianthium muscætoxicum,* so called because cattle feeding on its foliage in the fall of the year are poisoned.

Fall River, Mass., city, port of entry, in Bristol County; on Mount Hope Bay at the mouth of the Taunton River; on the New York, N. H. & H. R.R.; 49 miles south of Boston. It is connected with New York by the Fall River line of steamers, with Philadelphia by the Windsor freight line, and with New England seaports by passenger and freight lines of steamers. The area of the city is 41 square miles, and it is 200 feet above sea-level. It has a good harbor, sufficiently commodious for the largest steamers, and excellent water power, as the Fall River, the outlet of Watuppa Lake, has a fall of 129 feet in less than half a mile. The water for city uses comes from Lake Watuppa, and the waterworks plant is owned by the municipality. The streets are well laid out; many of the buildings are constructed of the granite which is found in the vicinity. It has excellent public and parish schools, notably the B. M. C. Durfee public high school and the Academy La Ste. Union des Sacrés Cœurs; good circulating libraries, a State armory, over half a hundred churches and chapels, daily and weekly newspapers, and electric street railway connections with neighboring cities and towns.

Fall River is the largest cotton-milling city in the United States. According to the Federal census of 1900 the city had 785 manufacturing establishments, employing $58,549,934 capital, and 32,780 persons; paying $11,739,129 for wages, and $19,789,859 for materials; and having a combined output valued at $43,071,530. The cotton industry, 42 establishments, with $45,641,084 capital, and a combined output valued at $29,097,667. Next in value of output was the dyeing and finishing of textiles ($2,995,979). Other important manufactures were foundry and machine shop products ($932,873); bakery products ($555,267). In 1901 there were 7 national banks with $2,150,000 capital and $1,193,779 surplus and several savings and co-operative banks. The exchanges at the United States clearing-house during the year ending 30 Sept. 1901, aggregated $45,369,554.

The city was originally a part of Freetown, but was incorporated separately in 1803. Later it was called Troy, but its first name was restored in 1834. The city charter was granted in 1854, and in 1862 Fall River in Newport County, R. I., was annexed. Pop. (1905), 105,762. JOHN H. ABBOTT.

Fall Trank, a drink once reputed to cure the effects of falls; a vulnerary made from several aromatic and slightly astringent plants which grow chiefly on the Swiss Alps; hence the name *Vulneraire Suisse,* given to such dried plants cut into fragments. Within the 19th century, in England, a kind of vulnerary known as black beer was often prescribed in country practice for inward bruises.

Fall Webworm. See WEBWORM.

Fallacy, in logic, an argument used as decisive of a particular issue, which in reality it does not decide. Fallacies are variously classified by different logicians. A fallacy may either exist in the substance or in the form of the argument. If it exists in the substance it does not belong to logic, as commonly understood, to expose it; but logicians differ as to what constitutes the proper distinction between form and substance. J. S. Mill in particular extends the sphere of logic in respect to the treatment of fallacies beyond what has been usually assigned to it.

Fallen Timbers, Battle of, 20 Aug. 1794; on the Maumee River, about 15 miles from Toledo, Ohio. The Indians had about 2,000 warriors, with 70 white rangers, French, English, and renegade Americans; they were in a line some two miles long at right angles to the river, behind a forest blown down by a hurricane. Wayne had some 3,000 men; 2,000 regulars, and 1,000 mounted volunteers from Kentucky, under Charles Scott, who were thrown to the left to turn the Indians' flank. The Indians began the attack and drove in the advance volunteers; then Wayne sent his regular cavalry to repel them, while his first line of infantry advanced with trailed arms, firing at close range and then charging with the bayonet. Both attacks were entirely successful. Less than 1,000 of the Americans were engaged. They chased the Indians up to the British fort some miles away. Their total loss was 33 killed and 100 wounded, the Indians and British probably losing two or three times as many killed. Eight Wyandot chiefs were slain. This defeat, the greatest ever suffered by the northwestern Indians, led to the treaty of Greeneville (q.v.).

Fallet, Nicholas, French author: b. Langres in the department of Haute-Marne, France, 1753; d. Paris 22 Dec. 1801. He was the son of a hatter, and was destined for the bar; but irresistibly drawn toward literature he removed to Paris, where he became a contributor to the ‹Gazette de France,› the ‹Journal de Paris,› and the ‹Dictionnaire Universel.› Chief among his works are the tragedies ‹Barnevelt› (1775) and ‹Tibère› (1783); the comic opera ‹Matthieu› (1783), ‹Les Fausses Nouvelles,› a comedy, and two collections of poems, ‹Mes Prémices› (1773), and ‹Mes Bagatelles› (1776).

Fallières, Clément Armand, French politician and statesman: b. Mézin, in the Department of Lot-et-Garonne, 6 Nov. 1841. He studied law, was admitted to the Bar of Nérac, and from 1871–5 was mayor of that city. In 1876, 1877, and 1878 he was elected as a Republican to the Chamber of Deputies, in the latter year being appointed Minister of the Interior, a position which he again occupied in 1882 and 1883. From 1883–5 and again from 1889–90 he was Minister of Public Instruction; in 1887 Minister of the Interior; and in 1887–8 and again from 1890–2 Minister of Justice. In 1890 he was elected Senator, a position which he has held ever since. In 1899, when Loubet became President of the Republic, Fallières succeeded him as President of the Senate, a post to which he was elected in 1900 and on 11 Jan. 1906. On 17 Jan. 1906 the National Assembly elected him President of the Republic to succeed Loubet (q.v.).

Falling Bodies. See ACCELERATION; FORCE; FORCE OF GRAVITY; GRAVITATION; GRAVITY; MECHANICS; etc.

Falling-sickness. See EPILEPSY.

Falling Stars. See METEORS.

Fallmerayer, Jacob Philipp, yä'kōp fē'lip fäl'mē-rī-ėr, German author: b. Tschötsch, Austrian Tyrol, 10 Dec. 1790; d. Munich 26 April 1861. As a scholar, especially linguist, and as an explorer of the Orient, his fame is international and his work authoritative. He published: ‹Fragments from the Orient› (1845); ‹History of the Peninsula of Morea in the Middle Ages› (1830), and other important writings.

Fallopian Tubes, two ducts or canals about five inches long and one third of an inch in diameter, attached to the upper corners of the uterus. Within they are lined by a mucous membrane continuous with that of the uterine cavity, but differing in having cilia. Outside of the mucous membrane there is a thin layer of muscle-tissue. The outermost layer is from the peritoneum, in large part a fold of the "broad ligament." At the free end the tube flares out into fimbriæ, thus exposing a large surface to catch the ova given off from the surface of the adjacent ovary. Aided by the waving cilia, an ovum passes down this tube to the uterine cavity, there to undergo development or to be extruded with menstrual blood. Spermatozoa can pass up the Fallopian tubes and impregnate an ovum within the lumen. Development then becomes possible, giving rise to tubal pregnancy or ectopic gestation.

Fallopio, Gabriele, gä-brē-ä'lē fäl-lop'pē-ō (usually known as FALLOPIUS), Italian anatomist: b. Modena 1523; d. 9 Oct. 1562. He studied at Ferrara and at Padua, at which last place he is said to have attended the lectures of Vesalius. He became professor at Ferrara, whence, in 1548, he removed to Pisa. He continued there three years, and was then made professor of surgery, anatomy, and the materia medica at Padua, where he remained till his death. The principal work of Fallopius is his ‹Observationes Anatomicæ› (1561, 8vo), which, as well as his other writings, has been several times reprinted. He was the first anatomist who accurately described the vessels and bones of the fœtus; and his account of the Fallopian tubes in females has perpetuated his name.

Falloux, Alfred Frédéric Pierre, äl-fred frā-dā-rik pē är fä-loo, French writer: b. Angers, France, 7 May 1811; d. there 7 Jan. 1886. Legitimist and clerical sympathies influenced his career, his typical writings being: ‹Madame Swetchine, her Life and Works› (15th ed. 1884); ‹Story of Louis XVI.› (6th ed. 1881); and ‹Political Speeches and Miscellany› (1882).

Fallow, land which, after being tilled, is left for a season or more without being planted or sown. The Roman system of wheat raising was a rotation of fallow and wheat alternately. Under the Romans Britain exported a great quantity of wheat, and for centuries afterward the same system was followed. The method presupposed a moderately fertile soil, and turned out best where clay was present. The object of fallowing is to liberate fertilizing elements from the mold, admitting air and destroying noxious plants and insects. Improvements in agricultural methods and the multiplication of fertilizing material has caused the abandonment of this resort to fallowing which, however, might in some cases be revived with advantage. For summer fallow the land should be ploughed at the end of May; for winter fallow the land should be ploughed in autumn.

Fallow crops is a term applied to green

manuring crops (see GREEN MANURING), which are of more advantage in moist than in dry climates, where injury is likely to be wrought by autumnal draughts. Bastard fallowing is the Scotch practice of ploughing hay-stubble at the end of summer. It is known in North America as short fallow and is very beneficial.

Fallow-deer, a dun-colored deer (*Dama platyceros*) native in southern Europe, and eastward. It is smaller than the red deer, has palmated antlers, and soft, fine fur. Its color is yellow-brown in summer, shading to white on the ventral surfaces, and its winter coat is darker. It is usually spotted, especially when a fawn. The male is called a buck, the female a doe, the young a fawn. The doe is without horns. The deer is smaller than the stag and has more spreading horns. It goes in herds and each herd has its master, an old buck, which all the others obey. This is a woodland deer, whose flesh supplies one of the choicest varieties of venison. Though native only southward the fallow-deer has been introduced into the parks and game-preserves of northern Europe, whence it has in some instances escaped and returned to a wild state. It has multiplied and flourished, especially in England.

Fallows, Samuel, American Reformed Episcopal bishop: b. Pendleton, Lancashire England, 13 Dec. 1835. He came to America in 1848; was graduated at the University of Wisconsin in 1859; was minister in the Methodist Episcopal Church 1859–75, and later of the Reformed Episcopal Church. He served with distinction in the Civil War; was State superintendent of public instruction in Wisconsin 1871–4; regent of the University of Wisconsin in 1866–74; and president of Wesleyan University in 1874–5. He became rector of St. Paul's Reformed Episcopal Church in Chicago in 1875, and bishop in 1876. He is author of numerous works, including: 'Handbook of Abbreviations and Contractions'; 'Life of Samuel Adams'; 'Students' Biblical Dictionary'; 'Past Noon'; 'Splendid Deeds'; 'Supplemental Dictionary of the English Language,' etc.

Falls City, Neb., city, county-seat of Richardson County; on the Burlington & M., and the M. P. R.R.'s; about 85 miles southeast of Lincoln. Its chief manufactures are flour, canned goods, cigars, foundry products, furniture, and beer. The trade is chiefly in wheat, corn, cattle, and manufactured articles. The electric light and waterworks plants are owned by the city. It has a good public library. Pop. (1900) 3,022.

Falmouth, fal'muth, England, a seaport town in the county of Cornwall, at the mouth of the Fal River, 11 miles from Truro. It has a good harbor, and a fine and spacious roadstead. There are two castles on the coast, one of which, Pendennis, commands the entrance of the harbor; and the other, on the opposite side, is St. Mawes Castle. Its trade consists chiefly in tin, copper, firearms and ammunition, and chemical products. Pop. 11,825.

Falmouth, Ky., city, county-seat of Pendleton County; 32 miles southeast of Cincinnati; on the Licking River, the Louisville & N. R.R. It is in an agricultural region, and its manufactures are woolen goods, flour, lumber, dairy products, and canned goods. Live stock and tobacco are shipped to Covington and Newport on the Ohio River. Pop. (1900) 1,134.

Falmouth, Mass., town in Barnstable County; on Buzzard's Bay, Vineyard Sound, and on the New York, N. H. & H. R.R., at the extreme west end of Cape Cod; 50 miles northwest of Boston. It is the centre of an agricultural and cranberry region. It is best known as containing the Wood's Holl (q.v.) Station of the United States Fish Commission. Pop. (1900) 3,500.

False Bay, an inlet on the coast of Cape Colony, South Africa; circular in form, about 24 miles long, and so well protected from storms as to make it a good shelter harbor. It is a British naval station.

False Cadence, a musical term. When the last chord of a phrase is other than the tonic chord, and is preceded by that of the dominant, the cadence is said to be interrupted, false or deceptive. See CADENCE.

False Chinch-bug. See WHEAT INSECT PESTS.

False Decretals. See DECRETALS, FALSE OR PSEUDO-ISIDORIAN.

False Demetrius, The. See DEMETRIUS.

False Imprisonment, the unlawful detention of a person, whether in a common prison or a private house, or even by forcibly detaining one in the streets or highways. The law punishes false imprisonment as a crime, besides giving reparation to the party injured, through an action in tort.

False Indigo, a common name for some American species of the genus *Amorpha,* of the pea family. The most widely known plant called by this name is *A. fruticosa,* a shrub growing from 5 to 20 feet in height, along streams in Ohio, Minnesota and Manitoba, south to Florida, Colorado and Mexico. When found in the Middle States, it is an escape from cultivation, its spike of purple flowers making an exceedingly ornamental shrub.

False Personation, for the purpose of obtaining property of others, was formerly a misdemeanor punishable by a fine or imprisonment, but is now made penal by special statute. The penalties for personation are frequently heavy. Thus to personate the owner of any share, stock, or annuity, etc., is felony, and liable to a term of imprisonment. The false personation of voters at an election is a misdemeanor punishable with imprisonment.

False Point, a cape and harbor of Bengal, 43 miles east of Cuttack. The harbor, with its large lighthouse on the cape, is safe and capacious, and is considered the best between Calcutta and Bombay; it is the entrepôt for the trade of Orissa, and a regular port of call for the British Indian Company's steamers. The name was given because frequently this projection was mistaken for Point Palmyras.

False Pretenses, for the purpose of obtaining property is a misdemeanor at common law, and punishable by fine or imprisonment. Some kinds of it are now punishable by imprisonment not exceeding five years, the statutes, however, varying in different States.

False Scorpion, or **Book Scorpion,** a diminutive spider-like creature of the order

Pseudoscorpionida (see ARACHINDA), allied to the «harvestmen» and «false spiders.» They occur in all the warmer parts of the world, under bark, stones and rubbish, or hidden in deep moss; and one typical species, the «book scorpion» (*Chelifer cancroides*), infests museums, old libraries, and dusty corners generally. Unlike the spiders these have no constricted «waist» separating the abdomen from the foreparts; and like the true scorpions the pedipalps are developed into relatively enormous chelate arms. The book scorpion thus resembles a minute crab. They are slow in their motions, feeling their way along with their pincers; and several blind species inhabit caverns. They have spinning glands, situated in the cephalothorax, but use the silk only for making small protective cells or cases into which they retreat when laying eggs (afterward carried about by the female), or molting, or during hibernation.

False Spider. See SCORPION SPIDER.

False Weights and Measures. See WEIGHTS AND MEASURES.

Falsetto (Ital.), in singing, a term applied to the notes above the natural compass of the voice. It is also called a head or throat voice, in contradistinction to the chest voice, which is the natural one. The falsetto voice is produced by tightening the ligaments of the glottis. Its thin, constrained effect is most noticeable in men with deep-set voices, the register of which it frequently extends more than an octave above the pure chest voice.

Falstaff, fâl'staf, SIR **John,** a character in Shakespeare's dramas, 'Henry IV.,' Parts I. and II.; 'Henry V.,' and 'Merry Wives of Windsor,' conspicuous for lying, cowardice, drunkenness, and boastfulness, yet brimming over with wit and geniality. See FASTOLF, SIR JOHN.

Falster, fäl'stĕr, **Christian,** Danish poet: b. 1 Jan. 1690; d. 24 Oct. 1752. His 'Satires' on his age, modeled on Juvenal, gave him eminent rank among the native poets. He wrote three volumes of 'Philological Amenities or Various Discourses,' containing a mass of highly interesting observations on the affairs of the time.

Falster, one of the Danish islands in the Baltic, separated by narrow straits from Zealand on the north, Moen on the northeast, and Laaland on the west; area, 18 square miles. It is well watered, richly wooded, and so prolific in fruit that it has been called the «Orchard of Denmark.» The chief products are corn, hemp, hops, cattle, honey, and wax. Some shipbuilding is carried on. The capital is Nykjöbing. Pop. (1901) 34,422.

Falun, or **Fahlun,** fä'loon, Sweden, town, capital of the county (län) of Kopparberg; on a stream connecting lakes Varp and Runn; 130 miles northwest of Stockholm. What is now included in the town of Falun was once nine little villages. Many of the buildings date from the 14th century; one, an old church, has a green copper roof. It is the seat of a mining school, and it contains a hospital, gymnasium, and several other public buildings of note. The town owes its prosperity to the copper mines in the vicinity, which have been called the richest in the world. Gold and silver are also mined, but the rich «copper mines of Falun» have given to the town the name of «The Treasury of Sweden.» Pop. (1901) 10,023.

Consult: Nordenström, 'L'Industrie Minière de la Suéde' (1897); Sundbarg, 'La Suéde, son Peuple et son Industrie.'

Faluns, fä-lun̄, a French provincial term for the shelly Tertiary (Upper Miocene) strata of Touraine and the Loire. Though generally composed of shelly sand and marl, in some districts they form a soft building stone, chiefly composed of an aggregate of broken shells, bryozoa, corals, and echinoderms, united by a calcareous cement. They are found in scattered patches of wide extent, but rarely more than 50 feet in thickness; they have long been known and utilized for their fertilizing properties. The fossils are chiefly marine, but there occur also land and fresh-water shells, and the remains of numerous mammals.

Fama, fā'ma, in mythology, the Roman goddess of fame, rumor, reports, news, or tidings of any sort, whether good or evil. A graphic description of this goddess is found in Virgil, who represents her as winged and with as many ears, eyes, and tongues as feathers. She is sometimes pictured with a trumpet, either blowing it or holding it in her hand.

Famagosta, fä-mä-gos'tä, or **Famagusta,** fä-mä-goos'tä (ancient ARSINOE), a seaport on the Island of Cyprus, 40 miles east of Nicosia. Famagosta, during the Venetian régime, was one of the richest and most populous towns in the Levant. The name, Fama Augusta, shows its Roman origin. It is now almost in ruins, with its once fine harbor nearly choked with sand, having declined since its conquest by the Turks in 1571. About five miles northeast are the ruins of Constantia, occupying the site of the ancient Salamis, now called Eski, or Old Famagosta. Guy de Lusignan was here crowned king of Cyprus in 1191. Since Great Britain obtained control of Cyprus, Famagosta has begun to revive in importance. Pop. (1901) 3,825. (See CYPRUS.) Consult: Fyler, 'Development of Cyprus, and Rambles on the Island'; Cesnola, 'Cyprus; its Ancient Cities.'

Familiar Spirit, one of those demons or evil spirits which were supposed to attend and be at the service of a magician or other favored person. The belief in familiar spirits is very ancient, and by the law of Moses such as had familiar spirits were to be put to death. Where Socrates speaks of his attendant demon, he is generally understood to refer to the inner feelings and promptings of his nature, and not to any familiar spirit. In Eastern countries the belief in familiar spirits is very general. Attendant genii in Oriental tales are represented as sometimes good and sometimes evil. The «slave of the lamp» mentioned in the 'Arabian Nights' is a well-known illustration of this superstition. A belief in familiars was widely diffused over Europe in the Middle Ages. Jovius says that Cornelius Agrippa was always accompanied by a devil in the form of a black dog; and Goethe makes Mephistopheles first appear to Faust in this shape. Paracelsus was believed to carry about with him a familiar spirit in the hilt of his sword. See WITCHCRAFT.

Familists, name of a sect which arose in Holland about the middle of the 16th century, and taught that the essence of religion consisted in the feelings of divine love; hence they were otherwise called the Family of Love.

Familistère, fä-mē-lē-stär (Fr.), a community living as one family; a familistery. It is especially used as referring to the community established by Godin (q.v.) in Guise, France. See GUISE.

Family, a category in the classification of animals and of plants, which falls between the narrower «genus» and the broader «group» order. It designates a natural group determined by the common possession of characters of a broader kind than those which determine the limits of a genus, and may be composed of many genera exhibiting the required affinity, or of only a single genus represented by one species. In the former case minor subdivisions may be convenient under the designation *sub-family;* an example of this occurs in *Falconidæ* (q.v.). On the other hand, certain groups of families, forming subdivisions of an order (q.v.), and called *super-families,* are sometimes made. In zoology a group of forms is ranked as a family on considerations of form as expressive of structure. This is sometimes very plain, as in the cat family, or the owl family; but frequently the limits are less easily marked, and the rank remains a subject of dispute pending the decisive results of better information. In zoology the technical name of a family, usually derived from that of its most typical or prominent genus, always ends in *idæ.*

In botany the corresponding category — that is, an assemblage of genera — is more frequently designated a «natural order,» and its taxonomic name always ends in *aceæ.* It is based upon similar appearance and habit of growth and flowering, as the *Ranunculaceæ, Coniferæ.*

Family Compact, the name given to a compact organized by the Duke de Choiseul, first minister of Louis XV., between the various members of the Bourbon family, then sovereigns of France, Spain, the Two Sicilies, Parma, and Piacenza, mutually to guarantee each other's possessions. It was signed 15 Aug. 1761. It entailed on Spain a war with England, then at war with France. Other similar agreements, especially those of 1733 and of 1743 between France and Spain, bear the same name.

Family, Law of. See LAW OF FAMILY.

Famine, a dire want of food affecting considerable numbers of people at the same time. Irregular rainfalls in tropical climates, imperfect methods of irrigation, or, as in Ireland, the too exclusive dependence of the mass of the people on a single article of food which happens to fail, are among the commonest causes of famines. In the early and mediæval ages they were frequent. The year 879 was one of universal suffering from lack of food. The famine of 1125 diminished the population of Germany one half. All through the Middle Ages public opinion upheld the city authorities in driving out of the gates the neediest inhabitants and letting them perish. In a famine which devastated Hungary in 1505 parents who killed and ate their children were not punished. It was after a famine of 1586 that the poor-law in England had its beginning. As late as the middle of the 17th century famines were a common affliction in Europe and even in the 18th century they still occurred. The last time a period of bad harvests was designated as a famine in Germany was in 1817. The rapidity of modern communication and transport has made severe famine almost impossible in western or central Europe or North America. In Ireland, famines more or less serious have at various times prevailed owing to failure of the potato crop. In 1846 the dearth was so great that 10,000,000 sterling were voted by Parliament for relief of the sufferers. India has long been subject to great famines, and the government's budget makes annual provision against such need. Under the rule of the English, the population has greatly increased, and as the majority of people live from hand to mouth in ordinary times, the slightest failure in the rice crop causes the famine point to be immediately reached. In 1769–70 as many as 3,000,000 perished; in 1865–6 about 1,500,000, and in 1877 about 500,000. The authorities grappled very successfully with the famines of 1896–7 and 1899–1900, which extended over large areas, yet there was great loss of life. The recent famine in India cost the government in 1900–1 $28,235,000, of which amount $21,135,000 was expended in direct relief. Apart from this $13,700,000 was advanced to native states for famine relief and $4,735,000 for special agricultural advances. Much help was sent from other countries, including very large contributions from the United States. In 1870–2 Persia lost 1,500,000 inhabitants, a quarter of the whole population. In China over 9,000,000 are said to have perished in 1877–8 from famine. In the northern provinces of Shensi, Shansi, and Honan, with a population of 56,000,000, during the years following 1877 it was reckoned that between 4,000,000 and 6,000,000 people perished, and famine visited the empire in 1903. In the famine of 1891–2 in Russia it was estimated that in 18 provinces 27,000,000 of inhabitants were affected. Although many of the causes of famine are beyond human control, it is probable that the extension of sound agricultural knowledge and the adoption of a more rational system as regards the kinds and quantities of crops grown will in the future render famine almost unknown in most countries.

Famine Fever. See RELAPSING FEVER.

Fan-Cheng, făn-cheng', China, city in the province of Hu-peh; on the Hankiang; 380 miles west of Nanking. It is located on one of the principal trade routes between the northern and southern provinces of China. Pop. 100,000.

Fan Coral, the spreading fan-like growths of corals of the family *Gorgonidæ.* The coral stock is here horny or calcareous and takes a bushy growth, or frequently spreads from its base into a flat network, making a «sea-fan.» In this coral the short calicles of the single retractile polyps stand perpendicularly to the axis, in which run communicating canals. These alcyonarians are numerous not only in the tropics, one beautiful red or yellow species (*Rhipigorgia flabellum*) flourishing along the coast of Florida, but also in the deep cold waters of the North Atlantic.

Fan Cricket, a British name for the mole-cricket.

Fan Palm, a name common to all those palms which have fan-shaped (flabellate) leaves, but more particularly applied to those of the genus *Chamærops,* of which a common species in the Mediterranean region is *C. humilis.* The East Indian «great» fan palms are species of *Corypha,* one of which is the taliput-palm (*C. umbraculifera*), whose leaves furnish the «palm-leaf fans" of commerce. The West Indian fan palm is *Sabal blackburniana.*

Fan-tan, a Chinese word, *fan,* number of times; *tan,* apportion: a gambling game very popular with the Chinese. There are various forms of fan-tan, the simplest and most commonly played is that in which a pile of copper coins, usually cash, is covered with a bowl, the player staking or betting money on what the remainder will be when the pile of coins has been divided by four. As in the American game of poker there is a "kitty" or house-percentage in fan-tan, usually 8 per cent of the winnings being deducted for the benefit of the *croupier* or proprietor of the gambling house.

Fan Tracery, in architecture, the decorative tracery on the surface of fan vaulting. It was used in late pointed work. Fan vaulting or fan-tracery vaulting is a very complicated mode of roofing or vaulting in which the vault is covered with fan-tracery. It is peculiar to English Gothic, very fine examples of it being found in Henry VII.'s chapel, Westminster, and St. George's Chapel, Windsor.

Fanariots. See PHANARIOTS.

Fanaticism, excessive zeal; unreasoning enthusiasm in religious matters. In ancient Rome the term fanatics was applied to such as passed their time in temples, and who, pretending to be inspired by the divinity, would burst into wild and frantic gestures, utter pretended prophecies, cut themselves with knives, etc. It has prevailed under different forms in all ages of the world; and one of its most remarkable and dangerous features is the tendency that it has to spread over large masses of people, as well as to favor measures of persecution. By an extension of the term it is also sometimes applied to other forms of extravagant enthusiasm which in their outward manifestation are accompanied with impetuosity and violence. Thus, we speak of political fanaticism, which, in affairs of state, displays itself in a violent and intolerant partisanship. Not unfrequently both kinds of fanaticism are found combined, and to this combination most of the religious wars which have desolated kingdoms are to be ascribed.

Fandango, a lively and voluptuous Spanish dance in triple time, said to be derived from the Moors. It is danced by two persons, male and female, and accompanied by the sounds of the guitar. The dancers have castanets which they beat in time to the measure, though sometimes the male dancer beats a tambourine.

Faneuil, fan'el or fun'el, **Peter,** American merchant: b. of a French Huguenot family, New Rochelle, N. Y., 1700; d. Boston 3 March 1743. The project of erecting a public market-house in Boston had already been discussed for some years, when in 1740 Faneuil offered, at a public meeting, to build a suitable edifice at his own cost, as a gift to the town; but so strong was the opposition to market-houses that, although a vote of thanks was passed unanimously, the offer was accepted by a majority of only seven. The building was commenced in Dock Square in September of the same year, and finished in two years. It comprised a market-house on the ground floor, and a town-hall with other rooms over it. In 1761 it was destroyed by fire; in 1763 it was rebuilt by the town; and in 1775, during the English occupation of Boston, was used for a theatre. In 1805 it was considerably altered and enlarged. During the Revolutionary period it was the usual place of meeting of the patriots, and from the stirring debates and important resolutions which were often heard within its walls, it gained the name of "the cradle of American liberty." It was extensively restored in 1900. The hall is some 80 feet square and contains many portraits and the large painting 'Webster replying to Hayne.' The lower story is still occupied as a market.

Faneuil Hall ("The Cradle of Liberty"), in Dock Square, Boston. There being no public market in Boston in 1740, Peter Faneuil offered to build one and give it to the city. It was finished in 1742,— a two-story brick building 100 by 40, containing not only a market in the basement, but rooms for town officers and a public hall for town meetings. It was destroyed by fire 13 Jan. 1761; rebuilt 1763, and used for town meetings during many years following. In 1805 it was doubled in size by adding a third story and moving a side wall back 40 feet, making the great hall (it holds 3,000 people) famous for the speeches of Webster, Choate, Sumner, Wendell Phillips, Everett, and others. The building is still used both for hall and market; the former contains some fine paintings, including Healy's 'Webster Replying to Hayne.' See Brown, 'Faneuil Hall and Market' (1901).

Fanfani, Pietro, pē-ā trō fän-fä'nē, Italian philologist, humorist, and novelist: b. Pistoia, Italy, 21 April 1815; d. Florence 4 March 1879. He founded in 1847 the 'Philological Record,' and afterward edited several other periodicals of a like character. His "vocabulary of Tuscan Usage" and other "vocabularies" are works of high authority. The 'Writ at Random,' and the whimsical satire 'The Laughing Democritus: Literary Recreations,' furnish examples of his brimming humor. His novels are: 'Cecco of Ascoli'; 'Paolina'; 'The Coachman and his Family'; etc.

Fanfare, in music, a short passage for trumpets. Certain flourishes in opera music are also called fanfares. Also any short, prominent passage of the brass instruments of an orchestra.

Fangwe. See FANS, a tribe.

Fannin, James W., American soldier: b. Georgia about 1800; d. Goliad, Texas, 27 March 1836. He removed to Texas in 1834 and in the Texas war of independence raised the "Brazo's Volunteers," a company which formed part of the army of Gen. Austin. Receiving orders from Gen. Houston to blow up Goliad and retire to Victoria he was attacked on the banks of Coleto Creek as he was retreating with women and children and a force of 350 men. The Mexicans were 1,200 strong and after a battle of two days he surrendered. Santa Anna instead of paroling the Americans, in accordance with the promise of Gen. Urrea, gave orders that all, excepting the women and children, should be shot.

Fanning, David, American freebooter: b. Wake County, N. C., about 1756; d. Digby, Nova Scotia, 1825. He was a carpenter by trade, but led a vagabond life. Late in the Revolutionary War he joined the Tories for the purpose of revenge; gathered a small band of despera-

FANEUIL HALL, BOSTON, MASS.

does like himself, laid waste to whole settlements and committed fearful atrocities. For these services he received a lieutenant's commission from the British commander at Wilmington. At one time he surprised a court in session and captured and carried off judges, lawyers, clients, officers, and citizens, and soon afterward seized Gov. Burke and his suite. The name of Fanning became a terror to the country, and he was outlawed. At the close of the war he fled to New Brunswick, where he became a member of the legislature.

Fanning, Edmund, American loyalist: b. Long Island, N. Y., 1737; d. London, England, 28 Feb. 1818. He was graduated from Yale in 1757; settled in North Carolina, where he became a member of the legislature, and as recorder for Orange County excited general dislike by his exactions. In 1771 he removed to New York and in 1777 organized the king's American regiment of foot. He was subsequently appointed governor of Nova Scotia by the English government and was governor of Prince Edward Island 1786–1805. In the English army he rose to the rank of general.

Fanning, John Thomas, American civil engineer: b. Norwich, Conn., 31 Dec. 1837. He served in a Connecticut regiment during the Civil War and was city engineer of Manchester, N. H., 1872–86. Since the last named year he has lived in Minneapolis. He has been connected with the planning and construction of various important public waterworks in New England and in the western States, and has published 'A Treatise on Hydraulic and Water Supply Engineering' (1877).

Fanning Islands, a group of coral islands, in the Pacific, between lat. 2° and 5° 49' N., and lon. 157° and 162° W. It comprises the islands of Jarvis, Christmas, Washington, Palmyra, and Fanning Island; area of the whole, about 260 square miles. Cocoanut and other tropical trees are found here. The islands of Fanning and Christmas belong to Great Britain. The group gets its name from an American sailor, Edmund Fanning, who discovered it in 1798.

Fanny, Aunt. See BARROW, FRANCES ELIZABETH.

Fanny Fern. See PARTON, SARAH PAYSON WILLIS.

Fano, fä'nō (ancient FANUM FORTUNÆ), a seaport of Italy, in a rich and fertile plain on the Adriatic, province of Pesaro e Urbino, 29 miles northwest of Ancona. It is surrounded by walls, built by the Emperor Augustus, and contains a triumphal arch, a cathedral with valuable paintings, a public library, and a fine theatre. Pop. commune 24,848.

Fanon, an ecclesiastical term of various applications. It was used to denote the cloth in which the deacon in the ancient or early mediæval Church received the oblations, and is now generally applied to a striped, oblong piece of silk gauze worn on the head and shoulders by the Pope in celebrating mass pontifically. It also designates the church banner carried in processions. In surgery, a fanon is a splint of a particular shape, formerly employed in fractures of the thigh and leg, to keep the bones in contact.

Fans, also known as **Fangwe Pahouins, Oshiba,** etc., an African people who emigrated from the interior to the coast of French Congo during the first half of the 19th century. They now number about 300,000 in the neighborhood of the mouths of the Ogoway and the Gaboon. They have been described by Du Chaillu, Burton, Lenz, Reade, and other travelers as a warlike and highly intelligent people, differing markedly from the surrounding negroid or Bantu tribes. Their complexion is rather light, their beard long, their frontal bone very prominent, and they are tall and well-built. They were formerly much given to eating human flesh, but their cannibalistic tendencies have been checked by contact with the Europeans of the coast regions.

Fans, instruments for producing an agitation of the air, and consisting of an extended flat surface, generally semicircular in outline. As hand-implements for cooling the air they have long been articles of luxury. Early Egyptian paintings prove familiarity with its use in a remote period. From a passage in the 'Orestes' of Euripides it appears that the Grecian fans were introduced from the East, that they were of a circular form, and were mounted plumes of feathers. Dionysius of Halicarnassus describes the courtiers of Aristodemus at Cumæ as attended by females bearing parasols and fans. Plautus mentions fan bearers as forming part of a Roman fine lady's retinue, and Suetonius describes Augustus as lying, during the heat of summer, in the shade, and fanned by an attendant. In the Middle Ages fans were used in the churches to chase away the flies from the holy elements of the Eucharist. Such a fan, known as a flabellum, is still used in the Greek and Armenian churches. The folding fan is said to have been a Japanese invention which originated in the 7th century, the idea having been supplied by the wing of the bat. From Japan the invention passed into China; but it was not till about the beginning of the 16th century that such fans began to be used in Europe, being introduced into Italy and Spain. The fan was first brought into European notoriety by Catharine de Medici, who introduced it in the folding form into France. Great sums were spent on the ornamentation of the fans first in vogue, and many were painted by Watteau. During the 16th and 17th centuries, they were used by gentlemen. In various nations and at various periods the manipulation of the fan has formed almost a separate language, especially for coquettes. Addison in his essay on the fan, in the 'Spectator,' and Disraeli in 'Contarini Fleming,' treat of this feminine art. They are said to have been introduced into England from Italy in the reign of Henry VIII.; and in the reign of Elizabeth they were framed of very costly materials, the body of ostrich feathers, the handle of gold, silver, or ivory, of curious workmanship. Walking fans were formerly in use. They were of large size and were employed to screen the face from the sun. The Chinese have greatly excelled in the art of making fans, those of the lacquered variety showing especial skill. For common use they make a cheaper sort, constructed of polished bamboo and paper. In Japan, where to this day the fan is an indispensable adjunct of the daily life of all classes, large rich fans are used in ceremonial dances in which they are accessories of peculiar significance. In Rome the pope is escorted on ceremonial occasions by attendants with flabella formed of peacock feathers. In Europe, France manufactures the greatest number of fans used by the world of fashion. A species of large fan known as a punkah is used in India for cooling the air of rooms and keeping down the temperature. Fans in the form of machines are used in agriculture for winnowing grain, the original form being very simple and dating back to primitive times. In metallurgy and other branches of manufacture fans are employed for ventilating and stimulating the combustion of fires; for the ventilation of mines; and for various other manufacturing purposes. The modern electric revolving fan is extensively used for cooling the air in public and private buildings.

Fans, Mine. See MINING.

Fanshawe, fan'shâ, **Anne Harrison,** LADY, an English memoirist: b. London, England, 25 March 1625; d. there 30 Jan. 1679 or 1680. Her admirably written and accurate observations of life and manners in many lands, preserved in 'Memoirs,' from which extracts have been published, are of historical value.

Fanshawe, Catharine Maria, English poet: b. Chipstead, Surrey, England, 6 July 1765; d. Putney Heath, Surrey, 17 April 1834. A lively fancy, brilliant wit, sound sense, and personal charm made this lady and her poetry admired in her own circle; but she rarely consented to publication, and only her riddle on the letter H, sometimes credited to Byron, is generally known, her stanzas not having been collected.

Fanshawe, SIR **Richard,** English diplomatist, poet, and translator: b. Ware, Hertfordshire, June 1608; d. Madrid, Spain, 26 June 1666. On the breaking out of the civil wars in 1641 he engaged actively in the royal cause. He was made a baronet in 1650, and sent on an embassy to Spain, and afterward appointed secretary of state for Scotland. He was taken prisoner at the battle of Worcester in 1651. In 1661 and 1662–3 he was employed on two several missions to the court of Lisbon, in the former of which he negotiated the marriage of Charles II. with Princess Catharine, and on his return in 1663 was advanced to a seat in the privy council. In 1664 he was sent ambassador to Madrid, and negotiated a peace between England, Spain, and Portugal. His poetical abilities were above mediocrity, as is evinced by his translations of the 'Lusiad' of Camoens, the 'Pastor Fido' of Guarini, the 'Odes' of Horace, and the fourth book of the 'Æneid' into English verse, and Fletcher's 'Faithful Shepherdess' into Latin.

Fantail, an Australian flycatcher of the genus *Rhipidura,* having a fan-like, and in some species prolonged, tail, which the bird opens and shuts gracefully as it tumbles about in the air when pursuing its agile prey. A familiar species is *R. mottacilloides,* whose habits are wagtail-like.

A warbler (*Cisticola cursitans*) of the Mediterranean countries and eastward, remarkable for its nest, which consists of soft materials enclosed in two leaves stitched together to sustain it, much after the method of the tailor-bird (q.v.).

A small variety of domestic pigeon, usually pure white, which holds its tail erect and distended like a fan.

Fantasia, fan-ta-zē'a, in music, a species of composition in which the author confines himself to no particular form or theme, but ranges as his fancy leads amid various airs and movements. Some writers, in defining this word, confine its meaning to extempore composition, and make this distinction between capriccio and fantasia; namely, that the former is a collection of singular and whimsical ideas strung together by an excited imagination, and written down at one's leisure, but the latter is an off-hand execution of whatever comes across the mind while playing on an instrument.

Fantee, or **Fanti,** făn-tē', a country of Africa, on the Gold Coast, which extends about 90 miles along the shore of the Atlantic, and 70 inland; lat. 5° 30' N.; lon. 1° W. The inhabitants, called Fantees, were at one time the most numerous and powerful people situated immediately on the Gold Coast; but their power was almost entirely broken after 1811 by invasions of the Ashantees. Their country now forms a district of the British Gold Coast Colony. The soil is fertile, producing fruits, maize, and tropical vegetation of nearly every variety. The custom of making small scarifications on the upper part of the cheek-bones and the back of the neck prevails among the Fantees. Their government is aristocratic. Their head chief is supreme judge or governor, and is attended by a council of old men. Each town has a chief. At one time they had several large cities. The country of the Fantees is populous and prosperous, owing to the protection afforded by the British settlements, and particularly by Cape Coast Castle. In 1873 they were again attacked by the Ashantees, who also threatened the British settlements, and compelled the government of Great Britain to send out an expedition under Sir Garnet (now Lord) Wolseley to suppress them. Consult: Barrow, 'Fifty Years in Western Africa'; Boyle, 'Through Fanteeland and Coomassii'; McDonald, 'The Gold Coast Past and Present.'

Fantoccini, făn-tō-chē'nē, an exhibition of puppets, or a dramatic representation on a small scale, performed by figures or dolls, an amusement of which the Italians are extremely fond, and which is frequently performed in a portable theatre — like that of Punch and Judy.

Fanum Fortunæ. See FANO.

Far from the Madding Crowd, a novel by Thomas Hardy, published 1874. It is perhaps the best example of his earlier manner, and of his achievements in the domain of comedy.

Farad (from Michael Faraday), the standard electrical unit, which is measured by the capacity of a condenser that with an electromotive force of one volt is able to overcome a resistance equivalent to one ohm in one second, or in other words the resistance offered by a cylindrical copper wire, 250 feet long, 1/20 inch in diameter, the ohm being the magneto-electric unit. See ELECTRICAL UNIT.

Faraday, Michael, English scientist: b. Newington Butts, England, 22 Sept. 1791; d. Hampton Court 25 Aug. 1867. He received little or no education and was apprenticed to the trade of a bookbinder. During his term of apprenticeship, a few scientific works fell into his hands, which he read with avidity, and forth-

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with devoted himself to the study of, and experiments in, electricity. Having attended the lectures given in 1812 by Sir Humphry Davy, and taken notes thereon, he sent them to that philosopher, and besought some scientific occupation. The reply was prompt and favorable. In 1813 Faraday was appointed chemical assistant, under Sir Humphry, at the Royal Institution. Faraday discovered in 1820, the chlorides of carbon, and, in the following year, the mutual rotation of a magnetic pole and an electric current. These were strong encouragements to proceed on the path of discovery, and led to the condensation of gases in 1823. In 1829 he labored hard, and, as he thought at the time, fruitlessly, on the production of optical glass; but though unsuccessful in his immediate object, his experiments produced the heavy glass which afterward proved of great assistance to him in his magnetical investigations. In 1831 the series of 'Experimental Researches in Electricity,' published in the 'Philosophical Transactions,' began with the development of the induction of electric currents, and the evolution of electricity from magnetism. Three years later Faraday established the principle of definite electrolytic action, and, in 1846 received at the same time the Royal and the Rumford medals for his discoveries of diamagnetism, and of the influence of magnetism upon light respectively. In 1847 he discovered the magnetic character of oxygen, and, also, the magnetic relations of flame and gases. His papers, including other contributions to the store of modern science, are too numerous to mention in detail. It should be observed that the 'Researches,' though termed 'Experimental,' contain many hypothetical ideas, and many inquiries into theories generally adopted up to their time. Among these may be specified the considerations respecting static induction, atmospheric electricity, and those relating to lines of force, both physical and representative, on which having sufficiently stated his views, he was content to leave them for solution to time and future experience. It may be added that his last hypothetical view relates to the conservation of force, and that one of his latest papers treats of the division of gold and other metals. In 1833 Faraday was appointed professor of chemistry in the Royal Institution, London, which chair he continued to hold until his death. In 1835 he received from government a pension of $1,500 per annum in recognition of his eminent scientific merits. In 1836 he was appointed a member of the senate of London University. From 1829 to 1842 he was chemical lecturer at the Royal Academy. In 1823 Faraday was elected corresponding member of the French Academy. In 1825 he was chosen a Fellow of the Royal Society, and in 1832 made a D.C.L. of Oxford University. He was, besides, a knight of several of the European orders, and a member of the chief learned and scientific societies in Europe and the United States. See Tyndall, 'Faraday as a Discoverer' (1868); Bence Jones, 'Life and Letters' (1870); J. H. Gladstone, 'Life of Michael Faraday' (1872); Thompson, 'Michael Faraday: his Life and Work' (1898).

Faraday Effect. See LIGHT.

Faradism. See ELECTRICITY IN MEDICINE.

Farafeh. See FARAFRA.

Farafra, fa-rä'fra, or **Farafeh,** an oasis of the Libyan Desert, in Africa, containing several ruins of Greek and Roman origin. A coarse woolen cloth and earthenware are the manufactures.

Farallones (fä räl-yō'nes) **Islands,** in the Pacific, off the coast of California, about 28 miles from the entrance to the Golden Gate; a group of six small rocky islands. A large number of rabbits are found on the islands and many sea-lions on the coast. The islands are owned by a company who market the eggs of the sea-gulls and murres (allied to the auk). A lighthouse, with all modern equipment, on the southern island, is 360 feet above the water.

Farandola, fa-ran'-dō la or **Farandole,** fa-ran'dōl, a dance with various figures, popular among the peasants of the south of France and the neighboring part of Italy. It is performed by men and women taking hands, and forming a long line, and winding in and out with a waving motion. The dance is often used in excited gatherings. The figures of the farandola, by the name of the Spanish dance, were once well known in English ball-rooms.

Farce (Ital. *farsa,* from Lat. *farcire,* "to stuff"), a dramatic piece of a broad comic character. The difference between it and comedy proper is one of degree and not of kind. The aim of both is to excite mirth; but, while the latter does so by a comparatively faithful adherence to nature and truth, the former assumes a much greater license, and does not scruple to make use of any extravagance or improbability that may serve its purpose. It does not, therefore, exhibit, in general, a refined wit or humor, but consists of ludicrous rencontres, exaggeration of personal peculiarities, and dialogues provocative of fun. The beginnings of Greek and Roman comedy consist of rustic farces or pantomimes (see ATELLANÆ FABULÆ); the first farces, in the modern sense, were composed by the fraternity of the Bazoche (q.v.) in Paris, as a contrast to the ecclesiastical plays performed by the religious orders. The most widely celebrated and most important of early farces is that of the advocate 'Maistre Pierre Patelin,' which was acted in the 15th century, and quickly spread itself over Italy and Germany. It is full of genuine comic quality, and its dialogue has brightness and reality. The *commedia dell 'arte* of Italy were of a farcical nature. Molière elevated and refined the farce into his wonderful series of comedies of character. In England the origin of the modern farce dates from about the commencement of the 18th century. Few farces have kept a place in literature. See COMEDY; DRAMA.

Consult: Chevaldin (L. E.), 'La Farce de Patelin et ses Imitations' (Paris 1889), from the work by Dr. K. Schaumburg.

Farcy, in horses, depends upon the same causes as glanders (q.v.) — in fact, is an outward manifestation of glanders. The absorbent vessels of the superficial parts of the body, but usually those of one or both hind limbs, are inflamed, tender, swollen, hard, and knotted. The vitiated lymph thus poured out softens, and ulcers or farcy buds appear. Unlike the ulcers of glanders, they are sometimes thought to be curable, but an animal apparently cured is not safe to be with other horses, as the *contagium* —

the *Bacillus mallei* — almost invariably remains, and the animal is thus a centre of infection and a source of danger.

Fardel-bound, a term applied to sheep and cattle when suffering from a disease caused by the retention of food in the third stomach, or maniplies. The disease frequently arises from the eating of over-ripe clover, vetches, or rye grass. The food being tough and indigestible, finally causes chronic inflammation.

Fareham, fār'am, England, a market town in Hampshire, at the head of a short arm of the Portsmouth harbor, and six miles northwest of Portsmouth. Pop. (1901) 8,246.

Farel, Guillaume, gē yōm fä-rel, Swiss reformer: b. near Gap, Dauphiny, 1489; d. Neufchâtel, Switzerland, 13 Sept. 1565. At an early period the study of the Bible led him to reject many of the chief doctrines of the Roman Catholic Church. At Basel, in 1524, he publicly sustained several theses in support of Protestantism, and he afterward preached in Strasburg, Montbéliard, and elsewhere. In 1530 he secured the public adoption of the reformed doctrines in Neufchâtel. Geneva, however, became the principal scene of his labors. Here, in the religious conferences of 1534 and 1535, he defended his beliefs so successfully that the reformed parishes not only obtained permission to hold public religious services, but the council formally embraced the Reformation. In concert with Calvin he took an active part in 1536 at the disputation in Lausanne, when the Reformation was embraced. In consequence of a quarrel, arising out of an attempt to enforce a stricter moral discipline, he was banished from Geneva in 1538, and ultimately took up his residence in Neufchâtel. See Life, by Bevan (1893).

Fargo, William George, American capitalist: b. Pompey, N. Y., 20 May 1818; d. Buffalo, N. Y., 3 Aug. 1881. He became Buffalo agent of the Pomeroy Express Company in 1843; established the first express company west of Buffalo, in 1844; and in 1868 became president of the great corporation controlling the whole West, the Wells-Fargo Express Company.

Fargo, N. D., city, county-seat of Cass County; at the head of navigation on the Red River; on the Chicago, M. & St. P., the Northern P., and the Great N. R.R.'s; opposite Moorehead, Minn. It contains a United States land office, Fargo College (Cong.), the State Agricultural and Mechanical College, St. John's Hospital, high school, court-house, waterworks, street railroad, and electric light plants, several banks. and a number of daily and weekly newspapers. It has the car shops of the Northern Pacific Railroad, flour-, planing-, and paper-mills, large grain elevators, a brewery, and large brick yards. Pop. (1900) 9,589.

Fargo College, a coeducational institution in Fargo, N. D.; founded in 1888 under the auspices of the Congregational Church. In 1901 there were in attendance 367 students.

Fargus, Frederick John ("Hugh Conway"), English novelist: b. Bristol, England, 26 Dec. 1847; d. Monte Carlo 15 May 1885. He adopted his pseudonym from the school frigate Conway, stationed on the Mersey, which he entered when he was 13, for the purpose of training for a seafaring life. He subsequently entered the auctioneer business, employing his leisure in writing clever newspaper verse and occasional tales. Some songs of his were accepted and published in 1878, a volume of verse in 1879; but it was the issue and rapid sale of his melodramatic story, 'Called Back' (1884), which made him famous. He then went to London, where he adopted the profession of authorship. His other writings include: 'Dark Days' (1884); 'A Family Affair' (1886); 'Slings and Arrows'; 'A Cardinal Sin' (1883); 'Bound Together' (1884).

Faria, fä-rē'ä, **Manoel Severim de,** Portuguese author: b. Lisbon, Portugal, 1583; d. Evora 25 Sept. 1655. He devoted many years to the study of his country's literature, giving his researches and thought a lasting form in 'Various Essays' (1624), containing appreciations and biographies of Camoens and other great writers. He also wrote 'Jottings of Portugal' (1655).

Faria y Sousa, fä-rē'ä ē sō'zä, **Manoel,** Portuguese historian and lyric poet: b. near Pombeiro, in Portugal, 18 March 1590; d. Madrid, Spain, 3 June 1649. A passion for a beautiful girl first awakened his poetical genius. He celebrated her under the name of Albania in his sonnets, married her in 1613, and went to Madrid. But he did not succeed there, and returned to Portugal. He also visited Rome, and gained the notice of Urban VIII. Among his writings are: 'Discursos Morales y Politicos'; 'Epitome de las Historias Portuguesas'; and a collection of poems called 'Fountain of Aganippe' (Fuente de Aganipe, Rimas varias, 1644–6). His style was pure and strong, and his descriptions full of vigor.

Faribault, fãr-ĭ-bō', Minn., city, county-seat of Rice County; at the confluence of the Cannon and Straight rivers; on the Minneapolis & St. L. and the Chicago, M. & St. P. R.R.'s; 53 miles south of St. Paul. It has manufactories of pianos, carriages, furniture, boiler works, foundry products, and rattan goods, and canning establishments, breweries, flour-, planing-, and woolen-mills. Faribault is noted for its fine schools, both public and private. The State schools for the deaf, dumb, blind, and feeble-minded are located here. The Seabury Divinity School, the Shattuck Military School for boys and the St. Mary's School for girls are flourishing institutions, all three of which are under the auspices of the Protestant Episcopal Church; Bethlehem Academy is in charge of the sisters of St. Dominic. Faribault was the home of Bishop Whipple (q.v.). Faribault became noted in 1891, because of a controversy which arose regarding the incorporation of parish schools into the public school system. It was called by many then a new movement; but it was similar to the plans which had long been in existence in several cities and towns in other parts of the United States; as Poughkeepsie, Corning, Ogdensburg, and Plattsburg in the State of New York; and several places in Connecticut, Ohio, and in other States. Pop. (1900) 7,868. See Parish Schools.

Faridpur, Furidpur, fũr-ēd-poor, or **Dacca Jelalpur,** däk'kä jel-ŭl-poor', a district in the Dacca division; area, 2,267 square miles. Pop. (1891) 1,797,320.

Farina, fä-rē'nä, **Salvatore,** Italian novelist: b. Sorso, Sardinia, 10 Jan. 1846. His tales were successful from the first, which was ‘Two Amours’ (1869). Among the others are: ‘A Secret’ (1870); ‘Forbidden Fruit’; ‘Romance of a Widower’; ‘Dounina's Treasure’; ‘Courage and Onward’; ‘Little Don Quixote’ (1890); ‘Living for Love’ (1890); ‘For Life and for Death’ (1891). The sympathy with lowly life and the rich humor of his stories have gained him the title of "The Italian Dickens." He is the best known abroad of all Italian novelists.

Farina (Lat. "flour"), a term popularly applied to a food product made from white maize, having grains coarser than those of meal, but finer than hominy. A somewhat similar preparation is made from the inner portion of wheat grain. Farinaceous dishes, in which farina is combined with milk, fruit, etc., furnish a light and nutritious diet for invalids and the young. In early works on botany the pollen of flowers was styled farina.

Farinato, fä-rē-nä'tō, or **Farinati,** fä-rē-nä'tē, **Paolo,** Italian painter: b. Verona 1524; d. there 1606. He took his style of painting from Veronese, and Guilio Romano. His works are characterized by wealth of imagination, graceful but not always correct drawing, combined with harmonious coloring. He finds his modern counterpart in the English Rosetti. He painted both in oil and fresco. There are some fine frescoes of his in the choir of San Nazaro at Verona; his wonderful ‘Miracle of the Bread and Fishes’ (1603) is in the church of San Georgio Maggiore, and his ‘Finding of Christ in the Temple’ is in the Berlin Museum.

Farinelli, fä-rē-nel'lē (real name Carlo Broschi), Italian soprano singer: b. Naples 24 Jan. 1705; d. Bologna 15 Sept. 1782. He studied under Porpora, and went from Rome to Vienna, where the Emperor Charles VI. loaded him with rich presents. In 1734 Farinelli went to London, and by the magic of his singing so delighted the public that Handel was obliged to dismiss a rival company over whom he presided, in spite of all his powers and popularity. Many extraordinary stories are related of Farinelli's vocal skill, and his command over the feelings and sympathies of his audience appears to have been unrivaled.

Faringdon, făr'ing-dôn, or **Great Faringdon,** England, a market town in the county of Berks; 16 miles southwest of Oxford. Pop. 3,133.

Farini, Luigi Carlo, loo-ē'jē kär'lō fä-rē'nē, Italian historian: b. Russi 22 Oct. 1812; d. 1 Aug. 1866. He studied medicine at Bologna, but early entered upon a political career, becoming minister of public instruction in 1850, of commerce in 1861, and president of the council in 1862 during Cavour's administration. His influence contributed much to the union of central Italy with the kingdom of Victor Emmanuel II. His ‘History of the Roman State from 1815 to 1850’ (1850) was translated into English; and his ‘History of Italy,’ a continuation of Botta's celebrated work, is a performance of standard merit.

Farjeon, fär'jun, **Benjamin Leopold,** English novelist of Jewish descent: b. London 1833; d. Hampstead 1 Aug. 1903. He spent some years in Australia and New Zealand as journalist and novelist, and was the editor and co-proprietor of the first daily newspaper published in the latter country. His first successful novel was ‘Grif: a Story of Australian Life’ (1870). It was followed in 1871 by ‘Blade-o'-Grass,’ and in 1872 by ‘Joshua Marvel.’ Later works of his include: ‘London's Heart’ (1873); ‘Bread and Cheese and Kisses’ (1874); ‘Love's Victory’ (1875); ‘At the Sign of the Silver Flagon’ (1876); ‘Solomon Isaacs: a Christmas Story’ (1877); ‘Aaron the Jew’; ‘Great Porter Square: a Mystery’ (1884); ‘The House of White Shadows’ (1884); ‘Self-doomed’ (1885); ‘Set in a Silver Sea’ (1886); ‘The Nine of Hearts’ (1886); ‘The Tragedy at Featherstone’ (1886); ‘The Secret Inheritance’ (1887); ‘Toilers of Babylon’ (1888); ‘Miriam Rozella’ (1897); ‘The Betrayal of John Fordham’ (1897); ‘Samuel Boyd of Catchpole Square’ (1899); ‘The Mesmerists’ (1900); ‘Pride of Race’ (1900); ‘The Mystery of the Royal Mail’ (1902); etc. Farjeon has been compared with Dickens in his "sentiment and minute characterization." The comparison is not altogether a happy one, and the knowledge that it had been made affected the novelist's style somewhat, and not for the better.

Farley, Harriet. See Donlevy, H. F.

Farley, James Lewis, Irish journalist: b. Dublin, Ireland, 9 Sept. 1823; d. London, England, 12 Nov. 1885. Established in Turkey as a bank official, he became correspondent of two or three great London dailies and speedily made himself an authority on Turkish questions. His books include: ‘The Resources of Turkey’ (1862); ‘Turkey: Its Rise, Progress, and Present Condition’ (1866); and ‘Modern Turkey’ (1872).

Farley, John Murphy, American Roman Catholic prelate: b. Newton, Hamilton, county of Armagh, Ireland, 20 April 1842. He began his college studies in Ireland, although only a youth when he came with his parents to America. He continued his studies for the priesthood in St. John's College, Fordham, N. Y., and St. Joseph's Seminary, Troy, N. Y., and in the American College in Rome. He was ordained in Rome 11 June 1870, and the same year returned to the United States to begin work in St. Peter's parish, New Brighton, Staten Island. In 1872 Archbishop McCloskey of New York chose him for private secretary. In 1884 Pope Leo XIII. made him private chamberlain with the title monsignor; and in 1891 he was made vicar-general of the archdiocese of New York. In 1892 he was made domestic prelate to Leo XIII., and in 1895 prothonotary apostolic, all of which positions gave him special privileges. In December 1895 he was consecrated titular bishop of Zeugma, and became assistant to the archbishop of New York. For several years he was permanent rector of St. Gabriel's Church, New York.

When the see of New York became vacant by the death of Archbishop Corrigan (1902), the lists of names sent to Rome by the suffragan bishops and permanent rectors, each had at the head the name of Bishop Farley as first choice for archbishop. He received his appointment from Leo XIII., but the pallium was conferred under Pius X., on 12 Aug. 1903. He is the fourth archbishop of New York and governs one of the largest Roman Catholic dioceses in the world, containing about 1,200,000 members of the Church. He is the metropolitan of the ecclesiastical province of New York, which is composed of eight dioceses outside the archdiocese; six in the State of New York and two in New Jersey. The author of the 'Life of Cardinal McCloskey,' Archbishop Farley has also been a contributor to various magazines, and quite recently he has received emphatic proof of Pope Pius X.'s favor by being made assistant at the pontifical throne. At present (1905), the archdiocese of New York comprises a Catholic population estimated at 1,200,000; 754 priests; 289 churches; 198 parochial schools; 1 theological seminary; 6 orphanages; 20 hospitals and other institutions, benevolent and educational.

Farlow, William Gilson, American botanist; b. Boston, Mass., 17 Dec. 1844. After graduating at Harvard, he spent several years in Europe pursuing his favorite study and became professor of cryptogamic botany at Harvard in 1879. His publications treat mainly of marine algæ, fungi, and diseases of plants. Upon these subjects, and particularly upon cryptogamic botany, he is considered an authority. He also published: 'The Potato Rot' (1875); 'Diseases of Olive and Orange Trees' (1876); 'The Marine Algæ of New England' (1881).

Farm, a tract of land devoted to agriculture, under the management of owner or tenant. The size of farms and their tenure differ very much in different countries. On the continent of Europe, where peasant proprietaries, cultivation by the metayer system (q.v.), and mixed tenures prevail, farms are generally small. In England, where the land is in the hands of a comparatively small number of proprietors, and is let out to farmers who pay a fixed rent and make a trade of cultivating their holdings, these are in many localities large compared with continental farms. In the United States the majority of farms are owned by those who operate them. In 1900 between 54 and 55 per cent were so operated. In 1890 tenants operated 28.4 per cent of all the farms, and in 1900, 35.3 per cent. A comparatively small number are worked by part owners. The short tenure of land usually prevailing in England and Ireland has given rise to many disputes about compensation for improvements effected by tenants, etc. In Scotland it has been customary to give a lease for 19 years.

In these statistics the term «farm» includes, as defined by the twelfth census of the United States, «all the land, under one management, used for raising crops and pasturing live stock, with the wood lots, swamps, meadows, etc., connected therewith. It includes also the house in which the farmer resides, with all other buildings used by him in connection with his farming operations.» As thus broadly defined the 5,739,657 farms in the United States in 1900 embraced, in addition to the general farm, the cotton, the sugar, and the rice plantations of the country; large ranges in the western States (of which however the area actually owned or leased is very small) — as well as smaller stock farms — the extensive farms devoted to the raising of grain; those producing chiefly hay and forage, tobacco, hemp, or hops, orchard fruits or small fruits; truck farms; dairy farms; poultry farms; bee farms; florists' establishments; nurseries, etc. The number of farms in the United States has increased so rapidly for several decades that in 1900 there were nearly four times as many as in 1850 and 25.7 per cent more than in 1890. Since 1880 the average size of farms has increased, being in 1900 146.6 acres. The number of farms under 3 acres is 41,882; and of farms of 1,000 acres and over 47,276. The medium-sized farms containing from 100 to 174 acres represent the highest value per acre. The total value of farm property in the United States is a little over $20,514,000,000. See AGRICULTURE; DAIRY INDUSTRY, AMERICAN; LIVE STOCK; FARM MACHINERY, AMERICAN.

Farman, Elbert Eli, American jurist: b. New Haven, Oswego County, N. Y., 23 April 1831. He was graduated at Amherst College in 1855, and admitted to the bar in 1858 and to the United States courts in 1862. He studied international law in Berlin and Heidelberg, Germany, in 1864–7; was district attorney of Wyoming County, N. Y., in 1868–75; United States diplomatic agent and consul-general at Cairo, Egypt, in 1876–81; was a member of the International Commission to revise the judicial codes of Egypt in 1880–1; judge of the mixed tribunal of Egypt in 1881–4; and United States member of the International Commission which examined the claims of the inhabitants of Alexandria for losses arising from the bombardment in 1882, 1883, and 1884. He secured the obelisk «Cleopatra's Needle» as a gift of the khedive to New York, in 1879; made large collections of ancient coins and Egyptian antiquities which he gave to the Metropolitan Museum of Art in New York.

Farman, Ella. See PRATT, ELLA FARMAN.

Farmer, Henry Tudor, American poet: b. England 1782; d. Charleston, S. C., January 1828. While very young he emigrated to Charleston, S. C., where he continued to reside till his death. He published a small volume of poems entitled 'Imagination, the Maniac's Dream, and Other Poems' (1819); also an 'Essay on Taste.'

Farmer, John, American genealogist: b. Chelmsford, Mass., 12 June 1789; d. Concord, N. H., 13 Aug. 1838. He published in 1829 a much valued 'Genealogical Register of the First Settlers of New England.'

Farmer, Lydia Hoyt, American miscellaneous writer: b. Cleveland, Ohio, 1842; d. 27 Dec. 1903. She was married to E. J. Farmer. Her works include: 'Aunt Belindy's Point of View'; 'The Doom of the Holy City'; 'A Story Book of Science'; 'A Knight of Faith'; 'Short History of the French Revolution'; 'Girls' Book of Famous Queens'; 'What America Owes to Women'; etc.

Farmer, Moses Gerrish, American electrician; b. Boscawen, N. H., 9 Feb. 1820; d Chicago, Ill., 25 May 1893. He was graduated at Dartmouth College in 1844. He invented several electro-motors, one of which he used in his workshop to drive a lathe, and another on a miniature railway. On this railway he transported by electricity the first passengers ever so carried in the United States. In 1847 he moved to Framingham, Mass., and invented the telegraph fire alarm. In 1865 he invented a thermo-electric battery and also built the first dynamo, and in 1880 patented an automatic elec-

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tric light system. Besides these inventions he brought to light and perfected many others of general utility.

Farmer, Richard, English Shakespearian scholar: b. Leicester 28 Aug. 1735; d. Cambridge, England, 8 Sept. 1797. In 1767 he published his 'Essay on the Learning of Shakespeare,' which passed through several subsequent editions. In it he showed that Shakespeare's knowledge of classical subjects was entirely obtained through translations, which he often followed very closely. He was appointed master of Emmanuel College, Cambridge, in 1775, and was a prebendary of Canterbury 1782–8, when he was appointed to a residentiary prebend in St. Paul's, London.

Farmers' Alliance, a national organization for improving agricultural conditions, advancing social life, securing favorable legislation, etc.; at first non-political, then political, then non-political again. Originating as a State body in Texas about 1876, it coalesced in 1887 with similar State bodies into a national one; and in 1889 joined the Knights of Labor in a common political party called the National Farmers' Alliance and Industrial Union, with a platform demanding more greenbacks, unlimited free coinage of silver, no national banks, anti-speculation laws, and government ownership of all transportation lines. The southern branch added a demand for government loans at low rates, and sub-treasuries to buy and store farm products. In the West in 1890 the party put up its own candidates; in the South it adopted and dictated the Democratic; it carried the Kansas and Nebraska legislatures, held the balance in Illinois, Minnesota, and South Dakota, and elected nine national representatives, and one senator each from South Carolina (nominally Democrat), Kansas, and South Dakota. In 1892 it fused with others and called itself the People's Party (q.v.), and nominated for President James B. Weaver, who received over 1,000,000 votes; but the southern branch declined to change its political affiliations, and seceded, the Alliance proper going out of politics again.

Farmers' Institutes, gatherings of farmers held annually in the various States, sometimes under the direct management of the agricultural colleges and sometimes controlled by other State officers. The object of these institutes is in great part the bringing together of the workers in agricultural science and the practical farmers, for the discussion of questions of mutual interest. The latest agricultural theories are presented and discussed and compared with the result of practical tests and long experience. The development of farmers' institutes has been chiefly due to the impetus given to the agricultural interests of the country by the Morrill Land Grant Act of 1862; yet they are to some extent an outgrowth from agricultural organizations existing previous to that date. These gatherings are held regularly in over 40 States. In 1899 over 2,000 institutes were held in this country, and the special appropriations for this purpose aggregated over $140,000, not including $30,000 funds estimated as expended from other sources. Pennsylvania and New York lead in the number of institutes, each holding 300 or more annually. In Wisconsin the institutes, numbering 120, are part of the university course in agriculture. Michigan has 200, attended by 120,000 farmers. In Ohio, 88 counties hold institutes. The meetings are generally in the winter when the farmers are free to attend them. The morning sessions are principally given to addresses with discussions, question-box methods, etc., and in the evenings there are popular lectures.

Farmers so frequently demand on the part of institute workers a wide range of scientific and practical knowledge, and the latest information regarding agricultural progress throughout the world, that it is impossible to meet the demand made on agricultural colleges and experiment stations in this direction. Under different names, meetings of farmers in many respects similar to those in the United States are held in other countries. In some parts of Europe, teaching of farmers by itinerant instructors is very thoroughly organized. See AGRICULTURE; AGRICULTURE, DEPARTMENT OF; AGRICULTURAL EXPERIMENT STATION; COLLEGES, LAND GRANT.

Farmers' National Congress, an organization having for its object the advancement of the agricultural interests of the Union, and composed of the same number of delegates from each State (or Territory) as the latter is entitled to in its representation in the United States Congress. The delegates are appointed by the governors of their respective States or by some other State official. All heads of State bureaus of agriculture are considered members, and one representative from each agricultural college.

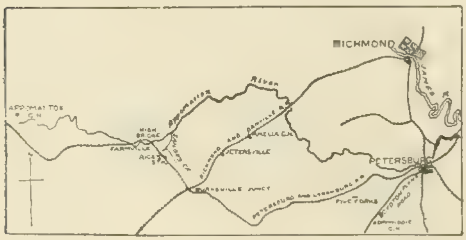
Farming. See AGRICULTURE; AGRICULTURAL CHEMISTRY; DAIRYING; DAIRY CATTLE; etc.

Farmington, Maine, town, county-seat of Franklin County, on the Sandy River and the Maine Cent. and Sandy River R.R.'s; 30 miles northwest of Augusta, on a direct route from the south to Rangeley Lakes. It is a business and educational centre, and has several banks, hotels, a courthouse, a weekly paper, and some manufactories. The town includes several villages, of which Farmington Village (incorporated) is chief. Farmington Academy (1807) was succeeded in 1863 by a State normal school, which has graduated over 1,300 teachers. The Abbott Family School for Boys (1844) opened in 1903 with new buildings. Cutler Memorial Library (1903) is a model granite building. Here for years lived the author Jacob Abbott (q.v.); John S. C. Abbott (q.v.), was once a pastor here; and this is the birthplace of Lillian Norton (Mme. Zoltan Döme), the prima donna, known as Madame Nordica. Pop. (1900) 3,288.

Farmington, Mo., city, county-seat of Saint François County; about 25 miles from the nearest point on the Mississippi. It is two miles from a railroad station (De Lassus). It is the site of the Farmington Baptist College, Elwood Seminary for Girls, and Carleton Institute. Its manufactures are flour, lumber, wagons, carriages, agricultural and mining implements. There are lead-mines near. Pop. (1900) 1,778.

Farmville, Va., town, county-seat of Prince Edward County; about 40 miles southeast of Lynchburg; on the Appomattox River, and the Norfolk & W. R.R. Here is the State Female Normal School. Farmville has a large manufacture of tobacco. Pop. (1900) 2,471.

Farmville and High Bridge, Engagements at (and THE SURRENDER OF THE ARMY OF NORTHERN VIRGINIA AT APPOMATTOX COURT-HOUSE). Farmville, on the south bank of the Appomattox, 70 miles southwest of Richmond, is noted as the place where Gen. Grant opened his correspondence with Gen. Lee which led to the surrender at Appomattox. After the battle of Five Forks (1 April 1865) and the successful assault on the Petersburg lines (2 April), Lee retreated and Grant pursued. Sheridan, with his cavalry and the Fifth corps, 3 April, pushed for the Danville railroad, keeping south of the Appomattox, followed by the Second and Sixth corps in the direction of Amelia Court-house, while Gen. Ord with the Twenty-fourth corps and a division of the Twenty-fifth, moved along the South-side railroad for Burkesville. On 4 April Sheridan struck the Danville road near Jetersville, and learned that Lee was at Amelia Court-house, eight miles northeast. He immediately entrenched the Fifth corps and awaited the arrival of Gen. Meade with the Second and Sixth corps. Meade found the roads so obstructed with Sheridan's cavalry that he did not get up until the afternoon of 5 April. Ord reached Burkesville on the evening of the 5th. He had been directed by Grant to cut the bridges in Lee's front, to intercept his movements toward Danville and Lynchburg, and await orders at Burkesville. To cut the High Bridge, four miles east of



Farmville, Ord, before daybreak of the 6th, sent two small infantry regiments (54th Pennsylvania and 123d Ohio), and 80 officers and men of the 4th Massachusetts cavalry, all under command of Col. Francis Washburn, with orders to push rapidly for the bridge and burn it. After Washburn had gone, Ord sent Gen. Theodore Read, his chief-of-staff, with a small party to overtake him and reconnoitre well before moving up to the bridge. Soon after Read had gone, Ord received a despatch from Sheridan that Lee was moving west of Jetersville and making apparently for Burkesville, upon which he put his command in position to meet him and sent an officer to caution Read that Lee's army was in his rear and that he must return by pressing on, crossing the Appomattox, and going around by Prince Edward Court-house. This last officer was driven back by Lee's cavalry. Read overtook Washburn, took the cavalry into Farmville, examined the country, returned to the infantry and pushing on, was within two miles of High Bridge, when about noon, he ran into Lee's advance, Rosser's and Munford's divisions of cavalry. Read and Washburn drew up the little band of cavalry and 500 infantry and began one of the most gallant fights of the Civil War. Again and again they led the cavalry in successive charges. Read and Washburn fell mortally wounded, and at last not an officer of the cavalry remained alive or unwounded, to lead the men, and the entire command, cavalry and infantry, was enveloped and surrendered.

At 6 A.M. 6 April, the Second, Fifth, and Sixth corps moved from Jetersville up the line of the Danville road toward Amelia Court-house, where it was hoped to intercept Lee, but during the night Lee had moved west, and when this was discovered, after a march of four miles, the advance on Amelia Court-house was suspended and the three corps marched westward parallel to Lee's line of retreat and endeavoring to head him off or bring him to a stand. The Second corps came up to Gordon's corps at Flat Creek and was for a time checked but, fording the creek, drove Gordon off and followed him to Sailor's Creek, where he made a stand, but was again driven with a loss of 13 colors, three guns, several hundred prisoners, and more than 200 wagons. During the day the Second corps had taken about 1,700 prisoners, four guns, and more than 300 wagons and ambulances. Its loss was about 400 men. While the Second corps was thus engaged, the Sixth corps on its left, with the cavalry divisions of Crook and Merritt had overtaken and attacked the commands of Ewell and Anderson on Sailor's Creek, routed them with a severe loss in killed and wounded, and took many thousand prisoners, among them six general officers, including Gen. Ewell. The Confederates continued their retreat. Longstreet with the divisions of Field, Heth, and Wilcox marched to Farmville, crossed to the north bank of the Appomattox and, on the morning of the 7th, began to move out on the road passing through Appomattox Court-house to Lynchburg. Fitz Hugh Lee with all his cavalry followed Longstreet. Gen. Gordon with the other half of Lee's army, crossed at High Bridge. On the morning of the 7th the Union army continued the pursuit, the cavalry, with the exception of one division, and the Fifth corps moving by Prince Edward Court-house; Ord, with his command, the Sixth corps and Crook's cavalry division on Farmville; the Second corps by the High Bridge road. With great difficulty Crook's cavalry waded the river above Farmville, and Gregg's brigade in moving out was fiercely assailed by Fitz Hugh Lee and driven back across the river, Gregg and many of his men being captured. Meanwhile Ord and the Sixth corps had come up to find the bridges destroyed, the water too deep for fording, and Lee's army in plain view on the opposite bank, drawn up for battle. The Second corps, pursuing Gordon, came to High Bridge just as Gordon's corps and Mahone's division had crossed and set fire to it and the wagon road bridge below it. Barlow, whose division was in advance, threw forward his head of column, which seized the wagon road bridge, extinguished the fire, and moved across, Mahone's division after some sharp skirmishing, retiring in a northwest direction, Gordon's corps moving along the railroad toward Farmville. Barlow followed Gordon, while Humphreys led Miles' and De Trobriand's divisions after Mahone and at 1 P.M. came up to Lee's army in an entrenched position, its left four miles from Farmville, on the crest of a long slope of open ground, covering the roads to Lynchburg. Poague's 16 guns opened on him, he threw forward skirmishers, and an unsuccessful attempt was made to take the position in flank. Barlow was sent for but did not get up until sunset. Meanwhile Miles saw an opening and attacked with part of a brigade and was repulsed with considerable loss. Barlow, who had followed Gordon, attacked him and succeeded in cutting off a large train of wagons, which he destroyed, and then rejoined his corps, which bivouacked within 100 yards of Lee's position. The loss of the Second corps during the day was 571, and it had captured 19 guns, many wagons, and had held Lee from continuing his retreat, until such time as Sheridan and Ord were fast gaining his line of escape.

At 5 P.M. Gen. Grant, from his headquarters at Farmville, wrote Gen. Lee asking the surrender of his army. This was sent through the Second corps lines at half past eight, and within an hour Lee replied, asking the terms that would be offered on condition of his surrender. During the night Lee retreated, Gordon leading and Longstreet bringing up the rear. The Second and Sixth corps followed Longstreet closely, and Sheridan, with his cavalry, followed by the Fifth corps and Ord's command, marched on the south side of the Appomattox, captured at Appomattox Station four trains of cars loaded with supplies for Lee's army, 25 guns, and a large park of wagons, and drove Lee's advance forces back to Appomattox Court-house. On the morning of 9 April Sheridan advanced but his cavalry was being pushed back just as Ord, who had marched all night, had formed in his rear, and the Army of Northern Virginia had made its last effort. Sheridan and Ord were in its front; the Second and Sixth corps were close on its rear, negotiations were in progress, hostilities were suspended and about 3 o'clock in the afternoon, 9 April, the terms of surrender were agreed upon, and the War of the Rebellion was practically ended.

Consult: 'Battles and Leaders of the Civil War' (Vol. IV.); Gen. Grant's 'Personal Memoirs' (Vol. II.); Gen. Sheridan's 'Personal Memoirs' (Vol. II.); Humphreys', 'The Virginia Campaign of 1864-5'; 'Official Records' (Vol. XLVI.); Powell, 'History of the Fifth Army Corps'; Walker, 'History of the Second Army Corps.'

E. A. CARMAN.

Farne, färn, or **Ferne** (fèrn) **Islands,** or **The Staples,** a group of islands in the North Sea, belonging to England; about two miles from Bamborough. Saint Cuthbert lived for some years on the largest island of the group and died here; ruins of the old abbey of which he was prior, of the ancient chapel, and of a peal tower still exist. These islands have been the scene of several disastrous shipwrecks, one of which, that of the Forfairshire steamer (1838), occasioned a display of remarkable heroism by Grace Darling, daughter of the keeper of one of the lighthouses. Another steamer, the Pegasus, going from Leith to Hull, was lost here in 1843 and 60 individuals perished. There are three lighthouses on the islands.

Farnese, Alessandro, ä-les-sän'drō fär-nā'sĕ, Italian general: b. Rome 1547; d. Arras, France, 3 Dec. 1592. He served his first campaign under Don John of Austria, and distinguished himself in the battle of Lepanto in 1571. In 1577 Philip II. ordered him to lead back the Spanish troops, which Don John had been obliged to dismiss from Flanders; and Don John dying that year, Alessandro was made governor. He recovered Maestricht and several other cities, and succeeded in reconciling the Catholic part of the insurgents to the Spanish government. The Protestants, however, formed the Union of Utrecht (1579), and called in the Duke of Anjou, a brother of Henry III. of France, to defend them. He appeared at the head of an army of 25,000 men; but Alessandro was constantly successful.

Farnese, Alessandro. See PAUL III., POPE.

Farnese Bacchus, a torso of Bacchus, an example of Greek sculpture of the 4th century B.C. It is in the National Museum at Naples.

Farnese Bull, a group of statuary representing Dirce, whom the sons of Antiope, her slave, are preparing to bind to the horns of the wild bull, which Dirce had intended to be the instrument of her vengeance upon Antiope. This is the most elaborate and dramatic, almost melodramatic, group to be found among the monuments of Greek art. It is the work of the vivacious Rhodian school, executed by Apollonius and Tyriscus. Having been transported to Rome, it was lost sight of for some hundreds of years. It was dug up in excavating the baths of Caracalla and in 1786 sent from the Palazzo Farnese to the National Museum at Naples.

Farnese, Elizabeth. See ELIZABETH FARNESE.

Farnese Hercules, a colossal statue, dating from the age of Hadrian, supposed to be a marble copy by Glycon of a bronze by Lysippus. It is an example of the turgidity and exaggeration which marked the decadence of Greek sculpture, wherein passion for scientific display of triumphs over all sense of ideal beauty, proportion and repose. Hercules is represented as leaning on his club, holding in one hand the Hesperidian fruit. The statue was dug up in the baths of Caracalla and passed through the Farnese family to the museum at Naples.

Farnese Homer, a bust of the Father of Poetry, which evidently belongs to the later period of Greek sculpture. It is in the National Museum at Naples.

Farnese Juno, a colossal head, a copy of a bronze original, representing Hera, "the Queen of Gods." It is in the National Museum, Naples.

Farnese, Minerva, The, an archaic statue of Athene, found at Velletri, at the foot of the Alban Hills, Italy. It is supposed to be a copy of the chryselephantine statue of Phidias, which stood in the main shrine of the Parthenon.

Farnham, färn'am, **Eliza Woodson Burhaus,** American philanthropist: b. Rensselaerville, N. Y., 17 Nov. 1815; d. New York 15 Dec. 1864. She traveled extensively; returned to New York in 1841; visited the State prison and lectured to the women convicts; and was matron of the Sing Sing State Prison for four years. She was the author of: 'California, Indoors and Out'; 'My Early Days' (1859); and 'Woman and Her Era' (1864), her most finished work.

Farnham, Ralph, American soldier: b. Lebanon, Me., 1756; d. Acton, Me., 1861. He was the last survivor of the Battle of Bunker

Hill, and the first settler in Acton. A public concert was given in his honor in Boston, October 1860, at which he was present. He was 104 years, 9 months, and 19 days old when he died.

Farnham, Roswell, American soldier and lawyer: b. Boston, Mass., 23 July 1827. He was graduated at the University of Vermont in 1849, admitted to the Orange County bar in 1857, and served as State attorney 1859–61. During the Civil War he was successively lieutenant of the 1st Vermont Regiment; provost-marshal of Newport News, Va.; and lieutenant-colonel of the 12th Vermont Regiment from enlistment to disbandment. He was governor of Vermont 1880–2.

Farnham, or West Farnham, Canada, in the province of Quebec; on the Yamaska River, the Canadian P., and the C. V. R.R.'s; about 40 miles southeast of Montreal. The chief manufactures are beet-root sugar, flour, and dairy products. Pop. 3,000.

Farnworth, färn'wėrth, England, a market town in Lancashire, three miles southeast of Bolton. It has a grammar school founded in 1715, and among its industrial establishments are paper-mills, iron foundries, cotton-mills, collieries, brick works, etc. The Bolton waterworks are at Farnworth. Pop. 25,927.

Faro, fä'rō, Portugal, a seaport on the south coast, capital of the district of Faro, on a bay protected by islands. It contains an old castle surrounded by Moorish fortifications. The town is well built, and has a fine square, a cathedral, and a number of good schools. There is a considerable trade, chiefly in oranges, dried fruits, oil, cork, wine, etc. Deposits of antimony and of salt are in the neighborhood. In 1722 and 1755 the city suffered great damage and loss of life from earthquakes. Pop. (1901) 11,908.

Faro, fā'rō, is a gambling game pure and simple. A pack of cards is fastened in a clip, face downward, so that one card at a time can be withdrawn. The spectators, before it is turned face upward, bet, some that it will be one kind of card in value, such as ace, king, queen, or jack; others that it will have this or that number of «pips» on it; others that it will be red or black. When all have been drawn but the last three the betting is restricted as to their order of appearance. Faro was introduced into France by the Venetian ambassador in 1674, in a form like bassette; but so many nobles were ruined by this game that Louis XIV. made a law against it. To elude this law it was called *pour et contre,* which gave rise to new prohibitions, to evade which the name Pharaoh was adopted. Faro is not a common game in the United States, although it is played at the large gambling houses in New York, Chicago, Long Branch, N. J.; Saratoga, N. Y., and on the Pacific coast. See GAMBLING.

Faroe, fā'rō, or **Faröer Islands** (that is «Sheep Islands»), a group of islands in the Northern Ocean, lying between lat. 61° 20' and 62° 25' N., about 280 miles southeast of Iceland, and about 190 miles northwest of the Shetland Islands; area 514 square miles. They belong to Denmark, and consist of about 20 islands, of which 17 are inhabited. The largest islands are Strömö (144 square miles), Osterö, Sandö, Suderö, and Vaagö. The islands generally present steep and lofty precipices to the sea; the surface rises toward the interior, Slattaratinde in Osterö being 2,894 feet high, while a pinnacle called the Witch's Finger is said to be 3,000 feet. The climate is milder than the latitude might indicate, but the weather is very variable; the annual rainfall is about 70 inches. Sheep and horses can winter in the open air. The soil is generally thin; barley is the only cereal that comes to maturity; turnips and potatoes thrive well. There are no trees, but plenty of excellent turf, and also coal. The wealth of the inhabitants is chiefly derived from fishing and the feeding of sheep. The feathers of sea-fowl form an important article of trade. Some horses and cattle are kept; the former are small, but strong and hardy. Thorshavn, in Strömö, is the seat of government, and the only town. These islands have belonged to Denmark since 1380. The inhabitants are Norse, and speak a Norse dialect in which there are a number of old ballads extant; the official language is Danish. They have a home government and are also represented in the Danish Parliament by two representatives elected by the people. Pop. (1890) 12,955. Consult: Jeaffreson, 'The Faroe Islands.'

Farquhar, Anna, American author (MARGARET ALLSTON), who became Anna Farquhar Bergengren on marrying, 26 Jan. 1900, Ralph Bergengren.

Farquhar. fär'kwär, **George,** Irish dramatist: b. Londonderry 1678; d. April 1707. About 1606–8 he went to London, where he commenced writing for the stage. His first production was 'Love and a Bottle,' performed with great success in 1699. In 1700 he added to his reputation by his comedy of 'The Constant Couple,' in which, under the character of Sir Harry Wildair, he exhibited a lively picture of the foppish fine gentleman of the end of the 17th century. In 1701 appeared 'Sir Harry Wildair,' a sequel to the former; and the following year he published a volume of 'Miscellanies.' 'The Inconstant, or the Way to Win Him,' appeared in 1703, and is among those which have kept possession of the stage. In 1706 appeared 'The Recruiting Officer,' one of his most popular plays; and this was succeeded by 'The Beaux' Stratagem,' which is reckoned his masterpiece. It is no mean testimony of the dramatic talents of Farquhar that three of his plays are still favorites with the public. His wit is genuine and spontaneous, and his characters are admirably supported, and drawn from nature. His plots excel in the arrangement of incidents and in unity of action. The libertinism of language and sentiment which his works exhibit cannot be defended; but it was the vice of the age rather than the writer, who was much less culpable in this respect than Dryden or Wycherley.

Farquhar, Norman von Heldrich, American naval officer: b. Pottsville, Pa., 11 April 1840; d. 3 July 1907. He graduated at Annapolis in 1859; was acting master in the African squadron engaged in the suppression of the slave trade 1859–61; and, during the Civil War, served in the North Atlantic blockading squadron. He commanded the Trenton when she was wrecked at Apia, Samoa, in 1889; became chief of the Bureau of Yards and Docks in 1890; and commandant of the Norfolk navy yard. He became rear-admiral in 1899, and retired 1902.

Farquharson, James, Scottish scientific writer: b. Coull, Aberdeenshire, 1781; d. 3 Dec. 1843. After obtaining his elementary education in the parish school at Coull he entered King's College, Aberdeen, whence he was graduated M.A. in 1798, receiving an appointment as schoolmaster that year at Alford. He later studied theology and was licensed to preach, but devoted all his leisure moments to the study of meteorology, botany, chemistry, zoology, and kindred branches. He wrote many papers for scientific journals, the most important of which are those on the aurora borealis, contributed to the 'Philosophical Transactions' of the Royal Society, the 'Edinburgh Philosophical Journal' (1823), and 'Philosophical Transactions' (1829–30). In 1836 he wrote for the last-named paper a remarkable treatise on the formation of ice at the bottom of running water. He also wrote: 'On the Nature and Localities of Hoar Frost' for the 'Transactions' of the Highland and Agricultural Society of Scotland for 1840. Among his religious publications are: 'On the Form of the Ark of Noah' (1831); 'A New Illustration of the Latter Part of Daniel's Last Vision and Prophecy' (1838); etc.

Farquharson, Joseph, Scottish painter: b. 1842. He inherited his love for painting from his father, who himself was an artist of some note. At the age of 13 he had become proficient enough in his art to send a picture, 'A Study from Nature,' to the exhibition of the Royal Scottish Academy at Edinburgh. When 16 years of age he entered the Board of Manufacturers School, Edinburgh, to pursue his studies under Hodder, and from there passed into the Life School. From 1859 to 1881 his pictures appeared in the periodical collections of the Royal Scottish Academy without a break. In 1880 he determined to perfect himself by a visit to the Parisian ateliers, and for several winters worked there under Carolus Duran. In 1900 he was elected an associate of the Royal Academy. Among his most noted pictures are: 'The Critics' (1866); 'Day's Dying Glow' (1873); 'Wonderland' (1879); 'The Babes in the Wood' (1880); 'Joyless Winter Days' (1883); 'Where Next?' (1883); 'The English Vintage' (1884); 'In Cairo' (1886); 'Under the Palm Trees' (1887); 'Summer Days' (1887); 'My Heart's in the Highlands' (1890); 'He Led Them Wandering O'er the Sandy Way' (1891); 'Leaving the Hills' (1892); etc.

Farquharson, Martha. See FINLEY, MARTHA.

Farr, Samuel, an eminent Scottish physician: b. Taunton, Somersetshire, in 1741; d. Upcott, near Taunton, 11 March 1795. He received his early education at the dissenting academy at Warrington, later pursued his medical studies at Edinburgh, and completed his course at Leyden University, whence he was graduated M.D. in 1765. He then settled in his native town, where he soon acquired a lucrative practice. It is for his medical writings that he is chiefly noted, his works showing the results of much original observation and extensive experience, and the majority of them are considered authorities in that line. They are 'An Essay on the Medical Virtues of Acids' (London 1769); 'A Philosophical Inquiry into the Nature, Origin, and Extent of Animal Motion' (London 1771); 'Aphorism de Marasmo, ex summis medicis collecti' (1772); 'Inquiry into the Propriety of Blood-letting in Consumption' (1775); 'The History of Epidemics by Hippocrates in seven books translated into English from the Greek, with Notes and Observations' (1781); 'A Preliminary Discourse on the Nature and Cure of Infection' (London 1781); 'Elements of Medical Jurisprudence' (London 1788); 'On the Use of Cantharides in Dropsical Complaints' ('Memoirs Medical,' ii. 132, 1789); etc.

Farr, William, English statistician: b. Kenley, Shropshire, 30 Nov. 1807; d. 14 April 1883. In 1837 he contributed an important article on vital statistics to Macculloch's 'Account of the British Empire,' and in the following year was appointed compiler of abstracts in the registrar-general's office. From 1839 he was connected with the Statistical Society, of which he was president 1871–2, and in 1885 there appeared a collection of Farr's statistical works entitled 'Vital Statistics,' comprising six parts treating respectively of population, marriages, births, deaths, life-tables, and miscellaneous matters.

Farragut, făr'a-gut, **David Glasgow,** American naval officer: b. Campbell's Station, Tenn., 5 July 1801; d. Portsmouth, N. H., 14 Aug. 1870. His mother, Elizabeth Shine, sprang from the Scottish family of MacIven. His father, George Farragut, was born on the island of Minorca in 1755. He was descended of an ancient and noble Spanish family, originally of Aragon but for 400 years of the Balearic Islands, where they held many positions of trust and responsibility. George Farragut came to America in 1776, espoused the colonial cause, and served creditably in the army, where he is alleged to have saved the life of Col. Washington at the battle of the Cowpens, and was afterward a sailing master in the navy.

Commander David Porter had been a shipmate of George Farragut. The latter had been transferred to the naval station at New Orleans and had bought a plantation on the Pascagoula River, where Porter visited him. The commander took a great fancy to David and with his father's consent — his mother being dead — practically adopted him with the intent of putting him in the navy.

David Farragut was warranted midshipman on 17 Dec. 1810, being less than 9½ years old. He had been nearly two years at school in Chester, Pa., when in August 1811 he was ordered to the frigate Essex, Porter's ship. He was in all the minor engagements before the famous Essex sailed on her unprecedented cruise to the Pacific. Such was the scarcity of officers that in June 1813 the little midshipman, not quite 12, was made prize master of the whaler Barclay. The English captain was sent along as adviser. He attempted to take things into his own hands, but Farragut, with a coolness and courage remarkable, retained command and brought his vessel into port.

He was slightly wounded in the terrific battle in which the Essex was destroyed by the Phœbe and Cherub. During a crisis in the action Porter actually sent this stripling to shoot a seaman who was reputed to be flinching from his gun. Farragut would have carried out his captain's orders if he had been able to find the man. In writing his report to the secretary of the navy Porter was compelled to say that Farragut was too young for the promotion he had earned by his gallant conduct.

After the war he remained in the service, taking advantage of such educational opportunities as were afforded him between and during his cruises. In the spring of 1819 he was appointed acting lieutenant of the brig Shark, being then 18 years of age. In 1823 cruised in the West Indies against Cuban pirates. He was married in September 1823 to Miss Susan C. Marchant of Norfolk. He was commissioned lieutenant 23 Jan. 1825. In 1828 witnessed the capture of San Juan de Ulloa by the French while in command of the Erie. Mrs. Farragut died 17 Dec. 1840, leaving no children. He was commissioned commander 9 Sept. 1841 and in December 1843 married Miss Virginia Loyall of Norfolk; by her had one son, who survives him. During the Mexican War commanded the Saratoga. Had no opportunity for distinction and became involved in a dispute with Commodore M. C. Perry, commanding naval forces. August 1854 established Mare Island Navy Yard, Cal.; commissioned captain 14 Sept. 1855. In general, his service between 1815 and 1861 was arduous and exacting and was diligently and successfully performed. His devotion to Union sentiment forced him to leave Norfolk in April 1861. Removed his family to Hastings-on-Hudson, N. Y., and at first vainly sought orders to active service.

In January 1862 was given command of the Western Gulf Blockading Squadron and ordered to open the mouth of the Mississippi River by taking New Orleans, which was defended by two forts, a river fleet of 17 vessels, including fireships and rams. The way up the river was barred by a boom. Farragut had a superb fleet of 6 heavy ships, 16 gunboats, 21 mortar vessels, and 5 smaller craft.

On 24 April 1862 the boom was broken, the forts passed, and the river defense fleet annihilated after a sanguinary and desperate battle. New Orleans surrendered four days later. The daring of the attack was only equaled by the skill with which it had been planned. Three vessels of the fleet failed to pass the forts. The Varuna was sunk, the flagship Hartford grounded in the midst of the action and was set on fire by a fireship pushed against her by the Confederate ram. She was got off in safety, however. As Farragut said, "They had a rough time."

Ordered to clear the Mississippi, in June 1862, Farragut passed the batteries at Vicksburg, but there being no land force there to coöperate with him he repassed the batteries and returned to New Orleans. Was commissioned rear admiral 16 July 1862, the first in the United States service. On 14 March 1863 attempted to take his fleet past the Confederate works at Port Hudson. Grant was then operating against Vicksburg. Farragut perceived that if he could get ships below Vicksburg he could prevent Confederate forces in that city from receiving supplies and re-enforcements from west of the Mississippi. Farragut's conception was strategically sound and brilliant. He boldly endeavored to carry it out.

Still in the Hartford, with a gunboat lashed alongside, he passed the batteries under a terrific fire. None of the other vessels succeeded in getting past. The Mississippi, of which George Dewey was the executive officer, grounded, was set on fire by Confederate shells, and burned to the water's edge. Farragut had only partially succeeded. Still the Hartford and the Albatross patrolled the river and practically cut all communication west of Vicksburg.

After the fall of Port Hudson he returned to New Orleans and on 1 Aug. 1863 sailed for New York to recuperate his health, impaired by his arduous labors. In January 1864 took command of the naval forces acting against Mobile. On the morning of 5 August entered the bay. The mouth was protected by two formidable forts, Morgan and Gaines. The narrow channel was obstructed by piling and lines of floating torpedoes. Farragut's fleet comprised 30 vessels, of which 8, including the flagship Hartford, were steam sloops-of-war of the first class. There were 4 monitors and 18 gunboats.

He attempted the passage with seven of his heavy sloops, each one lashed to a gunboat on its port side. The four monitors, the Tecumseh leading, were sent ahead, followed by the Brooklyn-Octorara couple, then the Hartford-Metacomet couple, and the other ships in succession. Farragut had ordered the column to pass close under the walls of Fort Morgan, through an opening left free of torpedoes for blockade runners.

At 7.45 A.M. the Tecumseh opened fire. The Confederate batteries did not reply until 20 minutes later. In Mobile Bay lay three gunboats and the ironclad ram Tennessee, Commodore Franklin Buchanan, a match, it was believed for the whole Union fleet. As Farragut approached the ram took position behind the torpedo line. In his eagerness to engage this redoubtable foe Craven on the Tecumseh disobeyed the admiral's order, and instead of passing through the opening headed for the Tennessee. He struck a torpedo and was blown up just as the Brooklyn got fairly under fire. Striking empty shell boxes thrown overboard from the vessels preceding it was thought she was in danger of torpedoes. She stopped and swung with her head toward the fort where none of her guns bore. The Confederates poured a rain of shot and shell upon her. The Hartford, coming up fast, nearly fouled the Brooklyn. The hesitant ships were bunched and made a target for every Confederate gun. The battle seemed lost.

Farragut, ascertaining that the Brooklyn had stopped for fear of torpedoes, ordered the Hartford to the head of the line, giving utterance to that immortal phrase: "Damn the torpedoes! Go ahead!" The Hartford passed the Brooklyn, narrowly escaping shoals to port and raced up the bay toward the Tennessee. It was now impossible to pass through the designated channel and Farragut drove the Hartford across the torpedo line. The example of the admiral put spirit into the Brooklyn and with the other ships she followed the flag. Fortunately no other torpedoes exploded and the whole fleet successfully passed the forts after a bloody and desperate battle.

The Tennessee had ranged along the Union ships and, immune to their fire, had shelled them at will. As soon as the passage had been made the Union gunboats were cast off from the frigates and the Confederate gunboats were captured or driven to the shelter of Fort Mor-

DAVID GLASGOW FARRAGUT.

gan. At 9 A.M. the Tennessee, with surprising gallantry, came up toward the Middle Ground to engage the Union fleet. To this battle Farragut was nothing loth. By his orders the wooden ships were hurled upon their antagonist. The Monongahela struck her a terrific blow at a right angle. The Lackawanna repeated the ramming tactics. The bows of the wooden ships were stove in to the water line. Both ships were raked by the Tennessee's rifles; their return broadsides doing no damage to the iron plating. The Tennessee made straight for the Hartford, which was bearing down directly upon her, bows on. One or the other ship would have been sunk had not the Tennessee swerved so that the Hartford struck her a glancing blow. The ram was now beset by all the vessels of the Union fleet which could get at her. She was rammed, hammered, and pounded. The monitors with their heavy guns were racking her from stem to stern. In the mêlée the Lackawanna rammed the Hartford, cutting her down to the water's edge. Finding his ship would still float Farragut ordered her again to ram the Tennessee. By this time the ironclad's smokestack had been shot away, the casemate was an inferno, the heavy battering had jammed the port shutters, shot had entered through the ports, not a gun could be fired, steam ran down in the boilers. She could neither fight nor fly, so she surrendered, after one hour of as fierce fighting as ever recorded.

During the passage of the forts Farragut had taken position in the main rigging in order to get above the smoke of the battle and be able to direct the maneuvers of the fleet the better. The quartermaster had passed a lashing around the admiral so that in case he should be wounded and lose his footing he would not fall to the deck.

In the battle Farragut should have led in the Hartford. It was only the urgent representations of his captains that made him take the second place. The battle was nearly lost by the gallant Craven's disobedience of orders and that it was finally won was due to the personal initiative of the admiral himself.

This completed his service during the war. He was 64 years old when he fought the battle of Mobile Bay. His health was quite broken. He was commissioned vice admiral 23 Dec. 1864; admiral 26 July 1866; sailed 28 June 1867 from New York in the steam frigate Franklin for an extended cruise in European waters, where he received such a welcome and was accorded such honors as have been tendered no other American save Gen. Grant. He returned to New York on 10 Nov. 1868, visited the Pacific Coast in the summer of 1869 and died 14 Aug. 1870. He was accorded the honor of a public funeral in New York 30 September, and was buried at Woodlawn Cemetery, Westchester County.

Farragut was a rather small man with broad shoulders and a well-knit, vigorous frame. His face was long with a broad high forehead and an aquiline nose. His complexion was dark and his eyes brown. He was a cultivated gentleman of the highest type, a most accomplished officer, a lion in bravery, a woman in gentleness. He was a simple-minded Christian of a high and humble type, a communicant of the Protestant Episcopal Church. A statue of him by Saint Gaudens stands in Madison Square, New York. One by Kitson in Boston; another by Vinnie Ream Hoxie in Washington. In the Church of the Incarnation, New York, is a mural tablet with a bas-relief of the admiral by Launt Thompson. Consult: 'Life and Letters,' by his son; Mahan, 'Admiral Farragut'; Barnes, 'Admiral Farragut'; Parker, 'Battle of Mobile Bay'; Brady, 'The Southerners.'

CYRUS TOWNSEND BRADY.

Farrakhabad. See FARUKHABAD.

Farrant, făr'ant, **Richard,** English composer: b. 1530; d. Windsor 1585. Very little is known of his history. He was a gentleman of the chapel royal for some time up till 1564, when he became organist and choir-master of St. George's, Windsor, but in 1569 he was again appointed to the chapel royal. His music is ecclesiastical, and is distinguished by purity, simplicity, tenderness, and elevation of tone. The anthems 'Call to Remembrance,' and 'Hide not Thou Thy Face,' composed by him, are well known and highly esteemed by lovers of good music. The exquisitely beautiful anthem, 'Lord, for Thy Tender Mercies' Sake,' has been attributed to him, but also to Thomas Tallis and John Hilton.

Farrar, Eliza Ware Rotch, American writer: b. Flanders, Belgium, 1791; d. Springfield, Mass., 22 April 1870. She married Prof. John Farrar of Harvard University. Her works include: 'The Children's Robinson Crusoe'; 'The Story of Lafayette'; 'The Youth's Love-Letters'; 'Congo in Search of His Master' (1854); and 'Recollections of Seventy Years' (1865).

Farrar, Frederick William, English clergyman and author: b. Bombay 7 Aug. 1831; d. London 22 March 1903. He studied at King William's College, Isle of Man, and Trinity College, Cambridge, having gained one of the college scholarships. He was ordained deacon in the Established Church 1854 and priest in 1857, and for 16 years was an assistant master at Harrow. From 1871 till 1876 he was head master of Marlborough College, resigning on his appointment as a canon of Westminster and rector of St. Margaret's. In 1883 he was appointed Archdeacon of Westminster, and in 1895 became Dean of Canterbury. From 1890 till 1895 he acted as chaplain to the House of Commons. Besides identifying himself with various social and philanthropic movements, he published many popular and able works of various kinds. In fiction he published: 'Eric, or Little by Little' (1858); 'Julian Home: a Tale of College Life' (1859); 'St. Winifred's'; 'Gathering Clouds: a Tale of the Days of St. Chrysostom' (1896); in philology: 'Origin of Language' (1860); 'Families of Speech' (1870); 'Language and Languages' (1878); etc.; and on theological and religious subjects: 'Seekers After God' (1869); 'The Witness of History to Christ' (1871); 'Life of Christ' (1874), a work which achieved extraordinary popularity; 'Life of St. Paul' (1879), also highly popular; 'Early Days of Christianity' (1882); 'History of Interpretation' (1885); 'Eternal Hope' (1888); 'Lives of the Fathers' (1889), a popular work: 'The Bible: Its Meaning and Supremacy' (1897); 'The Herods' (1897); 'The Life of Lives' (1899); 'Temperance Reform'; 'Texts Explained' (1899). In August 1885, he came to the United States, thereby realizing what he said had been one of the desires of his life. He remained in this country until the beginning of December, traveling, visiting friends and lecturing. He was a man of great eloquence, tremendous energy and was greatly beloved by all ranks, high as well as low. His most intimate American friend was Phillips Brooks.

Farrer, făr'ėr, **Henry,** American artist: b. London, England, 23 March 1844. He was the son of an English miniature painter, Thomas Farrer (1770–1850), and came to New York in 1863. He has painted largely in water colors but is widely known as an etcher also.

Farriery. See VETERINARY ART.

Farrington, Oliver Cummings, American geologist: b. Brewer, Maine, 9 Oct. 1864. He was graduated at the University of Maine in 1881; became lecturer on mineralogy in the University of Chicago in 1894, and curator of geology at the Field Columbian Museum in the same year. He has published: 'Meteorites'; and 'The Volcanoes of Mexico.'

Fars, färs, or **Farsistan,** fär-sis-tän' (ancient PERSIS), a province in the southwest of Persia, about 300 miles long by 250 miles broad. Its chief rivers are the Bandamir, the Sefid-rud, and the Mand; and it has several salt lakes, of which the largest is that of Bakhtegan. The most important products are grain, rice, fruit, wine, oil, cotton, tobacco, silk, cochineal, and attar of roses. The manufactures include woolen, silk, and cotton goods; and in these and other articles an active trade is carried on, chiefly with India. Many ancient ruins are scattered over the province. The capital is Shiraz, and the chief port is Bushire or Abushehr. About 30 miles north of Shiraz are the ruins of Persepolis, an ancient city. The people of this province are among the best preserved types of the Aryans. Pop. (estimated) 1,700,000.

Farsan (fär-sän') **Islands,** a group of two larger and several small islands on the east side of the Red Sea. The surface is diversified by hills composed of coral, and occasional valleys and plains. Pearl-fishing is here an important industry.

Farukhabad, fü-rook'ä-bäd, or **Farrakhabad,** fur-ruk-ä-bäd', India: (1) town in India, in a district of the same name in the northwest provinces; about two miles west of the Ganges, 90 miles west-northwest of Lucknow. It forms a single municipality with Fatehgarh, the civil headquarters of the district, situated three miles to the east. Pop. (1901), with cantonment, 67,338. (2) The district of Farukhabad forms part of the Agra division, and lies mainly along the western bank of the Ganges. Area, 1,720 square miles.

Farwell, Charles Benjamin, American merchant and legislator: b. Painted Post, N. Y., 1 July 1823; d. Lake Forest, Ill., 23 Sept. 1903. Having gone in 1838 to Illinois, he was there engaged in farming and government survey work until 1844, when he entered a mercantile career in Chicago. He accumulated a fortune in the dry-goods trade. In 1869 he was a national bank examiner, in 1871–6 and 1881–7 a representative in Congress. From 1887 to 1891 he was United States Senator, having been elected to fill the vacancy caused by the death of Gen. J. A. Logan. He was a figure of some prominence in both State and national politics.

Fasano, fä-sä'nō, **Italy,** a town in the southeast, near the Adriatic; 30 miles southeast of Bari. It is in the midst of an olive district, and there are numerous oil-presses in the town and neighborhood. The chief trade is in oil and wine. The cottages of many of the peasants have been made from the stone taken from old walls. Fasano was at one time a wealthy residential and commercial city. Pop. of the commune, 16,900.

Fasces, fas'ēz (Lat. *fascis,* a bundle), the most ancient insignia of the Roman magistrates, consisting of bundles of rods, usually birch, bound with which was an axe with projecting blade; used as a symbol of authority. The fascis was carried by an attendant known as a lictor. The number of lictors varied according to rank, and for a given dignitary frequently differed at different periods. Fasces were accorded quæstors in the provinces only.

Fascia, in anatomy, an animal tissue, consisting of dense connecting sheets or layers, of the nature of fibrous membrane, close and strong as tendon or ligament. The fascia in the economy of animal anatomy serves the purpose of confining within its proper area supporting as a sort of fulcrum, separating from one contiguous tissue, or attaching to another, some muscle, part or organ of the body. See the works on 'Anatomy' of Quain and Morris, in English; of Gegenbaur and Rauber, in German; and of Testut and Poirier, in French.

In architecture, a flat band, running horizontally across an entablature. The architrave in the Corinthian and Ionic orders is divided into three bands which are called fasciæ; the lowest being called the first fascia, the middle one the second, and the upper one the third. When there are only two fasciæ, they are called the upper and lower. See COLUMN; ENTABLATURE.

Fascination (Lat. *fascinare,* «to bewitch»). Various animals, such as toads, hawks, and notably certain varieties of serpents have been popularly invested with the power of controlling by their eyes the movements of intended victims. Such power has never been scientifically demonstrated, and supposed manifestations have generally been explained as paralysis through fear on the part of the victim. For an account of the belief in the evil eye in human beings, see SUPERSTITION.

Fascine, fă'sēn (Lat. *fascina,* a bundle of sticks), in fortification, a cylindrical bundle of faggots or brushwood used to form parapets, strengthen ramparts, elevate batteries, prepare temporary field defenses, and the like. They vary in size from 6 to 18 feet in length, 6 to 9 inches in diameter, and are bound with withes. Fascines dipped in pitch or other combustible matter are sometimes used in order to set fire to the enemy's lodgments or other works. In civil engineering fascines are used in making sea and river walls to protect shores subject to washing; or to collect sand, silt, and mud to raise the bottom and gradually form an island, either as a breakwater against inroads, or for purposes of cultivation, as in Holland.

Fasciolaria, a genus of mollusks. See FUSIDÆ.

Fashion, conventional usage in the matter of certain details of life, especially the changes and modifications of costume in civilized nations; mode or style in dress. Such variations of costume were unknown to most nations of the ancient world, and among the Romans only influenced the accessories of the toilet. The unchanging East is as unchanging in its dress as in everything else, and the fashions to which savage tribes uncompromisingly adhere remain unaltered for long periods. In some remote districts of European countries peasants still dress in the costume brought two or three hundred years ago by the local nobility from court, and the smock-frock of the English agricultural laborer is a relic of Saxon times. (For detailed history of the costumes of different periods, see article on COSTUME, and for certain principles underlying the subject, see DRESS.) Survivals in modern costume may sometimes be traced back to unexpected origins. With regard to the modern evening dress-coat we learn that it owes its peculiarities to its descent from the old-time everyday garment in which a man rode and worked. «The cutting away at the waist had once the reasonable purpose of preventing the coat skirts from getting in the way in riding, while the pair of useless buttons behind the waist are also relics from the times when such buttons really served the purpose of fastening these skirts behind: the curiously cut collar keeps the now misplaced notches made to allow of its being worn turned up or down.» It is said that the modern cylindrical hat is the indirect descendant of the Puritan steeple-crowned hat, carried across the Atlantic by the Pilgrim Fathers, thence again to France, when Benjamin Franklin and the young Republicans were the height of the fashion, and by the French manipulated into the hat which they have given to all the world. Certain striking features in vogue at different times in the dress both of men and of women have originated in the lack of bodily symmetry or in other physical defects in various monarchs or other leaders of fashion. Until the 19th century men's clothes were as delicate in color and as rich in material as women's. Pepys records in his diary how he had his wife's gowns cut up into waistcoats for himself. The uniforms of officials or of persons connected with public or special service, the judge's and the clergyman's robe and the student's cap and gown cannot be said to have had their origin in fashion; nor can the indication of political or religious opinions by peculiarities of dress, as among Puritans and Quakers, or as illustrated by colored cockades or other party emblems be called phases of fashion, yet fashion has been sometimes closely connected with political changes. Dress attained its highest point of significance in France during the last half of the 18th century, when it marks unmistakably the various stages of the Revolution. Rousseau's 'Emile and Nouvelle Héloïse' and Goethe's 'Werther' brought sentimentality into fashion; women's hair was dressed in *bandeaux d'amour* or *poufs de sentiment;* and Marie Antoinette and the ladies of her court sought to return to the simplicity of nature by masquerading in the Trianon attired as shepherdesses and milkmaids. The works of Montesquieu and Voltaire had created an admiration for England, and the courtiers of Versailles dressed themselves like English fox-hunting squires, while their wives and daughters got themselves up *á l'Anglaise* in coats with cuffs, collars, and facings, beaver-hats, and cravats. As the political turmoil increased, fashionable attire grew more and more eccentric and multiform, till at last republican institutions triumphed, and the women of France began to clothe themselves as like as possible those of Greece and Rome both in style and scantiness. They discarded costly materials, and shivered through the winter months clad in a few yards of muslin. Men wore a combination of antique and romantic costume invented by the painter David, which was finished off with Hungarian boots. At the present time the fashions for women in all civilized countries are set by Paris; for men, though not so exclusively, by London. One marked feature of the everchanging kaleidoscope of fashion is its tendency to revolve in cycles. Cycles of alternate luxury and simplicity have also distinguished all ages. Fashions change more quickly each decade, a fact due in great measure to increased facilities of communication, while the triumph of democracy is shown by their universal adoption by all classes. Consult: 'Nos Aieules,' translated as 'Ten Centuries of Toilet,' by Mrs. Cashel Hoey (1892). See also *Bibliography* of COSTUME.

Fashoda, fä-shō'dä, Egyptian Sudan town founded in 1867 by the Egyptian government, situated on the Bahr-el-Abiad or White Nile, 400 miles south of Khartum and about 70 miles northeast of the confluence of the Sobat River with the Nile. In July, 1898, it was occupied by a small French force, but some months later it was claimed by the British for Egypt. Ultimately the French force evacuated the town, which was then formally occupied by Sudanese troops.

Fassaite, fas'a-īt, the name applied to a pale green to pistachio or dark green variety of augite, or aluminous pyroxene (q.v.). It occurs in metamorphic, marly limestone in the Fassathal, Tyrol.

Fassett, fas'ĕt, **Cornelia Adèle Strong,** American artist: b. Owasco, N. Y., 9 Nov. 1831; d. Washington, D. C., 4 Jan. 1898. She studied in New York as well as in Paris and Rome, and from 1875 lived in Washington, where she painted portraits of many prominent statesmen. Her most important work is 'The Electoral Commission in Open Session,' including the portraits of some 200 persons.

Fassett, Jacob Sloat, American lawyer and capitalist: b. Elmira, N. Y., 13 Nov. 1853. He was graduated from Rochester University 1875, and was admitted to the bar 1878. He was State senator 1884–90 and was defeated as Republican nominee for governor in the year last named. He is the proprietor of the Elmira *Daily Advertiser,* and controls mining, banking, and other interests in the Western States and in Korea.

Fast and Loose, the name of a cheating game, also called «pricking at the belt,» which appears to have been much practised by English gypsies in the time of Shakespeare, and which is still played at fairs, races, and similar meetings under the name of «prick the garter.» The game consists in trying to pin to a table a belt or similar object so folded as to produce a misleading effect. The original name, in the phrase "to play fast and loose," has gone into the language to designate the conduct.

Fastenrath, Johannes, yō-hän'-nēs fäs'ten-rät, German poet and story writer: b. Remscheid 3 May 1839. A brief sojourn in Spain (1864) filled him with a permanent enthusiasm for the land and literature which inspired nearly all his life-work. He translated Juan Diana's comedy 'Receipt Against Mothers-in-Law'; and compiled a series of volumes which are less translations than transcriptions in the spirit of the originals — 'A Wreath of Spanish Romances'; 'Hesperian Blooms'; 'The Book of My Spanish Friends'; 'Voices of Christmas.' He has also published several works on the history of Spanish literature; and in Spanish, 'Passion-Books of a German-Spaniard,' a description of the Oberammergau Passion Play; and 'Walhalla and the Glories of Germany.' A volume of war songs dedicated 'To the German Heroes of 1870' is likewise his.

Fasti, fas'tī (Lat. *fasti,* lawful, *fas,* divine law, DIES, days), in ancient Rome, days on which the transaction of business before the prætor was legal, days on which court did not sit being *dies nefasti.* The name thence came to be applied to two sorts of registers or tables: (1) The *fasti sacri* or *fasti kalendares,* containing the calendars of the year. These were at first known only to the *pontifices,* or priests, who announced them to the people, and had thus a source of power and profit. In 304 B.C. Cn. Flavius, who had been secretary to the *Pontifex Maximus* Appius Claudius, Cæcus, exposed them to the people. (2) The *fasti annales* or *historici,* which formed a chronicle of contemporary events, containing the names of the chief magistrates of the year, and a series of the more remarkable events noted in the order of the days of their occurrence.

Fasting, or the practice of self-denial in regard to food and drink has obtained not only in Judaism and Christianity but in the religions of paganism: it is commended to Christians by the example of the prophets of Israel, Moses, Elias, and John the Baptist, and above all by the example and precepts of Christ and his apostles. Under the Mosaic law only one day was appointed to be observed annually by the whole people as a day of fasting — the Day of Atonement; but in addition to that solemn and divinely ordained fast numerous other fasts were enjoined by the Jewish traditional law. In the New Testament no stated days or seasons of fasting are prescribed, nor in the existing records of the Church's history do we find clear proofs of days or seasons of fasting being enjoined on the faithful till the beginning of the 4th century, though the practice of stated fasts was doubtless widely extended at an earlier period. In the strict sense of the word, fasting involves abstinence from all food and drink for a definite period; in the practice of the Church it means abstinence from food on a given day till a certain hour, till noon, or till sunset. The days and seasons of fasting in the Roman Catholic Church are: The 40 days of Lent; the Wednesdays, Fridays and Saturdays of the Ember weeks; the vigils or eves of certain festivals; the Wednesdays and Fridays of Advent. All Fridays throughout the year (except the Friday which happens to be Christmas Day), are "days of abstinence," that is, days on which the Church forbids the use of flesh-meat. Custom and church legislation have so modified the strict law of fasting, that besides the one meal a "collation," or light repast, is allowed in the afternoon or evening; and it is permitted to take at the usual hour of breakfast a small quantity of food. The days of fasting prescribed in the Anglican Book of Common Prayer are nearly the same as are observed in the Roman Catholic Church.

Fastnet Lighthouse. See CAPE CLEAR.

Fastolf, fas'tolf, SIR **John,** English soldier: b. Caister, near Yarmouth, about 1378; d. there 5 Nov. 1459. He saw much service in the French wars, and distinguished himself in the battle of Agincourt, the capture of Caen, the siege of Rouen, and other events. He was knighted about 1417, and made governor of the Bastile in 1420. In 1429 he was ordered to bring supplies to the English camp in front of Orleans, then in a state of siege. He went to Paris and obtained the provisions, but when returning was attacked at Rouvray by a French force much stronger than his own. In spite of this disadvantage, however, he succeeded in driving off the attacking party, mainly owing to the skilful manner in which he used barrels of herrings for defensive purposes. The battle is usually known from the last-mentioned circumstance, as the Battle of the Herrings. Some have charged him with cowardly behavior in the subsequent battle at Patay, and it is said that the Duke of Bedford deprived him of the Garter which had been conferred on him in 1426. This charge is, however, probably unfounded. In 1432 he was appointed English ambassador to the Council of Basel, and in 1441 he withdrew from the army. The 'Paston Letters' (q.v.) contain a long account of his later life in Norfolk, and show him to have been keenly bent on amassing a large fortune. He has been regarded as the prototype of Shakespeare's 'Sir John Falstaff.'

Fasts. Among the Jews fasts were numerous; founded on tradition, except that of the day of expiation, which was appointed by Moses. We find, however, fasting mentioned in the Old Testament. Herodotus says that the Egyptians prepared themselves by fasting for the celebration of the great festival of Isis. So in the Thesmophoria at Athens, and in the rites of Ceres at Rome, it was practised. Protestants consider that Christ and his apostles give no precept respecting fasting. It was probably, however, early practised by the Christians as a private act of devotion. The fast days in the Roman Catholic Church are: All the week days of Lent, beginning on Ash Wednesday, the Fridays in Advent, the Ember days, namely, Wednesdays, Fridays, and Saturdays following (1) the first Sunday in Lent; (2) Whitsunday; (3) the 14th of September; (4) the third Sunday of Advent; also the vigils of Pentecost, the Assumption, All Saints, and Christmas. When the vigil falls on Sunday, the fast is kept on the Saturday preceding. The days of abstinence (on which flesh-meat is not allowed) are all Fridays in the year and fast days. Illness, old age, and other causes may entitle a person to a dispensation from these regulations. The Protestant Episcopal Church appoints the following fixed days for fasting and abstinence, between which no difference is made: (1) the 40 days of Lent; (2) the Ember days, at the four seasons; (3) the three Rogation days before Holy Thursday; (4) every Friday except Christmas Day. The Church, however, gives no directions concerning fasting.

Fat-back, a name for the menhaden (q.v.), and for certain mullets, in allusion to the thickness of the dorsal adipose tissue.

Fat-bird, a name among sailors for the guacharo; and among sportsmen in New Jersey for the pectoral sandpiper.

Fata Morgana, fä'tä mor-gä'nä, a remarkable aërial phenomenon observed in the Strait of Messina, and other points in Italy and Sicily, and thus called because supposed to be the work of the fairy Morgana. Objects are reflected sometimes on the surface of the sea, and sometimes on a kind of aërial screen. An object has often two images, of which one is inverted.

Fatalism, the doctrine that all things are ordered for men by the arbitrary decrees of God or the fixed laws of nature. In theology it has given birth to theories of predestination, and in moral science to such systems as those of Spinoza and Hegel, and more recently to the philosophy of Herbert Spencer. It is carried out to its most pitilessly logical extreme among the Mohammedans, where everything that can happen is "kismet," that is, fated, or decreed by fate. See DETERMINISM; PREDESTINATION; WILL.

Fatality in Color. The color of a soldier's uniform is based upon a principle of fatality. Experience and statistics prove that men are hit in battle according to the color of their dress. Red is the most fatal; the least fatal is Austrian gray. The proportions are: red 12; green 7; brown 6; gray or blue 5.

Fategarh. See FATHIGARH.

Fatehpur. See FATHIPUR.

Fatehpur-Sikri, or **Futtipur-Sikra,** Hindustan, the site of an ancient town in the district of Agra. It was the favorite residence of the Emperor Akbar, who enclosed and fortified it, and the part of the palace containing the apartments of his celebrated prime-minister, Abu-Fazel, is still in good preservation. It is built of dark-red sandstone, in a fine style of Oriental Gothic, adorned with numerous pilasters and rich tracery and carvings, and crowned by two domes. In a tomb of elaborate workmanship, standing in the centre of an arcaded square and approached through a noble gate, several members of the royal family were interred.

Fates, Μοῖραι, *Moirai;* Lat. *Parcæ,* in ancient mythology, the inexorable sisters who spin the thread of human life. Homer mentions neither their separate names nor their number. The appellation *Clotho* (the spinner) was probably at first common to them all. As they were three in number, and poetry endeavored to designate them more precisely, *Clotho* became a proper name, as did also *Atropos* and *Lachesis.* Clotho means she who spins (the thread of life); Lachesis, the disposer of lots; Atropos, unalterable fate; so that all three refer to the same subject under different points of view. The first spins the thread, the second determines its length, and the third cuts it. In Homer and Hesiod they appear as goddesses of human fate and individual destiny, both in life and death. Among the lyric poets they seem to have a general power over events, and are always present where anything is to be divided. In the narrowest signification they are the goddesses of death, as of that destiny which closes the scene with all. In this capacity they belong to the infernal world, and are daughters of Erebus and Night. As goddesses of fate they are the servants of Zeus and the offspring of Zeus and Themis. The former genealogy is the more modern. As daughters of Zeus, they have a share in the decisions of fate, and are commissioned by him to execute his commands.

Father, Duties of a. See PARENT.

Father John, or **Father-of-Sickle,** translations of Arabic names for the common or sacred ibis of the Nile region. See IBIS.

Father Prout. See MAHONY, FRANCIS.

Fatherlasher, a small, ugly, cottoid fish, or bull-head (*Cottus bubalis*), from 8 to 10 inches in length. The head is large, and is furnished with several formidable spines. The fish is found on rocky coasts on both shores of the North Atlantic. On the Labrador coast it attains a large size, and is a considerable article of food.

Fathers of the Church, a title bestowed upon certain Church writers who stand preeminent as authorities in the interpretation of Scriptures, the ritual practice of the age they lived in, and the formulation of doctrine as accepted dogma. This authority is weightiest in the Apostolic Fathers (q.v.). Next come the Fathers of the Greek Church, such as Athanasius, Basil the Great, Gregory Nazianzen, and John Chrysostom. Parallel with these are Fathers of the Latin Church, among whom are Jerome, Ambrose, Augustine, and Gregory the Great. While these are the most important of the Fathers, the term is employed with some looseness and often made to include Greek writers like Origen, and Latin writers like Tertullian, whose speculations are sometimes charged with being unorthodox. In modern times, when the study of Christian doctrine has a tendency to become largely historical, the value of the patristic monuments is esteemed more highly than ever before in the progress of European learning.

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Fathigarh, Fategarh, Futtygurh, or **Futtigarh,** British India, a military district of Farnkababad (q.v.), three miles east of the city of that name. Pop. (1900) 12,400.

Fathipur, Fatehpur, or **Futtehpur,** British India, capital of the district of the same name, on the highway between Delhi and Calcutta, 70 miles northwest of Allahabad. It contains government buildings and a mosque. Pop. (1900) 20,000.

Fathom. See WEIGHTS AND MEASURES.

Fatigue, a condition of body or of mind brought about by excessive expenditure of energy. Fatigue may occur in any organ of the body as a result of overstimulation; but it is usual to speak of muscular fatigue and nervous fatigue, since the muscle-functions and nerve-functions may be more readily measured; and furthermore, when muscle-tissue and nerve-tissue become tired, this state is associated with certain conscious states that are more or less clearly understood. Fatigue of the sense-organs is included in nerve-fatigue. The sensations, if present, from fatigue, biologically considered, in other organs, such as liver-cells, kidney-cells, etc., are at present little known. The study of protoplasmic fatigue in plants and lower animals promises to open up much heretofore buried knowledge concerning these problems.

Fatigue in muscle results in the main from its excessive use, over and above its capacity to repair by physiological rest. The heart-muscle, while doing an immense amount of work, also does a great amount of resting. Less than one fourth of the time of the heart-cycle is used in contraction. Over three fourths is used in resting. The sense of fatigue is probably a distinct sensation from the organs of muscular sense conveyed to consciousness as a warning to stop excessive muscular activities. The causes leading up to the production of fatigue in muscles are by no means thoroughly understood. The present theory in popular belief teaches that fatigue is due to a form of poisoning of the nerve-end organs in the muscle, the poisonous materials being formed by the metabolism of the muscle — fatigue-stuffs, they have been named by physiologists. If these could be washed out of the muscle the sense of fatigue would go, the muscle-substance itself being apparently unaffected, and conversely, inactive muscles may be made to feel tired if the juices of tired muscles are made to circulate in their blood vessels. What these fatigue-stuffs are is yet undetermined with certainty. They are probably very complex, and probably include substances, like lactic acid and phosphates, that change the chemical reaction of the muscle-plasma, and most likely also a variety of other bodies.

Fatigue in sense-organs, such as taste, smell, touch, etc., may show itself by loss or change of the function. The taste is lost when the stimulation becomes excessive; so with smell and touch; and the same is true for the other sensations. A chemical basis for fatigue in the end-organs is probable, but little is known concerning this. Fatigue in the nerve-cell itself has been widely studied by physiochemical histological methods and certain changes in the nerve-cells seem correlated with fatigue-processes. These involve certain structures in the nucleus and in the stainable constituents (Nissl bodies) of the cells. Fatigue in the reflex arc, as, for instance, in the knee-jerk, is manifested by a steady diminution in the muscular response. Whether the reflexes are purely muscular or neuromuscular phenomena or not, similar changes take place in the end-organs and in the nerve-cells. Mental fatigue is probably closely correlated with the forms of fatigue in other nervous cells of the body. The cells of the brain are probably more complex, both histologically and chemically, than those in other parts of the nervous system, but the changes causing fatigue, and the results in modification of form, are probably of the same kind, if not of the same degree. Tire of the mental functions causes a sympton-complex that is very characteristic. See NEURASTHENIA.

A measure of fatigue-states is possible for most of the simpler muscle and nerve end-organ phenomena, but accurate methods of registering mental fatigue are much needed. School test-methods by which children are made to undergo psychological "stunts" are yielding some very valuable material, although vitiated by much amateurish pedagogical theorizing.

The measuring of the changes in the various reflexes, the nerve-end organs — sensations, perceptions, correlation of ideas, memory-images, etc.— constitutes an important part of a specialist's work in the study not only of normal psychology, but of the abnormal psychology of the insanities. Consult: Schäfer, 'Physiology'; Atwater, 'Digest of Metabolism Experiments'; Ziehen-Sommers, 'Psychophysiologische Methoden'; Verworn, 'General Physiology'; Mann, 'Physiological Histology'; 'American Journal of Psychology'; 'Psychological Review'; 'Educational Review.' See AUTO-INTOXICATION; INSANITY; MUSCLE-EXCITATION; NERVE-CELL; NERVE-FIBRE; NEURASTHENIA; SPECIAL SENSES.

Fatigue of Materials. See STRENGTH OF MATERIALS.

Fatima, fä-tē-mä, (1) The favorite daughter of Mohammed: b. Mecca, Arabia, about 606; d. Medina, Arabia, 632. She had three sons, Al-Hasan, Al-Husein, and Al-Muhsin. From the first two were descended the Saiyides. (2) In 'Aladdin,' the enchantress. (3) In the story of 'Bluebeard' the last wife, and the only one not murdered.

Fatimides, fat'i-mīdz, or **Fatimites,** fat'i-mīts (named from Fatima, the daughter of Mohammed and wife of Ali, from whom the founder of the dynasty described in the definition professed to have sprung), a race of Mohammedan kings, whose founder was Abu Abdallah Husein. Obeid Allah (909–33), subdued northern Africa from the Atlantic coast to Egypt, assumed the title Mahdi ("Leader of the Faithful"), established his capital at Mahadi and made himself independent of the Abbassic caliphs. The most important of the dynasty was Al-Mu'izz (955–78), who conquered Sicily and Egypt (972), transferred his court to the latter country, and founded Cairo. Al-Hakim (996–1021) persecuted Jews and Christians, and destroyed the Church of the Resurrection at Jerusalem (1009). His cruelties were a leading cause of the Crusades (q.v.). The dynasty included 14 caliphs, of whom Al-Adhid was the last (1171). Consult: Wüstenfeld, 'Geschichte der Fatimiden-Khalifen' (1881).

Fats. In chemistry, this class of substances was originally understood to include all those compounds of carbon, hydrogen and oxygen which leave a permanent, translucent grease-spot upon paper. In more recent times, however, it has been the custom to include only such bodies of this sort as admit of saponification. Our knowledge of the constitution of the fats is due in large measure to the labors of the French chemist Chevreul, who showed that they are mostly composed of glycerin, in combination with certain organic acids, prominent among which are oleic, stearic and palmitic acids. Fats may be extracted from animal tissues by heat, a temperature of 212° F. being sufficient. From seeds and other vegetable matters in which they occur they are commonly extracted by heating the ground-up tissues, and subjecting them to heavy pressure. As obtained by these methods, the fats often retain fragments of the original tissues in which they occur, as well as certain nitrogenous substances that come away with them. The nitrogenous matter may be removed by shaking the fluid fat (or oil) with sulphuric acid, and the fragments of tissue may be removed by dissolving the fat in ether, carbon disulphid, benzene, or light petroleum, and subsequently filtering the solution and recovering the fat by the evaporation of the solvent. The membranous particles that come away with the animal fats may also be removed by treating the fats with very dilute hydrochloric acid, which dissolves the membranous matter while leaving the fat unaltered.

The fats are decomposed when heated to 400° F., by the separation of their glycerin from the fatty acids with which it is combined. They may also be decomposed by saponification, — that is, by boiling them with aqueous solutions of the alkalis,— the decomposition, in this case, being due to the replacement of the combined glycerin by the alkali. The glycerin is thereby set free, and the resulting compounds of the alkali with the organic acids of the fats are known as soaps. (See SOAP.) The rancidity that develops in fats when they are kept for some time is due to the formation or liberation of certain volatile fatty acids, and it may be removed by boiling the fat with water (in which case the objectionable acids are volatilized), or by treating it with an aqueous solution of sodium carbonate (in which case the volatile acids are neutralized by the alkali, with the formation of their unobjectionable sodium salts).

As has been noted above, stearic, oleic and palmitic acids are the commonest of the acids that occur in fats. Their compounds (or "esters") with glycerin are known, respectively, as stearins, oleins, and palmitins, and are markedly similar in their general properties. The nature of these compounds may be sufficiently illustrated by taking stearin as an example. The formula of stearic acid is $H.C_{18}H_{35}O_2$ and that of glycerin is $C_3H_5(OH)_3$. If the two are heated together, they may combine in the following manner: $C_3H_5(OH)_3 + H.C_{18}H_{35}O_2 = C_3H_5(OH)_2.(C_{18}H_{35}O_2) + H_2O$, in which case the compound that is formed is known as "monostearin," or they may combine in this manner: $C_3H_5(OH)_3 + 2H.C_{18}H_{35}O_2 = C_3H_5(OH).(C_{18}H_{35}O_2)_2 + 2H_2O$, in which case the compound formed is known as "distearin" or, finally, they may combine thus: $C_3H_5(OH)_3+3H.C_{18}H_{35}O_2 = C_3H_5.(C_{18}H_{35}O_2)_3 + 3H_2O$, in which case the compound is called "tristearin." Similar reactions occur with oleic and palmitic acids. The compounds of these three acids that occur most commonly in fats are tristearin, triolein, and tripalmitin.

Fat Tissue, the deposits of fat in various parts of the animal organism. Fat is found in the young of vertebrate mammals from the moment of their birth, and under normal conditions continues to increase till puberty, when a marked diminution takes place. In middle life fat increases, and sometimes is acquired to gross excess. The chief use of fat in a proper quantity, is as a protective shield against atmospheric changes; it serves as a lubricant to several organs, and above all, it stores up the heat energy so essential to animal vitality.

Fatty Acids, monobasic acids formed by the oxidation of the primary alcohols. Such are formic and acetic acids, oleic, stearic and palmitic acids. Thus, when a fat is heated in combination with a stronger base than glycerin, such as potash or soda, the fatty acids leave the glycerin and combine with the metallic base, thus forming soap.

Fatty Compounds, or **Aliphatic Compounds**, in organic chemistry, are those compounds whose molecules do not include a closed chain of carbon atoms. (See AROMATIC COMPOUNDS.) The name "fatty" no longer implies any necessary relation to the fats, but it was originally given to the group because many of its earliest-known representatives occur in the animal or vegetable fats, or are related to them in a simple manner. The name "methane compounds" has also been proposed for the group, but it has not been generally adopted, although it is a particularly happy designation, since all of the compounds of the group are theoretically derivable from methane, CH_4, by addition or substitution. The fatty compounds may be subdivided, in a general way, into those that are "saturated," and those that are "unsaturated." Saturated compounds are those in which the atomic linkage is such that no more atoms can be attached to the carbon chain of the molecule, without causing it to split; and unsaturated compounds are those in which this condition is not fulfilled. For example, ethane, C_2H_6, has the structural formula

$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & — & C & — & C & — & H \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

and it is therefore a saturated compound, because there is obviously no way to introduce more atoms without separating the carbon atoms, or removing one or more of the hydrogen atoms. If we introduce (say) the group CH_2 ("methene"), we must place it between the two carbon atoms, or between a carbon atom and one of the hydrogen atoms now attached to it. In either case the structural formula of the resulting compound (known as "propane," C_3H_8), is

$$\begin{array}{ccccccccc} & & H & & H & & H & & \\ & & | & & | & & | & & \\ H & — & C & — & C & — & C & — & H \\ & & | & & | & & | & & \\ & & H & & H & & H & & \end{array}$$

so that the new compound is also saturated. Ethylene (q.v.), C_2H_4, is an unsaturated compound, because carbon (according to the present theory) is always a tetravalent element, and a carbon nucleus containing two atoms of carbon is capable of fixing six atoms of hydrogen, as appears in the first of the foregoing structural formulæ. It is, therefore, usual to consider that in this case two valencies in the carbon nucleus satisfy each other, so that the structural formula for ethylene is

$$\begin{array}{ccc} H & & H \\ | & & | \\ C & = & C \\ | & & | \\ H & & H \end{array}$$

Here it is obviously possible to introduce two additional monad atoms or radicals, by breaking one of the two valencies uniting the carbon atoms, and attaching one of the monad atoms so introduced to each of the free ends of the valency so broken; the carbon atoms remaining constantly united by *one* of the bonds. If a pair of hydrogen atoms be introduced in this way, ethane is produced, as will be seen by inspecting the structural formula of that substance, given above. In acetylene (q.v.) C_2H_2, three bonds are commonly assumed to unite the two carbon atoms, so that the structural formula of this substance is $H - C \equiv C - H$. Acetylene therefore, is an unsaturated compound. Much attention has been paid to the theory of these double and triple bonds between adjacent carbon atoms, and it has been conclusively established (contrary to what might be naturally assumed) that a double or triple linkage between two carbon atoms constitutes a weaker bond than the single linkage. When, for example, an unsaturated compound is broken up by the action of powerful chemical reagents, it is almost invariably the double (or triple) bond that is ruptured. A quantitative study of the heat-energy liberated when compounds of carbon and hydrogen are burned also shows that the force required to break a double or triple bond is smaller than that required to break a single bond.

Although the fatty and aromatic groups of chemical compounds are differentiated so strongly that it is not easy to convert a representative of either group into a representative of the other one, such a transformation is nevertheless possible. Thus Berthelot showed that when acetylene gas is passed through a red-hot tube it is converted into benzene, naphthalene, and other members of the aromatic group; and an example of the opposite kind of transformation, in which an aromatic compound is converted into a fatty compound, is afforded by the formation of methyl chlorid, CH_3Cl, when hydrochloric acid gas is passed through boiling metaxylene, $C_6H_4(CH_3)_2$. It has been pointed out that there is probably much significance in the fact that the carbohydrates, which are the chief constituents of plants, are fatty compounds containing six (or a multiple of six) atoms of carbon; while the products obtained by the dry distillation of coal (that is, the fossilized remains of such plants), are chiefly aromatic compounds, in which six carbon atoms are united in the form of a "benzene nucleus." It is likely, in view of this fact, that most of the carbohydrates might be transformed into members of the aromatic group, by the prolonged action of great pressure and moderately high temperature.

Fundamental among the fatty compounds are three series of hydrocarbons, which contain only carbon and oxygen, and are known respectively as the paraffins, the olefines, and the acetylene series. The simplest member of the paraffin series is methane ("marsh gas"), CH_4, from from which the higher members are derived by successive additions of the group CH_2, as has already been illustrated in connection with the derivation of propane from ethane. The paraffins are very numerous, and many of the higher members of the series have been but little studied. As will be seen from their mode of derivation from methane, they all come under the general formula C_nH_{2n+2}, where n may have any value from unity up to a limit which probably exists, but is at present unknown. Isomeric forms of the paraffins are possible when n is greater than 3, and the number of such possible isomeric forms increases rapidly with n. Thus in the case of butane, C_4H_{10}, there can be but one isomer, while the compound $C_{13}H_{28}$, known as tridecane, is theoretically capable of existing in no less than 802 distinct forms. See ISOMERISM.

The olefine series of hydrocarbons begins with ethylene ("olefiant gas") C_2H_4, from which the higher members may be regarded as derived, just as before, by successive additions of CH_2. The general formula for the olefine series therefore is C_nH_{2n} and many isomers are known here also. The acetylene series, which has not been so thoroughly studied as the paraffins and the olefines, begins with acetylene gas, C_2H_2, and has the general formula C_nH_{2n-2}. See HYDROCARBONS.

Among the derivatives of the fatty hydrocarbons, the fatty alcohols and fatty acids require special mention. Alcohols, as a class, are considered under ALCOHOL. In general, they may be regarded as derived from the hydrocarbons by replacing one or more of the hydrogen atoms by an equal number of molecules of hydroxyl (OH). They are known as "monohydric," "dihydric," "trihydric," etc., according as one, two, three, etc., atoms of hydrogen are replaced in the original hydrocarbon. A vast number of monohydric alcohols are known, but the number of recognized dihydric alcohols (also known as "glycols") is far smaller. Five trihydric fatty alcohols are known, of which glycerin, $C_3H_5(OH)_3$, is the only familiar example; and only one fatty tetrahydric alcohol, erythrite, $C_4H_6(OH)_4$, is known, though a few that are still more highly hydrated have been prepared. The most important series of the monohydric fatty alcohols is that derived from the paraffin series of hydrocarbons, C_nH_{2n+2}, by the substitution of OH for H. The general formula for this series of alcohols therefore is $C_nH_{2n+1}.(OH)$; it includes methyl alcohol, ethyl alcohol, and, in fact, nearly all of the more familiar alcohols. The monohydric alcohols of the olefine series of hydrocarbons have the general formula $C_nH_{2n-1}.(OH)$, but they include only a single familiar example— allyl alcohol, $C_3H_5.OH$. Those of the acetylene series have the general formula $C_nH_{2n-3}.(OH)$, but they do not include any that are of importance save to the theoretical chemist.

The fatty acids are exceedingly numerous, and play a highly important part in the processes of animal and vegetable life. A complete classification of them cannot be here attempted, but three of the known series must be mentioned. The series derived from the paraffins has the general formula $C_nH_{2n}O_2$ and its members may be derived, by oxidation, from the alcohols of the paraffin series that contain the same number of carbon atoms. The best-known examples of this series are as follows:

Formic Acid	CH_2O_2
Acetic Acid	$C_2H_4O_2$
Propionic Acid	$C_3H_6O_2$
Butyric Acid	$C_4H_8O_2$
Capric Acid	$C_{10}H_{20}O_2$
Lauric Acid	$C_{12}H_{24}O_2$
Palmitic Acid	$C_{16}H_{32}O_2$
Stearic Acid	$C_{18}H_{36}O_2$
Melissic Acid	$C_{30}H_{60}O_2$

The alcohols corresponding to these acids have not all been prepared, but many of them have been, and the chemical deportment of the remaining members of the group leaves no doubt of their relation with the normal paraffins from which they are assumed to be derived. All of the foregoing acids are monobasic, containing but one atom of replaceable hydrogen; and these acids, together with the others that belong in the same series, are the ones to which the name "fatty acids" is often applied, by writers on chemistry, to the exclusion of all other organic acids. According to the definition of "fatty compounds" adopted above, however, all organic acids that do not contain closed carbon chains would appear to be logically included under this same title.

Two important series of acids are derived, by oxidation, from dihydric alcohols, or "glycols," of the paraffin series. The general formula for these glycols being $C_nH_{2n}(OH)_2$, the lactic acid series of acids is obtained from them by an oxidation which consists in the replacement of two atoms of hydrogen by one atom of oxygen. The general formula of the lactic acid series therefore is $C_nH_{2n}O_3$. Its most important members are as follows:

Carbonic Acid	CH_2O_3
Glycollic Acid	$C_2H_4O_3$
Lactic Acid	$C_3H_6O_3$
Hydroxybutyric Acid	$C_4H_8O_3$
Hydroxyvaleric Acid	$C_5H_{10}O_3$
Leucic Acid	$C_6H_{12}O_3$

Carbonic acid is included in this list on the hypothesis that it exists in aqueous solutions of the gas in the form $CO_2 + H_2O$. Except for carbonic acid, all the acids of the foregoing list are monobasic. For the reason why carbonic acid is not also monobasic, reference must be made to the more extended treatises on organic chemistry.

The oxalic acid series is derived from the glycol series, given above, by an oxidation which consists in the substitution of two atoms of oxygen for four of hydrogen. The general formula for this series of acids therefore is $C_nH_{2n-2}O_4$. The most important representatives are:

Oxalic Acid	$C_2H_2O_4$
Malonic Acid	$C_3H_4O_4$
Succinic Acid	$C_4H_6O_4$
Pyrotartaric Acid	$C_5H_8O_4$
Adipic Acid	$C_6H_{10}O_4$
Azaleic Acid	$C_9H_{16}O_4$
Sebacic Acid	$C_{10}H_{18}O_4$

The foregoing acids are all dibasic.

The carbohydrates constitute a large and important class of open-chain (or fatty) compounds. They all contain carbon, hydrogen, and oxygen, and are called "carbohydrates" because, like water, they contain precisely twice as many atoms of hydrogen as of oxygen, and can therefore be regarded as consisting merely of water and carbon. O'Sullivan's classification of these substances is given under CARBOHYDRATES; but the carbohydrates are more commonly divided simply into (1) glucoses (or hexoses); (2) saccharoses; and (3) amyloses. The glucoses comprise glucose (or dextrose), fructose (or levulose), galactose, and sorbose (or sorbinose); and they all have the empiric formula $C_6H_{12}O_6$. The saccharoses include cane-sugar, lactose, melezitose and maltose; they all have the empiric formula $C_{12}H_{22}O_{11}$, and are all derived by the union of two molecules of a glucose, with the elimination of one molecule of water. Their general formula may therefore be written $(C_6H_{11}O_5)_2O$, and they may be regarded as related to the glucoses in the same way that ether is related to alcohol. The amyloses include starch, glycogen, dextrin, cellulose, inulin, and the gums. They have the general empiric formula $(C_6H_{10}O_5)n$, but their structural formulæ are not yet known. Consult: Hjelt, 'Principles of General Organic Chemistry'; Allen, 'Commercial Organic Analysis'; Remsen, 'An Introduction to the Study of the Compounds of Carbon'; Richter, 'Chemistry of the Carbon Compounds'; Perkin and Kipping, 'Organic Chemistry'; Roscoe and Schorlemmer, 'A Treatise on Chemistry'; Meyer, 'Modern Theories of Chemistry'; Cohen, 'The Owens College Course of Practical Organic Chemistry'; Roscoe, 'Lessons in Elementary Chemistry'; and, in fact, any work on organic chemistry. See also, in this encyclopædia, ALCOHOL; HYDROCARBONS; ISOMERISM; SUGARS; and many other titles.

Fatty Degeneration. See DEGENERATION.

Fatuity, in present usage, synonymous with idiocy (q.v.). Foolishness or weakness of mind.

Fatwa, fut'wä, India, town Patna district, eight miles from Patna, at the junction of the Punpun with the Ganges. Fatwa is a place of great sanctity to Hindus. It is on the East Indian R.R., and has considerable trade. Pop. (1891) 10,919.

Faucigny, fō-sē-nyē, a district of France, department of Haute Savoie; area about 840 square miles. Belongs almost wholly to the basin of the Arve, and not more than one third of its surface is fit for culture. Pop. 102,000.

Faucit, fâ'sit, **Helen** (LADY MARTIN), English actress: b. London, England, 11 Oct. 1819; d. Wales 31 Oct. 1898. In 1851 she was married to Theodore (now Sir Theodore) Martin (q.v.). She made her professional début as Julia in the 'Hunchback' at Covent Garden in January 1836. She was at once successful, took a leading part in Macready's Shakespearean revivals, in the first representation of Lytton's plays, and in Browning's 'Blot in the Scutcheon' and 'Strafford.' As an interpreter of Shakespeare's heroines, Juliet, Rosalind, Portia, Beatrice, Imogen, Cordelia, and Lady Macbeth, she stood first among the actresses of her time. After her marriage she left the stage, appearing only at rare intervals for public or charitable purposes, as in Beatrice at the opening of the Shakespeare Memorial Theatre at Stratford. In 1885 she published a volume of delightful studies, entitled: 'On Some of Shakespeare's Female Characters' (Ophelia, Portia, Desdemona, Juliet, Imogen, Rosalind, and Beatrice).

Faulkner, fâk'nėr, **Charles James,** American lawyer: b. Berkeley County, Va., 1805; d. 1 Nov. 1884. He was admitted to the bar in 1829, set at various times in both houses of the Virginia legislature and was a member of Congress 1851–60. In the last-named year he was appointed minister to France. Returning to the United States in 1861 he was imprisoned on suspicion of disloyalty, in Fort Warren, Boston, but was exchanged the same year. He was elected to Congress from West Virginia in 1874.

Faulkner's Island, in Long Island Sound, belonging to Connecticut, and about four miles from the mainland. A lighthouse, still in use, was erected here some years ago.

Fault, in geology, any rock-crack or fissure with dislocation of the strata. The rock-movement may accompany the formation of the crack, or may come later, and the total movement may vary from a small fraction of a foot to many thousands of feet. Faults come by the same strains and stresses which make folds, the rocks breaking instead of bending; a brittle stratum may be faulted, while softer strata above or below may be only bent. The dip of a fault is the amount of inclination of the plane of fracture from the horizontal; the hade or slope is the complement of the dip, being the amount of inclination of the plane from the vertical. Thus the hade of a fault with a dip of 60° would be 30°. The rock-strata relatively dropped from the downthrow side; the upthrow side is opposite; the side of the fracture that overlies the other is the hanging wall; the underlying side is the foot-wall. The throw of a fault is the total vertical displacement; the heave is the total horizontal displacement — both measured in the plane of the dip. If a fault dips 45° the heave and throw are equal.

Faults are classified as normal and reversed. In a normal or gravity fault the hanging wall is on the downthrow side. In a reversed or thrust fault the hanging wall is on the upthrow side. Normal faults, as the strata occupy more space than before faulting, were produced by tension. Thrust faults are caused by compression, the beds on one side of the fracture being thrust past those on the other. As a rule thrust faults have lower dips than normal faults. The best examples of great normal faults in the United States are in the Arizona-Colorado plateau. Thrust faults are common in the southern Appalachian Mountains. Generally a fault-fissure is filled with more or less ground-up material from the dislocated strata, and the hanging and foot wall faces are grooved and polished, giving the appearance called slickensided.

It is obvious that faults are essentially surface phenomena; for with increasing depth and increasing pressure from above, rocks bend rather than break, and we can easily imagine a depth at which all rocks, while not truly molten, are plastic. See ESCAPEMENT; GEOLOGY; MOUNTAIN; ORE DEPOSIT.

Faun, fân (Lat. *Faunus,* from *favere,* to be favorable to), in Roman mythology, a Latin rural deity. See FAUNUS.

Faun of Praxiteles, a statue in the Capitoline Museum, Rome, known also as the 'Satyr of the Capitol. It is the best copy extant of an original attributed to the great Greek sculptor and furnished Hawthorne the title for his novel, 'The Marble Faun.' See PRAXITELES.

Fauna, fân'a̤, a term used by zoologists to signify the animals native to a special locality, region, or period of time, as the term "flora" is used by botanists. The term, when prefixed by certain words, is restricted to a more special usage, as "pisci fauna," the fishes of a certain region, etc. Geologists and palæontologists employ the term in a somewhat wider sense, as covering all the animals of a given region, during a geological period — the fossil remains of such animals being found in the successive layers of deposits formed during the entire period in which they lived.

Fauna, in Roman mythology, a Roman goddess, originally called Marica, but after her marriage with Faunus, named Fauna. She is sometimes identified with Cybele.

Faunce, Daniel Worcester, American Baptist clergyman: b. Plymouth, Mass., 3 Jan. 1829. He was graduated from Amherst College in 1850 and was ordained to the Baptist ministry in 1853. He has held various pastorates in New England and elsewhere and has published: 'The Christian in the World'; 'Words and Works of Jesus'; 'Words and Acts of the Apostles'; 'A Young Man's Difficulties with His Bible'; 'The Resurrection in Nature and Revelation'; 'Prayer as a Theory and a Fact'; 'Hours With a Skeptic'; 'Shall We Believe in a Divine Providence?'; etc.

Faunce, John, American naval officer: b. Plymouth, Mass., 25 March 1807; d. Jersey City, N. J., 5 June 1891. He entered the United States marine service as third lieutenant in 1837, and in 1845 was placed in charge of the Long Island and New Jersey life-saving stations. In 1858 he was made commander of the revenue steamer Harriet Lane, which, under his command, accompanied the naval expedition to Paraguay in 1858–9, and which in 1861 was one of the small fleet that was hastened to the relief of Fort Sumter, and was fired on by the Confederates at Charleston. After the War he was detailed to service in the life-saving department, in which capacity he did much toward its thorough organization and perfection.

Faunce, William Herbert Perry, American educator: b. Worcester, Mass., 15 Jan. 1859. He is a son of D. W. Faunce (q.v.). He was graduated at Brown University in 1880, and at the Newton Theological Seminary in 1884; held pastorates in Springfield, Mass., 1884–9, and New York 1889–99; was long a trustee of Brown and Rochester universities; lecturer at the University of Chicago; and preacher at Harvard University. He was made president of Brown University in June 1899.

Faunus, an Italian divinity, probably an ancient Italian king, who instructed his subjects in agriculture and the management of flocks, and was afterward worshipped as the god of fields and of shepherds. The festival of the Faunalia, held on 5 December, referred to the protection he exercised over agriculture and cattle. Fauna was his female complement. He was also worshipped as a prophetic divinity. As deity of the woods and of flocks and herds, he corresponds to the Greek Pan, and hence with his name became associated the attributes of the latter. The idea also arose of a plurality of fauns, like the Greek satyrs, who were represented with short horns, pointed ears, tails, and goats' feet, and to whom all terrifying sounds and appearances were ascribed. Readers of Hawthorne's 'Marble Faun' will remember the artistic use there made of the conception.

Fauque de Jonquières, fōk' de zhōn'kē-ār, Jean Phillipe Ernest, French admiral and mathematician: b. Carpentras, department of Vaucluse, France, 3 July 1820. He entered the navy in 1825 and became an admiral in 1874. He held important commands in Cochin China (1864) and as maritime prefect of Rochefort, and published several valuable mathematical treatises, including 'Système de courbes et surfaces algébriques d'ordre quelconque (1866).

Fauquier, fâ'kwėr, **Francis,** American colonial governor: b. about 1704; d. 1768. He succeeded Dinwiddie as lieutenant-governor of Virginia in 1758 and retained the office for the remainder of his life. Upon the passing of Patrick Henry's Stamp Act resolutions he dismissed the Virginia house of burgesses, opposed the Stamp Act Congress, and prevented the colony of Virginia from choosing delegates at the invitation of Massachusetts, by refusing to issue writs for summoning the house of burgesses.

Faure, François Félix, frän-swä fā-lēks fōr, French president: b. Paris 30 Jan. 1841; d. there 16 Feb. 1899 He was for a time a tanner in Touraine, but became a wealthy shipowner in Havre, and an authority on all questions concerning shipping, commerce, and the colonies. During the Franco-Prussian war he commanded a body of volunteers and gained the ribbon of the Legion of Honor. He entered the Assembly in 1881, served as colonial and commercial minister in the cabinets of Gambetta, Jules Favre, and Tirard, and as minister of marine in that of Dupuy. A moderate republican, he was elected president of the republic on the resignation of Casimir-Perrier in 1895.

Fauriel, Claude Charles, clōd shärl fō-rē-el, French historian: b. St. Etienne, France, 21 Oct. 1772; d. Paris 15 July 1844. He published: 'History of Southern Gaul under its German Conquerors' (1836); 'The Origin of the Epic of the Middle Ages' (1833); 'History of Provençal Poetry' (1846); and 'Dante and the Origin of the Italian Language and Literature' (1854); etc.

Faust, or **Fust, Johann,** yō'hän foust or foost, German goldsmith of the 15th century and one of the persons to whom the invention of printing is generally ascribed. It is, however, doubtful if he did more than advance money to Gutenberg, who had previously made some attempts with movable types at Strasburg. The third person concerned was Schöffer, who married the daughter of Faust, and who is allowed the honor of having invented punches and matrices for casting types, by means of which this grand art was carried to perfection. The first fruits of the new process, that is a work printed with cast letters, appears to have been the 'Mazarin Bible,' or 'Forty-two-line Bible' (the latter name from the number of lines in a column) completed about 1455. Another early work was 'Durandi Rationale Divinorum Officiorum,' published by Faust and Schöffer 1459, followed a year or two after by the 'Catholicon Johannis Januensis'; after which, in 1462, succeeded the 'Latin and German Bible,' so much sought for by those fond of early specimens of typography. There is reason to believe that Faust died of the plague in 1466, as the name of Schöffer alone is found in the books printed after that time at Maintz. Owing, perhaps, to a similarity of name some of the noted deeds of Dr. Faust have been ascribed in popular German legends to the printer.

Faust, foust, or **Faustus,** fâs'tus, **Doctor John,** German magician: b. Knittlingen, Suabia; d. Staufen 1540. The facts of his life have almost entirely disappeared amid the legends and fables in which they have become wrapped up. He appears to have been a charlatan and adventurer who traveled from place to place, putting himself forward as a physician, alchemist, and astrologer, and as a great magician and enchanter. At Würzburg he professed that he could perform all the miracles that Christ performed, and at Wittenberg claimed that the successes of the imperial troops in Italy had been brought about by his magical powers. Among the credulous and ignorant he naturally found many to put faith in his claims and at last his name became associated with a whole series of marvels. The first literary work of which he is the subject was published at Frankfort in 1587, by Johann Spies, and professes to narrate the 'History of Dr. John Faust, the Far-famed Enchanter, and Professor of the Black Art.' Enlarged editions soon appeared and the book was translated into English (about 1588), Low German, Flemish, and French. In it we find most of the famous stories associated with Faust's name; how he sold himself to the devil for a period of 24 years; how, by the aid of the fiend Mephistopheles, he and his attendant and pupil, Wagner, were able for this time to enjoy all sorts of sensual delights and to travel about performing the most marvelous exploits, and how at last, when the end of the fatal compact arrived, after a night of dreadful tempest, his body was found almost torn limb from limb, lying on a dunghill at the village of Rimlich, near Wittenberg. It was on the English translation of Spies' book that Marlowe's great tragedy, 'The Tragical History of Doctor Faustus,' was based. In 1599 the legendary history of Faust appeared at Hamburg in a new form, as narrated by G. R. Widmann, a zealous Lutheran, always eager to draw a lesson from the events with which he deals. In an altered edition of this by Pfitzer (1674) we first find the germ of Goethe's Margaret, the maiden whose fate is so tragically connected with that of Faust, in the great drama of the German poet. In the second part of his 'Faust,' Goethe has attempted a poetical solution of the legend. Through all vicissitudes he leads Faust to a point where at last he experiences the feeling of perfect happiness in devoting his intellectual faculties to the promotion of the welfare of his kind. Then he has attained the end which he has pointed out to Mephistopheles as the object of all his longings, and is removed from this life, not, however, to be lost, but to be saved by love, the «ever-womanly» that «leads us on high." Goethe's famous poem attempts to show that man's longing after knowledge may lead him into many errors and failings, but cannot destroy his better nature. Goethe's 'Faust' was arranged for the stage by W. G. Wills in 1885. Among the various English translations of Goethe's 'Faust' that by Bayard Taylor is one of the most important. The well-known opera of 'Faust,' by Gounod, was first produced in 1859.

Fausta, Flavia Maximiana, flā'vi-a mak"-sim-i-ā'na fâs-ta, Roman empress: d. probably 326 A.D. She was a daughter of the emperor Maximianus Herculius and was married to Constantine the Great 307.

Faustina, Annia, an'i-a fâs-tī'na (surnamed JUNIOR) Roman empress: d. near Mount Taunis, Asia Minor, 175 A.D. She was a daughter of Annia Galeria Faustina (q.v.) and was married to Marcus Aurelius 145 or 146 A.D. She was noted for her profligacy.

Faustina, Annia Galeria (surnamed SENIOR), Roman empress: b. about 104 A.D.; d. 141. She was the wife of Antoninus Pius, and like her daughter, the wife of Marcus Aurelius, was famed for her licentiousness.

Fava, Onorato, ō-nō-rä'tō fä'vä, Italian author: b. Collobiano, Piedmont, 7 July 1859. He has published: 'Early Follies' (1881); 'Against the Majority' (1888); a novel, 'To the Country of the Stars' (1889); a juvenile, 'Our Life' (1885); 'The Departure of Hannibal' (1891); and various other works, showing as much originality as versatility.

Favara, fä-vä'rä, Sicily, town, four miles southeast of Girgenti. It has mines of sulphur, tourmaline, and alum, and nearby are marble-quarries. Pop. of the commune (1901) 20,400.

Favart, Charles Simon, sharl sē-môn fä-vär, French dramatist: b. Paris, France, 13 Nov. 1710; d. there 18 May 1792. His very youthful poem, 'France Freed by the Maid of Orleans,' won the prize of the floral plays; and at 24 he was writing successful comedies. These and his operettas number about 150 (his wife, Marie Justine Bénédicte Duronceray, 1727–72, being his constant collaborator), and are for the most part pretty and realistic scenes of love in the country; but some of them are amusing drolleries like the mediæval fabliaux. His most celebrated compositions are: 'Annette and Lubin'; 'The Village Astrologer'; 'Ninette at Court'; 'The Three Sultanas'; 'The Englishman at Bordeaux.' His 'Memoirs and Correspondence' (3 vols. 1808) is of great value for the history of literature.

Favenc, fav'ĕn, **Ernest,** Australian journalist and author: b. London 1846. He was a pioneer in Queensland 1865–79 and since 1888 has been active in journalism. He has published: 'The History of Australian Exploration'; 'Tales of the Austral Tropics'; 'The Secret of the Australian Desert'; 'Marooned in Australia'; 'The Moccasins of Silence'; 'Tales from the Sydney Bulletin.'

Faversham, fav'ėr-sham, **William,** American actor: b. England 17 Feb. 1868. After serving for a time in the English army in India he went on the stage in 1887 and the next year came to the United States. Since then he has been prominent under Frohman's management in New York.

Faversham (ancient FAVERSFIELD), **England,** a municipal borough and seaport in the county of Kent, 45 miles east-southeast of London. It contains three suburbs, and has a handsome cruciform church, good schools, a literary institute, and reading-rooms. The chief manufactures are gunpowder, Roman and Portland cement, bricks, and beer; it has large oyster fisheries. It was once the seat of the Saxon kings, and, in 930, Athelstane held here a Witenagemot, or great national council. There are still in existence remains of the abbey built by King Stephen, in 1147, for the Benedictine monks. The tomb of the king, who was buried in the abbey, is now pointed out in the parish church. In 1688 James II., when trying to escape to France, after the landing of William of Orange, was seized at Faversham and sent back to London. Later he succeeded in reaching France. Pop. (1901) 11,290.

Favignana, fä-vēn-yä'nä (ancient ÆGUSA or ÆTHUSA): (1) an island of the Ægades group in the Mediterranean, eight miles from the west coast of Sicily; area, 11 square miles. There is a fine bay on the east on which stand the town and fortress of San Leonardo. San Giacomo, the principal place, is on the north coast. The island has several quarries, and extensive tunny and anchovy fisheries, in the produce of which, and in sheep, goats, and poultry, it has a flourishing export trade. Pop. 5,149. (2) A town of the same name is on the north side of the island.

Favositidæ, fav-ō-sit'i-dē, a palæozoic family of fossil tabulate corals, having the septa and corallites distinct, and little or no true cœnenchyma. The corallites are uniformly prismatic, tall and united by their thick walls, which are perforated by large pores, representing aborted buds. The typical forms (*Favosites*) make large compact masses, taking an important part in the formation of Silurian and Devonian limestones. About 10 genera are indicated by the numerous and widely distributed species.

Favre, Gabriel Claude Jules, gä-brē-el clōd zhül fävr, French politician: b. Lyons 21 March 1809; d. Versailles 20 Jan. 1880. He took an active part in the Revolution of July 1830, studied law, and after distinguishing himself at the Lyons bar came to Paris in 1835, where he became famous as a defender of political prisoners. On the outbreak of the revolution of 1848 Ledru-Rollin made him secretary to the ministry of the interior. He was a leader of the party of opposition to the President Louis Napoleon; and after the *coup d'état* (1851) retired from political life for six years, till in 1858 his defense of Orsini for the attempt on the life of the emperor again brought him forward. From this time he again became an active leader of the Republican opposition to the emperor. On the fall of the empire he became vice-president of the government of national defense and minister of foreign affairs, and as such conducted the negotiations for peace with Prince Bismarck. But though he showed great energy and was very eloquent, his operations both in the matter of the armistice and the peace showed a lack of skill and judgment. He was elected to the French Academy in 1867. He was author of: 'Rome et la République Française' (1871); 'Gouvernement de la Défense Nationale'

(1871–5); ‹Conférences et Discours Littéraires› (1873); ‹Discours Parlementaires› (1881); ‹Mélanges Politiques› (1882).

Favre, Louis, French engineer: b. Chêne-Bourg, near Geneva, 29 Jan. 1826; d. 19 July 1879. In 1872 he gained the contract for constructing the Saint Gothard tunnel within the space of eight years, an engineering feat which he accomplished shortly before his death.

Favus. See RINGWORM.

Fawcett, fâ'set, **Edgar,** American novelist and poet: b. New York 26 May 1847; d. London, England, 1 May, 1904. He was graduated at Columbia College in 1867. His novels are: ‹Purple and Fine Linen› (1873); ‹A Hopeless Case› (1880); ‹A Gentleman of Leisure› (1881); ‹An Ambitious Woman› (1883); ‹Rutherford› (1884); ‹Tinkling Cymbals› (1884); ‹The Adventures of a Widow› (1884); ‹Social Silhouettes› (1885); ‹The Confessions of Claude› (1886); ‹The House at High Bridge› (1887); ‹Miriam Balestier› (1888); ‹A Man's Will› (1888); ‹Olivia Delaplaine› (1888); ‹A Demoralizing Marriage› (1889); ‹Fabian Dimitry› (1890); ‹A New York Family› (1891); ‹An Heir to Millions› (1892); ‹Women Must Weep› (1892); ‹A Mild Barbarian› (1894); ‹Outrageous Fortune› (1894); etc. His poetical works include: ‹Short Poems for Short People› (1872); ‹Fantasy and Passion› (1877); ‹Song and Story› (1884); ‹Romance and Revery› (1886); ‹The New King Arthur›; ‹Songs of Doubt and Dream› (1889).

Fawcett, Henry, English political economist: b. Salisbury, England, 26 Aug. 1833; d. Cambridge 6 Nov. 1884. An accident which deprived him of sight early in life did not prevent his attainment of distinction as postmaster-general in 1880. He was the author of ‹Manual of Political Economy› (1863); ‹The Economic Position of the British Laborer› (1865); ‹Pauperism: Its Causes and Remedies› (1871); and ‹Protection and Reciprocity› (6th ed. 1885), in which the liberal theory of the younger Mill is carried to its logical extreme; ‹Labor and Wages› (1884). See Stephen, ‹Life of Henry Fawcett› (1885).

Fawcett, Millicent Garrett, English political economist: b. Aldeburgh, Suffolk, 11 June 1847. She was married to Henry Fawcett (q.v.) 1867. She has taken a very prominent part in many movements relating to women, more particularly in that for obtaining the parliamentary franchise for them. In 1889 she was elected president of the Women's Unionist Association. Her published works include: ‹Political Economy for Beginners› (1870); ‹Tales in Political Economy› (1875); ‹Janet Doncaster,› a novel (1875); ‹Some Eminent Women of Our Time› (1889); and ‹Life of Queen Victoria› (1895); ‹Life of Sir William Molesworth› (1901). With her husband she published in 1872 a volume of ‹Essays and Lectures.›

Fawkes, fâks, **Guy,** English conspirator: b. York, England, 1570; d. Westminster 31 Jan. 1606. He enlisted in the Spanish army in the Netherlands, where he was found by Winter, one of the Roman Catholic conspirators, and with him returned to England in 1604, after agreeing to assist in the Gunpowder Plot (q.v.). He passed under the name of Johnson, as servant to Thomas Percy, another conspirator, and was placed to lodge in the house next to the Parliament House. After collecting the necessary combustibles, Fawkes worked his way into the coal cellar under the House of Lords, and after storing it with gunpowder, etc., was appointed to the dangerous duty of firing the mine. The government having had timely information of the detestable plot, the House of Lords and its cellar were searched, and Fawkes found secreted amid some casks of gunpowder, 5 Nov. 1605. He was at once arrested, and suffered death at Westminster with several of the other conspirators.

Fay, Amy, American lecturer on music: b. Bayou Goula, La., 21 May 1844. She has published ‹Music Study in Germany.›

Fáy, fī or fäy, **Andreas,** Hungarian author: b. Kohány, Zemplin, Hungary, 30 May 1786; d. Pest 26 July 1864. Till the appearance of Kossuth on the scene (1840) he was the foremost leader at Pest of the Opposition party; thereafter he took no considerable part in politics, but promoted many important national enterprises. His volume of poems, ‹New Garland› (1818) established his fame as a poet, but his admirable prose ‹Fables› (1820) attained a far wider popularity. Among his dramatic works are the tragedy, ‹The Two Báthorys› (1827); and several comedies, the most notable being ‹The Old Coins; or the Transylvanians in Hungary› (1824), and ‹The Hunt in the Matra› (1860). His social novel, ‹The House of the Béltekys› (1832), and a number of short stories, entitle him to a place among the great masters of Hungarian prose.

Fay, Charles Ernest, American educator and mountain climber: b. Roxbury, Mass., 10 March 1846. He was graduated from Tufts College in 1868 and has been professor of modern languages there from 1871. He has been several times president of the Appalachian Mountain Club and has been very prominent in the development of mountaineering in the Canadian Rocky and Selkirk mountains. He has lectured publicly on literary and geographical themes, and has edited ‹Appalachia› from 1879.

Fay, fī, **Joseph,** German painter: b. Cologne 10 Aug. 1813; d. Düsseldorf 27 July 1875. His art education began in the Düsseldorf Academy and was continued in Paris where he turned his attention to historical painting. His first picture, ‹Samson and Delilah,› was exhibited in his 27th year. He painted a series of frescoes in the Council Chamber at Elberfeld, in which was portrayed the history of Germany from the destruction of the Varian legions. The work is creditable. His fertile pencil produced among other pictures, ‹Thisbe›; ‹Romeo and Juliet›; ‹Gretchen.› He later on paid some attention to genre, depicting scenes in Italian life, reminiscences of travel in the peninsula. Felicitous conception, brilliant coloring and dextrous brush work are conspicuous in his productions.

Fay, Theodore Sedgwick, American writer: b. New York 10 Feb. 1807; d. Berlin, Germany, 17 Nov. 1898. He was eminent in periodical journalism for years. To this period belongs his book, ‹Dreams and Reveries of a Quiet Man› (1832). He served with ability in the United States diplomatic service, and wrote: 'Norman Leslie' (1835); and 'The Countess Ida' (1841), tales; 'Ulric' (1851), a poem; 'The Three Germanys' (1889); 'Great Outlines of Geography'; 'History of Switzerland,' etc. After 1861 he lived in Berlin.

Fayal, fī-âl'; Port. fī-äl, one of the Azores group, in lon. 28° 41' W.; lat. 38° 31' N. It is circular in form, about 10 miles in diameter; area 69 square miles. It rises abruptly from the sea, and the centre is about 3,000 feet in height. The climate is temperate all the year. Volcanic eruptions have taken place, but not in recent years. The soil is fertile, and the principal productions are wheat, maize, flax, fruits. Hunting small game, fishing, raising cattle, and agriculture are the leading occupations. Horta or Orto is chief port. Pop., estimated, 40,000.

Faye, Hervé Auguste Etienne Albans, ār-vā ō-güst ā-tē-en äl-bän fā, French astronomer: b. St. Benoit du Sault, France, 5 Oct. 1814; d. Passy, near Paris, 4 July 1902. He studied at the Ecole Polytechnique, where he was professor of geodesy in 1848–54, and later of astronomy, and at the Paris Observatory. He discovered the comet which bears his name in 1843; became rector of the university academy of Nancy in 1855; inspector-general of higher education in 1877; and was made chevalier of the Legion of Honor in 1843, and promoted to grand officer of the Legion in 1889. He wrote several books on astronomical subjects, among which are: 'Sur l'Origine du Monde'; 'Cours d'Astronomie Nautique.'

Fayence. See FAÏENCE.

Faye's Comet, discovered by the astronomer Faye 22 Nov. 1843. It has returned in the years 1851, 1858, 1865, 1873, 1880, 1888, and 1895. See COMETS.

Fayerweather, făr'-wet'h ėr, **Daniel B.,** American merchant and philanthropist: b. Stepney, Conn., 1821; d. 1890. He was long prominent in the leather business in New York and bequeathed some $5,000,000 to educational and charitable institutions, which is now (1904) being contested and the case is pending in the United States Supreme Court.

Fayette, fā-et', Iowa, town in Fayette County; on the Chicago, M. & St. P. R.R.; 65 miles northwest of Dubuque. It is the seat of Upper Iowa University, a Methodist Episcopal institution founded in 1857, one year after the settlement of the town. It is located in an excellent agricultural section. Pop. (1900) 2,717.

Fayette, Mo., city, county-seat of Howard County; 105 miles east by south of Kansas City; on the Missouri, K. & T. R.R. It is the seat of the Howard Payne College for women, founded in 1844, and the Central College, coeducational, founded in 1857, both under the auspices of the Methodist Episcopal, South, Church. It is in an agricultural section and the trade and industries are connected with agricultural products. Pop. 2,708.

Fayetteville, fā-et'vil, Ark., city, county-seat of Washington County; on the St. Louis & S. F. R.R.; in the Ozark Mountains. It is a well-known summer resort and is called the "Athens of Arkansas." Fayetteville is a fruit centre for northwestern Arkansas. It is the seat of the Arkansas Industrial University. Its chief manufactories are a foundry, flour-mills, large wagon factory, and fruit evaporating establishment. Pop. (1900) 4,061.

Fayetteville, N. C., city, county-seat of Cumberland County; on Cape Fear River, and on the Central Coast Line, and the Cape Fear and Y. V. R.R.'s, 120 miles south of Wilmington. It contains a high school, military academy, a State colored normal school, a bank, and several newspapers. It has manufactories of edge tools, carriages, wooden-ware, flour, turpentine, cotton, etc. On 22 April 1861, the Confederates seized the United States arsenal at this point. Gen. Sherman occupied the town 11–14 March 1865, and destroyed the arsenal. Pop. (1900) 4,670.

Fayetteville, Tenn., town, county-seat of Lincoln County; on the Elk River, the Nashville, C. & S. L. R.R.; 180 miles east of Memphis. The Fayetteville Collegiate Institute and Dick White College are located here. The manufactures are flour, lumber, wagons, and dairy products. Pop. (1900) 2,708.

Fayum, or **Fayoum,** fī-oom', **The** (Egypt. *Phiom,* "marsh-land"), a province of Egypt, consisting of a nearly circular basin or oasis, about 30 miles in diameter, or 840 square miles in area, sunk beneath the level of the Libyan desert, about half a degree south of Cairo, and connected with the Nile valley by a narrow pass, through which an ancient canal flows. This canal is the Bahr-Yûsuf, or "Joseph's stream," so named after Saladin, who restored an original construction of the Theban Pharaohs, which pours the fertilizing water which renders the Fayyûm one of the most productive parts of Egypt. The irrigation was anciently regulated by a large reservoir, called Lake Mœris (q.v.), described by the Greeks as a work of extraordinary hydraulic ingenuity, and the overflow now forms the large sheet of brackish water, 35 miles long, known as the Birket-el-Karn, which marks the eastern boundary of the oasis. The site was identified by Linant near the modern capital Medinet-el-Fayyûm, though other sites have been proposed by Cope, Whitehouse, and others. On the banks of Lake Mœris was the famous Labyrinth, probably built by Amenhemhat III., and reckoned one of the wonders of the world. The remains of this vast palace are seen in the ruins of numerous chambers near the brick pyramid of Hawâra. The capital of the Fayyûm was Crocodilopolis, afterward named Arsinoë, after the queen of Ptolemy Philadelphus, near the site of which is the modern chief town (pop. 31,262). Fidimin is a picturesque village in the Fayyûm. Recent explorations by Petrie and others have revealed more interesting remains of antiquity in the province than had formerly been suspected. The Fayyûm abounds in fruit, oranges, peaches, pomegranates, olives, figs, grapes, etc., and is famous for roses and other flowers. The inhabitants are chiefly agriculturists and fishermen. The fields yield splendid crops of cereals, besides rice, cotton, sugar, flax, and hemp. Pop. 160,000. Consult, for an account of excavations in the Labyrinth, the ruins at Hawâra, etc., Flinders Petrie, 'Hawâra and Arsinoë'; Brown, 'The Fayyûm and Lake Mœris' (1893).

Fea, fē, **Allan,** English antiquarian: b. 25 May 1860. He was employed in the Bank of

England 1880–90, and is the author of: 'The Flight of the King'; 'Secret Chambers and Hiding Places'; 'King Monmouth.'

Fealty, loyalty; faithful adherence; true service or duty to a superior lord, the obligation which bound the tenant, especially in feudal times. Fealty, suit of court, and rent, were conditions upon which the ancient lords granted their lands to feudatories; it being stipulated that they and their heirs should take the oath of fealty or fidelity to their lord, which was the feudal bond (*commune vinculum*) between lord and tenant; that they should do suit, or duly attend and follow the lord's courts, and there from time to time give their assistance, by serving on juries either to decide the property of their neighbors in the court baron, or correct their misdemeanors in the court leet; and lastly, that they should yield to the lord certain annual stated returns, in military attendance, in provisions, in arms, in matters of ornament or pleasure, in rustic employments (prædial labors), or (which is *instar omnium*), in money, which provided all the rest; all of these services being comprised under the one general name of redditus, return, or rent. The right of fealty still exists in England, but is exacted only from copyholders. It lasted in the United States for a short time after the Revolution, but soon became obsolete.

Fear, apprehension of approaching evil, danger or harm; solicitude, dread, terror. The term fear is also used in the sense of respect for and obedience to authority, especially as these take the form of awe and reverence toward the Supreme Being, with due regard to his law and word. The operation of fear on the mind is often, if uncorrected, attended with the most serious consequences, especially where sickness is present or disease threatened. On many persons the influence of fear is far more serious in its effect than the worst form of any dreaded malady. In epidemic diseases the terror they inspire is often as fatal as the infection — paralyzing the system, and robbing the body of the natural elasticity of its nervous stamina, and the mind of the buoyancy of hope, making victims of those who, from age and strength, had the best probability of escaping. Fear is a mental poison, and the most potent of all antagonists to health and medicine; it is often fatally active in the morbid developments which result in various forms of insanity; and as faith has cured more diseases than physicians ever prescribed for, so fear is more destructive than the worst physical malady. In the conflicts of the modern business world, especially in monetary centres, its contagion now and then breaks out in fright which imperils the fortunes of individuals, or a people's financial stability, as a country's cause is sometimes lost through panic striking its armies in battle. Recent psychology finds in fear one of its most important subjects for analysis and definition; and the physician, the teacher, the moralist, and the sociologist all deal with it as an element calling for special study and control in the development of the individual and of society at large. See EMOTION.

Fearnley, fĕrn'lĭ, **Carl Frederik,** Norwegian astronomer: b. Frederikshald 19 Dec. 1818; d. Christiania 22 Aug. 1890. He studied at Bonn and Königsberg, returning to Christiania and becoming professor of astronomy at the university 1857, and director of the observatory 1861. He was appointed head of the geodetic survey of Norway 1876. He published: 'Zur Theorie der terrestrischen Refraction' (1884); 'Zonenbeobachtungen der Sterne zwischen 64° 50′ und 70° 10′ nördlicher Deklination' (1888).

Fearnley, Thomas, Norwegian landscape painter: b. Frederikshald 27 Dec. 1802; d. Munich 16 Jan. 1842. He studied at Copenhagen, and subsequently traveled much, painting excellent landscapes, most of which are in England. Among his works are: 'Copenhagen' (1823); 'View of the Marumelf'; 'Justeldas Glacier'; 'Duck Shooting'; 'Romsdalhorn'; 'Grindelwald Glacier'; 'Waterfall and Sawmill'; 'Sorrento'; 'Madumsfall'; 'Castelmare'; 'Moonlight'; 'Gravius Fjord'; 'View in Norway'; 'Labrofos Waterfall.'

Feast, a festival, banquet, solemnity, holiday, etc. Almost every religion has had its solemn feast-days. The ancient Greeks and Romans had them, as well as the Jews and modern Christians. According to the Old Testament, several festivals among the ancient Jews were divinely appointed, the first and most ancient of which was the Sabbath, or seventh day of the week, commemorative of the creation. The Passover was instituted in memory of their deliverance out of Egypt, and of the favor of God in sparing their first-born when those of the Egyptians were slain. The feast of Pentecost was celebrated on the 50th day after the Passover, in memory of the law being given to Moses on Mount Sinai. The feast of Tents or Tabernacles was instituted in memory of their fathers who dwelt in tents for 40 years in the wilderness; and all Israel was obliged to attend the temple and dwell eight days under tents. These were their principal feasts, but they had numerous others — the feast of Trumpets, the feast of Expiation or Atonement, the feast of the Dedication of the Temple, etc.

In the Christian Church no festival appears clearly to have been instituted by Jesus or his apostles, yet Christians have always celebrated the memory of his resurrection, and numerous other feasts were introduced at an early period. At first they were only appointed to commemorate the more prominent events in the life and death of Christ, and the labors and virtues of the apostles and evengelists; but martyrs were soon introduced, and by the 4th century the number of feasts had very greatly increased. Many of the festivals were instituted on pagan models, and were characterized by rites similar to those which the pagans observed.

Feasts are either movable or immovable. Immovable feasts are such as are celebrated constantly on the same day of the year, among them being Christmas Day, Circumcision, Epiphany, Candlemas or Purification, Lady-day or the Annunciation, All-Saints', All-Souls', and the days of the several apostles, as St. Thomas, St. Paul. Movable feasts are those which are not confined to the same day of the year. Of these the principal is Easter, which gives law to all the rest, all of them following and keeping their proper distances from it; as Palm Sunday, Good Friday, Ash Wednesday, Sexagesima, Ascension Day, Pentecost, and Trinity Sunday. Besides these, which are general, there are others which are local or occasional, enjoined by the magistrate, or voluntarily set on foot by the people, such as, in this country, Independence Day, celebrated annually on the 4th of July, and Thanksgiving Day, also held every year on a day set apart by the President for the occasion. See FOOLS, FEAST OF.

Feather, one of the elastic horny dermal outgrowths of the skin, forming plumage, the characteristic covering of birds. See PLUMAGE.

Feather Bunch-grass (*Stipa viridula*), a rather slender grass, one to three feet high, growing in the Rocky Mountain region and on the foot-hills and mesas, from British Columbia southward to Mexico and westward to the coast. On good land, under irrigation, this grass attains the height of three feet or more, and is by far the most valuable of the *Stipas* for hay. The leafy culms are terminated by a narrow, many-flowered panicle of comparatively small and rather short-awned spikelets. The seed may be easily gathered. The callus at the base of the fruiting glume is short and barely pointed and not produced into a long, very sharp, spur-like extension, as in porcupine-grass.

Feather-star, a crinoid of the existing family *Comatulidæ,* which is composed of several genera of highly developed crinoids which differ from the "stone-lilies" and other existing forms in swimming freely as adults instead of being rooted by a stalk. The headquarters of the family is in the Malayan seas, but several species occur on the American and British coasts, and one of the latter, the rosy feather-star (*Antedon rosaceus*), has been exhaustively studied, contributing greatly to our knowledge of the whole group. It has the general characteristics of a crinoid (q.v.), and when young is attached to a long stalk, but when full grown drops off and thereafter creeps and swims about, back downward, by means of five pairs of radiating arms which are so fringed and flexible that they look like feathers. These arms expand about three inches.

Feather-tracts, one of those regulated spaces where feathers grow on the body of a bird, the arrangement of which is various and characteristic of groups. This regular distribution of feather-growths is known as "pterylosis," and the study of it as "pterylography." Pterylosis is further treated under PLUMAGE.

Feather-wings, a plume-moth (q.v.).

Feathering Float, the paddle or float-board of a paddle-wheel, so arranged as to turn on an axis to present its broad side to the water at its lowest submergence, but to turn its edge to the water in entering and emerging.

Feathering Paddle-wheel, a wheel whose floats have a motion on an axis, so as to descend nearly vertically into the water and ascend the same way, avoiding beating on the water in the descent and lifting water in the ascent.

Feathering Propeller, an invention of an Englishman, Maudslay, in which the vanes of the propeller screw are adjustable, so as even to be turned into the plane of the propeller-shaft and offer no resistance when the vessel is under sail and the propeller not used.

Feathers, Artificial. Artificial feathers and flowers have long been made in the United States. It is probable that the industry was brought here by French immigrants, who had fled from their own country. The number of French people here was soon increased by those who had come hither from the island of Haiti. It was necessary that these strangers should live, and one of the first industries they took up was artificial flower and feather making. Artificial feathers serve as cheap decorations for ladies' hats and bonnets. As long ago as 1840 there were 10 manufacturers in this line in New York. No separate enumeration of these products appears in the early census returns, but the quantity demanded increased greatly. Within the past few years a great change has taken place; feathers now being used as trimming on ladies' dresses, and as boas and collars. New York is the principal seat of the industry.

Featherstonhaugh, fĕth'ėr stŭn hâ, **George William,** English traveler in America: b. 1780; d. Havre, France, 28 Sept. 1866. He made geological surveys in the West for the United States War Department 1834–5, and was appointed by Great Britain a commissioner to determine the northwestern boundary between Canada and the United States, under the Ashburton-Webster treaty. He was the author of numerous technical reports and papers, including the 'Geological Report of the Elevated Country Between the Missouri and Red Rivers' (1834); 'Excursion Through the Slave States' (1844); 'Canoe Voyage to the Minnesota' (1847), etc.

Feb'iger, John Carson, American naval officer: b. Pittsburg, Pa., 14 Feb. 1821; d. Londonderry, Pa., 9 Oct. 1898. He was appointed a midshipman in the navy in 1838; became commander 16 July 1862, and was assigned to the steamer Kanawha of the Western Gulf blockading fleet. On 5 May 1864, while in command of the Mattabeset, of the North Atlantic fleet, he participated with the little squadron under Capt. Melanchthon Smith in defeating the Confederate ram Albemarle, in Albemarle Sound, N. C., and was commended for his bravery and skill in that engagement. He was promoted rear-admiral 4 Feb. 1882.

Febrifuge, feb'rĭ-fūj, a remedy used to destroy or mitigate fever. When rise in temperature was considered the important feature of a disease and this single symptom was considered apart from the rest of the life history of a disease process, febrifuges were much in use, but at the present time, when a disease is considered in its entirety rather than from its purely symptomatic manifestations, this class of remedies has fallen into a position of less prominence. High temperatures are now looked upon as evidences of a reaction in the body in its struggle with disease and, unless excessive and prolonged, should not necessarily be interfered with. A temperature of 103° to 104° F. is rarely harmful, but when the thermometer registers above 104° F. it is advisable to reduce it, for which purpose cold packs and cold sponging are among the best means. Such drugs as the newer synthetics, acetanilid, antipyrine, phenacetine, salol, and other like derivatives, and aconite, diaphoretics, etc., are still much in use; but only within restricted limits may they be said to be curative. In malaria, the high temperature being due to the development of large numbers of parasites in the blood, quinine, by killing the parasites, destroys the fever. See ANIMAL HEAT; ANTIPYRETICS; FEVER.

Febrile. See FEVER.

Febro'nianism (from Justinus Febronius, a pseudonym assumed by John Nicolaus von Hontheim, archbishop of Trèves), a system of doctrines antagonistic to the admitted claims of the Pope, and asserting the independence of national Churches, and the rights of bishops to unrestricted action in matters of discipline and church government within their own dioceses. Febronianism is opposed to Ultramontanism (q.v.), and developed into the Old Catholic Movement.

February. See CALENDAR.

February Revolution, The, in French history, the revolution of 1848, which brought about the fall of the July monarchy. See FRANCE.

Febvre, Alexandre Frédéric, äl-ek-sŏṅ-dr frā-dā-rik fevr, French actor: b. Paris 1835. He made his début at Havre, subsequently appearing in Paris at the Beaumarchais, the Porte St. Martin, the Gâité, the Odéon and the Ambigu theatres. He is very successful in comedy, among his principal creations being Clarkson in 'L'Etranger'; Kobus in 'L'Ami Fritz,' and Bourdon in 'Les Corbeaux.' He went to London with a company in 1877, making his farewell appearance at the Théâtre Français in 1893, "touring" the principal cities of Europe in 1894, and was sent to the United States to study the drama here in 1895. He is the author of 'Album de la Comédie Française' (1880); 'Au bord de la Scène' (1889); 'L'Heritage de Mme. Naudin' (1893); 'Le Journal d'un Comédien' (1896); 'La Clef des Champs' (1899).

Fécamp, fā käṅ, France, town in the department of Seine-Inférieure, at the mouth of a stream of the same name, 23 miles northeast of Havre. It stretches along a narrow valley enclosed by two parallel ranges of hills, and has a parish church, which originally belonged to the famous abbey of Fécamp, a school of hydrography, manufactures of cotton, linen, and woolen goods, sugar works, tanneries, building yards, several mills, a valuable fishery, and a spacious harbor with deep water and good anchorage. The town was celebrated for its herring fishery as early as the 13th century. Pop. (1901) 15,380.

Fechner, Gustav Theodor, goos täf' tā'ō dōr fĕн'nĕr, German philosopher: b. Gross Särchen, Prussia, 19 April 1801; d. Leipsic 18 Nov. 1887. His works on purely scientific topics, 'Elements of Psychophysics' (1860), and 'Text Book of Experimental Physics' (1828) among them, and his 'Three Motives and Grounds of Faith' (1863), are well known, while under the name of "Doctor Mises" he wrote various popular humorous and satirical works, notably, 'A Proof that the Moon is Made of Iodine' (1821); 'Comparative Anatomy of the Angels' (1825); and 'The Little Book of Life After Death' (1836). See Kuntze, 'Gustav Theodor Fechner, ein deutsches Gelehrtenleben' (1892); Lasowitz, 'Gustav Theodor Fechner' (1896).

Fechter, Charles Albert, sharlz äl-bār fĕн-tē' French actor: b. Belleville, near Paris, 23 Oct. 1824; d. Quakertown, Pa., 4 Aug. 1879. He made his first public appearance in 1840 at the Salle Molière, in Paris, after which he went to Florence with a dramatic company as leading juvenile. Subsequently he apeared as Seide in Voltaire's 'Mahomet,' in 1844; as Valère in Molière's great comedy; and as Armand Duval in 'La Dame aux Camelias.' In 1860 he went to London, where he presented 'The Corsican Brothers,' 'Don César de Bazan,' and 'Hamlet.' In 1870 he came to the United States and played to crowded houses, being especially popular in 'The Count of Monte Cristo.'

Fecial. See FETIAL.

Feckenham, fek'ĕn-am, or **Fecknam,** fek'-nam, **John de,** English Roman Catholic prelate: b. Feckenham Forest, Worcestershire, about 1516; d. Wisbech, Cambridgeshire, 1518. He served as chaplain to Bell, the bishop of Worcester Bell, and to Bonner, the bishop of London, going as a prisoner to the Tower upon Bell's fall 1549. Upon Queen Mary's accession to the throne he was made chaplain 1553, later becoming dean of St. Paul's. He held a conference with Lady Jane Grey shortly before her execution. He became abbot of Westminster 1556, and was a member of Queen Elizabeth's first parliament, the last mitred abbot to appear in that legislative body. Being active against the Reformation he was again sent to the Tower 1560, was released 1574, but kept under surveillance as long as he lived.

Fecundation. See PREGNANCY.

Federal Courts. See COURT.

Federal Government. Federal is derived from the Latin *fœdus*, a league, treaty, covenant, and applied to the governments of confederations, which consist of several united sovereign states, as, for instance, the United States, Switzerland, Mexico, etc. The degree to which such states give up their individual rights as sovereign bodies may be very different. Thus, the old German empire was a confederation under a head, and yet one member of it might wage war with another; while the different members of the United States have given up, among other things, all political power in so far as it relates to foreign affairs. In the Swiss Confederation the different members are allowed to conclude treaties with foreign powers, if they are not expressly prohibited by the constitution. It must be observed that every confederation has not a federal government, because sometimes a confederation consists merely of a union between a number of states, not stricter than a treaty, defensive and offensive, between two states, as, for instance, the former Germanic Confederation. See GOVERNMENT.

Federal Hall, New York city, originally the City Hall, built 1699 in Nassau Street, to replace the old Dutch "stadt-huys." It had a cage in front for criminals, a whipping-post, and stocks. On the assumption of independence it was made the State capitol; the Declaration was read in front of it, and Washington was inaugurated on its steps 4 March 1789. In 1836 it was torn down, and the sub-treasury building erected on its site.

Federal States, states united by a federation or treaty which, binding them sufficiently for mutual defense and the settlement of questions bearing on the welfare of the whole, yet leaves each state free within certain limits to govern itself. Switzerland and the United States are examples of this political constitution. Such a union or confederation is sometimes known as a federacy. The term federation indicates centralization in government, while confederation is used where state sovereignty is stronger.

Federalist, The (1787-8). When the text of the Constitution was published in New York 27 Sept. 1787, the opposition was at first overwhelming; the State held too advantageous a position, as general gatekeeper of the commerce of her neighbors and able to support herself by levying customs duties on them, to surrender it. Unless New York ratified the Constitution, there could be no Union; and New York certainly would not ratify it as things stood. Alexander Hamilton, therefore, induced James Madison and John Jay to unite with him in publishing a series of anonymous essays to defend the new instrument and urge its absolute necessity; Gouverneur Morris was asked to join, but declined. From 27 Oct. 1787 to 2 April 1788, 77 essays were published in the semi-weekly 'Independent Journal' of New York, entitled, 'The Federalist,' and signed first "A Citizen of New York," then "Publius." Eight more were added when they were collected in book form. Their influence was enormous not only in New York, where they greatly aided the final ratification by two votes, but elsewhere the essays circulated extensively in pamphlet form; they were so acute and massively learned in their exposition of the true intent of the Constitution, that even the courts have accepted them as authoritative comments in doubtful cases; and they are held by all the civilized world as among the noblest storehouses of political philosophy in existence, a classic text-book of political science. The exact authorship is matter of debate. Jay certainly wrote 5; Hamilton's son claimed 63 for his father and 3 for him and Madison jointly, leaving the latter 14, but Madison in 1819 claimed 29 for himself alone, leaving Hamilton 51. John Fiske thinks Madison's 29 much the most valuable for constitutional exposition; the Hamiltonians can claim half of them. There are many editions; the best is Paul Leicester Ford's indexed edition of 1898. In John C. Hamilton's of 1875 he has a long essay on the authorship.

Federalists, or **Federal Party,** in the United States; in power 1789–1801; died nationally about 1817, locally about 1823; the lineal ancestor in succession of the National Republican, Whig, and present Republican parties. Its origin (see ANTI-FEDERALISTS) was on the question of adopting the Constitution; but it represented two unrelated elements. The commercial interests wished protection at once from foreign aggression, and from barriers set up by independent selfish State legislatures; the patriots pure and simple wished a strong and energetic nation, able to command respect and secure fair treatment. The union of these, their reinforcement for the time by the more statesmanlike even of the Anti-Federalists and Washington's influence, gave them complete control of the new government. They organized the executive departments (see EXECUTIVE) anew, and created the federal judiciary and the Territorial system. The Hamilton, the greatest man of the party and its natural leader, pushed through his schemes for paying the foreign and funding the domestic debt in full, restoring national credit and for assuming the State debts, binding the States to support the new government (see DISTRICT OF COLUMBIA for the "log-roll" which carried it); excise laws, a United States bank, a protective tariff and bounty system to develop manufactures and agriculture, and a postal system, followed rapidly; and in 1794 the crushing of the Whiskey Insurrection (q.v.) showed the new national strength. Meantime the refusal to be dragged into an alliance with revolutionary France had fused the Democrats with the Republicans, the successors of the Anti-Federalists; and Jefferson had organized and Madison joined the new Democratic-Republican party. The most influential Federalist leaders besides Hamilton were Adams and Jay, among others were the "Essex Junto" (q.v.), Fisher Ames, Roger Sherman, Jonathan Trumbull, Rufus King, Gouverneur Morris, Jonathan Dayton, Elias Boudinot, William Bradford, James A. Bayard, John Marshall, Richard Henry Lee, C. C. Pinckney, and William Smith. The party began a new navy, but was prevented by the Democrats from going on with it. This ultimately killed the Federal party; unable to protect commerce by force, it had to do so by humiliating concessions to England, and thus become dependent on and an apologist for that country, which alienated public confidence. By 1796 it had become almost entirely a northern party. The French war afforded a chance of increasing the navy, which they did; but they committed the huge folly of passing the Alien and Sedition laws (q.v.), gratifying resentment at the expense of votes. Finally, when Adams took away their one issue by ending the French war (see ADAMS, JOHN), the Hamilton wing broke with his, and the Democrats ousted the party in the elections of 1800. Its course in opposition deprives it of respect; when the Democrats almost at once dropped their original tenets, practically if not theoretically, and acted on those of the Federalists, the latter (as in the Louisiana Purchase, a pure Federalist measure) changed coats with the Democrats and fought them on their own discarded ground. Their best patriotic elements deserted them in swarms, and in 1804 they carried only Connecticut and Delaware and part of Maryland. But the Embargo (q.v.), and the selfish attempt of the agricultural sections to sacrifice the entire commerce of the country to their own supposed interests, temporarily reinforced the Federalists; in 1808 they had every New England State but Vermont (the only one with no seaboard), besides Delaware and parts of Maryland and North Carolina. The War of 1812 was so unpopular in the North that in the elections of that year New York and New Jersey went Federalist also, and Maryland solid; and the balance of power was held by the three backwoods States of Kentucky, Tennessee, and Ohio, — or by Pennsylvania, whose agricultural west had now swamped the Philadelphia region. But the party as such was really dead; half the old leaders were gone, several of the others had turned Democrat or Independent, Marshall was imbedding its best principles in the national system from the Supreme bench; the chief men now were King and Pinckney. When the war closed, the issue on which the commercial sections had joined them was closed and these at once deserted the party; the Hartford Convention (q.v.) had driven all the remaining leaders out of public life with the stigma of secession and treason; and in 1816 the party carried only Massachusetts, Connecticut, and Delaware, with three Maryland electors who would not vote. The scattered Federalists in Congress did not act as a party, having no issues even as a pretense, and as a national party it ceased to exist. Statewise, it controlled Connecticut and Delaware till after 1820, and Massachusetts till 1823, when the Democrats swept even Essex County from the «Junto.» It lingered for some time also in Maryland and North Carolina.

Federals, the name given to those who during the Civil War in the United States fought to maintain the Union of the Federal States, as opposed to the Confederates.

Federation of Labor. See AMERICAN FEDERATION OF LABOR.

Federmann, Nikolaus, nē'kō-lous fā'dĕr-män, German explorer: b. Ulm, Swabia, 1501; d. about 1542. He was sent to Venezuela by the Welsers of Augsburg, becoming chief lieutenant of Alfinger, and making explorations into the interior of the country. He returned to Europe 1532, going back to Venezuela 1534, as the lieutenant of George of Speyer. He did not follow the latter on one of his expeditions, as ordered, but made an independent exploration with 200 men, spending some years in the valley of the Orinoco, and reaching New Grenada in 1539, where he met Gonzulo Kuesada, already in possession, and relinquished the region to him. Federmann returned again to Augsburg, but was discharged by the Welsers for misfeasance. His account of his first exploration was published in German, 'Indianische Historia,' 1557, and in French 1837.

Fee, John G., American abolitionist: b. Bracken County, Ky., 9 Sept. 1816; d. Berea, Ky., 12 Jan. 1901. He entered the Lane Theological Seminary, Cincinnati, Ohio, in 1842, and soon afterward began to preach against slavery. As a result he was mobbed several times, but in 1853 went to Berea, Ky., where he succeeded in founding a church and establishing Berea College (q.v.), an institution open alike to blacks and whites.

Fee, Fief, or Feudum, is a legal term of feudal origin, signifying an inheritable estate in land, held by some superior, or lord; as distinguished from *allodium*, which is land held by absolute ownership. In the United States, however, where land is generally held in allodium, the private ownership is termed the *fee*, if subject to no paramount right except that of the State. In England the legal theory is that all the lands of the kingdom, except the royal domains, are held in fee, or by a tenure, of some superior lord, the absolute or allodial property being only in the sovereign, so that all the tenures are strictly feudal. This was a significant doctrine while the feudal system flourished in Europe; and the remnants of it are still blended, in a greater or less degree, in the land titles, or rather as a theoretical doctrine, from which certain inferences are drawn, than a plain, direct, practical fact; for the property of a proprietor in land held in *fee simple*, in England, is as absolute, to all intents and purposes, as where the land titles are allodial, there being no practical or theoretical doctrine of a tenure, or holding under a superior. *Fee tail* is any fee granted upon condition; or a fee limited to any particular heir or class of heirs; a qualified fee as differing from fee simple.

Fee Simple, an inherited estate belonging to the owner, his heirs and assigns forever. This is the most complete and exclusive interest that the possessor of lands can have in them, and the word continued to be employed in real estate law after the feudal system had passed away. This is the case even in the United States, where land is generally held in allodium (q.v.) and subject to no paramount claim excepting that of the eminent domain which belongs to the State.

Fee Tail, an estate limited to a certain line of descent, to certain heirs or to a certain class of heirs; sometimes known as a conditional fee.

Feeble-minded, Education of. The term feeble-minded is now used to embrace all classes and grades of the mentally defective, excepting the insane, who, properly speaking, are mentally sick. Idiocy was the term formerly used to cover the same range. Idiocy or feeble-mindedness may be defined as «mental deficiency depending upon imperfect development, or disease of the nervous system, occurring before, at, or after birth, previous to the evolution of the mental faculties.» At the time the feeble-minded were first taught, it was supposed that their growth of body and mind, which was seen to be but partial, had simply been stopped by malign influences, and that in many cases all that was needed was proper environment in order to start the growth again; it was hoped that the improvable cases at least could be educated and trained to approach in capacity the normal-minded individual. The first attempts to train the feeble-minded in this country were made in 1848. Before that time idiots who were not kept at home were to be found in almshouses or in insane asylums. Kind-hearted physicians who saw this «rubbish of humanity» cowering in terror before lunatics or abused by almshouse associates, agitated for their relief, care, and training. The movement began in New York and Massachusetts in the year 1846. In the latter State the legislature appointed a commission to report upon the number, condition, and the best means of relieving the idiots in the commonwealth. Dr. Samuel G. Howe, the director of the Perkins Institution for the blind, was made chairman. The report made in 1848, and widely known as «Dr. Howe's report on idiocy,» was exhaustive, and ended by recommending the opening of an experimental school. One was opened at the expense of the State and under the guidance of Dr. Howe himself. The results were so favorable that in three years' time the State doubled its appropriation, and founded in South Boston the Massachusetts School for Idiots, the first State school for them. The State of New York followed, establishing its school similarly, or experimentally, in 1851, and permanently in 1853. Between the appointment of the Massachusetts commission and its report, a country physician, Dr. H. B. Wilbur, had opened a small private school for idiots at Barre, Mass., really the first school of its kind in America. Dr. Wilbur was soon called to take charge of the New York State school. The Pennsylvania school followed in 1852, and was established in Philadelphia as a private corporation in 1853; then in 1857 came the Ohio State institution at Columbus; in 1858 the semi-public school in Lakeville, Conn.; the Kentucky State school at Frankfort in 1860; the Illinois State school in 1865; the Hillside home, a private school at Fayville, Mass., in 1870. "Thus up to 1874, 26 years after this work was begun in America, public institutions for the feeble-minded had been established in seven States. These institutions then had under training a total of 1,041 pupils. There were also two private institutions in Massachusetts, with a total of 69 inmates." Applications for admittance were numerous and pressing. At first it was the theory that only imbeciles, the improvable idiots, should be taken into the institution, that the institution should be a school and should graduate its pupils into the world. But most of the superintendents soon recognized that the pupils would always be children though adult in years; that they needed guidance and protection always; that for obvious reasons girls and women of child-bearing age should not be discharged — for no girl is so exposed as the simple, weak-willed, feeble-minded girl — and finally that practically all cases would have to be retained within the institution. Physiology and pathology now teach that "mental deficiency generally, if not always, is the result of a definite cerebral abnormality or defect, or the result of actual disease or damage to some part of the central nervous system"; that feeble-mindedness is practically a permanent condition, and that it cannot be cured. From the time this fact came to be realized the institutions began to change in character. There arose two distinct departments — the training school and the asylum.

The school is the fundamentally important department. Education is just as much a right of the improvable imbecile as it is of any child. The aim in the education of an ordinary child is to give a liberal all-round training, fitting him for anything in life he may choose to take up. With our feeble-minded child the aim of his education, which is to lead a useful life within the institution, is kept ever in mind. He is happiest when occupied. Hence his education is principally practical. The difference between a normal person and a feeble-minded person after training is that the latter has no initiative, no power to resist the seduction of stronger minds. He may be useful and even self-supporting, but he can become so only under guidance and direction. When they come to school these children have extremely weak will power. In fact, the feeble-minded as a class have been divided by Sollier according to the attention, thus:

"1. Absolute idiocy. Complete absence and impossibility of attention.

"2. Simple idiocy. Attention feeble and difficult.

"3. Imbecility. Instability of attention."

With all these the condition of the hand indicates that of the brain. The "idiotic hand" is proverbial. Many imbeciles see but do not perceive; hear but do not understand. They rarely make a purposive effort, but need to be directed in everything. When it is comprehended that though they love games they do not even play of their own accord, it will be understood how their teachers must begin at the very bottom rung in the ladder of education. The special senses of seeing, hearing, and feeling, actually have to be aroused and developed, (1) as simple physiological functions; (2) as intellectual faculties. Callisthenics in classes, marching to music, military drill — movements and exercises of all kinds — exert a most salutary and energizing influence, and are in great use in all the schools. The normal child does not need to be taught each step; his power of attention, his will, his desire, his originality enable him to fill the gaps in instruction from his own daily experiences. On the contrary, the feeble-minded child has to be taught each step, hence, his education is extremely slow. The simple occupations of the kindergarten fit these children of 8 to 12 years of age as they do bright children of 4 and 5. The teacher devises all manner of busy work for them, generally using coarse materials; the stringing of spools; beads; buttons; spool-knitting; plain knitting; braiding with broad leather strips, with shoe-strings, with straw; and block building from the simple cube to the forms that are more complex. No instruction is in more general use and is more helpful to the children than that of the kindergarten. After this all their education continues on a very elementary plane beyond which it is impossible for them to go. Many learn reading, writing, and arithmetic. The brightest read simple stories with pleasure, and go as far in arithmetic as multiplication. Division is beyond them. Calculation in the abstract they cannot master. The greater part of their education is, therefore, of a purely practical kind. They are taught a good deal of fancy work, like knitting, crocheting, embroidery, and lace-making; but chiefly domestic work, sewing, washing and ironing, baking, farming, house-painting, shoemaking, brushmaking, etc. Entertainments are very frequent at these institutions, and the "men and women children" are always present. No discrimination as to age or capacity is permitted, and happiness prevails. The institution is a small community. It must have a given number of employees, one or more to each section or department. But the stronger grown up children do the bulk of the work: baking, laundry work, shoemaking, sewing, mending, dressmaking, and tailoring. Each institution aims to have as many acres of land as it has children, and on the grounds a barn, cattle, horses, and all the paraphernalia of a farm. This farm is worked by the boys. By utilizing the energies of the pupils in profitable labor the average per capita expense may be reduced to $125 or $150 a year. Supt. Doren of the Columbus institution has said that if the State will provide him 1,000 acres of good land he will care for all the custodial cases in Ohio free of expense to the State. When an old school has moved to a new site as the Massachusetts school has recently done, the labor of the boys has been utilized in clearing the land and ditching it, in building the roads, etc. Where the grounds contain suitable clay soil, as at Fort Wayne, Ind., the boys have made the bricks with which to build new structures as needed. But in all this care is taken that there is no overwork. The work of an average laboring man more than supports himself — it is generally reckoned to support three people. If the feeble-minded man does one half or one third of a man's work, and does it every day, his support costs only that which will pay for his superintendence and care. The lowest cases of the unimprovable idiots, whom nearly all the institutions have been forced to admit, are termed the "custodial cases," and are kept by themselves. They are profoundly helpless, can neither speak nor attend to their bodily wants, but must be cared for like babies, which they are. Attendants willing to do this work are not easily found. But trained feeble-minded girls are delighted and flattered at the privilege of taking care of those more helpless than themselves. And it has been found that they make the best attendants for such cases. So far, then, as methods of instruction go, American teachers have but broadened the physiological methods of the Frenchman, Seguin. The distinctive results of our schools lie in training the pupils to be helpful, especially in the way of labor for these institutions.

A distinctive result of work for the feeble-minded has been the gathering of statistics of causes. It has been known that a very large percentage of cases, variously estimated from 50 per cent to 70 per cent, are of congenital origin; that of all classes of defectives the feeble-minded most surely tend to transmit their defect; hence, that the feeble-minded must be sequestrated for life. It has been shown that there is a strange but strong correlation between the forms of degeneracy, namely, the criminal, the inebriate, the prostitute, and the feeble-minded. Of late years the energies of charitable and sociologic organizations "have turned toward combating the causes of degeneracy, thereby protecting posterity." The United States census for 1890 gives in round numbers 95,000 feeble-minded, and this number is undoubtedly short of the actual number. Still but one twelfth or about 8,000 of those returned in the census are cared for in special institutions. Here is a terrible problem ahead for the sociologists to work out. Those who have most thoroughly studied the feeble-minded are convinced that, as prevention is cheaper than cure, so the gathering of all this vast army into institutions and especially colonies where 50 per cent of them can be taught to be at least partly self-supporting, and where their multiplication can be cut off, is, by all odds, the most economical and the best policy for the States to pursue in the future. It should not be forgotten that for every idiot cared for we restore at least one productive person to the community. The matter is receiving widespread and intelligent attention. The work for the feeble-minded is considered by those in it as being still in a tentative stage. Nearly all the superintendents are physicians; they do not agree on the different questions involved. They meet regularly in convention, and have an organ of communication, called 'The Journal of Psycho-asthenics.' As the methods of teaching the feeble-minded and the other defective classes have become understood, they have modified the old methods of teaching children of normal intelligence. Child study is now interesting teachers, and already has led to the sending of many feeble-minded children to special schools for their training. The city of Providence, R. I., has recently led the way in a new movement, that of teaching in special classes the dull or backward pupils of the public schools. The movement is slowly spreading elsewhere, and, in justice both to the dull and the bright children, is of inestimable value, and, as such, is a hopeful sign of the times.

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Principal of the Pennsylvania Institution for the Instruction of the Blind.

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Feed Pump, a force-pump, for supplying the boiler with water.

Feeder, (1) a stream, fountain, or channel which feeds or supplies a main stream or canal with water. (2) A branch or side railway, intended to bring traffic to the main line. (3) In hydraulic engineering, a feeder is a water-course, natural or artificial, carrying water to a canal or reservoir. (4) In mining, the side branch of a vein which passes into a lode. (5) In sewing-machines, that part which carries the cloth along the length of a stitch between each penetration of the needle. (6) In machinery, an auxiliary or supplying part of a machine, that which leads along the stuff being operated on. (7) In iron founding, a head or supply of fluid iron to a runner or mold in heavy castings. (8) In nail-making, a contrivance with an intermittent oscillating or semi-rotary and forward motion to present the plate to the cutters, so that the head of the nail may be taken from the respective edges alternately. (9) In printing, a device with fingers which take the top sheet from a pile and lead it into the press where it is printed or folded. (10) In steam engineering, a device for supplying steam boilers with water in quantities as required. Automatic boiler-feeders act by means of floats on the surface of the water in the boilers. (11) In threshing, the grain-feeder, which forwards the opened sheaves into the throat of the thresher, or the grain into the eye of the millstone, or the grain and chaff from the hopper to the riddle of a winnowing machine, or the grain from the bin to the manger of sheep or other stock. (12) In electricity, a lead in an electric central station distribution system, which lead runs from the station to some point in the district to supply current.

Feeding, Forced, a mode of putting food into the body of persons who are incapable of feeding themselves, or who refuse to take food. In many protracted diseases, such as typhoid and pneumonia; in certain stages of tuberculosis; in cancer of the stomach; in ulcer of the stomach, and in other conditions, it may be impossible for the patient to hold food in the stomach. Under such circumstances feeding by rectum may be practised. (See NUTRIENT ENEMATA.) Forced feeding more properly applies to the giving of nourishment to those who are suffering from one of the insanities, and by reason of their disease refuse food. They may be fed either through the stomach-pump or by means of rectal enemata, the former being the method to be preferred. In this the physician passes a soft rubber tube through the nose into the œsophagus and stomach, care being taken that the tube does not pass into the larynx.

Through the tube, then, either by means of a Davidson syringe or through a funnel, the food, usually milk, is passed. Insane people rarely attempt to vomit their food after it has been once passed in this way, although many refuse to take it and swallow it in the ordinary manner. If forced feeding by way of the rectum is necessary, nutrient enemata (q.v.) may be employed.

Feeding Machine. By this name are commonly known the machines used to automatically supply printing-presses or the like with paper sheets. Printing of a high grade is not done on the great web printing machines, which feed from a roll of paper. Those are built for speed, but for fine printing presses of the single cylinder type, using single sheets of paper are almost universally used. Such presses were always fed by hand until about 1895, when the first practical paper-feeding machines for printing-presses began to come into use. The first of these machines to secure a considerable sale was the Economic feeder, made by E. C. Fuller & Company of New York. In its latest form the Economic feeder is attached at the rear of a cylinder printing machine, and lifts a sheet of paper from the top of a pile by first buckling the two rear corners, then blowing air under the buckled sheet to separate it wholly from the rest of the pile, after which the sheet is advanced or pushed forward to the guides of the press by means of rubbers and traveling endless tapes. The pile of paper from which the sheets are fed is placed on a platform that is arranged with mechanism for raising it very slowly, so that the top of the pile is always kept at substantially the same level. The perfecting of these machines has been obtained only after very costly experimenting, and the addition of improvements as defects were found. Paper piled in sheets has a tendency to stick together, in fact, sheets are sometimes actually glued in spots, as by the crushing of an insect between them. The automatic feeding machine has to provide for such contingencies, and when a torn sheet is found, or a wrinkled one, or two sheets stuck together, the feeder must not only be stopped, but the printing-press also must be brought quickly to a standstill or damage results. Ingenious automatic devices have been introduced for controlling these conditions, and the machines are now commonly used in connection with the printing of magazines of large circulation, some of the larger magazine and book printers employing as many as 30 or more feeding machines in one establishment. The Economic machines will accommodate 10,000 to 20,000 sheets of paper at a single loading, which saves the time formerly lost by the hand feeder about once in 1,000 sheets, in stopping to put up another pile. There is also a saving in soiled sheets, in wages paid, and often in the speed at which the printing-press can be run. The Economic feeder is built in a slightly different form for use with paper-folding machines and with paper-ruling machines. See FOLDING MACHINE.

The Dexter feeding machine was introduced in New York about 1900. Its general characteristics resemble the Economic, but the details of mechanism are different. Dexter was the first to introduce a machine driven by floor connections, which secures greater rigidity than when driven by a chain from the cylinder of the press. Non-electrical devices are employed throughout, some of the most ingenious being the devices for calipering the sheet, to make sure that two sheets do not go into the press together, and the controlling apparatus for tripping the impression of the printing cylinder if a sheet is missed or fails to come down properly to the guides. The Dexter Company also builds folding machines, and their feeders are adapted to use with these, as well as for ruling machines.

The Cross paper-feeder, made by the American Paper Feeder Company of Boston, does not occupy any floor space, as do those previously described, being located above the feed-board of the press. It accommodates several hundred sheets at a time, and reloading is accomplished without stopping the press. It requires no adjustments for quality or weight of paper, and is practical for short as well as long runs. The sheets of the pile are combed out, then turned completely over and reversed in direction, and guided one by one to the feed-guides of the press. The Harris printing-press, a small rotary machine for envelopes, cards, etc., employs a feeding mechanism that should be mentioned in this connection. It automatically picks an envelope or card from the bottom of a pile and carries it into the press. The attendant loads on more cards or envelopes without stopping the machine. See PRINTING; AMERICAN PRINTING TRADE.

Feed-water Heaters, in steam engineering, are devices in which feed-water is heated to a certain extent, before it is introduced into a steam boiler. If cold water is fed into a hot boiler, its chilling action upon the plates and other metal parts causes them to undergo a powerful contraction, which often strains the structure so that leakage occurs about the riveted joints, tube ends, and other places where the parts of the boiler are secured to one another. If the water is heated as nearly as practicable to the temperature prevailing within the boiler, these contraction strains are in large measure avoided, and the life of the boiler is correspondingly prolonged. Furthermore, many feed-waters contain compounds of lime in solution, which are in large measure precipitated by the action of heat. If such a water is fed into the boiler cold, these compounds are thrown down within the boiler, where they form a most troublesome scale, sometimes of stony hardness, upon the heating surfaces. When a heater is used, these objectionable matters are precipitated in the heater itself, which should be so designed that it can be periodically opened and cleaned. (See SCALE.) Another highly important feature of the feed-water heater is that it enables the engineer to utilize a considerable quantity of heat that would otherwise be wasted. When (as is often the case in certain localities) it is impossible to avoid the use of a feed-water highly charged with lime, the primary object in using the heater may be to effect the removal of the lime, as explained above; and in this case the heating is often effected, wholly or in part, by live steam drawn directly from the boiler, because in this way it is possible to attain a higher temperature, and a consequently more perfect precipitation. In other cases, however, it is usual to effect the heating either by means of exhaust steam, or by the hot gaseous products of combustion as they pass from the boiler to the chimney or stack. When the hot flue gases are utilized for this purpose, the heater is commonly called an «economizer,» and usually consists of a series of tubes through which the water to be heated circulates, these being placed in a chamber which the flue gases are obliged to traverse on their way to the chimney. Flue-heaters, or «economizers,» are very common in England, but they are not generally met with in the United States, although their use in this country is increasing. The exhaust-steam heaters are divided into two general classes, known respectively as «closed heaters» and «open heaters.» In the closed heater the exhaust steam from the engine is caused to flow through a series of tubes which are surrounded by the water to be heated, the steam giving up its heat to the water through the walls of the tubes in such a manner that the vapor and liquid never come into contact with each other. In open heaters, on the other hand, the steam and the water to be heated are brought into intimate contact with each other in a chamber or tank, into which the water is introduced in the form of thin sheets or spray. High feed-water temperatures are attained more readily in open heaters than in closed ones, and for this reason the open form is much used when the removal of scale-forming matter from the water is the chief object in view. On the other hand, exhaust steam is apt to carry over considerable quantities of oil from the engine, and when an open heater is used this oil mingles with the feed-water and so is introduced into the boiler, where it is likely to give trouble by adhering to the heating surfaces and causing them to become overheated and burned or bulged.

Fee'han, Patrick Augustine, American Roman Catholic prelate: b. Tipperary, Ireland, 29 Aug. 1829; d. Chicago, Ill., 12 July 1902. He was graduated from Maynooth College, Ireland, came to the United States in 1852, when he was ordained; and soon after became president of the Seminary of Carondelet. He had charge of St. John's Church, St. Michael's, and the Church of the Immaculate Conception, all in St. Louis, till 1865, when he became bishop of Nashville; and was installed as first archbishop of Chicago in 1880. During his administration as archbishop he founded several new parishes, a college of the Christian Brothers and other institutions.

Feejee Islands. See Fiji Islands.

Feeling, the sense of touch, emotion. See Emotion; Psychology.

Feer-Herzog, Karl, kärl fãr-hĕr'tsoh, Swiss statesman: b. Rixheim, Alsace, 2 Oct. 1820; d. Aarau 16 Jan. 1880. He became a member of the Grand Council 1852 and was twice its president. In 1865 he was made Swiss representative in the Latin Monetary Union, which position he held for the rest of his life. He was director of the Swiss department of the Paris Exposition 1867, and for many years was president of the Swiss Financial Commission. Among his works are: ‹Unification monétaire international› (1869); ‹La France et ses allies monétaires› (1870); ‹Gold oder Silber?› the latter in German (1874).

Feet Washing, or Washing of Feet, a religious ceremony observed in the Roman Catholic Church, on Holy Thursday or the Thursday before Good Friday. This ceremony takes place just after everything has been removed from the altar. The pastor or principal prelate of the church washes the feet of 12 men, in imitation of the action of Jesus Christ, when he washed the feet of the apostles. The Pope washes the feet of 13 priests. The ceremony is sometimes called «Mandatum» from the first word of the antiphon sung during the ceremony: «Mandatum novum,» etc.: «A new commandment I give unto you that you love one another.» This custom, although mentioned in the Council of Toledo (694), is not now generally recognized.

Fehling, Hermann, hĕr'män fā'ling, German chemist: b. Lübeck, Germany, 9 June 1811; d. 2 July 1885. He studied chemistry in Heidelberg, at Giessen in Liebig's laboratory and at Paris. He became professor of chemistry in the Polytechnic School at Stuttgart, and professor emeritus in 1882. He had great authority in the educational and manufacturing circles of his time, as a teacher and prescriber of chemical formulæ for commercial products, such as sugar, and mineral waters. The so-called Fehling's' Solution (q.v.) is famous. He wrote: ‹Text-book of Organic Chemistry›; translated Payen's ‹Précis de Chimie Industrielle,› and edited a new edition of ‹Glossary of Chemical Terms.›

Fehling's Solution, a solution much used by chemists for the detection and estimation of glucose and certain other sugars. In its preparation, 34.64 grams of pure sulphate of copper crystals are dissolved in 200 grams of distilled water, and (separately) 173 grams of crystallized neutral tartrate of sodium are also dissolved in 500 or 600 grams of a solution of caustic soda having a specific gravity of 1.12. The copper solution is then gradually added to the caustic soda solution, and the mixed liquid is diluted to one litre. Fehling's solution must be freshly prepared, for, like all other copper test solutions, it becomes unreliable in a short time, thereafter indicating sugar where none exists. For use, a small quantity of the solution is placed in a test tube and diluted with about four times its bulk of water. It is then boiled for a few seconds, and if it remains clear, it may be considered to be in good condition. The fluid to be tested is then immediately added, drop by drop, until a bulk equal to that of the diluted test fluid has been added. If glucose is present a yellow precipitate of hydrated cuprous oxid is thrown down, which subsequently loses its water of hydration and becomes reduced to ordinary red cuprous oxid. When prepared as described above, one cubic centimetre of the standard (undiluted) solution corresponds to five milligrams of glucose. Fehling's solution is of a deep blue color, and in testing a complicated organic fluid (such as urine) for glucose it often happens that the test solution is decolorized even when no glucose is present. It is, therefore, important to observe whether or not an actual precipitate is formed, as mere decolorization is not a sufficient indication. Cane-sugar does not reduce Fehling's solution in the cold, but it does so when warmed, because heat changes cane-sugar to a mixture of glucose and fructose in the presence of the alkali that the test solution contains. See PAVY'S SOLUTION; URINARY ANALYSIS.

Fehmarn. See FEMERN.

Fehmgerichte. See VEHMGERICHTE.

Feia (fā'ya) **Lake,** in the province of Rio de Janeiro, in Brazil, near the coast. Area, 192 square miles. Connections by canals have been made with the Parahyba River on the north and the Atlantic on the east.

Feigned Disease. See HYSTERIA.

Feijo, or **Feijoo, Diogo Antonio,** dē-o'go än-to'nē-ō fā zho', Brazilian statesman: b. São Paulo, Brazil, 1784; d. 1843. As a priest he did pastoral work for many years, and in 1822 was elected to the Cortes, Lisbon, Portugal. When Brazilian independence was won he returned to America; in 1826 was chosen by the Liberal party as their deputy and representative, and introduced measures for municipal reform and the abolition of clerical celibacy. He served as minister of justice 1831–2, but in 1837 he retired from politics, before the storm of Conservative opposition which his liberal policy had called up.

Feisi, Abul Feis ibn Mubárak, ä'bool fā ēs ibn moo-bä'räk fī'si or fā-ē-sē', Indo-Persian poet and scholar: b. Agra, India, 1547; d. there 1595. He surpassed all his contemporaries in philological, philosophical, historical, and medical knowledge, and about 1572 was crowned «king of poesy» in the court of the Emperor Akbar. Of his poems the most noteworthy are his lyrics — odes, encomia, elegies, and specially his four-line pieces or apothegms. Their exalted pantheism brought on him the enmity of the orthodox Moslem clergy. He wrote also many double-rhymed poems; and a Persian imitation of the famous Indian epic: 'Nala and Damajanti,' designed to form the third member of an epic cycle of which the first was to be 'The Centre of the Circle,' the second 'Solomon and Balkis' (the Queen of Sheba), the fourth 'The Seven Zones of the Earth,' and the fifth 'The History of Akbar'; only the first and third were completed. His scientific treatises were numerous.

Feith, fīt, **Rhijnvis,** Dutch poet: b. Zwoll, Over-Yssel, 7 Feb. 1753; d. there 8 Feb. 1824. He was made burgomaster, and afterward receiver at the admiralty college in Zwoll, but did not cease to cultivate the art of poetry, and to enrich Dutch literature. He tried his powers in almost every department of poetry. In his earlier years he was too much inclined to the pensive and sentimental style. It predominates particularly in his romance 'Ferdinand and Constantia' (1785), and, through his example, has for a long time prevailed in Holland. His 'Grave' (Het Graf, 1792) is the first distinguished didactic poem since the revival of Dutch poetry. His 'Old Age' (De Ouderdom) appeared 1802. Among his lyric poems, 'Oden en Gedichten' (1798), are several hymns and odes distinguished for great elevation and feeling. His ode on 'Ruyter' is very celebrated. He also made that naval hero the subject of an epic poem. The best of his tragedies are: 'Thirza'; 'Johanna Gray'; and particularly 'Inès de Castro.' His poetical 'Letters to Sophia on Kant's Philosophy' (Brieven aan Sophie over de Kantiaansche Wijsbegeerte, Amsterdam, 1805) are a feeble effort of his old age. Among his prose works, his 'Letters on Different Subjects of Literature' (1784), contributed much to the dissemination of good taste, by their finished style and excellent criticisms.

Felch, Alpheus, American lawyer and politician: b. Limerick, York County, Maine, 28 Sept. 1806; d. 1896. He was graduated at Bowdoin College 1827, was admitted to the bar and practised law in Michigan, being elected to the legislature of that State 1836, and appointed bank commissioner 1838–9. He was judge of the Supreme Court 1842–45; governor of Michigan 1846–7; and United States senator 1847–53; he was appointed professor of law in Michigan University in 1879, holding that position till 1883.

Feldmann, Leopold, lā'ō-pōlt feld'män, German dramatist: b. Munich, Bavaria, 22 May 1802; d. Vienna 26 March 1882. In 1835 appeared his 'Lays of Hell'; next the comedy 'The Son on His Travels,' which made a brilliant success at Munich. After five years in travel, chiefly in Greece, as correspondent of the 'Allgemeine Zeitung,' in 1850 he settled in Vienna for life. His comedies were very popular in their day. Among them are: 'Free Choice'; 'Sweetheart's Portrait'; 'The Late Countess'; 'The Comptroller and His Daughter.'

Feldspars, the most important group of silicate minerals. They are characterized by monoclinic or closely related triclinic crystallization, the frequent occurrence of twin crystals, cleavage in two similar directions inclined at an angle of 90° or nearly 90°, a hardness of about 6, a specific gravity between 2.5 and 2.9, a light color, usually white, pale yellow or green, or flesh-red, a white streak and a low relief and low order of interference colors as seen in thin sections with the polarizing microscope. In composition the feldspars are all silicates of aluminum, combined in the different species with one or more of the common alkaline bases, potash, soda, or lime, or rarely baryta. Magnesium and iron are conspicuously absent.

Forms.— Feldspars occur in massive, granular, lamellar, cleavable, and compact forms, but crystals are very common. The monoclinic feldspars include orthoclase, or common feldspar, and the very rare barium feldspar, hyalophane. Triclinic feldspars include microcline, anorthoclase, and plagioclase or the feldspars of the albite-anorthite series, embracing albite, oligoclase, andesine, labradorite, and anorthite. Descriptions of these minerals appear as separate topics. The feldspar group presents a striking illustration of the approximation in angle to forms of higher symmetry coincident with a wide difference in habit. In orthoclase, for example, the common planes *n, y* approximate very closely to the cube; *q*, to the octahedron; *m, b, c, o* to the dodecahedron, and *z, x* to the trapezohedron. Feldspar crystals usually appear prismatic and are often tabular parallel to the clinopinacoid, *b*. Twins of most remarkable variety abound, the commonest of which are after the Carlsbad, Baveno, albite, and pericline laws (see CRYSTALLOGRAPHY). Polysynthetic twinning is almost universal in the plagioclase feldspars, and, while best observed in thin sections with the polarizing microscope, it is often detected in large masses by the fine striations which so beautifully mark some of the cleavage faces of labradorite, oligoclase, or albite.

COMPOSITION AND PHYSICAL PROPERTIES OF FELDSPARS.

Mineral.	Formula.	SiO_2	Al_2O_3	CaO	Na_2O	K_2O	Hardness	Fusibility	Cleavage	Specific Gravity	Extinction on *c*	Extinction on *b*
Orthoclase	$KAlSi_3O_8$	64.7	18.4	......	......	16.9	6.-6.5	5.0	89°53′	2.57	0°	—3° to 7°
Microcline	$KAlSi_3O_8$	64.7	18.4	......	......	16.9	6.-6.5	5.0	89°30′	2.57	+15°30′	+5° to 6°
Albite ...	Ab = $NaAlSi_3O_8$	68.7	19.5	......	11.8	......	6 -6.5	4.0	86°24′	2.62	+ 3°	+17°
Oligoclase	$Ab_3\ An_1$	62.0	24.0	5.3	8.7	......	6.-7.	3.5	86°8′	2.66	+ 1°	+4°
Andesine .	$Ab_1\ An_1$	55.6	28.3	10.4	5.7	......	5.-6.	3.5	86°14′	2.69	—5°	—17° to 21°
Labradorite	$Ab_1\ An_3$	49.3	32.6	15.3	2.8	......	5.-6.	3.0	86°4′	2.73	—14° to 25°	—28° to 32°
Anorthite	An = $CaAl_2Si_2O_8$	43.2	36.7	20.1	......	......	6.-6.5	5.0	85°50′	2.76	—36° to 42°	—37° to 43°

Optical Characters.— Orthoclase is optically negative, with the axial plane usually at right angles to the clinopinacoid, *b*; but sometimes it is parallel to *b* and always becomes so when the temperature is increased to 600° to 1,000° C., this change also being produced by pressure. Microcline is also optically negative and the axial plane is nearly perpendicular to the *b*-pinacoid. Among the plagioclase feldspars the position of the axial plane changes with the composition, there being a regular progression in its position in passing from albite to anorthite. Albite is optically positive, anorthite is negative, while in some andesine, lying midway between them, the axial angle is practically 90°. Microcline is distinguished from all the other feldspars by the characteristic "gridiron" structure which is exhibited by thin basal sections when viewed under the microscope in polarized light. This is due to polysynthetic twinning according to the albite and pericline laws. The plagioclase feldspars may usually be recognized in thin sections, between crossed nicols, by their characteristic polysynthetic twinning, which manifests itself by parallel bands alternately dark and light.

Composition.—Orthoclase, or potash feldspar, is a potassium-aluminum polysilicate, $K\ Al\ Si_3O_8$. This compound is dimorphous, microcline, having an identical composition. Sodium often in part replaces the potassium, making soda-orthoclase or soda-microcline. When the sodium largely predominates the mineral passes into anorthoclase $(Na,K)Al\ Si_3O_8$; when it excludes the potassium, the mineral is albite, $Na\ Al\ Si_3O_8$. Anorthite is a calcium-aluminum polysilicate, $Ca\ Al_2Si_2O_8$. Between it and albite lie various triclinic feldspars, which are regarded as isomorphous mixtures of albite and anorthite. In the table above, the symbol *Ab* is assigned to albite and *An* to anorthite, and the ratio of these albite and anorthite molecules present in these feldspars is thus shown. The variation of the proportions of the constituent molecules gives rise to innumerable varieties filling up the gaps between the typical species which thus graduate from one into another. The change in chemical composition is attended by a change in specific gravity, fusibility, crystal form, cleavage angle, and optical properties. The foregoing table shows the progressive changes, there being an increase in specific gravity from albite at one end to anorthite at the other, while the fusibility and hardness decrease toward the centre of the series and increase at each end.

Occurrence.— The feldspars are not only the most abundant of all rock-forming minerals, but also the most important from a scientific standpoint, since the present scheme of classification of igneous rocks is chiefly based on the identity of the contained feldspar (see ROCKS). Orthoclase is an essential constituent of granite, syenite, and porphyry, while it is also one of the constituents of gneiss and the other granitoid rocks. Its variety sanidine is the feldspar of trachyte and phonolite. Microcline occurs similarly and is not easily distinguished from orthoclase except by an optical examination, though its two prominent varieties, amazonstone and chesterlite, are quite distinct. Albite is an essential constituent of diorite and is one of the component minerals of many crystalline rocks, occurring associated with orthoclase and microcline in much granite and gneiss. Albitic granite is often the matrix of the rarer minerals, and especially of some of the gems. Oligoclase abounds in granite, syenite, gneiss, diorite, trachyte, andesite, and diabase, often being associated with orthoclase. Labradorite is an essential constituent of various basic, eruptive rocks, in which it is commonly associated with some member of the pyroxene or amphibole groups, as in norite, gabbro, diabase, and basalt. Anorthite occurs in gabbro, basalt, and porphyry.

Alteration.— The feldspars are often altered into other silicates such as talc, chlorite, or the zeolites, but much the most common change is the production of kaolin (see CLAY). Infiltrating waters containing carbon dioxide dissolve out the alkaline ingredients of the spar, which, entering into new combinations, form various secondary minerals, while the aluminum silicate becomes hydrated and forms kaolin. If the waters contain magnesium salts the feldspar may be altered to talc.

Uses.— Feldspar is extensively used in the manufacture of porcelain, serving as a flux to bind together the other constituents, clay and flint. It is also one of the principal ingredients in the glaze for chinaware and tiles, and it has less important applications in soap-making, polishing materials, and dentistry. The beautiful change of colors in labradorite has led to its use for table tops and inlaid work. The gem moonstone is a variety of feldspar, usually oligoclase.

Production.— The production of feldspar in the United States during 1902 amounted to 21,870 short tons of crude spar, valued at $55,501, and 23,417 tons of ground spar, valued at $194,-923. The chief supply comes from Pennsylvania, Connecticut, New York, and Maine. Potash feldspar, that is, orthoclase or microcline, is the material most used. Although it is such an abundant rock constituent, it is comparatively rarely segregated sufficiently to be available for commercial uses. The quarries of greatest value are usually those in which the feldspar occurs in pegmatite dikes, in gneiss or mica schist. The larger masses of mica and quartz are broken and picked out by hand, but considerable percentages of quartz often remain, which, however, within reasonable limits, are not objectionable for pottery, since flint is always mixed with the spar in the process of manufacture. The quarries are nearly all worked by open pits, some of which are of mammoth size, one in Glastonbury, Conn., having produced 200,000 tons, another at Elam, Pa., 100,000 tons.

George Letchworth English,
Mineralogist, New York City.

Félegyháza, fā'ledy-hä-zo, or **Kiskun-Fé,** kish'koon'fĕ, Hungary, town about 65 miles southeast of Budapest. Agriculture and grazing are the principal occupations of the people of the surrounding country and the trade is in cattle, dairy, and agricultural products. Pop. 33,300.

Felicudi, fā-lē-coo'dē (ancient Phœnicusa), one of the Lipari Isles, off the north coast of Sicily, 10 miles west of Salina. It is about nine miles in circumference, has rugged cliffs of basalt, and three lofty summits, evidently produced by an extinct volcano. The soil is both fertile and well cultivated. Pop. 800.

Felidæ, fē'lĭ-dē, the cat family, which contains the most highly developed of the order *Carnivora.* The characters of the family are: the possession of a slender, extremely flexible body, of great muscular power; the limbs five-toed, the thumb of the anterior limbs not reaching the ground; the skull relatively short, the facial portion much shortened, very broad, and giving, by its capacious zygomatic arches, a rounded outline, and abundant space for the powerful muscles which move the lower jaw. The incisors are three in number on each side, above and below; the powerful canines are trenchant on both edges, and are sometimes grooved; the premolars are three above and two below, the molars one above and below — in all, 30 teeth. The premolars are laterally compressed, the third upper tooth, the carnassial, or sectorial premolar, having only a minute inner tubercle. All are digitigrade. The divisions, as given by Carus, are: Sub-genus 1. *Felis.* Claws retractile; limbs low; tail as long as the body. A. Old World forms. (a) Lions (*F. leo*). Color uniform; a mane. Africa and Western Asia. (b) Tigers (*F. tigris*). No mane; body striped. Whole of Asia, from the Altai and Amur to Java and the Caucasus. (c) Leopards (*F. pardus*). Large species, with spots or rings, and round pupils. Africa and South Asia. (d) Serval (*F. serval*). Small spotted species. South Africa. (e) Cats (*F. catus*). Small, not spotted, sometimes striped; pupils elliptic vertical. B. New World forms. (a) Leonine. Color uniform, no mane. Puma (*F. concolor*). (b) Leopard-like. Jaguar (*F. onca*). Sub-genus 2. *Cynailurus.* Claws not quite retractile. Hair on neck and between shoulders, long, manelike. Cheetah (*F. jubata*). Africa and South Asia. Sub-genus 3. *Lynx.* With ear-tufts and short tails. A. Old World forms. Caracal (*F. caracal*) and chaus. South Asia and Africa. B. New World forms. Canadian lynx (*F. canadensis*). Red cat (*F. fasciata*). Bay lynx (*F. rufus*) — all in North America. The family was represented in Tertiary times by the cave-tiger (*F. spelea*); an American species (*F. protopanther*); and an Indian (*F. cristata*). *Machairodus,* with its enormous sabre-like upper canine, ranged from Miocene to Pleistocene times in Europe.

In addition to this formidable apparatus of cutting-teeth, the tongue is covered with small recurved prickles by which they can clean from the bones of their prey every particle of flesh.

There are no quadrupeds in which the muscles of the jaws and limbs are more fully developed. The skeleton presents a light but well-built mechanism; the bones, though slender, are extremely compact; the trunk, having to contain the simple digestive apparatus requisite for the assimilation of highly organized animal food, is comparatively slender, and flattened at the sides. The muscular forces are thus enabled to carry the light body along by extensive bounds, and thus it is that the larger felines generally make their attack. The five toes of the fore-feet and the four toes of the hind-feet of cats are armed with very strong, hooked, sharp claws, which are preserved from being blunted by a peculiar arrangement of the phalanges. For this purpose the claw-joint of each toe is drawn back by ligaments attached to the penultimate joint, till it assumes habitually a perpendicular position, when the claw which it supports is completely retracted within a sort of sheath, and is entirely concealed by the fur. When, however, the animal springs on its prey, the tendons of the flexor muscles of the toes, overcoming the elasticity of the retractile ligaments, pull forward the claws, and they are ready to be buried in the flesh of the victim. The lower surface of the foot is furnished with thick ball-like pads of the epidermis, on which the animal walks; this gives them the noiseless tread peculiar to this family.

Members of the cat family hunt in the gloom, and, consequently, while escaping observation, require every ray of light that can be made available. The pupil is a long, vertical fissure; but this only obtains among the smaller genera; in all of the family above the ocelot in size, the pupil is round in form. On the top of the skull there runs a tolerably high bony crest, which reaches its greatest elevation at the very back of the head. This bone ridge is necessary for the attachment of the powerful muscles which operate the jaws and enable the cats to drag away their often very heavy prey.

In the digestive organs of the *Felidæ,* the salivary glands are small, and the stomach of a simple cylindrical form. The œsophagus opens at its anterior extremity, and the intestine commences from the posterior; so that everything favors a quick passage of the food, which receives no mastication, and is retained a very short time in the stomach. The intestine has no valves, is small in diameter, but muscular, and the whole canal, when compared with the length of the body, is extremely short, being as

3 or 5 to 1. In the domestic cat they are 5 to 1; but in the wild cat only as 3 to 1.

The *Felidæ* are now regarded as including only two genera, *Felis* and *Cynælurus*, the latter reserved for only one species, the chetah (q.v.).

Wild cats are found in all parts of the world except Australia, but principally in the warmer regions, where alone the larger species are met with.

In the caverns and river deposits of the Quaternary Period in Europe and America are found fossil remains of cats allied to or identical with living species. Such are the huge cave lion of Europe (*Felis leo*, race *Spelæa*) and others not so well known. During the Tertiary Period they were rare, their place being taken by the Machærodonts or sabre-tooth tigers (q.v.), animals similar to cats in many respects, but less agile, more powerful, and distinguished by enlarged sabre-like upper canine teeth, which indicate different habits of attack on their prey. The appearance of true cats, both in Europe and America, is correlated with the abundance of modern types of ruminants, etc.— slender, thin-skinned, long-necked, and swift-footed, in place of the powerful and heavily proportioned pachyderms common through most of the Tertiary Period. It is probable that both sabre-tooth tigers and true cats were evolved from the *Palæonictidæ*, a group of primitive carnivora or Creodonta (q.v.), in the early Eocene; but the proof from fossils is at present fragmentary and incomplete.

See CAT; COUGAR; LEOPARD; LYNX, and other names of wild cats.

Felix I., Saint, a citizen of Rome, reigned as pope from 269–74. He excommunicated Paul of Samosta, bishop of Antioch, for teaching that Christ was no more than a mere man. A portion of a treatise on the Incarnation, written by Felix I., is still extant. He was martyred (274) in the Aurelian persecution.

Felix II., Pope. He occupied the pontifical see during the banishment of Liberius, 355. In reply to a proposition for the recall of Liberius, it was proposed by the Emperor Constantius that Liberius and Felix should reign conjointly, but the people exclaimed: "One God, one Christ, one Pope." Felix retired until after the death of Liberius (358) when he was recalled and became pope until he was martyred in the last of the 4th century. By many historians he is called an antipope.

Felix III., Pope, succeeded Simplicius in 483, and died in 492. Under him began the Acacian schism, headed by Acacius, Patriarch of Constantinople. Acacius was excommunicated by Felix III. at the Roman Synod of 484.

Felix IV., Pope from 526 to 530. He is noted for his promulgation of the 25 canons adopted by the Council of Orange (529) against Semi-Pelagians.

Felix V., an antipope: b. Savoy; d. Ripaille 1451. He is better known by his rightful name and titles, Amadeus, Duke of Savoy, Count of Geneva, and Cardinal. He was elected pope by the schismatical Council of Basel (1439), and in 1449 submitted to Nicholas V. who had been elected pope canonically. Felix V. is the last one of the antipopes.

Felix, Antonius, an-tō'nĭ-us fē'liks, Roman procurator of Judea. It was before him that Paul "reasoned of righteousness, temperance, and judgment to come." Felix rose from slavery, having been manumitted by Claudius Cæsar. His rule in Judea, notwithstanding its severity or rather in consequence of it, was marked by constant disorders and disaffection; and but for the interest of his brother (the notorious freedman Pallas) with Nero, the charges carried up against him to Rome would have been his ruin. Drusilla, "the Jewess," his second wife, had been seduced by him from her husband, Azizus, king of Emesa. Tacitus paints Felix in the darkest colors — a character confirmed by what is related of him in the New Testament, that he had expected a bribe from Paul, and that, disappointed in this, he left him bound, "to show the Jews a pleasure." Acts xxiii., xxiv.

Felix, Eugen, oi-gān' fā'līks, Austrian painter: b. Vienna 27 April 1836. He studied art under Waldmuller in Vienna and under Cogniet in Paris, and settled in Vienna 1868. He painted religious and mythological subjects, studies of horses, portraits and interior scenes, among his canvases being: 'The First Friend'; 'Pan and the Bacchantes,' his portraits including those of Rubinstein, and Philip, Duke of Würtemberg.

Felix, Marcus Minucius, mar'cus min nu'shĭ-us fē'liks, Roman lawyer: flourished about 230 A.D. He embraced Christianity, and wrote an excellent defense of it in a dialogue entitled 'Octavius.' The period when he flourished is uncertain, some making it as early as the reign of Marcus Aurelius, while others make it as late as that of Diocletian. The purity of the Latin style, and some of the allusions to the existing state of the Church, would seem to favor the earlier date; but it is not easy to set aside the direct testimony of Jerome, who, in a regular list of Christian writers, places him between Tertullian and Cyprian, thus fixing the period to about 230 A.D. The 'Octavius' has been translated into most European languages.

Felix Holt, the Radical, a novel by George Eliot (1866). It is a picture of upper middle-class and industrial English life of the period of the Reform Bill agitation.

Felix'ians, a Spanish sect of the later part of the 8th century, so called from Felix, bishop of Urgel.

Fell, John, English prelate: b. Longworth, Berkshire, 23 June 1625; d. 10 July 1686. He was graduated at Christ Church, Oxford, 1643, took up arms for the royal cause, and later, at the Restoration, became canon of Christ Church and dean 1660, becoming vice-chancellor of Oxford 1666, which office he held till 1669. He displayed much interest in the development of the University Press, and in 1675 he was appointed bishop of Oxford. Among his works are: 'The Interest of England Stated' (1659); 'The Life of Dr. Henry Hammond' (1661); 'Grammatica Rationis sive Institutiones Logicæ' (1673); 'The Vanity of Scoffing' (1674); and several editions of classical Latin and Greek authors. He was satirized in Tom Brown's famous epigram beginning "I do not like you, Doctor Fell."

Fell (Norw. *fjeld*, Swed. *fjäll*), the name given in Scandinavia to the bare plateaus which occur in its mountainous regions; they are destitute of vegetation, and generally lie above the snow-line. The word enters as a component into the names of innumerable mountains, owing to the fact that in their formation they have taken on the shape of a fell. Fell is also used in the north of England and south of Scotland to designate a barren hill, and indicates Scandinavian settlements. See MIDDLESEX FELLS.

Fellahs, fel'az, or **Fellahin,** fel'a-hēn, the people of Egypt who live in villages and cultivate the soil. The name signifies "tillers." They form a large part of the population; are the most ancient race in that country, and are generally believed to be the descendants of the old Egyptians, their physiognomy resembling that which is found on the ancient sculptures. They are a patient and laborious population, and were heavily taxed before the period of English influence in the government. See EGYPT.

Fellatahs, fel-lä'täz, or **Fulahs,** foo'läz, native **Fulbe,** fool'bĕ, a remarkable race of the negro type, the original locality of which is unknown, but which is now widely diffused throughout the Sudan, where they form a kind of ruling aristocracy. The states or kingdoms of Senegal-Futa, Futa-Jallon, Haussa, Sokoto, etc., are in their hands, and they thus extend from Senegambia eastward to Lake Tchad. Though of the negro family, they differ widely in their physical characteristics from that race. In person they are decidedly handsome, and mostly of a light copper color. They have regular features, small mouths, and noses inclining to aquiline; silky hair, and fine black eyes; and are tall, well proportioned, and of erect and graceful figure. Some of the young women are very good-looking, and would be considered beautiful even in Europe. The Fellatahs are shrewd and intelligent; extremely active, polished, and insinuating in their manners, and said to possess great bravery and perseverance. They are not very much inclined to trade or agriculture, leaving these chiefly to the subject peoples. They are mostly Mohammedans, to which religion they became converts about 400 years ago. In the beginning of the 19th century they spread Islamism through the Sudan and established their dominion over a wide territory.

Fellenberg, Philipp Emanuel von, fē'lēp ā-mä'noo-el fon fel'len bĕrH, Swiss educational and agricultural reformer: b. Berne 27 June 1771; d. Hofwyl 21 Nov. 1844. The years 1795–8 he spent in traveling over France and Germany, visiting in preference the villages, and chiefly devoting his attention to the material, intellectual, and moral condition of the agricultural classes. He became convinced that the cause of all the existing poverty and misery was the absence of sound and rational instruction, and that the remedy lay in combining with a sound general education special training for the pupil's future trade. On his return to Berne he devoted himself to the improvement of the social and intellectual welfare of the peasantry. For this purpose he purchased the estate of Hofwyl, and established successively an institution for instructing the children of the poorer classes, a seminary for children in the higher grades of life, and a normal school. The pupils were all trained to work in the fields or at the bench, and the product of their labor was sufficient to cover the expenses of their education. Fellenberg's scheme was at first ridiculed by his countrymen, and looked upon for a time with some suspicion by the government; but ere long its beneficial results attracted even the attention of foreign governments. Alexander I. of Russia conferred upon the philanthropist the decoration of St. Vladimir, and sent seven young nobles to be educated at his institution. Several foreign princes visited the establishment, and founded institutions on a similar plan. The Fellenberg institutions still exist, though on a less extensive scale, and are partly carried on by his descendants.

Fell'ing, England, town, in Durham County, on the Tyne, two miles southeast of Newcastle. It has chemical works, forges, factories, and coal mines nearby. Pop. 22,460.

Fellows, SIR **Charles,** English traveler and antiquarian: b. Nottingham Aug. 1799; d. there 8 Nov. 1860. Without any claims to classical attainments, he collected unassisted a vast amount of material for the learned to labor upon. He first explored the valley of the Xanthus in Lycia, in 1838, and discovered the remains of the two cities Xanthus, the Lycian capital, and Teos. Under the auspices of the trustees of the British Museum he made further explorations in 1839 and 1841, and succeeded in obtaining the marbles now in the Lycian salon of the Museum. He was knighted by the queen in 1845. His principal works are: 'The Xanthian'; 'Travels and Researches in Asia Minor'; and 'Coins of Ancient Lycia before the Reign of Alexander.'

Fellows, John, American author: b. Sheffield, Mass., 1760; d. New York 3 Jan. 1844. His publications include: 'The Veil Removed' (1843); 'Exposition of the Mysteries or Religious Dogmas and Customs of the Ancient Egyptians, Pythagoreans, and Druids'; 'Mysteries of Free-Masonry'; and a work on the authorship of the Junius letters.

Fellowship, an institution or feature of ancient origin in certain European universities, but of recent introduction in the colleges and universities of the United States. In an English university the fellowship entitles the holder, a graduate, who generally is called a fellow, to participate in the revenues of a certain college, or to have the benefit of a special endowment, and also confers a right to rooms in the college, and certain other privileges, as to meals, etc. Fellowships are generally forfeited upon the attainment of a certain position in the church or at the bar, and are retained after marriage only by special vote of the college. With these exceptions, the tenure was formerly for life, but many fellowships have altered in this respect. In Cambridge the tenure is now limited to six years. Both resident and traveling fellowships are granted for work in a special line. Formerly the value of some of the fellowships at Oxford and Cambridge was equivalent to $2,500, and even $4,000, but great changes have been made in the number and emoluments of the fellows at both universities. At Cambridge there are in all about 400 fellowships, some of the colleges having as many as 50 or 60 attached to them. The average annual value is from $750 to $1,250. At Oxford there are now two classes of fellowships, ordinary and tutorial. The emoluments of an ordinary fellowship are $1,000 a year, those of a tutorial fellowship usually $1,500. New fellows are generally elected by the head of the college to which they belong and the fellows. There are also fellows connected with Dublin University, and in recent years a few have been attached to the Scotch universities. In American universities many fellowships have been established by private individuals, to promote research in special departments of knowledge. Fellowships are frequently awarded for study abroad, but others are for resident holders who, in some cases, give part of their time to instruction. Fellowships, unlike scholarships, are awarded to graduates only. The Johns Hopkins University first used the system extensively. The value of fellowships varies greatly. The most common amount is about $500 per annum, but in some cases the income is only $120 and in others it reaches $1,000. Chicago University has nearly 80 fellowships and several other institutions from 22 to 55 each. Annual fellowships may generally be reassigned more than once to the same holder, and there are fellowships with a tenure of several years. There are several fellowships at the American schools of classical studies in Athens and in Rome, open to graduates of American universities.

Felltham, or **Feltham,** fĕl'tham, **Owen,** English author: b. Mutford, Suffolk, probably 1602; d. Great Billing, Northamptonshire, 1668. He resided in the family of the Earl of Thomond, had strong royalist sympathies, was well known to the literary men of his time, and published a work of great merit, entitled: 'Resolves, Divine, Political, and Moral.' This book went through 12 editions by the year 1709.

Felo de se, fē'lo dē sē, from the mediæval Latin, felon or traitor to himself, is the legal technical description for a suicide. See Suicide.

Felony, in law, a term originally applied to those crimes which were punished by forfeiture of lands and goods, in addition to any other punishment prescribed by law. As so used it was distinguished from a *misdemeanor,* which was an offense that did not entail forfeiture as part of the penalty. The word cannot now be said to have any very definite meaning in law. It may be applied to crimes entailing capital punishment, as well as to others for which capital punishment is not inflicted; and is so applied by statute in the States of New York and Massachusetts. In many States the distinction between felony and misdemeanor has been abolished, an example that in time will probably be universally followed. Compounding a felony in refraining from prosecuting a felony for a consideration, constitutes a crime.

Fel'site. As a rock name, felsite is rather indefinite but is a very convenient name for those dense fine-grained igneous rocks, usually gray but often red or green, that to the naked eye show no crystals of minerals. Felsites generally are ancient lavas containing a high per cent of silica and are composed almost wholly of minute crystals of quartz and feldspar. The percentage of silica varies, and the relationship and probable origin of a felsite can be determined by analysis and examination with the microscope. Igneous rocks having a finely crystalline ground mass with visible crystals are said to have a felsitic ground mass, thus petrographers speak of felsite-porphyry. See Rock; Rhyolite; Trachyte.

Felt, Joseph Barlow, American historian: b. Salem, Mass., 22 Dec. 1789; d. there 8 Sept. 1869. He was graduated at Dartmouth College 1813, and was ordained Congregationalist minister, having churches in Sharon, Mass., and Hamilton, Mass. In 1836 he was appointed to classify the Colonial and State archives of Massachusetts. His 10 years' work at this task was invaluable to the State. Among his works are: 'Annals of Salem' (1827); 'History of Ipswich, Essex and Hamilton' (1833); 'Historical Account of Massachusetts Currency' (1839); 'Ecclesiastical History of New England' (1855–62); and 'Collections for the American Statistical Association on Towns, Population, and Taxation' (1847).

Felt, from Dutch *vilt,* a fabric made from wool, or wool and hair or fur, by rolling, beating, and pressure, generally with the use of lees or size. The process of felting is similar to that of fulling. The fibres of fur, hair, or wool are rough in one direction only, and thus they can glide among each other in such a way that when the mass is agitated the anterior extremities slide forward in advance of the body, or posterior half of the hair, and serve to entangle and contract the whole mass together. Articles of felt, such as rugs, carpets, clothing, and hats, have been made from remote antiquity, and are still made and widely used among various Asiatic peoples. Legend ascribes the invention of felt to St. Clement, who found that carded wool, placed in his shoes to protect his feet while on a pilgrimage, worked into a felt by the pressure and moisture; but it has a much earlier origin, being apparently known in Homer's time. The Saracens used it for tents and it was probably introduced into Europe at the time of the crusades. In Europe and America felt cloths are also made for several purposes, the finer kinds especially for carpets and table-covers, which may be dyed or printed and finished in various ways. In the machinery by which felt fabrics are produced, rollers with a rubbing and oscillating movement have generally an important action. The materials commonly used for felt hats are the furs of the rabbit and other animals, and the wool of sheep. The latter material is employed for common and medium hats, only the finer felt hats being made from fur. The hats, after being stiffened, are dyed. They now undergo the operation of blocking in order to give them their proper shape. Coarse varieties of felt are used for covering steam boilers and cylinders, steam-pipes, and otherwise as non-conductors. Asphalted felt is a coarse felt saturated with pitch, asphalt, or coal-tar, and used for covering sheds and other buildings, and a superior kind called inodorous felt is used for lining damp walls. Another kind is asbestos felt. See Hat.

Felton, Cornelius Conway, American classical scholar: b. Newbury, Mass., 6 Nov. 1807; d. Chester, Pa., 26 Feb. 1862. In 1834 he became professor of Greek literature at Harvard; in 1860 its president. His publications include many translations from German, French, and Greek, of which 'The Clouds' and 'The Birds' of Aristophanes are the most distinguished; also 'Familiar Letters from Europe' (1864); 'Greece, Ancient and Modern' (1867); 'Selections from Modern Greek Writers'; etc.

Felton, Samuel Morse, American railroad president: b. Philadelphia, Pa., 3 Feb. 1853. He is a nephew of C. C. Felton (q.v.). He early entered railway service, being employed by the Chester Creek Railroad 1868 and appointed assistant engineer of the Lancaster Railroad 1870. He worked his way upward on various roads, through the positions of chief engineer, general superintendent and general manager, to the vice-presidency of the Erie Railroad 1885–90. He also served as president of several southern railroads and became president of the Chicago & Alton Railway Company 7 Sept. 1899.

Feltre, Henri Jacques Guillaume Clarke, Duc de, äṅ rē zhäk gē yōm klärk dük dė feltr, a marshal of France: b. Landrecies, France, 17 Oct. 1765; d. Neuviller, France, 28 Oct. 1818. In 1781 he entered the military school at Paris, and was afterward imprisoned during the Revolution. He was subsequently employed by Carnot; in 1807 he became minister of war and was created Duc de Feltre. Though indebted to Bonaparte for his dukedom, he contributed toward the restoration of the Bourbons, by whom, in 1816, he was created marshal of France.

Felucca, fē luk'ä, a class of small merchant-vessels used in the Mediterranean. They have two masts, carrying lateen sails, and frequently have a rudder at each end. Formerly feluccas were also employed in war and piracy.

Female Rhymes (Fr. *rimes féminines*), double rhymes, or rhymes in which two syllables, one accented and the other unaccented, correspond at the end of each line. They are so called because they end in a weak or feminine syllable; thus, fable, table; motion, notion, are female rhymes.

Femern, fā'mĕrn, or **Fehmarn,** fā'märn, an island in the Baltic; taken from Denmark in 1864 and now part of Sleswick-Holstein, Germany. Area, 70 square miles; surface, level; soil, fertile, producing corn. Cattle are abundant. The inhabitants are mostly engaged in fishing, and agriculture. Large quantities of stockings knit by hand are exported. Pop. 9,900.

Femgerichte. See Vehmgerichte.

Femur, fē'mur, the large bone of the thigh. The femur is the chief supporting bone of the lower limbs and is in man the main organ of locomotion, for the larger muscles of the thigh and hip are attached to it. It is the largest and longest bone of the body. The upper extremity includes a head, neck, and two bony protuberances which give attachment to the muscles rotating it. The head fits into the socket in the hip-bone, making a ball-and-socket joint. (See Hip-Joint.) It is this joint that so frequently becomes affected in tuberculosis, resulting in deformities, and also at this joint that the dislocation of the femur takes place. The main shaft of the femur is nearly circular above; below, it is somewhat flattened, and running throughout its entire posterior surface there is a rough ridge to which muscles are attached. The lower end of the femur is enlarged, and has two surfaces to articulate at the knee with the tibia and fibula of the leg. These are known as the internal and external condyles, the external one being the broader, the internal the narrower and more projecting behind and to the sides. The upper portion of the front surface of the lower end of the femur is grooved to receive the patella or kneecap. The femur averages about 18 inches in the male, and is about one inch shorter in the female. It is inclined inward at an agle of about nine degrees in the male. In the female, by reason of the comparatively broader pelvis, the angle of the femur inward is greater. Consult: Gerrish, 'Human Anatomy' (1902). See Leg; Skeleton.

Fen, a place overflowed with water, or abounding with bogs, as the bogs in Ireland, the fens in Lincolnshire, Kent, and Cambridgeshire. These fens abound in duck, teal, mallards, pike, eels, etc., and an herbage that is very nourishing to sheep and cattle. The soil of fen lands is generally black and rich to a depth of two or three feet.

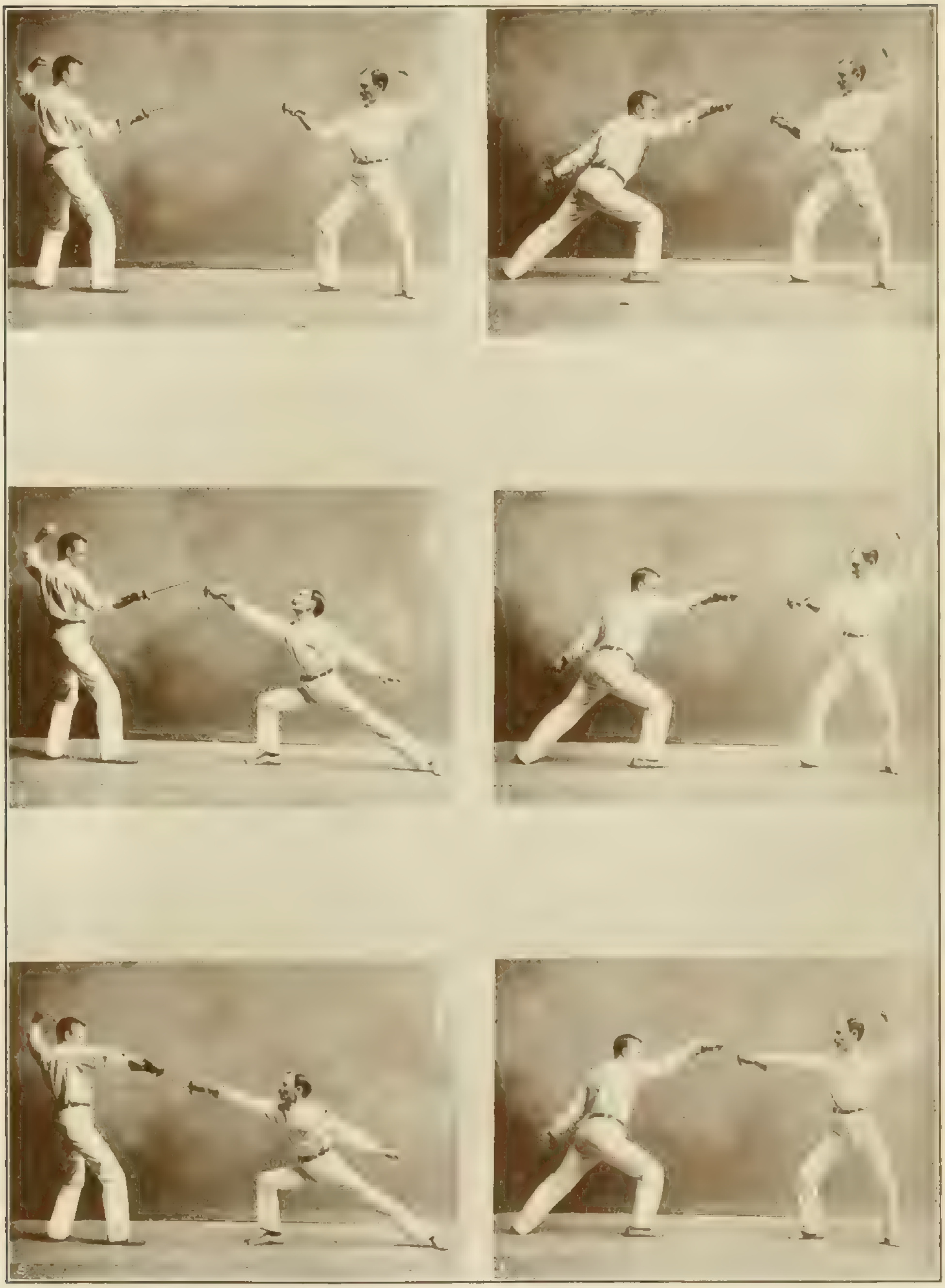
Fence Lizard. See Sceloporus; Swift.

Fence-viewers, town officers in New England to supervise the erection and repair of fences along the highways, or of boundary fences between private owners if called upon by either party. In early colonial days they had other duties also, including that of building inspectors.

Fences, continuous lines of obstacles artificially interposed between one portion of the surface of the land and another for the purpose of separation or exclusion. The kind of obstacle or material varies according to the articles to be excluded, confined, or separated, and the nature of the soil and situation. All fences are either live or dead, or a combination of these. Live fences are hedges, that is, rows of trees or shrubs, such as hawthorn, crab, blackthorn, holly, beech, box, etc., planted close together, and pruned on the sides. Dead fences are stone walls, structures of wood or iron, or mounds of earth, or ditches. Iron or wire fences are now in common use and vast tracts of waste land in this country are enclosed in this manner. Strong wires are stretched on posts firmly secured in the ground at from 100 to 200 yards distance from each other; a number of lighter posts are put in at 4 to 6 yards distance; when the wires are stretched they are fixed to the smaller posts by staples if the posts are of wood, or threaded through if of iron. The snake fence, also called rail fence and stake and rider fence, is made of split rails laid zigzag, with the ends resting on each other, supported by posts in pairs driven into the ground. A ring fence is one which completely encircles an estate. The height of fences is regulated by statute in the United States, the general height being four feet, although in some States it is four and a half feet. The practice of fencing has provided the language with striking figures of speech. «To be on the fence,» is a phrase used of a man who does not commit himself to any political party or take sides in any question. «To repair one's fences,» or «to look after one's fences,» is a phrase used in the United States for the efforts made by a politician to further his own interests, especially among his constituents.

Fencing, the art of attack and defense, with any weapon having either a point or an edge. In the general acceptance of the word, it means the use of the sword or foil, particu-

FENCING.



1. On Guard.
2. Attack and Parry of Quarte.
3. Attack and Parry of Tierce.
4. Attack and Parry of Septime.
5. Attack and Parry of Seconde.
6. A Riposte in Seconde, after a Parry of Tierce.

larly the latter. All swords may be divided into two general classes, small swords and broadswords; the former being one with which the attack is delivered with the point only, the latter one that has a cutting edge.

The foil used in fencing represents the small sword. The earliest swords of which there are any authentic records were those of the Assyrians and Greeks. They were straight or leaf-shaped, and made of bronze. The swords of the Romans were of steel, short, straight, and double-edged.

Light armor was worn by both the Greeks and the Romans, and a shield was carried for defense. During the Middle Ages when complete armor was worn, the sword was a long, heavy weapon used for striking blows, reliance being placed entirely upon the armor for defensive purposes.

When, after the invention of gunpowder, armor began to be discarded, it became evident that some other means of defense must be discovered, and it was in meeting this need that the art of fencing came into existence. The Italians were the first to recognize the fact that the point was more deadly than the edge, and that a thrust could be delivered more quickly than a blow, and to them belongs the credit of laying the foundations of the present school of fence. They invented the rapier, a long, straight sword having a cup-shaped guard with quillons, which was the parent of the small sword and foil. The early rapier was a weapon of offense only, parries being made with a dagger held in the left hand, or the point avoided by a leap aside. Camillo Agrippa of Milan was the first man to divide the body into four parts and to assign a definite guard to each. Agrippa published a book in 1553 explaining his system, which is said to have been illustrated by Michelangelo.

When daggers ceased to be worn, the cloak wrapped around the left arm was used in parrying. Later as the art of fence became better known, even the cloak was discarded, and the sword became a weapon of defense as well as offense.

While the Italians were building up their school on practical lines, the Spaniards invented a most complicated system of fence based on mathematical and geometrical principles. It was, however, of little use in actual fighting save that it taught coolness. The French and English were both followers of the Italian school, rapier play being introduced into England during the early part of Queen Elizabeth's reign. During the 18th century, the rapier, which had been constantly growing lighter, was replaced in France by the small sword, a weapon almost as light as our modern foil. The Italians, however, still clung to their ancient weapon and hence arose the two rival schools of fence, the French, and the Italian. Fencing masks also came into use at this time.

Broadsword play in some form or other was in existence during the periods of both the rapier and small sword and did not differ in its essential features from the system in use to-day. The Scots have always been especially noted for their dexterous use of the claymore, a species of heavy broadsword.

The French foil used in fencing consists of a quadrangular-shaped blade about 33 inches long, mounted in a slightly curved handle, and having either a bell-shaped or ring guard. The blade is divided into two imaginary parts, the part nearest the point being termed the "feeble," that nearest the guard the "forte." Parries are made by opposing the forte of one blade to the feeble of another. The foil is held in the right hand with the fingers underneath, the thumb extended along the upper part of the handle and nearly touching the guard. The thumb and forefinger direct the blade, the grasp of the other fingers being tightened or relaxed as occasion requires. In coming "on guard" the fencer raises his hand to the height of his breast, curves his arm so that his elbow will be about six inches from his body, and places the point of his foil on a level with his adversary's eye. At the same time he places his feet at right angles, about 12 inches apart, with the right foot in front, bends his knees, keeping the weight of the body slightly more on the left leg than on the right, and curves the left arm so that the hand will be behind the head. For fencing purposes, the body is divided into inside and outside, and high and low lines; an inside line being one to the left of the blade, an outside line one to the right of it; a high line one above the hand and a low line one below it. The high inside lines are termed Prime and Quarte, the low ones Septime and Quinte. The high outside lines are Tierce and Sixte, the low ones Octave and Seconde. All attacks, no matter how complicated, must eventually be delivered in one of these lines. For each attack there is a simple and a counter parry. Simple parries are made by turning aside the opposing blade in the line in which the attack is delivered; counter parries are made by circling round the blade and carrying it off in the line from which the attack began. To deliver an attack, the right hand is raised quickly to the height of the face, the right arm straightened, and the point directed against the place to be attacked. At the same time, the left leg is straightened, the right foot advanced, and the left hand dropped to a position about four inches above the left knee. This movement is termed the "Lunge."

Whenever fencers are in the position of guard opposing each other, they are said to be "engaged." Carrying the blade into another line is called "disengaging." An opening for an attack is made by feinting in one line and attacking in another, by forcing the blade aside, or by a combination of these movements. After a parry, a fencer delivers a return thrust termed a "Riposte," with which he endeavors to hit his opponent before he can recover his guard.

Hits only count when the point is placed squarely on the jacket between the neck and the hip. Disarming does not count and is not now practised to any great extent. The Italian foil is a trifle longer than the French one and has a straight handle, a bell guard and quillons. It is held by hooking the first and second fingers of the right hand around the quillons, the other fingers being tightly grasped around the handle, while the thumb is placed over the flat piece of the blade which is between the guard and its crosspiece. Further rigidity of the grasp is often assured by binding the foil tightly against the wrist with a long piece of tape. When on guard, the right arm is nearly straight, on a line with the shoulder, with the point directed at the opponent's chest. The body is always more effaced (turned away from the opponent) in the Italian school than in the French. The Italians divide the body into eight lines, as do the French, but as a general rule they use only four of them (quarte, tierce, septime and seconde) in making their attacks. Their parries are made more forcibly than those of the French; in some of them the movement of the forearm being very pronounced. The Italians fence much more vigorously than do the French and have a number of startling tricks, such as dropping under, or stepping away from the opposing blade, which they have retained from their old rapier play. The dueling sword is a heavier kind of foil, having a triangular blade and a large bell guard. It is used in nearly the same manner as a foil, but a hit may be made with it upon any part of the person.

In the use of the broadsword the attack is delivered with the edge rather than with the point. A limited number of thrusts can be made with it, but it is primarily a cutting weapon. The swords used for this kind of fencing are of various weights and shapes, the majority of them, however, are of the sabre model, with blunted edges and rounded points. Wooden singlesticks are also used. In assuming the position of guard the sword is held in the right hand with the thumb extended along the back of the grip, the edge to the right, with the hand at the height of the breast. The positions of the body and the feet are the same as in foil fencing, but the left hand is placed at the small of the back instead of behind the head. Attacks with the broadsword are made by giving a cutting blow with the edge. Cuts are made for the head, cheek, chest, girdle, flank, thigh, leg and arm. Thrusts with the point may also be made at the body. Cuts are parried with the edge; thrusts, with the back of the blade.

The student corps of Germany have a system of fence with a long straight sharp sword called a *schläger,* which differs from sabre play, in that the cuts are directed solely against the head. In this kind of fencing, masks are not worn, the eyes, ears, and throat, alone being protected, the sword arm is heavily padded and the blows are made with a wrist movement only.

The Japanese have a method of sword play which differs greatly from any of the present European systems. Their sword is a weapon some two and a half to three feet in length, having a heavily backed blade, a very sharp edge, a long handle, and a small protecting guard. It is wielded with both hands, the right hand being placed close to the guard and the left hand grasping the end of the grip. The first two fingers of both hands control and direct the blow, the grasp of the other fingers being tightened or loosened as occasion requires. The edge is generally kept downward while on guard. Cuts are made for the head, wrist, and waist, and thrusts for the throat and abdomen. A marked peculiarity of Japanese fencing is that parries are always made with the back or side of the blade, never with the edge. Bamboo swords are used for practice.

The bayonet attached to the end of a rifle makes a formidable weapon which is wielded in the same general manner as the small sword. In the position of guard, however, the left foot is in front, and the piece is grasped at the small of the stock, with the right hand, and at the balance with the left. When employed against cavalry the footman endeavors if possible to attack the horseman from the left side.

Among the famous fencers of the past four men stand out pre-eminently. These were the Chevalier de Saint Georges; the Chevalier d'Eon de Beaumont; Henry Angelo; and Jean Louis; all of whom lived during the latter part of the 18th or the early part of the 19th century, and were renowned for their great skill at fence. The prominent fencing masters of the present day are Mérignac, Prévost and Rouleau of the French school; and Conte and Pini of the Italian school. In the United States Gousky, Senac and Rondelle are well known masters. Contests for the amateur fencing championship of America are held annually under the auspices of the Amateur Fencers League of America.

Consult: Castle, 'Schools and Masters of Fence'; Alfred Hutton, 'Old Sword Play'; 'The Sword and the Centuries'; Louis Rondelle, 'Foil and Sabre'; and Bazancourt, 'Secrets of the Sword.'

FRED GILBERT BLAKESLEE,
Late Swordmaster 1st Regiment, Connecticut National Guard.

Fen'dall, Josias, colonial governor of Maryland: b. England about 1620. He was governor of Maryland 1656–60, and received a large landed estate from Lord Baltimore. He was superseded by Calvert, and was heavily fined and banished for sedition 1681.

Fénelon, François de Salignac de la Mothe, frän-swä dė sä-li-nyäk dė lä mōt fān lōn, French missionary: b. 1641; d. 1676. He was a half-brother of Archbishop Fénelon (q.v.). He emigrated to Quebec in response to Bishop Laval's appeal for missionary reinforcements, and being a Sulpician established a mission of his order on the north shore of Lake Ontario. In 1674 he offended the choleric Frontenac, governor of New France, by a sermon, was summoned before the council and ultimately felt himself compelled to leave for Europe. He was forbidden by the king to return to Canada.

Fénelon, François de Salignac de la Mothe, French prelate: b. Château de Fénelon, Périgord, France, 6 Aug. 1651; d. Cambray 7 Jan. 1715. He was educated at Plessis College in Paris, and at the seminary of St. Sulpice, where he received holy orders in 1675. In 1678 he was appointed head of an institution, then newly organized in Paris, for the reception of women converts to the Roman Catholic faith; and the success with which he there discharged his duties led to his appointment as head of a mission to Saintonge for the conversion of the Huguenots. In 1689, Louis XIV. entrusted to him the education of his grandsons, the dukes of Burgundy, Anjou, and Berri; and in 1694 he was created archbishop of Cambray. A theological dispute with Bossuet, his former instructor, terminated in the condemnation of Fénelon's side of the controversy by Pope Innocent XII., and his banishment to his diocese by Louis XIV. To the Pope's decision Fénelon unreservedly and humbly submitted.

His works in philosophy, theology, and the belles-lettres have immortalized his name. He was familiar with the best models of ancient and modern times, and his mind was animated by a mild and gentle spirit of benevolence. His style is fluent and pleasing, pure and harmonious. His most celebrated work is 'Les Aventures de Télémaque,' in which he endeavored to exhibit a model for the education of a prince. It was carried off and published by a valet employed to transcribe the manuscript. On the appearance of this work Louis manifested displeasure toward Fénelon, conceiving this historical romance to be a satire on his reign, and forbade the completion of the printing. Some malicious persons pretended, what Fenelon himself never thought of, that Calypso represented Madame de Montespan, Eucharis Mademoiselle Fontanges, Antiope the Duchess of Burgundy, Protesilaus Louvois, Idomeneus the exiled King James, and Sesostris Louis XIV. Among his other works are: 'Traité de l'Education des Filles'; 'Traité du Ministère des Pasteurs'; 'Explication des Maximes des Saintes'; 'Dialogues on the Eloquence of the Pulpit'; 'Demonstration of the Existence of God'; 'On the Temporal Power of the Mediæval Popes.' See Ramsay, 'Vie de Fénelon' (1725); Bossuet, 'Histoire de Fénelon' (1808); Gosselin, 'Histoire Littéraire de Fénelon' (1843); Butler, 'Life of Fénelon' (1810); Lamartine (1854); Roy, 'Histoire de Fénelon' (1842); Werfer, 'Leben des Fénelon' (1852); Gandar, 'Fénelon et son Temps' (1864); Lear, 'Fénelon, Archbishop of Cambrai' (1876); Crausle, 'Fénelon et Bossuet' (1895); Sanders, 'Fénelon: His Friends and His Enemies' (1901); Saint Cyres, 'François de Fénelon' (1901).

Fenelon Falls, Canada, township in Victoria County, province of Ontario. A waterfall 300 feet wide, 21 feet high, is the chief attraction of the place. The river affords facilities for the transportation of lumber, in which the vicinity abounds. Pop. 1,150.

Fenestra'tion, in architecture, is, in contradistinction to columniation, the system of construction, mode of design, and arrangement of windows in a building.

Fenians, a name said to be derived from Fionn or Finn, an Irish hero of the 2d century, assumed in recent years by those Irish who formed a brotherhood in their own country and in America, with the intention of delivering Ireland from the sovereignty of England, and establishing an Irish republic. About the end of 1861 the Fenian Brotherhood was regularly organized in America; and its chief council, consisting of a "head-centre" and five other members, which had its seat at New York, soon had branches in every State of the Union; while at the same time large numbers joined the cause in Ireland. The close of the American Civil War, when large numbers of trained Irish soldiers who had taken part in the war were released from service, was thought to be a convenient time for taking some decisive steps. Two risings were planned in Ireland, but they were both frustrated by the English government, which had received timely information. The first, in September 1865, was prevented by the seizure of the office of the 'Irish People,' the Fenian journal published at Dublin, in which papers were found which revealed to the government the secrets of the conspiracy, and which led to the capture of a number of suspects. The second, in February 1866, was suppressed by the suspension of the Habeas Corpus Act in Ireland.

An invasion of Canada was attempted in the same year. The advocates of Ireland's independence counted upon aid from the veterans of the Civil War, who were incensed at England's attitude toward the United States during the war. In this they were not disappointed; as among the trained men who were under command of Gen. Sweeney, himself an ex-officer of the United States army, there were many men not of Irish blood or lineage. The troops under Gen. Sweeney are estimated to have been at least 35,000 in number; but so well was the recruiting done that reserve forces who never went to the frontier numbered about 200,000. Gen Sweeney's men, in May 1866, were stationed at various points on the frontier from Lake Erie to Lake Champlain; at St. Albans, Vt., under Gen. Spear; at Rouse's Point, N. Y., under Gen. Reilly; at Malone, N. Y., under Col. Michael C. Murphy (q.v.), and around Buffalo, under Gen. John O'Neill (q.v.). Large quantities of arms and ammunition were sent north, a sufficient amount for 50,000 men; but the United States officials hearing of the expected raid, seized the consignment of arms addressed to suspected Fenians, and when the troops arrived on the frontier they were powerless because of lack of arms. An attempt was made to regain them, but the officers were arrested by the United States government. Gen. O'Neill invaded Canada by way of Fort Erie and two battles followed, in both of which O'Neill was successful. One, known as the "Battle of Ridgeway," occurred 1 June 1866. Reinforcements not arriving as expected, O'Neill abandoned the place and returned to the American side. He, his staff, and men were captured by the United States gunboat Michigan. The whole movement was crushed at that time by the United States forces under Gen. Meade, who acted under government instructions in accordance with the treaty between the United States and England. On 18 Sept. 1867 occurred, in England, the release by force of prisoners from a prison van which was conveying Kelly, the Fenian chief, and Deasy, his assistant, to Manchester prison. (See MANCHESTER MARTYRS.) In 1870 and 1871 another and unsuccessful attempt was made to gain a foothold in Canada. Various crimes and attempted crimes against the English government and anti-Home Rule leaders have been charged against the Fenians; but they were repudiated and denounced by the Fenians themselves, and attempts to prove them guilty have failed. Various organizations have taken up the cause for which the Fenians labored, and other methods have been used to secure some form of self-government for Ireland. (See HOME RULE.) Consult: Sullivan, 'Story of Ireland.'

Fenn, George Manville, English novelist: b. Westminster 3 Jan. 1831. His earliest literary ventures were short sketches published in 'All the Year Round, Chambers' Journal,' and 'Once a Week' (of which he became proprietor in 1873). In 1867 he published 'Hollowdell Grange,' a story for boys, which has since been followed by a long series of excellent and highly popular tales and novels, many of them boys' stories. The following may be specially mentioned: 'Bent, not Broken' (1867); 'The Parson o' Dumford' (1879); 'Eli's Children'

(1882); ‹The New Mistress› (1883); ‹Double Cunning› (1886); ‹The Master of the Ceremonies› (1886); ‹The Man with a Shadow› (1888); ‹A Double Knot› (1890); ‹The Mynns Mystery› (1891); ‹King of the Castle› (1892); ‹In an Alpine Valley› (1893); ‹High Play› (1898). Among his boys' books are: ‹In the King's Name›; ‹Nat the Naturalist›; ‹Bunyip Land›; ‹Menhardoc›; ‹Patience Wins›; ‹Brownsmith's Boy›; ‹Commodore Junk›; ‹The Crystal Hunters›; ‹The Grand Chaco›; ‹Blue-jackets›; ‹Fire Island.› Mr. Fenn has also produced, either alone or in collaboration, several works for the stage.

Fenn, Harry, American artist: b. Richmond, Surrey, England, 14 Sept. 1838. He removed to the United States in 1856 and has achieved great success as an illustrator of books. He was one of the founders of the American Water Color Society. Some of his best work is contained in ‹Picturesque America›; ‹Picturesque Europe›; and Picturesque Palestine.›

Fenn, William Wallace, American Unitarian clergyman: b. Boston 12 Feb. 1862. He was graduated at Harvard 1884 and at the Harvard Divinity School 1887, and was ordained to the ministry in 1887. He has since had charge of churches in Pittsfield, Mass., (1887–91), and Chicago (1891–1901). He was lecturer on biblical literature in Meadville Theological School 1892–1901 and in the last named year was appointed professor of systematic theology in Harvard Divinity School. He has published: ‹Lessons on Luke› (1890); ‹Lessons on Acts› (1894); ‹The Flowering of the Hebrew Religion› (1894); ‹Lessons on Psalms› (1900).

Fen'nec, a small desert animal (*Fennecus zerda*) found in the Sahara, which looks like a diminutive fox. It is of a pale creamy yellow color, harmonizing well with its sandy habitat; its breast is white, and the tail tipped with black. It is a graceful little animal, about 15 inches long, with a bushy tail, about 7 inches in length; and its small face and large erect ears give it an expression of attentive hearkening for unseen foes. It burrows into the sand, and can dig so rapidly as to escape pursuers. It is, like most of its kind, nocturnal in habits, searching for water and its food — small birds, mice and insects — after the sun sets, spending the day curled up in its burrow.

Fennel, a plant of the genus *Fœniculum* of the carrot family. The plant is native of parts of England, and is common from New Jersey, through Pennsylvania to Virginia and Louisiana, as a fugitive from cultivation. The plant has umbels of small yellow flowers, and finely divided leaves. It grows to the height of three or four feet. In its natural state the seeds are intensely acrid. By cultivation this acridity is lost, and an agreeable taste and flavor acquired. In European cookery the leaves are often used as a seasoning, or as an accompaniment of fish. A smaller species, sweet or Italian fennel (*F. dulce*), is commonly cultivated on the continent of Europe, and is used in salads, soups, etc. Several other species of fennel are known, some of which are admired for their pungency. The seeds (or "half fruits") are flat on one side and convex on the other, seldom exceeding one fourth of an inch in length. They have a fragrant odor, and warm, pleasant taste. Their infusion in boiling water is used as a carminative, and having no actively exciting qualities, is employed to disguise by its pleasant aromatic nature the flavor of disagreeable medicines, as senna and rhubarb. The oil of fennel is obtained from the seed. It is yellowish, somewhat thick, with an aromatic odor and sweet taste. It is lighter than water, and solidifies with moderate diminution of temperature.

The seed from which the volatile oil is obtained is used in medicine as an aromatic stimulant and as a carminative. It is useful in infantile diarrhœa with excessive fermentation, and as a flavoring vehicle for many medicines.

Fenollo'sa, Ernest Francisco, American writer: b. Salem, Mass., 18 Feb. 1853. He was educated at Harvard, was professor of political economy and philosophy at Tokio University, Japan, 1878–80, and of philosophy and logic 1880–6; professor of æsthetics in the Tokyo Fine Arts Academy 1887–90; and curator of the oriental art department, Boston Art Museum 1890–6. Since 1897 he has been professor of English in the High School of Tokyo. He has published monographs on art and ‹The Discovery of America and Other Poems› (1893).

Fenollosa, Mary McNeil, American writer: b. Alabama. She was married to E. F. Fenolosa (q.v.), 28 Dec. 1865, and has since published ‹Out of the Nest: a Flight of Verses› (1899); ‹Children's Verses on Japanese Subjects›; ‹Hi roshige.›

Fenton, Elijah, English poet: b. Shelton, Staffordshire, 20 May 1683; d. East Hampstead, Berkshire, 13 July 1730. He studied at Cambridge, but becoming a non-juror he was obliged to leave the university, after which he accompanied the Earl of Orrery to Flanders as private secretary. Some years later Fenton became associated with Pope, who was then undertaking his version of the ‹Odyssey,› and was in quest of assistants. According to Dr. Johnson, Fenton translated the 1st, 4th, 19th, and 20th books of that poem. In 1723 a tragedy entitled, ‹Mariamne,› which he brought out, had an immense success, and gained him more than £1,000. In 1727 he published a new edition of Milton's works, to which he prefixed a brief but elegant life of the author. This was soon followed by a fine annotated edition of Waller.

Fenton, Ferrar, English author: b. Lincolnshire 1832. Among other works he has published: ‹Seven Years of an Indian Officer's Life›; ‹Poems from the Persian›; ‹The New Testament in Modern English›; ‹The Five Books of Moses, direct from the Hebrew, in Modern English with Critical Notes›; ‹St. Paul's Epistles in Modern English.›

Fenton, Reuben Eaton, American statesman: b. Carroll, Chautauqua County, N. Y., 4 July 1819; d. Jamestown, N. Y., 25 Aug. 1885. He was admitted to the bar in 1841; was elected to Congress in 1852, and there opposed the further extension of slavery. In 1856 he was again elected to Congress, where he remained till 1865, when he resigned to become governor of New York, in which office he served for two terms. In 1869–75 he sat in the United States Senate, and in 1878 was chairman of the United States Commission to the International Monetary Conference in Paris.

Fenton, England, town of Staffordshire, near and to the southeast of Stoke-upon-Trent. The chief industries are china and earthen-ware manufacture, brick making, coal mining and iron founding. Pop. (1901) 22,742.

Fen'ugreek, the seed of *Trigonella fœnum-græcum,* a plant of eastern Europe and western Asia and which spreads throughout the Mediterranean basin. It is a member of the clover family, and has been used like clover for many years as a fodder plant. The seed contains an aromatic essential oil, and has been very extensively used as a seasoning. In medicine its use has practically been abandoned, although the seed has unquestionably many excellent properties, its food value alone being considerable. It is still very extensively used in veterinary practice.

Fen'wick, Ethel Gordon, English nurse: b. 26 Jan. 1857. She married Dr. Bedford Fenwick in 1887. She has been connected with various English hospitals as nurse, and is a member of many nurses' associations. She was president of the British Nursing department at the Chicago World's Fair, receiving two medals on that occasion; was awarded the Red Cross medal in the Græco-Turkish war 1899, and was president of the International Nurses' Congress at Buffalo 1901. She is the editor of 'The British Journal of Nursing.'

Fenwick, George, American colonist: b. England about 1602; d. 15 March 1657. He came to America in 1636 to take charge of the plantation of Saybrook, so called after Lords Say and Brook, who, with others, in 1632 had procured a patent for the territory from Robert, Earl of Warwick. Returning to England, he came back again in 1639, and from that time, as one of the patentees, and agent for the others, superintended and governed the settlement of Saybrook till 1644, when he sold its jurisdiction and territory to the Connecticut colony, as his associates had given up their contemplated removal to America. He afterward returned to England, where he was appointed one of the judges for the trial of Charles I., but did not act in that capacity. He served in Cromwell's army in Scotland in 1650.

Fenwick, or **Fenwicke, John,** American colonist: b. England 1618; d. 1683. He was a Quaker and settled at Salem, N. J., in 1675 with a colony of Quakers. Disputes arose with Gov. Andros of New York, and Fenwick was arrested and remained two years in prison, being released on parole. His land grants passed to the possession of others during his life, and he died in poverty.

Fenwick, Sir **John,** English conspirator: b. England about 1650; d. 28 Jan. 1697. He became major-general in the army, and was a member of parliament in 1677. He conspired with others against William III. and was accused of participation in the Assassination Plot in 1696. A bill of attainder being passed, he was executed for high treason, the last execution in Great Britain in consequence of attainder.

Feodor I., Ivanovitch, ē-vän'ō-vich fā'ō-dōr, Russian czar: b. 11 May 1557; d. 7 Jan. 1598. He began his reign in 1584, and being weak both in body and mind, assigned the government of his affairs to Godunoff, who seems to have managed them with dexterity and vigor. In his reign the peasants of Muscovy were converted into serfs and attached to the land. Previously they had enjoyed personal liberty. The conquest of Siberia was achieved by Godunoff, and many remarkable diplomatic relations with foreign courts were effected.

Feodor II., Alex'ievitch, Russian czar: b. 1589; d. 10 June 1605. He was the son of Boris Godunoff.

Feodor III., czar of Russia, and eldest brother of Peter the Great: b. 8 June 1656; d. Moscow 27 April 1682. He ascended the throne when only 19 and evinced a strength of will and determination of character which, had he lived, might have anticipated the reforms which his younger brother subsequently effected. His reign is rendered memorable on account of his calling into his presence the Muscovite nobles, who desolated the country with broils about their claims of family precedence, and throwing the rolls of the Razriad or «Arrangement,» into the fire. The genealogical records, which did not relate to claims of precedence, were preserved and properly arranged in accordance with his will.

Feodosia, fā-ō-dō'sē-ä (ancient Caffa or Kaffa), Russia, town on the west angle of a magnificent bay in the southeast of the Crimea. The ancient Theodosia, from which the modern Feodosia takes its name, was founded at a very early period by a colony of Greeks from Ionia, and its site was probably not far from its modern namesake. From 1266 to 1474 or 1475 this town was in the possession of the Genoese, except for a short interval about the end of the 13th century, when it was held by the Venetians. While in the hands of the Genoese it was the seat of an extensive commerce with the East by way of Astrakhan and the Caspian Sea, and at that time it is said to have had a population of 80,000. From the Genoese it was taken by the Turks, and after that its prosperity rapidly declined. Much has been done for it since it came into the possession of Russia, and it is still one of the most important towns in the Crimea. Pop. (1897) 27,238.

Fer-de-lance, fār-dė-läñs, the lance-headed or yellow viper (*Lachesis lanceolatus*), a serpent native to northeastern South America, and one of the most terrible members of the rattlesnake family. It is ordinarily 3 to 4 feet in length when full-grown, and has no rattle, but the tail ends in a horny spine which is vibrated rapidly when the snake is excited. It has the general appearance and habits of the rattlesnake (q.v.), feeds upon small mammals, frogs and the like, and was long ago introduced into Martinique, Santa Lucia and a few other of the Antilles, as a means of devouring the rats which were a pest to the fields of sugarcane. It flourished and multiplied greatly, and has become greatly dreaded by all who work in the fields of those islands.

Feræ, fē'rē, wild animals; a term adopted by Linnæus for one of his orders of *Mammalia,* embracing a variety of carnivorous animals now scientifically reclassified.

Feræ Naturæ, fē'rē na-tū'rē («of a wild nature»), the legal name for beasts and birds that are wild or non-domesticated, as contradistinguished from those which are *domitæ naturæ,* that is, tame animals, such as horses, sheep, etc. The Roman law held such animals as naturally belonging to the first person who should take possession of them, but regarded the right of possession as continuing only as long as the possessor kept them in confinement. As soon as the animal escaped it again became common property, and might be taken possession of by any other person who could capture it, unless the animal had an *animum revertendi,* that is, an intention of returning, which it was to be presumed it had, if it had been trained to return to its master's property, and was in the habit of doing so. This principle has been adopted by both British and American law. When such animals as are classed as *feræ naturæ* make nests or burrows on any person's property, and have young, the young are held as belonging to this person as long as they are unable to fly or run away. Those persons who have the right of hunting, taking, or killing those wild animals which are included under the designation of game, have a qualified property in such animals as long as they continue within their liberty, but no longer. A person who keeps an animal indisputably *feræ naturæ* is responsible for any injury which it may do to the person or property of another. Consult: Schouler's 'Treatise on the Law of Personal Property' (1896).

Fer'dinand I. (surnamed «THE JUST»), king of Aragon: b. 1379; d. Igualada 2 April 1416. He was king of Aragon 1412–16, and was succeeded by Alfonso V.

Ferdinand II., king of Aragon. See FERDINAND V. OF CASTILE.

Ferdinand I., emperor of Austria: b. Vienna 19 April 1793; d. Prague 29 June 1875. He was a son of Francis I. and ascending the throne in 1835, continued to pursue the policy of his father, leaving the chief direction of affairs in the hands of Metternich (q.v.). In his reign, the republic of Cracow was annihilated, and a portion of it added to the empire. During the revolutionary war of 1848 he dismissed Metternich and made several concessions which were found insufficient. Vienna revolted in May, and Ferdinand at length retired to Olmütz, and on 2 Dec. 1848, abdicated, having no children, in favor of his nephew, Francis Joseph I.

Ferdinand I., German emperor: b. Alcalá, Spain, 10 March 1503; d. Vienna 25 July 1564. He was a brother of Charles V., after whose abdication in 1556 he took the title of emperor of Germany, although his claim to the title was not recognized by the electors till 1558. In 1526 or 1527 he became king both of Hungary and Bohemia, and after that period these two kingdoms remained attached to the empire. Ferdinand had been chosen king of the Romans in 1531. In 1559 he held a diet at Augsburg, in which the currency of the empire was regulated, and many religious grievances suffered by the Protestants were exposed. Ferdinand was of a mild and tolerant character, and in 1562 obtained from the Council of Trent several religious privileges for his subjects.

Ferdinand II., German emperor. b. Gratz, Styria, 9 July 1578; d. Vienna 15 Feb. 1637. He succeeded his uncle Matthias as emperor of Germany in 1619. His zeal was excited against every deviation from the decrees of the Council of Trent, and he firmly adhered to an anti-Protestant policy. The Bohemians, jealous of the privileges which they had secured from Rudolph, and of which they saw that Ferdinand was disposed to deprive them, declared that he had forfeited the Bohemian crown, which they offered to the Elector Palatine Frederick V., a step which lead to the outbreak of the Thirty Years' war. The support of the league, and of the Elector of Saxony, John George I., placed him firmly on the throne of Bohemia, where he vigorously pursued the Protestants, whose opposition to him was as much political as religious.

Ferdinand III., German emperor, son of Ferdinand II.; b. in Gratz, Styria, 11 (or 13) July 1608; d. Vienna 2 April 1657. He was made king of Hungary in 1625, of Bohemia in 1627, and succeeded his father in 1637.

Ferdinand I., king of Naples, illegitimate son of Alfonso I.; b. about 1424; d. 25 Jan. 1494. He succeeded his father in 1458. His false and cruel character provoked a civil war, in which John of Anjou took part with the barons, and the king was aided by the Pope Pius II., Sforza, Duke of Milan, and by Scanderberg. The king defeated his rival in 1462, and made peace; but breaking his word war broke out again. Again the king won, and established order by terror.

Ferdinand II., king of Naples, son of Alfonso II.; b. 26 July 1469; d. 7 Oct. 1496. He succeeded his father when the latter abdicated in 1495.

Ferdinand III., king of Naples. See Ferdinand V. of Castile.

Ferdinand IV., of Naples, and I., of the Two Sicilies: b. Naples, Italy, 12 Jan. 1751; d. there 4 Jan. 1825. He ascended the throne in 1759, and after the death of Louis XVI. he joined the coalition engaged in the general war against France (1793-6). The victory gained at Aboukir by Nelson again brought Ferdinand into a hostile attitude against the French, who summarily drove him from his kingdom in 1799. In the same year, however, his troops regained possession of the capital. In 1806 Ferdinand was again forced to abandon Naples, the crown of which Napoleon I. conferred first on his brother Joseph Bonaparte, and afterward on his brother-in-law, Murat (q.v.), Ferdinand, however, continuing to reign in Sicily under English protection. In 1814 the Congress of Vienna finally established Ferdinand as King of the Two Sicilies. Revolutionary movements, set afloat by the Carbonari (q.v.), compelled the establishment of a constitution, against the advice and interests of Austria, Russia, and Prussia; the first named power marched an army across the Po, defeated the Neapolitan army, and occupied Naples. Ferdinand who, refusing to sanction the liberal declarations of his subjects, had quitted his capital, was then reestablished, and ruled thenceforward with absolute power.

Ferdinand II., king of the Two Sicilies: b. Palermo 10 Jan. 1810; d. Naples 22 May 1859. He succeeded his father Francis I. 8 Nov. 1830. The new sovereign at first made some concessions to his subjects; but presently gave them to understand that henceforth his will was to be their only law, and that the least opposition to it would be followed by banishment or incarceration in a dungeon. This was no empty threat. Devoting much time to hunting, he left the government to be administered by favorites, and reserved his interference chiefly for occasions requiring the exercise of that mixture of obstinacy and energy which formed the leading feature in his character. After a succession of partial outbreaks, the revolutionary year of 1848 brought matters to a crisis, during which Ferdinand II. earned the nickname of "King Bomba," by bombarding his capital from the forts commanding it. At the commencement of the insurrection, which first broke out at Palermo, and threatened to extend over both divisions of the kingdom, Ferdinand issued a decree promising a constitution, but ultimately, when he had by main force re-established his ascendency, retracted all his promises and established one of the vilest despotisms which has disgraced modern times. Great Britain and France endeavored, by friendly remonstrance, to check him, and being only rebuked for presuming to interfere, testified their displeasure by withdrawing their ministers from Naples. This measure seems only to have made Bomba more resolute than ever to rule in his own way. He died leaving his dungeons crowded with the best and bravest of his subjects.

Ferdinand, titular king of Portugal: b. Vienna 29 Oct. 1816; d. Lisbon 15 Dec. 1885. He was a son of the Duke of Saxe-Coburg-Gotha, and married Maria de Gloria, Queen of Portugal, in 1836. The title of king was granted him in 1837, and after the queen's death, in 1853, he was regent till 1855, during the minority of his son Pedro. In 1869 he married an American singer, Eliza Hensla, whom he made Countess of Edla. He possessed not a little skill as artist and engraver.

Ferdinand I. (surnamed "The Great"), king of Castile and Leon: b. about 1000; d. Leon, Spain, 27 Dec. 1065. He was the second son of Sancho II., king of Navarre, and by the death of Bermudo, 1037, he became king of Leon. He then made war against the Moors, from whom he took several cities, and pushed his conquests as far as Portugal. He next declared war against his brother, Garcias III., king of Navarre, in which that prince lost his kingdom and his life.

Ferdinand II., king of Leon: d. 1188. He was the son of Alphonso VIII., and in a war with Portugal made the king, Alphonso Henriquez, prisoner. In the reign of this prince the military order of St. James was instituted, 1177, for the purpose of defending the dominions of the Christian powers against the Saracens.

Ferdinand III. (surnamed "The Saint"), king of Castile and Leon: b. about 1200; d. Seville, Spain, 30 May 1252. He was the son of Alphonso IX., and obtained the crown of Castile by the abdication of his mother, Berengaria, in 1217, and that of Leon by the death of his father in 1230. He took many places from the Moors, was canonized by Pope Clement X., and is regarded as the founder of the University of Salamanca.

Ferdinand IV., king of Castile and Leon: b. Seville 1285; d. 1312. He succeeded to the throne of Castile in 1295, at the death of his father, Sancho IV.

Ferdinand V. (surnamed "The Catholic"), king of Aragon: b. Sos, Aragon, 10 March 1453; d. Madrigalejo, Spain, 23 Jan. 1516. On 18 Oct. 1469 he married Isabella of Castile (q.v.) and thus brought about a close connection between Aragon and Castile, although both kingdoms continued to be governed separately, for Isabella allowed her husband no other share in the government of Castile than the privilege of affixing his signature to the decrees, and of uniting his arms with her own. With Ximenes they raised Spain to an eminence which she had never before attained. After a fierce war of 10 years they conquered Granada (1491), the only kingdom of which the Moors yet retained possession in Spain; but the most brilliant event of their reign was the discovery of America, for which Isabella had furnished the ships, and which made them sovereigns of a new world. (See Columbus.) This politic prince laid the foundation of the Spanish ascendency in Europe by the acquisition of Naples (1503), by means of his general Gonsalvo of Cordova, and by the conquest of Navarre (1512); but his policy was sometimes deceitful and despotic. These stains obscure the great qualities which made him the first monarch of his time. It was during his reign that the court of the Spanish Inquisition was established (1480). In 1492 he expelled the Jews from the kingdom, and banished the Moors in 1501. Two years after the death of his wife Isabella, which took place in 1504, he married Germaine de Foix. See Prescott, 'The Reign of Ferdinand and Isabella' (1837).

Ferdinand VI., king of Spain: b. 23 Sept. 1712; d. Villaviciosa, 10 Aug. 1759. He was the son of Philip V., and ascended the throne in 1746. He promoted the internal welfare of his country, reorganized the navy, encouraged manufactures, and by his judicious political conduct placed his elder brother on the throne of Naples, and another under the ducal canopy of Parma.

Ferdinand VII., king of Spain: b. San Ildefonso 13 Oct. 1784; d. Madrid 29 Sept. 1833. He was the eldest son of Charles IV. From the earliest years he manifested a strong dislike to the favorite Godoy, who ruled both the king and queen; and in 1807 was arrested as a conspirator. After the popular rising at Aranjuez, in March 1808, his father was forced to abdicate in his favor. A month later, having been induced to meet Napoleon at Bayonne, he himself abdicated in turn, placing the crown at the disposal of Napoleon, who at once gave it to his brother Joseph. Ferdinand was kept a prisoner at Valençay till 1813, when Napoleon offered to re-establish him on his throne. He returned to Spain in March 1814, having previously promised to maintain the constitution of 1812. In spite of his promise he annulled this constitution and dissolved the Cortes two months after his return. In consequence of this and of his arbitrary rule a military insurrection broke out 1 Jan. 1820. The rebels were at first successful, and Ferdinand was obliged to swear to the constitution of 1812; but having received support from Louis XVIII. of France, who sent an army to his aid, commanded by his nephew, the Duke of Angoulême, he was ultimately enabled to suppress the insurrection, and to make his authority once more absolute in Spain. Ferdinand was married four times, but only left one daughter, Isabella, by his fourth wife, Maria Christina of Naples. By a decree issued 29 March 1830, called the Pragmatic Sanction, he abolished the act of 1713, by which Philip V. had excluded women from the throne of Spain. He then left his crown to his daughter Isabella, to the exclusion of his brother, Don Carlos. It was during the reign of this king that the Spanish colonies in South America broke away from the mother country.

Ferdinand III., Joseph John Baptist, grand duke of Tuscany and archduke of Austria: b. 6 May 1769; d. Florence, Italy, 18 June 1824. He succeeded his father, the Emperor Leopold II., as grand duke of Tuscany, in 1790. He was the first sovereign to acknowledge the French Republic, and although compelled to join the first coalition against it, took the first opportunity of withdrawing. In spite of this he was, in 1799, at the time of the second coalition, deprived of his dominions, which, at the Peace of Lunèville, in 1801, were given to the Prince of Parma. He afterward received as compensation the duchy of Salzburg, in Germany, with the title of elector. In 1805 he exchanged Salzburg for the grand-duchy of Würzburg; in 1806 he joined the Confederation of the Rhine, and till 1813 remained a faithful ally of Napoleon. By the first Peace of Paris (30 May 1814) he recovered his hereditary dominions. See Inghirami, 'Storia della Toscana' (1843); Thayer, 'Dawn of Italian Independence' (1893); Tivaroni, 'Italia Durante il Dominio Austriaco' (1892-4).

Ferdinand IV., grand duke of Tuscany: b. 10 June 1835. He was a son of Leopold II., whom he succeeded in 1859, and in 1860 his country was incorporated with the kingdom of Sardinia and subsequently with the kingdom of Italy.

Ferdinand, duke of Brunswick, German field marshal: b. Wolfenbüttel 12 Jan. 1721; d. Brunswick 3 July 1792. Entering the Prussian service in 1740 he rose rapidly and became one of the famous commanders of the age. He was also noted for his patronage of science and art as well as for his many benevolences.

Ferdinand, Maximilian, prince of Bulgaria: b. Vienna 26 Feb. 1861. He is the youngest son of Prince Augustus of Saxe-Coburg, and was offered and accepted the rulership of Bulgaria in 1887. In 1896 Turkey recognized his election as ruler and urged the other interested powers to do so, and in April following, the acts of reconciliation and recognition were completed by his being received by the czar and the diplomatic corps at St. Petersburg.

Ferdinand, Victor Albert Meinrad, prince of Rumania: b. Sigmaringen, Prussia, 24 Aug. 1865. He is the second son of Prince Leopold of Hohenzollern and nephew of Charles I. of Rumania, and was declared heir presumptive to the Rumanian crown in November 1888. In the following March he was granted the title of Prince of Rumania and declared successor to the crown. He married Maria, eldest daughter of the Duke of Edinburgh, in January 1893.

Ferdinand, a noted figure in Shakespeare's 'Tempest.' He is the son of the King of Naples, and after being shipwrecked through the magic of Prospero, on the latter's enchanted island, falls in love with Prospero's daughter, Miranda.

Ferentino, fā-ren-tē'nō (ancient FERENTINUM), Italy, city in the province of Latium, six miles northwest of the town of Frosinone. It belonged to the Volsci, under whom it rose to be a place of considerable importance, and it still exhibits the remains of ancient walls, built of hewn stone without mortar. It is the see of a bishop. Pop. 9,096.

Feretory, fĕr'e-tō-ri, the bier or shrine containing the relics of saints borne in processions, which was usually done upon their feast days, as a token of gratitude in times of public rejoicing, or to obtain some favor in seasons of calamity. The type of a feretory is a coffin, but the form is usually that of a ridged chest, with a roof-like top. It was made of precious metals, wood, or ivory.

Ferghanah, or **Ferganah,** fĕr-gä'nä, a province, since 1876, of Russian West Turkestan, formerly the khanate of Kokand, lying among the western ranges of the Tian-Shan Mountains; area, 35,654 square miles, four fifths of which are mountainous, the Tchotkal Mountains being in the north, and the Ala-tau and the Trans-Ala-tau chain in the south. The rest of the province consists of the fertile irrigated plain of the Sir-Daria (Jaxartes), which traverses Ferghanah from northeast to southwest. The chief towns are Kokand, capital; Margelan, Namangan, and Andidjan. Pop., estimated, 1,560,411.

Fergus (fur'gus) Falls, Minn, city, county-seat of Otter Tail County; on the Red River, the Northern P. and the Great N. R.R.'s. It is in the heart of the "park" section of the State, being surrounded by prairie land and forests of pine and hardwood and the Park Region. It contains the Norwegian Lutheran College, high school, public library, State Hospital for the Insane, waterworks, electric lights, several banks and newspapers. The manufactures are flour, lumber, wagons, sleighs, woolen goods, furniture, brooms, etc. Pop. (1900) 6,072.

Ferguson, Adam, Scottish writer: b. Logierait, Scotland, 20 June 1723; d. St. Andrews 22 Feb. 1816. He was graduated at the University of St. Andrews in 1742; was professor of natural philosophy in Edinburgh University in 1759, and of mental and moral philosophy 1764-85; and was later professor of mathematics. He wrote: 'Institutes of Moral Philosophy' (1769); 'History of the Progress and Termination of the Roman Republic' (1782); 'Principles of Moral and Political Science' (1792), etc.

Ferguson, Henry, American educator: b. Stamford, Conn. He was graduated at Trinity College 1868, and entered Episcopal ministry 1873. He was rector of Christ Church, Exeter, N. H., 1872-8, and rector of Trinity Church, Claremont, N. H., 1878-80. Since 1883 he has been professor of history and political economy at Trinity College. He has published: 'Four Periods in the Life of the Church,' 'Essays on American History.'

Ferguson, James, Scottish physicist: b. Keith, Banffshire, 25 April 1710; d. London 16 Nov. 1776. As soon as his age would permit he was employed by a farmer to tend his sheep, in which situation he acquired a knowledge of the stars and constructed a celestial globe. This extraordinary ingenuity becoming known he was enabled to obtain instruction in mathematics and drawing, in which latter art his improvement was so rapid that he drew portraits in miniature, by which employment he supported himself for some years. In 1743 he went to London, where he published astronomical tables and lectures and lectured on experimental philosophy. In 1763 he was chosen a Fellow of the Royal Society, without the usual fees. His chief works are: 'Astronomy Explained on Sir Isaac Newton's Principles' (1756 — many editions); 'Lectures on Select Subjects in Mechanics, Hydrostatics, Pneumatics, and Optics' (1760); 'Analysis of a Course of Lectures on Mechanics, Pneumatics, etc.' (1763); 'Young Gentleman's and Lady's Astronomy' (1768); 'Introduction to Electricity' (1770); 'Select Mechanical Exercises' (1773); 'The Art of Drawing in Perspective' (1775). Most of his works were very popular.

Ferguson, James, American astronomer and civil engineer: b. Perthshire, Scotland, 31 Aug. 1797; d. 26 Sept. 1867. In his infancy he was brought to New York (1800), and on reaching manhood worked as an assistant engineer in the excavation of the Erie canal (1817-19). The three following years he was employed as assistant surveyor to the boundary commission appointed to carry out the provisions of the Treaty of Ghent. From 1822 to 1827 he was astronomical surveyor on the same work. The pursuit of practical astronomy occupied his later life, and as assistant astronomer of the United States Naval Observatory, he discovered several asteroids, and was a frequent contributor to scientific magazines.

Ferguson, Lady Mary Catharine, Irish writer: b. Stillorgan County, Dublin, Ireland, 1823. She was married in 1848 to Sir Samuel Ferguson (q.v.). She has published 'The Irish Before the Conquest' (1867); 'Life of William Reeves' (1893); 'Sir Samuel Ferguson in the Ireland of His Day' (1896), and edited her husband's works (1887-97).

Ferguson, Patrick, British soldier and inventor of the breech-loading rifle: b. Pitfour, Scotland, 1744; d. King's Mountain, S. C., 7 Oct. 1780. Entering the army in 1759, he served in Germany and Tobago. In 1776 he patented his rifle, firing seven shots a minute, and sighted for ranges of from 100 to 500 yards; and with it he armed a corps of Loyalists, who helped at the battle of Brandywine (1777) to defeat the American army. He himself had a chance there of picking off an officer, but "let him alone, disgusted with the idea of firing at the back of an unoffending individual, who was acquitting himself very coolly of his duty." Next day he learned that the officer was Washington. Three years later, Ferguson fell, defending King's Mountain, S. C., with 800 militia, against 1,300 Americans.

Ferguson, Robert (surnamed "The Plotter"), Scottish conspirator: b. near Alford, Aberdeenshire, about 1637; d. 1714. He went to England about 1655 and in 1662 was ousted as a Presbyterian from the Kentish vicarage of Godmersham. He played for 10 years a leading part in every treasonable scheme against the last two Stuart kings, and twice had to flee the kingdom. But after the Revolution he changed sides, and conspired as busily for the losing Jacobite cause. He wrote: 'History of the Revolution' (1706); 'Qualifications Requisite in a Minister of State' (1710); etc. See James Ferguson, 'Ferguson the Plotter' (1887), ibid. 'Two Scottish Soldiers' (1888).

Ferguson, Sir Samuel, Irish poet: b. Belfast, Ireland, 10 March 1810; d. Howth, Ireland, 9 Aug. 1886. In early life he was a prominent member of the Irish bar; in 1867 was appointed deputy keeper of the public records of Ireland; and in 1878 was knighted in recognition of his antiquarian and literary accomplishments. He will best be remembered as the author of the stirring poem, 'The Forging of the Anchor,' which first appeared in 'Blackwood's Magazine.' Chief among his other publications are: 'Lays of the Western Gael' (1864); 'Congal' (1872), a poem in five books; 'Poems' (1880); 'Shakespearean Brevities' (1882).

Fergusson, Arthur Walsh, American linguist: b. Benicia, Solano County, Cal., 4 Dec. 1859. He was graduated at St. Augustine College, Benicia, in 1877, and at the Georgetown University Law School in 1885. He first came into public notice in 1889 when made official interpreter of the American conference at Washington. Subsequently he was secretary of the International American Monetary Commission in 1891; official interpreter of the Intercontinental Railroad Commission in the same year; secretary of the United States Chilean Claims Commission in 1893; secretary of the United States and Venezuelan Claims Commission in 1894; chief translator of the Bureau of American Republics in 1897; official interpreter of the American and Spanish Peace Commission at Paris in 1898; and Spanish secretary of the United States Philippine Commission in 1900.

Fergusson, James, Scottish writer on architecture and archæological subjects: b. Ayr, Scotland, 22 Jan. 1808; d. London 9 Jan. 1886. He went to India as partner of an important commercial house, started an indigo factory on his own account, and after some years retired from business to devote himself to the study of architecture and early civilizations. In 1845 he published 'Illustrations of the Rock-cut Temples of India'; in 1849, 'A Historical Enquiry Into the True Principles of Beauty in Art'; in 1851, 'The Palaces of Nineveh and Persepolis Restored'; in 1855 'Illustrated Hand-book of Architecture'; in 1862, 'History of the Modern Styles of Architecture,' a sequel to the handbook, both being afterward combined in his 'History of Architecture in All Countries, From the Earliest Times to the Present Day' (1865-7), and completed by a 'History of Indian and Eastern Architecture' (1876). He also wrote 'Fire and Serpent Worship'; 'Rude Stone Monuments in All Countries.' He ranks among the foremost writers upon architecture.

Fergusson, Robert, Scottish poet: b. Edinburgh 17 Oct. 1750; d. 16 Oct. 1774. He became clerk in a law office, and wrote poems both in pure English and in the Scottish dialect, the latter being much superior to the former. His best productions display a rich fund of natural humor, keen powers of observation, and an excellent command of language. He was buried in the Canongate churchyard, Edinburgh, where Burns erected a monument to the memory of this kindred genius. His 'Poems' first appeared in 1773, and have been often reprinted

Fergusson, Sir **William,** English surgeon: b. Prestonpans, Scotland, 20 March, 1808; d. London 10 Feb. 1877; and educated at Edinburgh University. Sir William was one of the leading consulting surgeons in Europe, the author of 'A System of Practical Surgery,' and the inventor of numerous surgical instruments embodying ingenious improvements. He was created a baronet in 1865, "in consideration of distinguished merit and eminence as a surgeon."

Feriæ, fē'ri-ē, in ancient Rome, public holidays, during which all labor ceased, and all judicial and political proceedings were suspended. The feriæ were divided into two classes, general holidays and private holidays, observed by certain families or individuals. On these days the temples were visited, and prayers and sacrifices offered.

Feringhee, or **Feringee,** fe-ring'gē, the name given by the Hindus to the English and other Europeans. The word is intended to be disrespectful rather than complimentary.

Ferino, Pierre Marie Barthélemy, pē ār mä rē bar tāl mē fā rē'nō, Count of, French general: b. Caravaggio, Lombardy, 1747; d. Paris 28 June 1816. Having entered the Austrian army, he served in the Seven Years' war, but being unjustly treated by the Austrian government, went to France in 1789, and rose to prominence in the French army. The courage which he displayed at the defense of the bridge of Huningen procured for him the rank of grand-officer of the Legion of Honor (1804), as well as the title of senator. In 1808 he was made a count. Having voted for the deposition of Napoleon, Ferino received from Louis XVIII. the cross of St. Louis, as well as letters of naturalization, which in consequence of the separation of Lombardy from France had become necessary in order to entitle him to sit in the new chamber of peers. The name of this general is written on the east side of the triumphal *Arc de l'étoile.*

Fermanagh, fėr-man'ạ, an inland county, in the province of Ulster, Ireland; area, 714 square miles. The county is divided lengthwise into two nearly equal portions by Lough Erne. The principal towns are Enniskillen and Fermanagh. Its port is Ballyshannon. Pop. 65,300.

Fermat, Pierre de, pē ār de fār mä, French mathematician: b. Montauban 1601; d. Toulouse 12 Jan. 1665. He was engaged in his youth with his friend Pascal in very profound investigations as to figured numbers, on which he afterward founded his calculation of probabilities, of which he may be considered the inventor. He also devoted particular attention to the general theory of numbers, and made many important discoveries in regard to it, far outstripping any of his predecessors; he squared the parabola in a much simpler way than Archimedes had done, and contributed greatly to the progress of geometry. His method of finding the greatest and least ordinates of curve lines is closely analogous to the method of the differential calculus, then unknown. He carried on a keen controversy with Descartes, whose 'Geometry and Optics' were at variance with his 'Theoria de Maximis et Minimis.' Letters of his, written in 1636, prove that he was acquainted with the method of representing curves by equations before the publication of the 'Geometry' of Descartes, hence M. Libri has declared that he shares with Descartes the honor of having invented the mode of applying algebra to geometry. His collected works were published after his death, under the title of 'Varia Opera Mathematica' (1679).

Fermat's Last Theorem, the celebrated proposition that the equation $X^n + Y^n = Z^n$ cannot be satisfied by integral values of X, Y, and Z, and when n is an integer greater than 2. It was stated, though without proof, by the French mathematician Pierre de Fermat, about 250 years ago. Proofs have been found for many other remarkable theorems in the theory of numbers that were given by Fermat in the same manner, but this one has resisted all attempts at demonstration. There is no sufficient reason to believe it false, and it has indeed been proved to be true for every value of n from 3 up to about 97, and also for many special values greater than this; but no general proof, valid for all values of n, has yet been given. Many interesting things about the equation have been established, however. It is true for n, for example, if it is true for any factor of n; and this has led mathematicians to limit their study of it to the case in which n is a prime number. When n is prime, it is easy to show that the equation cannot be satisfied if any one of the three numbers X, Y, and Z is prime. It is also easy to show that when n is prime there is no solution unless $X + Y - Z$ is divisible by n. Many other similar properties are also known, but the general demonstration of the proposition does not appear to be possible by any of the methods with which mathematicians are now familiar.

Ferment Oils, in chemistry, volatile oils produced by the fermentation of various plants, not originally contained therein, and different from the oils which are extracted from the unfermented plants by distillation with water. They were known to the alchemists, and by them designated quintessences. Ferment oils are for the most part more soluble in water than ordinary volatile oils.

Fermentation (from Lat. *fermentare,* from *fervere,* to boil), a term whose meaning has undergone considerable changes at different times in consequence of the progress of chemistry and biology. By the alchemists it was often used to describe any reaction accompanied by boiling or effervescence, even when purely inorganic, but among older meanings that which comes nearest to its present signification has reference to its use to describe such familiar but mysterious processes as the transformation of grape-juice into wine, the formation of alcohol from the saccharine fluids prepared from cereals, and the raising of the dough in bread making. Closer examination has shown that these processes are only a few out of many of a similar kind, and now all such processes are included under the name fermentation. In its present sense it may be defined as including all chemical changes brought about through the agency, immediate or at least apparently immediate, of micro-organisms or of organic substances immediately derived from the vegetable or animal kingdom, these substances remaining essentially the same after the reaction as they were before it. The organism or substance which produces the fermentation is known as a *ferment,* and in accordance with the foregoing definition ferments may be divided into two main groups, namely, (1) organized or formed ferments, and (2) unorganized, unformed, or soluble ferments, usually called *enzymes.* Both kinds are nitrogenous organic bodies of somewhat unstable character, and in both cases the amount of ferment required to transform a given amount of the fermentable substance is relatively very small. The organized ferments are, however, living bodies of microscopic size belonging to the groups of fungi and bacteria, and are therefore capable of growth and reproduction, while the enzymes are lifeless substances of definite chemical composition. The action of the enzymes, accordingly, is often separated from that of the organized ferments and not included under the term fermentation, but the present state of our knowledge does not seem to offer sufficient warrant for such a course.

The enzymes or unorganized ferments play an important part in the vegetable and animal kingdoms. Thus, the solid, insoluble reserve materials stored up in the seeds, roots, underground stems, and other parts of plants are by their means transformed into soluble substances capable of being diffused throughout the plant-body. These enzymes are of protoplasmic origin, and are complex proteid compounds. The exact nature of their action is unknown, but all, or nearly all, produce their changes by a process known as *hydrolysis,* the nature of which may be best elucidated by citing a particular instance, the action of the enzyme *invertase* or *invertin* (see below) on cane-sugar. The molecule of cane-sugar under the influence of the ferment takes up a molecule of water, which becomes *fixed,* that is, incorporated with it, and then the combination resolves itself into the two simpler sugars, dextrose and levulose. The equation is as follows: $C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6$. The enzyme remains apparently unchanged, and a very small quantity of it seems capable of transforming an indefinite amount of the substance on which it acts. In one case, however, it has been proved that the enzyme forms a compound with the fermentable substance, and that the final products, including the enzyme, are then produced by the solution of this compound in water. This is probably the mode of action in all cases, and it is certainly much more intelligible than the former explanation by *catalytic* or contact action. The optimum temperature for most enzymes is between 85° and 120° F., and they are most active in the dark. The best-known enzyme is *diastase,* which is present in malted grain and converts starch into maltose and dextrin. Other enzymes are: *invertase,* already referred to; *cytase,* which acts chiefly on the cellulose of the cell-walls of grain and other seeds; *inulase,* which transforms inulin into levulose in various bulbs and tubers; *emulsin,* which decomposes the glucoside amygdalin of many rosaceous plants into glucose, benzoic aldehyde, and hydrocyanic acid; *pepsin,* found in gastric juice; *trypsin,* secreted by the pancreas; *zymase,* to which the alcoholic fermentation has been ascribed; and *urase,* to which the fermentation of urea into ammonium carbonate is primarily due.

The organized ferments, or micro-organisms concerned in fermentation, all belong to the group of cryptogamic plants known as Fungi, and their near allies the Bacteria. The most highly organized members of this group concerned in fermentation are some of the molds, but their part in fermentation is of little importance, and we need not further consider them. We may therefore discuss the micro-organisms of fermentation under the two heads: (1) Saccharomycetes, or Yeast-Fungi, and (2) Schizomycetes, or Bacteria. The Saccharomycetes are minute unicellular plants of an oval shape, surrounded by a cell-wall and containing granular protoplasm in which several vacuoles are conspicuous. They reproduce themselves by gemmation or budding, and by this means chains of cells closely resembling the hyphæ of a mycelium are formed; but very few species develop any true mycelium, such as we find in the molds and other fungi. The Bacteria, Schizomycetes, or Fission-Fungi, are a very important group of microscopic cryptogams usually classed with the fungi. Their importance arises not only from the part they play in fermentations, but also from their widespread activity in the order of nature, and especially from their action in producing numerous zymotic diseases in man and other animals. See Bacteria.

The yeast-fungi cannot assimilate free nitrogen, but they can extract it from salts of ammonia and from various organic bodies. They can take up carbon from sugars, glycerin, tartaric acid, citric acid, acetic acid, ethyl alcohol, benzoic acid, phenol, and other organic bodies; but they can obtain their nutriment only in the presence of such substances as potash, lime, and phosphoric acid. Unlike nearly all the bacteria, the yeasts can live in acid media if the acid be not present in excessive quantity. The presence of free oxygen is very favorable to the growth of yeast-fungi, but under these conditions the transformation of sugar into alcohol greatly diminishes in vigor. If, however, free oxygen be excluded, fermentation proceeds vigorously. The optimum temperature for the growth of yeast-fungi is from 77° to 86° F., and they seem to be quite indifferent to light and electricity. Bacteria assimilate nitrogen most readily from peptone, but many other substances can also yield. Carbon is most readily taken up from sugars, glycerin, tartrates, citrates, lactates, acetates, etc. Most bacteria are unfavorably influenced by light, and in respect to temperature there is a great diversity among the different species, some flourishing at 60° to 70° C. and others at freezing point, but for several of the best-known species the optimum temperature is 25° to 35° C. The *obligate aërobic* forms cannot live in the absence of free oxygen, while the *obligate anaërobic* kinds are destroyed by the smallest trace of free oxygen. Between these two extremes we have *facultative aërobic* species, which are generally anaërobic, but can tolerate some free oxygen, and *facultative anaërobic* species, generally aërobic but able to live when the free oxygen is much diminished. Phosphoric acid, potash, lime, and similar bodies are necessary to their growth.

The most important of all fermentations due to Saccharomycetes is that by which alcohol is obtained from sugar (the sugar itself being largely that derived from the starch of barley or other cereal), and it is in connection with this process that the subject has been most thoroughly studied. The species of fungus or yeast used in this process is known as *Saccharomyces cerevisiæ*, but of this two kinds are distinguished, namely, *top yeast and bottom yeast.* The former is used in top fermentation, which is carried on at a rather high temperature (60° to 85° F.) and is rather violent, carbon dioxid being freely evolved and carrying the yeast to the surface. Bottom yeast is used in the slower bottom fermentation at about 40° to 50° F., in which carbon dioxid is more gently evolved and the yeast therefore remains at the bottom. Bottom fermentation is chiefly used in the manufacture of lager beer. The sugars directly fermentable by this process are those with the formula $C_6H_{12}O_6$, namely, dextrose, levulose, and galactose. Cane-sugar ($C_{12}H_{22}O_{11}$) is first changed by an enzyme *invertase* (see above) contained in the yeast into dextrose and levulose, which are then fermented. The chief products of the fermentation are alcohol and carbon dioxid, but other bodies, such as glycerin, succinic acid, propyl, amyl, and other higher alcohols, are also produced. The process of fermentation continues until the alcohol forms about 14 per cent of the solution, when the yeast-plant cannot continue its action any longer.

Many theories of alcoholic fermentation have been advanced. Lavoisier, treating sugar as an oxid, thought that it was chemically resolved by fermentation into two other oxids, carbon dioxid and alcohol. When the organic nature of yeast was proved beyond doubt, the physiological theory was advanced, according to which the sugar is the food of the plant and the products of fermentation are its excretions. The celebrated chemist Liebig, however, contended that fermentation was a purely chemical process, and his later opinion has been in part reverted to by more recent observers. Pasteur proved conclusively that fermentation was bound up with the life of the organisms, but in what manner is still uncertain. Traube regarded the cells as centres for the production of enzymes, thus reducing fermentation by organized ferments to that produced by unorganized ferments. Traube's theory has gained considerable ground lately on account of the successful extraction from yeast by Buchner of an enzyme, *zymase*, which can produce all the phenomena of alcoholic fermentation.

The chief micro-organism of the vinous fermentation is *S. ellipsoïdeus*. The elliptical cells of this species are found on the grapes and in the air of grape-growing districts, and fermentation is thus set up spontaneously without the actual addition of yeast. Recently pure cultures of the wine-yeast have been prepared and used with very good results in the fermentation of grape-juice. E. C. Hansen, an able Danish investigator, has added greatly to our knowledge of the chief yeast-fungi, and has prepared and thoroughly examined several pure cultures of the three most important species, *S. cerevisiæ*, *S. pastorianus*, and *S. ellipsoïdeus*. He has described six kinds in all, two belonging to the last species, three to the second, and the sixth to the first, the distinctions being founded on the temperature of spore-formation and the conditions under which a surface film forms in a liquid medium. Hansen has also cultivated two pure forms of brewers' yeast, known as Carlsberg No. 1 and No. 2. Both are bottom yeasts, but the beer produced by No. 1 has less carbon dioxid than that of No. 2, and is used chiefly for bottling, the No. 2 beer being preferred for export.

Of the fermentations set up by bacteria only some of the most important can be referred to here. (1) *Acetic Acid Fermentation.* In this fermentation alcohol becomes oxidized into acetic acid, the total reaction being representable by the equation:

$$C_2H_5OH + O_2 = C_2H_4O_2 + H_2O.$$

The microbe concerned in the fermentation, if allowed to continue its action, will oxidize the acetic acid into carbon dioxid and water. Two bacilli, namely, *Bacillus aceti* and *B. pasteurianus*, have been described as taking part in this important fermentation, which is the basis of the commercial manufacture of vinegar from wine. (2) *Lactic Fermentation.* The souring of milk which has stood for some time is due to this fermentation, by which the milk-sugar becomes transformed into lactic acid through the agency of bacteria. Carbon dioxid is an invariable product of the fermentation. (3) *Butyric Fermentation*, often set up in milk which has undergone the lactic fermentation. (4) *Nitrification of Ammonia*, a process of vital importance in nature, by which organic nitrogen becomes fixed in soils as nitrates and nitrites. The process of decay and putrefaction, with the production of *ptomaïnes*, also belong to this section of the subject of fermentation.

(See ALCOHOL; BREWING; DISTILLED LIQUORS; VINEGAR; WINE; etc.) Among treatises on the subject the following may be mentioned: A. Jörgenson, 'Die Mikroorganismen der Gärungsindustrie,' translated into English by H. T. Brown as 'The Micro-organisms of Fermentation'; Schützenberger, 'Fermentation'; Trouessart, 'Microbes, Ferments, and Moulds.'

Fermented Liquors. See DISTILLED LIQUORS.

Ferments, agents in causing fermentation; these may be either organized or unorganized. The former belong to microscopic fungi of the lowest order. The latter are sometimes called chemical ferments, as they bring about chemical changes in other substances, with which they are brought in contact, without themselves undergoing a permanent transmutation.

Fermo, fĕr'mō (ancient FIRMUM PICENUM), Italy, city in the province of Ascoli Piceno, 32 miles south-southeast of Ancona. It was founded by the Sabines before Rome existed; and has remains of old walls. It gives name to an archiepiscopal see, and has a cathedral, several other churches, a town-house, part of which dates from the 14th century; collections of statuary and paintings. Its harbor is situated on the Adriatic, about three miles distant. Pop. 15,000; of the commune, 20,542.

Fermor, Henrietta Louisa, COUNTESS OF POMFRET, English writer: d. 15 Dec. 1761. Her letters were published in 'Correspondence between Frances, Countess of Hartford (afterward Duchess of Somerset), and Henrietta Louisa, Countess of Pomfret, between . . . 1738 and 1741' (1805).

Fermoy, fĕr-moi', Ireland, town, in the county of Cork, 22 miles north-northeast of the city of Cork, on the Blackwater. On the river opposite to the town are infantry, artillery, and cavalry barracks, accommodating about 3,000 men. There are here Fermoy College, St. Coleman's Roman Catholic College, two convents, and a handsome Roman Catholic cathedral. It has some large flour-mills and a brewery. Pop. 6,469.

Fern, Fanny. See PARTON, SARA PAYSON WILLIS.

Fern, Male (*Dryopteris filix-mas*), a native fern of the northern part of the United States and of Europe, Asia, Africa and South America. In medicine the rhizome is used. It contains an active oleoresin, the most important constituent of which is filicic acid, and is a very efficient remedy for the treatment of tapeworm, particularly of the genus *Tænia*. Other American species of the same genus, *D. marginale, D. goldianum*, contain small amounts of the same oleoresin as that found in male fern, and can be used for much the same purposes.

Fern-owl, the common British nightjar (*Caprimulgus europæus*), which goes by many other provincial names, as "goat-owl" and "churn-owl," due to the noises it makes and an erroneous supposition that it is a kind of owl. Consult White's 'Selborne'; and see NIGHTJAR.

Fer'nald, Charles Henry, American zoologist: b. Mount Desert, Maine, 16 March 1838. He was an acting ensign in the United States navy during the Civil War; and professor of natural history at the Maine State College in 1871-86. In the latter year he was appointed professor of zoology at the Massachusetts Agricultural College. His publications include: 'Tortricidæ of North America'; 'The Crambidæ of North America'; 'The Pterophoridæ of North America'; 'Pyralidæ of North America'; etc.

Fernald, Chester Bailey, American writer: b. Boston, Mass., 18 March 1869. He is author of: 'The Cat and the Cherub, and Other Stories' (1896); 'Chinatown Stories' (1899); 'The Moonlight Blossom' (1899), a drama; etc.

Fernald, James Champlain, American Baptist clergyman and author: b. Portland, Maine, 18 Aug. 1838. He was graduated at Harvard 1860, and at Newton Theological Seminary 1863, and was ordained to that ministry 1864. He settled in Ohio, holding pastorates in Granville and Springfield; removing to New York in 1889. He has since done much editing and writing, having been editor of 'Synonyms,' 'Antonyms,' and 'Prepositions in the Standard Dictionary' and editor-in-chief of the 'Student's Standard Dictionary,' and of the 'Homilitic Review.' Among his works are: 'The Economies of Prohibition'; 'The New Womanhood'; 'Synonyms, Antonyms, and Prepositions of the English Language'; 'The Spaniard in History' (1898); 'The Imperial Republic' (1898); 'Training of Children' (1898); 'True Motherhood' (1900).

Fernandez, Juan, hoo än' fĕr nän'deth, Spanish navigator and explorer: b. probably Cartagena, Spain, 1536; d. Ligna, Chile, 1602. In sailing between the ports of South America he stood out to sea, benefiting by the trade winds and thus shortening the time of the voyage, for which he narrowly escaped condemnation as a sorcerer. He discovered the island which was named after him 1563, and tried to establish a colony there, but failed in this enterprise. He also discovered the islands of St. Felix and St. Ambrose 1574. The sojourn of Alexander Selkirk upon the island of Juan Fernandez probably suggested 'Robinson Crusoe' to Defoe.

Fernandez, Leandro, Mexican statesman: b. in the state of Durango, 27 Feb. 1851. He was educated at the Juarez Institute at Durango and the School of Engineers, Mexico City, adopting engineering as his profession. Was given the title of 'assayer' in 1873 and 'engineer' in 1876. Was 'official mayor' of the department of communications for 19 months, then successively director of the government mint at Mexico City six and a half years; governor of Durango one year; and secretary of Fomento more than two years. He has also been director of the National Astronomical Observatory and professor in and director of the National School of Engineers, Mexico City. He was appointed secretary of communications and public works in 1904.

Fernandez de Cordova, Diego, dē-ā'gō fĕr-nän'deth dā kor'dō-vä, marquis of Guadalcazar, Spanish statesman: b. Cordova about 1580; d. after 1629. He was made viceroy of Mexico in 1612, holding the office till 1621. He founded the cities of Lerma, Cordova, and Guadalcazar, completed the Mexican aqueduct and was viceroy of Peru from 1622-29.

Fernandez de la Cueva, Francisco, frän-sĭs'cō fĕr-nän'deth dā lä kwā'vä, duke of Albuquerque, Spanish statesman: b. about 1610. He was appointed viceroy of Mexico 1653, holding the office until May 1661. During his term the city of Mexico was greatly developed and the cathedral constructed. His later years were spent as viceroy of Sicily.

Fernandez y Gonzalez, Manuel, mä-noo-äl' fĕr-nän deth ē gōn thä leth, Spanish poet and novelist: b. Seville, Spain, 1830; d. Madrid 6 Jan. 1888. A boyhood in Granada and seven years' army service afforded him varied experience of life and men. From 1846 he gave himself to literature; and the plays, 'Struggling Against Fate' (1848); 'The Cid' (1858); 'A Duel on Time' (1859); 'Imperial Adventures' (1864), well constructed and full of humor, won great popularity. Among his novels are: 'The Seven Children of Lara' (1862); 'The Bloody Queen' (1883); 'The Plantagenet Brothers' (1889). A volume of his poems appeared in 1858.

Fernandez-Lizardi, José Joaquin, hō-sā' hōä-kēn' fĕr-nän'deth-lē-thär'dē, Mexican novelist: b. City of Mexico 1771; d. there June 1827. His most famous work is 'Periquillo Sarniento' (1816, new ed. 1884). He also published two novels, 'Sad Nights and Gala Days' (1823), and 'Life and Exploits of the Famous Knight Don Catrin de la Facheuda' (1832).

Fernandez Madrid, Jose, hō-sā' mä-thrēth fĕr-nän'deth, Colombian poet and statesman: b. Cartagena, Colombia, 9 Feb. 1789; d. near London, England, 28 June 1830. He was for a short time president of his country in 1816, but was afterward exiled to Cuba where for nine years he was prominent as a physician. In 1825 he was sent by Bolivar as minister to England. He published a volume of poems: 'The Roses' (1822); also two tragedies, 'Atala' (1822), and 'Guatimozin' (1827).

Fernandez Navarrete. See NAVARRETE, JUAN FERNANDEZ.

Fernández, de Palencia, Diego, dē-ā'gō dā pä-lĕn'thē-ä fĕr-nän'deth, Spanish-American historian: b. Palencia, Spain, about 1530; d. Seville 1581. He was apparently a soldier of fortune, lured to the scene of Pizarro's great conquest in the hope of fabulous wealth. He had some fighting experiences, and wrote: 'The First and Second Parts of the History of Peru' (1571), a narrative of the subjugation of the Incas.

Fernandez de los Rios, Angel, än-hāl' fĕr-nän'deth dā lōs rē'ōs, Spanish writer: b. Madrid, Spain, 27 July 1821; d. 1879. Active in politics and political journalism at home, he was banished, and became a man of letters in Paris. He wrote: 'All or Nothing' (1876), an anti-Bourbon prose study of social conditions: 'A Week in Lisbon' (1876); and many essays of value on the politics and resources of the Peninsula.

Fernandina, fĕr-nan-dē'na, Florida, city, port of entry, and county-seat of Nassau County, on Amelia Island, Amelia River, and the Florida C. & P. R.R.; 33 miles north by northwest of Jacksonville. Its manufactures are lumber, canned oysters, plastering fibre (made from palmetto), and cotton goods. It exports cotton, phosphates, lumber, plastering fibre, and canned goods. It is a favorite winter resort. A shell road leads to Amelia Beach, and nearby is Cumberland Island, the home of Gen. Nathaniel Greene (q.v.). Pop. (1900) 3,245.

Fernando de Noronha, fĕr-nän'dō dā nō-rōn'yä, an island, of volcanic origin, in the South Atlantic, belonging to Brazil; area, about 12 square miles. It has a rugged, mountainous, wooded surface. It is used as a penal settlement for Brazilian male criminals.

Fernando Po, fĕr nan' pō (Span. fĕr nän'dō pō'), an island belonging to Spain, in the Bight of Biafra, 20 miles from the West African coast. It is of volcanic origin, about 40 miles in length by 20 miles in breadth. It is mountainous and covered with dense forests of valuable timber, while the land gradually rises from the steep and rocky coasts into two peaks culminating upward of 10,000 feet above sea-level. It is well-watered, and sugarcane grows in abundance. Yams form the staple food; birds and fish are plentiful. The climate is very unhealthy. The capital is Clarence Cove. This island was discovered in 1471 by the Portuguese, who ceded it to Spain in 1778. The Spaniards eventually abandoned it, and the British, in 1824, selected it as a suitable military depot and naval station. They, in their turn, abandoned it in 1834, on account of its unhealthfulness. The Spaniards again took possession in 1844. It is now used by them as a penal settlement, to which, in 1869, several Cuban patriots were deported, as political prisoners.

Ferne Islands. See FARNE ISLANDS.

Ferney, or **Fernex,** fār-nā, France, town in the department of Ain, about five miles north of Geneva. It is small, and its only manufactures are watches and pottery. It is chiefly noted for having been the chief residence of Voltaire (who in fact founded it) from about 1760 to 1778. The house in which he lived is still standing, and the church, with the inscription, '*Deo erexit Voltaire,*' is now a farmhouse. Pop. 1,189.

Fernkorn, Anton Dominikus, än'tōn dō-mi-ni-koos' fĕrn'korn, Austrian sculptor: b. Erfurt, Saxony, 17 March 1813; d. Irrsin, near Vienna, 16 Nov. 1878. He studied under Stiglmayer and Schwanthaler 1836–40, and attracted attention by his first group, 'St. George and the Dragon,' the Austrian government then appointing him director of the Imperial bronze foundry at Vienna, where he executed his masterpiece, a colossal statue of Archduke Karl 1860, and his statue of Prince Eugéne 1865. Among his other works are a colossal bust of Radetsky; a marble statue of the poet Frederick Heffel, and a monument of Ressil.

Fer'now, Bernhard Eduard, American scientist: b. Inowraclaw, Germany, 7 Jan. 1851. He was educated at the University of Königsberg; removed to the United States in 1876 and engaged in metallurgical work; and was chief of the division of forestry in the United States Department of Agriculture in 1886–98. In the latter year he was made director and dean of the New York State College of Forestry at Cornell University. He is the author of 'The White Pine' (1899); 'Report Upon Forestry Investigations of the United States Department of Agriculture 1877–98' (1899); etc.

Fernow, Berthold, American author: b. Inowraclaw, Germany, 28 Nov. 1837. He entered the Prussian army and became lieutenant in 1860. He soon after removed to the United States; became a private in the 4th Missouri Cavalry in 1862; and was promoted lieutenant of the 3d United States Colored Infantry in 1863. He was archivist of New York State in 1876-89. He has written 'Albany and Its Place in the History of the United States' (1886); 'Ohio Valley in Colonial Days' (1889); etc., and edited 'Documents Relating to Colonial History of New York' (Vols. XII., XIII., XIV.); 'New York in the Revolution' (1887); and 'Records of New Amsterdam' (1897).

Ferns and Fern-allies. The ferns are representatives of an extensive branch of the plant world technically known as *pteridophytes,* standing between the mosses and hepatics (*bryophytes*) on the one hand and the cycads and conifers (*gymnosperms*) on the other, at the head of the now obsolete subdivision of plants known as cryptogams. They resemble the former groups so closely in their method of sexual reproduction and in showing alternating phases of growth that both mosses and ferns are often united under a single primary division of plants as *archegoniates,* so called from the common possession of a structure described below as the archegone. The ferns differ from the mosses in their highly developed vascular or woody system seen in the fibrous strands of the leaf-stalks and the veins of the leaves, and so are still sometimes called vascular cryptogams. Besides the ferns, popularly so known, there are various groups of plants closely allied to ferns which with them make up the branch pteridophytes. Among these fern-allies are the running-pine or ground-pine, familiar in its use for Christmas decoration, the selaginellas frequent in cultivation, the field horsetail, and the scouring-rush. These will be treated in their proper sequence below.

The mature fern-plant, which may stand as a representative pteridophyte, consists of a woody axis bearing scattered or clustered leaves according as this axis is a creeping structure or an upright trunk. In our northern species this axis is either below the surface of the ground or just at the surface, but in some of the species of tropical regions it often forms a trunk from one foot to fifty feet in height, or even more, bearing its leaves at the summit and forming a tree-fern.

On the under surface of certain leaves of ordinary ferns little clusters of stalked bodies (*sporangia*) appear, which are variously arranged in different species, in rounded or linear masses (*sori*) or in a few species are scattered over the surface of the leaf. These structures consist of a membranous wall enclosing minute bodies — the fern-spores. These are the reproductive bodies of the fern asexually produced by repeated division of the interior portion of the young sporangium, and are often popularly known as "fern-seeds." This is a misnomer, for they rather find their homology with the pollen-grains and young embryo-sacs of the higher plants. In the sporangia of some ferns a series of peculiar cells serves the purpose of rupturing the sporangium wall, and by an elastic movement scatters the spores at some distance from the plant producing them. Either at once or after a period of rest the fern-spore sprouts and produces a green hepatic-like structure known as a prothallus. This is a flat expanse of soft green tissue, usually more or less heart-shaped, and ranging up to a half inch or more in diameter. It forms root-hairs beneath, and grows exactly like an ordinary new plant. On its under surface among the root-hairs two sorts of structures are produced: (1) A series of rounded bodies known as antherids, in which minute motile cells are formed known as antherozoids, these being the male or sperm cells connected with the sexual reproduction of the fern; (2) a series of flask-shaped bodies (archegones) more deeply imbedded in the tissues of the prothallus, which contain a single specialized cell at the bottom of the flask, known as the egg, this being the female reproductive cell. The sperm-cells escaping from the antherid swim in the delicate film of moisture which may bathe the surface of the prothallus, swarm about the mouth of the archegone, and one of them enters the neck of the flask-like structure, penetrating the mucilaginous contents of its tube, and fuses with the egg, thus effecting a true sexual reproduction. The fertilized egg soon commences division, increases in size, and develops a primary root and leaf, ultimately growing into a new fern-plant. The two alternating phases of growth in the life period of the fern are thus strongly marked; the sexual phase (prothallus) is often known as the gametophyte, and the asexual phase (the fern-plant) which follows is known as the sporophyte or spore-producing phase.

In some of the fern-allies like *Marsilea* and *Selaginella* the plants produce two kinds of spores, (1) microspores, which develop into prothalli producing only antherids, and (2) macrospores, which develop into prothalli producing only archegones. In these plants, particularly *Selaginella*, the prothallus is much reduced in size, and the sexual reproduction approaches that of the pines and other conifers, except that it takes place away from the plant producing the spores. The microspores of *Selaginella* are thus the exact counterparts of the pollen-grains of the pine, and the macrospores correspond to what is known as the embryo-sac in the young pine-cone, to that part of the ovule in which the egg-apparatus appears, and in which the seed is ultimately developed.

Ferns are distributed all over the world but diminish in the number of species, in the profusion of individuals, and in the relative proportion to the total vegetation of the locality as we pass from tropical to polar regions. Moist insular climates are best adapted to their development. Java has 575 species of ferns, while New York State with about the same area has scarcely one tenth as many. Jamaica, with about the area of Connecticut, has nearly 500 species; Hawaii, Samoa, New Zealand, and the Philippines are other prolific regions. While moist conditions favor fern-growth and development, certain species have adapted themselves to dry climates and grow on open exposed rocks of semi-arid regions. Such ferns are provided with woolly hairs, tangled scales, waxy powder, or other mechanical contrivances to conserve their moisture. One species of the so-called "resurrection-plants" (*Selaginella lepidophylla*) of the arid regions of the southwest conserves its moisture during the dry season by coiling its branches inward so as to form a compact ball. On the return of moisture it flattens out and exposes its fresh green surface. The "resurrection-fern" curls up in a similar way, its under surface being protected by a layer of scales. It grows on trees in the southern States and the West Indies.

The ferns of temperate regions are terrestrial in their habit, but as we approach the tropics a large number become epiphytic, growing with mosses and orchids on the trunks and branches of trees. The filmy ferns frequently cover the trunks of tree-ferns completely.

There are over 5,000 described species of pteridophytes in the present flora of the world, which are grouped according to their characters under seven distinct orders. Of these we have nearly 290 species within the limits of the United States.

Geologically, the pteridophytes are a very old group dating back to the Devonian and reaching their first culmination during the Carboniferous Age, in which they formed the bulk of the vegetation of the coal-measures. Besides ferns, some of the fern-allies of those times attained very great size, as shown in the giant trunks of *Lepidodendron* and *Sigillaria*, related to the modern club-mosses, and in the large stems of *Calamites*, related to our present diminutive scouring-rushes. The various types of the modern pteridophytes and their distinctive characteristics will be treated under their respective orders, arranged, as nearly as a lineal series can show it, in their relative rank in the scale of vegetable life.

I. *Ophioglossales.*— The adder-tongues and grape-ferns are eusporangiate; that is, their sporangia develop from the interior tissues. They include plants of a fleshy texture, bearing their thick-walled sporangia in spikes or panicles. The prothallus, so far as known, is subterranean and colorless. We have in the United States seven species of adder-tongue (*Ophioglossum*), and 17 species of grape-ferns (*Botrychium*), the former having the sporangia in spikes and the latter having them in panicles. All our northern species are terrestrial plants with fleshy roots. *Cheiroglossa palmata* of Florida and the West Indies is a hanging epiphyte growing on palmetto-trunks and on other trees, and the curious strap-like *Ophioderma* of Hawaii and other Pacific isles grows in similar situations, with its pendant leaf from two to five feet long. The order *Ophioglossales* represents the simplest type of fern-growth in existence, and probably the oldest type as well. The species (about 60) are not numerous, but are very widely distributed.

II. *Marattiales.*— This order includes only tropical ferns of a coarse habit, ranging from two feet to ten feet in height. They are eusporangiate like the last order, but have the coiled-bud form of the true ferns. They also bear their sporangia dorsally, that is, on the under surface of the leaf, but these are formed in special boat-like receptacles known as synangia. *Marattia* and *Danæa* are the two principal genera. Two species of the former and nine of the latter are found in the North American tropics. The order is a smaller one than the last and, like it, consists of a single family.

III. *Filicales.*— The ferns proper, including nearly 4,000 species, are divided unequally among the eight families of this order. They are leptosporangiate (that is, the sporangia develop from the epidermal tissues), and all produce green prothalli of the type described above. Except the *Matoniaceæ*, a small family of two species, all are represented in America. Two families are tropical only, while the remaining five are also represented in the United States.

1. The flowering ferns, so called because the sporangia are panicled, are among the conspicuous features of our northern swamp vegetation in spring and early summer. The cinnamon-fern grows in great crowns, sending up its spore-producing leaves, which have a rich cinnamon color, a short time in advance of its rich crown of foliage-leaves. The royal flowering-fern grows in similar locations, but is larger, has more compound foliage, and bears its panicle at the summit of the foliage-leaf. The flowering ferns (*Osmunda*), with two genera from New Zealand and Africa, make up the family *Osmundaceæ* with 16 species. In this family the ring of the sporangia is rudimentary and the sporangia open longitudinally.

2. The Hartford fern or climbing fern (*Lygodium*) is the type of a second small family. Our species is low-growing, only two or three feet high, and twines closely about other vegetation. It is quite local, but where it grows it sometimes forms tangles. In Connecticut it is so rare that it is protected by law. The tropical species of this genus often climb trees for 40 feet or more. Another member of the same family is the curious curly-grass (*Schizæa*) of the pine-barrens of New Jersey. It is wholly unlike ordinary ferns, the foliage-leaves resembling curled grass-leaves and the spore-bearing leaf resembling a small sedge. The entire plant is only four or five inches high. These two species with two subtropical species of *Ornithopteris* form our four representatives of the family *Schizæaceæ*, whose 80 species are largely South American, though several species occur in the Old World. They are characterized by their pear-shaped sporangia with an apical ring. The sporangia are usually borne in spikes or panicles.

3. The *Gleicheniaceæ* are found in the tropics of both hemispheres, several species of *Dicranopteris* occurring in the uplands of the West Indies, forming almost impassable tangles or thickets. These ferns, instead of uncoiling at once, produce buds in the axils of the forked branches, and as the lower portions mature these buds develop successive upper growths. The tangles thus formed are often sufficient to bear the weight of a man, and it is possible to walk for some distance on these thickets.

4. The floating-fern (*Ceratopteris*), found rarely in Florida and Louisiana, and occasionally throughout the tropics of both hemispheres, is almost the only aquatic representative of the order. Its sterile leaves float on the surface of shallow waters, and its pad-like fertile ones project above the surface. The name *Ceratopteris* is derived from this fertile leaf, which branches like a deer's horn, and gives the name to the family *Ceratopteridaceæ*.

5. The tree-ferns of both hemispheres form a separate family *Cyatheaceæ*, though several members of this family are very diminutive, and ferns with trunks occur occasionally in other families. No tree-ferns occur in the United States, but 30 species or more are found in the higher altitudes of the West Indies, and many more occur in other tropical regions. In some portions of the mountains of Jamaica tree-ferns form half or three fifths of the forest vegetation, the trunks ranging from 6 to 50 feet in height. A well-developed tree-fern forms one of the most beautiful types of vegetation, rivaling the palms in grace and perfection of form. Some 200 species have been described, belonging chiefly to the genera *Cyathea, Alsophila, Hemitelia, Dicksonia*, and *Cibotium*.

6. The great mass of our ferns belong to the family *Polypodiaceæ*, often known as the true ferns, perhaps for no better reason than that they were the first to be called by the name of ferns. The members of this family have definitely stalked sporangia, always provided with an elastic vertical ring which causes the sporangium to burst transversely and thus disperses the spores. In some species, like the stag-horn fern, the sporangia are spread over the under-leaf surface in a uniform layer; in others, like the spleenworts and bird's-nest fern, they are in definite lines; while in our common polypody, the maidenhair, and the wood ferns they are in small rounded masses (sori). In some species the sorus is naked, but in most it is covered by a small membrane (indusium), primarily for the purpose of protecting the young sporangia. In some ferns, like the spleenworts, the indusium develops along a vein; in others, like the Christmas-fern, it is attached at one point and covers the sorus like an umbrella; in still others, like the maidenhair, it is formed of a modified portion of the margin of the leaf folded under so as to cover the young sporangium. The nature and position of the indusial covering forms one of the leading characters for the separation of genera under the Hookerian scheme of classification, while the Preslian scheme lays stress on the character of the venation, the fundamental branching of the fibro-vascular system of the plant. A more rational and natural scheme combines with these the habital and biological characters that serve to group in each genus ferns that really have a natural relation to one another.

In so large a group of plants as that presented by this family we must expect to find the greatest diversity of size and structure, dependent on the geographical distribution, the altitudinal distribution, and on the ecological conditions under which the various members of the family have become developed. Marsh, swamp, rocky hillside, cliff and moist ravine each have their characteristic species in every country, while the trees of every tropical region support an extensive epiphytic series which varies with every considerable change of altitude. Even exposed cliffs in semi-arid regions support their own peculiar ferns, which have become adapted to conditions that at first would appear wholly unsuited to fern-growth. Obviously only a few of the more common species which grow wild or in cultivation can be mentioned here.

The sword-fern (*Nephrolepis*), some forms of which are known in cultivation as the "Boston Fern," is a native of tropical America, occurring frequently in peninsular Florida. In its native haunts it is more commonly found on the trunks of palm-trees, though it often grows on the ground or on rotten wood. It is a favorite in cultivation, either in hanging baskets or in jardinières, and requires a rich soil and moist surroundings to thrive best. The sori are provided with a kidney-shaped indusium.

The maidenhairs (*Adiantum*) are perhaps the most graceful of the herbaceous ferns. Over 60 species are known, many of which have long been in cultivation. The luxuriant split-leaved *A. Farleyense* and the numerous fine-leaved varieties of *A. cuneatum and A. gracillimum* are among the most graceful in cultivation. Owing to their readiness to wilt most maidenhairs thrive best in Wardian cases.

In late years Japanese fern-balls have become popular in cultivation, consisting of the slender rootstocks of a species of *Davallia* wrapped about a mass of peat-enclosed soil, and held in form by wires. The Davallias are graceful ferns mostly confined to the Old World, though related genera are found in the American tropics. Numerous species are found in cultivation in the larger conservatories. Among our wild species the ostrich-fern (*Matteuccia*) is one of the best for out-of-door cultivation, to which it readily yields. It grows in graceful crowns from an erect rootstock, and has a bright green color. Its spore-bearing leaves are curiously rolled together so as to have the appearance of pods containing the copious sporangia. It requires a moist soil for its growth, and when growing wild thrives best in low ground. Other ferns suited for bed-cultivation are the graceful wood-ferns (*Dryopteris spinulosa*, and related species) and the Christmas-fern (*Polystichum*), both with dark foliage and crown-like habit, and the hay-fern (*Dennstædtia*) with a foliage of lighter green and a more scattered habit of growth resulting from its creeping rootstocks. The wood-ferns and Christmas-fern are firm in texture, and remain green throughout the winter; the hay-fern dies down with the early frosts. Another delicate pale-green species suitable for cultivation is the New York fern (*Dryopteris Noveboracensis*), which, however, has a range from New England to Alabama.

For rockeries the bladder-fern (*Filix fragilis*), the smaller spleenworts (*Asplenium trichomanes* and *A. platyneuron*), the rock-brake (*Pellæa*), and the curious walking-leaf are common among the best native species; and all thrive best if the rocks are part limestone. The last-named fern has a peculiar habit among our native species, shared, however, by many exotic ferns. The leaf, which is simple and tapers to a slender point from a rounded lobed base, takes root at the apex and forms a new plant, whose leaves may again take root and form still other plants. This peculiarity of taking steps away from the mother plant has given the name walking-leaf to this small fern, whose leaves range from 4 to 10 inches in length.

Aside from decorative value, ferns have little utility. The matted tufts of soft hair-like scales of some of the Hawaiian tree-ferns (*Cibotium*) are collected in commercial quantities and used for filling mattresses under the name "pulu." The male-fern (*Dryopteris filix-mas*) and some of its near allies are used in medicine as a vermifuge, and the soft parts of certain species are used for food. The mission of the fern, however, seems to be an æsthetic one, to minister grace and beautify the duller and more prosaic sides of nature.

7. In point of grace and delicacy none of the ferns as ordinarily known can equal the filmies, which flourish best at the higher elevations of tropical lands. These ferns differ from the true ferns not only in the form of the sporangium, and its attachment to a thread-like receptacle, but also in the texture of the leaf, whose blade is often only a single cell thick, so that the leaf is strongly translucent. Add to this delicacy of texture the most exquisite fineness of cutting and pattern, and place the leaves dripping with diamond dew-drops in masses on trunks of tree-ferns in the midst of a tropical luxuriance, and you have perhaps the nearest approach to a fern-paradise that could be imagined by the most ardent lover of nature. Such a picture can be found in the mountains of Jamaica and in many other tropical islands. The filmy ferns belong chiefly to the genera *Trichomanes* and *Hymenophyllum*, and although many are apparently so simple, the *Hymenophyllaceæ* form one of the most highly differentiated families among the ferns. A few others simulate them in texture, like the delicate New Zealand species of *Leptopteris* and some species of *Asplenium* in the American tropics, but these are representatives of two distinct families. The genus *Loxsoma* represents a structural connecting-link between the genus *Davallia* and the filmy ferns, and this is apparently their only point of kinship. Two species of *Trichomanes* occur under moist rocks in some of our Gulf States, one of them scarcely over a half inch in height.

IV. *Salviniales.*— Next to the ferns are the members of this order, in which spores of two sorts are produced in special conceptacles resembling small pods or spheres. There are two types of habit represented, one series (*Salviniaceæ*) floating on the surface of water, and the other (*Marsileaceæ*) rooting in mud. *Salvinia*, with oval leaves, is occasionally seen in cultivation but is rare in a wild state. *Azolla* is found in great abundance in Florida, sometimes covering the surface of ponds with its delicate branching small-leaved stems. A second species occurs in California. *Marsilea* is the type of the second family, and has a four-parted leaf resembling that of *Oxalis*. It grows on the wet borders of ponds, or if the water becomes high, it elongates its leaf-stalks and the leaves float on the surface like four-leaf clovers. Its conceptacles are oval and are borne on short stalks. One species grows abundantly at Bantam Lake, Connecticut, and others in Florida and in the far Northwest, where they are more common. *Pilularia* is a second genus of the family with thread-like leaves, and spherical pill-like conceptacles. Our single species occurs in California, Oregon, and Arkansas.

V. *Equisetales.*—About 25 species forming a single genus and family make up this order. There are two types of growth, both common species of *Equisetum,* which have received different popular names. One is the field horsetail, which appears in low sandy ground early in spring, sending up a flesh-colored stalk terminating in a cone, followed by the "horsetails," which are the vegetative parts of the plant, consisting of a central hollow stalk with angular whorled branches. The leaves are reduced to sheaths encircling the stem. Under the surface-shields that cover the cone, the spores, which in mass resemble a fluffy mold, are borne in sporangia. The peculiar appearance of the spores is due to the fact that each is surrounded by an outer covering which splits spirally into four branches arranged cross-like at one end of the spore. These are exceedingly hygroscopic, and they absorb water and coil up at the slightest breath; then uncoiling as soon as the moisture dries, they jostle each other about. The purpose of this mechanism is to scatter the spores gradually from the sporangia at maturity. The second type of *Equisetum* grows on banks with stiff, jointed, rush-like, often clustered stems surrounded at the joints by a light-colored sheath. These also bear cones in late spring similar to those of the field-horsetail. These plants are sometimes called "scouring-rushes," from the fact that their roughness caused by silica in the epidermis led to their use for scouring floors and woodenware.

VI. *Isoetales.*—This order likewise contains a single genus (*Isoetes*) and family. The plants are aquatic, either growing submerged or on the shores of ponds and rivers. They consist of a short fleshy base, bearing a cluster of leaves which are broadened at the base and contain an axillary sporangium, and end in awl-like joints. The position of the order is problematical, as these obscure plants seem to show unexpected affinities with several other groups. They are eusporangiate and produce spores of two sorts.

VII. *Lycopodiales.*—This order contains the ground-pines or club-mosses and the selaginellas or little club-mosses, which are alike in producing their spores in the axils of leaves, but differ in the spore-characters. The club-mosses (*Lycopodium*) have yellow dust-like spores, which are used commercially under the name of lycopodium powder for the relief of chafing and for producing flash-lights, since they contain a large amount of oil and are highly inflammable. *Selaginella,* on the other hand, produces two kinds of spores — *microspores,* from which develop the male prothalli, and *macrospores,* from which develop the female prothalli. The lycopods are familiar as Christmas greens, but are rarely seen in cultivation. Over 100 species are known of which 17 are found within the limits of the United States. *Selaginella,* on the other hand, is frequent in cultivation, some of the species being exceedingly delicate and graceful; but most of our native species are inconspicuous and little known. The "resurrection-plant" has already been mentioned. Some of the tropical species attain enormous size as climbing-plants. Over 600 species have been described, of which 27 are found in the United States. A third family is represented in the Southern States by a leafy epiphyte (*Psilotum*). Two other small genera occur in Australia and neighboring islands.

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Feronia, fĕ-rō'nĭ-a, (1) An ancient Italian goddess, who presided over woods and orchards. The ancient grove, not far from Anxur (Terracina), was consecrated to her, and is very celebrated. Emancipated slaves received a cap in her temple as a badge of freedom. (2) A genus of beetles of the family *Carabidæ.* (3) A genus of plants allied to the orange.

Ferrand, Marie Louis, mä-rē loo-ē fĕ-räṅ, French soldier: b. Besançon, France, 12 Oct. 1753; d. Santo Domingo, 7 Nov. 1808. He served as a volunteer in the American Revolution, was imprisoned during the French Revolution as a friend of Lafayette, but was released and placed in command of a brigade in the armies of Ardennes and Sambre-et-Meuse. He went with General Leclerc to Santo Domingo 1801, succeeding Le Clerc as governor-general 1802. He was besieged by General Dessalines 1804, but withstood until the arrival of reinforcements under Admiral Missiessy, holding the eastern part of the island for several years, but, defeated at Paolo Fincado by Ramireshu, he shot himself on the battlefield.

Ferrara, fĕr-rä'rä, a province of Italy; on the north boundary is the Po River and on the east the Adriatic Sea; area, 1,144 square miles. The low ground is marshy, but good crops are raised on the uplands. The climate is unhealthful. Ferrara was once a duchy of Italy; it was held by the House of Este as a papal fief till 1597. It became a part of the States of the Church in 1598. In 1860 it was incorporated into the kingdom of Italy. Pop. 271,776.

Ferrara, Italy, city, capital of the province of Ferrara, 26 miles north-northeast Bologna, in a fertile but unhealthy plain, at a short distance from the north branch of the Po. It is a large and well-built town, with spacious and regular streets, and is enclosed by a wall seven miles in circuit. It is defended on the west side by a citadel regularly fortified. In the middle of the city is a castle, flanked with towers, and surrounded by wet ditches, which was once the residence of the dukes. Ferrara, though still retaining many traces of its former grandeur, has long been falling into decay; its pavements are overgrown with grass, and the staircases and balconies of many of its noble palaces are overrun with ivy, while others are without either doors or windows. The population has also fallen to one fourth of its former amount. It has a cathedral and numerous churches, most of which contain valuable paintings, together with some interesting specimens of sculpture. There are here a public gallery of paintings, called the Palazzo del Magistrato, containing many excellent works by the leading painters of the Ferrara school, of which Dosso

Dossi was one of the leaders. The city contains also a school of medicine and jurisprudence, and a public library containing about 100,000 volumes and 900 manuscripts, the latter including some of those of Ariosto and Tasso. The house in which Ariosto was educated, and that in which he lived during his latter years, and known by the names respectively of the Casa degli Ariosti and the Casa d'Ariosto, are shown to strangers. The latter is now national property, and is ranked among the national monuments. Another object of interest is the cell in the Hospital of St. Anna, in which Tasso was imprisoned. The house occupied by Guarini, the author of the Pastor Fido — the Casa Guarina — is still inhabited by the marquises of that name. Ferrara is an archbishopric: the bishopric dates from 661; its archbishopric was founded by Clement XII. in 1735. It carries on some trade in corn and other produce of the soil. There are manufactures of silk ribbons, wax candles, and brazen utensils; tanneries and glass works. Pop. of the commune (1901) 87,-648.

Ferrari, Gaudenzio, gâ-dĕn'dzē-ō fĕr-rä'rē, Italian painter: b. Valduggia, Piedmont, 1484; d. Milan 31 Jan. 1549. A scholar of Andrea Scotto, he also caught some inspiration from Da Vinci and Raphael. The chief characteristics of his style are correct and vigorous delineation, strong but often hard coloring, considerable power of invention, and skill in the arrangement of drapery. He executed innumerable paintings both in fresco and in oil, the greater part of which are possessed by the Lombard galleries. His most comprehensive work, the frescoes at Varallo, in Piedmont, represents the Passion; another good specimen of his work, the 'Martyrdom of St. Catharine,' is in the Brera Gallery at Milan. He died at Milan in 1549. The chief of his pupils was Andrea Solario. See Colombo, 'Vita di Ferrari' (1881).

Ferrari, Giuseppe, gwē-sep'pā fĕr-rä'rē, Italian philosopher and historian: b. Milan, Italy, 1812; d. Rome 1 July 1876. He wrote: 'On Error' (1840); 'Campanella's Religious Opinions' (1840); 'Machiavelli as Judge of the Revolutions of Our Time' (1849); 'Philosophy of Revolutions' (1851); 'History of Italian Revolutions, or Guelphs and Ghibellines' (1856–8); etc.

Ferrari, Paolo, Italian dramatist: b. Modena 5 April 1822; d. Milan 9 March 1889. He produced his first comedy, 'Bartolommeo il Calzolajo,' in 1847. Of his many later works, 'Goldoni' (1852), and 'Parini e la Satira' (1857) rank as the finest examples of modern Italian comedy, and are distinguished — as, indeed, are most of his plays — by a piquancy and sparkling dialogue, as well as cleverness of construction and occasional sharp contrasts, such as have been mostly identified with French comedy. A collection of his 'Opere drammatiche' was published at Milan in 14 volumes (1877–80). In 1860 he became professor of history at Modena, and afterward in the Academy at Milan.

Ferraris, Carlo Francesco, kar'-lō frän-chĕs'kō fĕr-rä'rēs, Italian political economist and statistician: b. Moncalvo, Alessandria, Italy, 15 Aug. 1850. In 1878 he was appointed professor extraordinary in the University of Pavia and in 1885 professor of statistics at Padua. Among his works are: 'La Statistica e la Scienza delle Amministrazione nelle Facultà Giuridiche' (1878); 'Moneta e Corso Forzoso' (1879); 'Saggi di Economia Statistica e Scienze delle Amministrazione' (1880); 'La Statistica del Movimento dei Metalli Preziosi fra l'Italia e l'Estero' (1883); 'L'assicurazione obbligatoria e la risponsibilita dei Padroni, ed imprenditori' per gli sufortuni sul lavoro' (1890); 'Principii di scienza bancaria' (1892).

Ferraris, Galileo, gä-lē-lā'ō fā-rä'rēs, Italian physicist and electrician: b. Livorno, Piedmont, 1847; d. 1897. He was graduated in civil engineering at the Royal School of Engineering' (1869). On being appointed professor of physics in the Industrial Museum and in the Military College at Turin, he devoted himself to the study of technical physics and was in a short time recognized as one of the foremost electricians in Europe. In 1885 his investigations into the properties of various electrical transformers resulted in the discovery of the rotatory magnetic field, produced by two alternating currents with a quarter difference of phase. This discovery made possible the two-phase motor. In 1893 he published a theory of the single-phase alternating motor, and to him the present development of alternating currents must largely be credited. His works on such subjects are standard authorities, and among them must be mentioned: 'On the Difference of Phase of Currents'; 'On the Lag of Induction'; and 'On the Waste of Energy in Transformers' (1887).

Ferrate, fĕr'-āt, in chemistry, a salt made of ferric acid, a weak, unstable compound of iron and oxygen, with bases. See Iron.

Ferrazzi, Giuseppe Jacopo, yä'kō-pō gwē-sep'pā fĕr rät'sē, Italian author: b. Cartigliano, Italy, 20 March 1813; d. Bassano, Italy, 1881. He published: 'Hand-books to Dante' (1865–77); 'Torquato Tasso: a Biographical, Critical, and Bibliographical Study' (1880); and studies of Ariosto, besides an 'Italian Anthology' (1858–9).

Ferree, James Barr, American architect and art critic: b. Philadelphia, Pa. He was graduated from the University of Pennsylvania 1884. He is the president of the department of architecture in the Brooklyn Institute of Arts and Sciences; is a member of several American and foreign architectural societies, and has written many professional papers for leading architectural and other periodicals.

Ferreira, Antonio, äṅ-tō'nē-ō fĕr rā'ī-rä, Portuguese poet: b. Lisbon, Portugal, 1528; d. 1569. He held a professorship at the University of Coimbra, and subsequently became judge of the supreme court at Lisbon. During his leisure he composed sonnets, odes, and epigrams, which earned for him the title of the "Portuguese Horace." His high literary reputation, however, is due to his 'Epistles' and the tragedy of 'Inez de Castro,' the second regular tragedy produced in Europe. The subject is a popular Portuguese legend; and the play is modeled upon the Greek tragic drama.

Ferreira de Vasconcellos, Jorge, zhōr'zhā fĕr-rā'i rä dā vas"kon-sel'ōsh, Portuguese dramatist: b. Coimbra or Montemor o Velho; d. 1585. His prose comedies, 'Euphrosyne' (1560); 'Usilippo' (1618); 'Aulegraphia'

(1619), are strictly national, and are valuable both philologically and for the proverbs in which they abound. He wrote also a romance of chivalry, 'The Triumph of Sagramor' (1567).

Ferreiro, fĕr-rā'ĭ-rō, a Brazilian tree-frog (q.v.).

Fer'rel, William, American meteorologist: b. Bedford County, Pa., 1817; d. 1891. He was graduated at Bethany College, Virginia, in 1844, and early attracted attention by his researches in meteorology, of which science he was the first to propound the fundamental principles. From being an associate in the work of putting forth the 'Nautical Almanac' he was appointed to the United States Coast and Geodetic Survey. From 1882 to 1886 he was an assistant in the Signal Service Bureau, and the maxima and minima tide-predicting machine which he invented has been used for many years in government coast surveys. Among his writings are: 'Popular Treatise on the Winds, Monsoons, Cyclones, etc.' (1889); 'Tidal Action'; 'Meteorological Researches.'

Ferreras, Juan de, hoo än' dā fĕr-rā'ras, Spanish historian: b. Labañeza, Spain, 7 June 1652; d. 8 June 1735. He was a scholarly priest, whose careful 'History of Spain' (1700–27) is authoritative for the period prior to 1598; his 'Poems' (1726) are less important.

Fer'rers, fĕr'ėrz, **Norman Macleod,** English mathematician: b. Gloucestershire 11 Aug. 1829. He was educated at Eton and Gonville and Caius College, Cambridge, of which latter institution he has been master from 1880. He has published: 'A Treatise on Trilinear Coordinates' (1861); 'A Treatise on Spherical Harmonics' (1877).

Ferret, a small and slender variety of polecat (q.v.), usually an albino, yellowish white, with pink eyes. It is bred chiefly as a domestic exterminator of mice and rats, and is used also in rabbit hunting. Unlike the ordinary polecat, it is exceedingly sensitive to cold, and must be well protected in northern climates which do not at all affect the polecat. Though bred in confinement, the ferret exhibits no affection, even for its master; and must be carefully secured, lest it escape and do injury. It has been known to hurt infants, and, if it gets at poultry, it will kill far more than it can eat. The female even, at times, devours her young. A cross between the ferret and the polecat is sometimes used.

Ferret, Col de, cōl de fē-rā, a pass of the Alps, in Switzerland, connecting Orsières, in the latter country, with Cormayeur, in Italy. Height 8,320 feet above sea-level. See ALPS.

Ferreting, the sport, well known in England, of chasing rabbits or hunting vermin (rats) with trained ferrets (q.v.). To pounce upon the victim and kill ("pith") it by a single bite in the neck, is regarded as a mark of high excellence in a ferret by ferreters. The principal use of ferrets, however, is not to kill the prey, but to go into their burrows and hiding places, muzzled, and drive out the animals.

Ferri, Ciro, chē'rō fĕr'rē, Italian painter, architect, and engraver: b. Rome 1634; d. there 4 Sept. 1689. He was a pupil and imitator of Pietro da Cortona, but displays less grace and less richness of color than his master. His canvases are scattered through Italy. He completed the frescoes in Pitti Palace, begun by da Cortona, and among his other paintings are the ceiling of the Annunziata and the cupola of St. Agnese, Piazza Navona, Rome, unfinished; 'Repose in Egypt'; 'Alexander Reading Homer'; 'Death of Dido,' Dresden; 'Triumph of Bacchus,' London. Among his architectural pieces are the altars of Chiesa Nuova and other churches in Rome. He left a great number of etchings.

Ferri, Enrico, en rē'kō fĕr'rē, Italian sociologist: b. San Benedetta-Po, Mantua, 25 Feb. 1856. He was educated at Bologna, Pisa, and Paris, and was admitted to the bar. He practises law at Rome, having been a member of the Chamber of Deputies since 1886, representing a socialistic following. Among his works are: 'Sociologie Criminelle' (1893, English translation 1896); 'La Scuola positiva di dirrito criminale' (1883); 'Difese pmali e studi di giurisprudins a' (1898); 'Deliquenti nell' arte' (1901).

Ferri, Luigi, loo-ē'jē fĕr'rē, Italian philosopher: b. Bologna 1826; d. Rome 1895. He entered the normal school, Paris, 1847, teaching philosophy in Châlon, Evreux, Dieppe, Blois, and Toulouse 1850–5. Returning to Italy he became secretary of public instruction 1860, professor of philosophy and history at the Institute of Florence 1863, and at the University of Rome 1871. Among his works are: 'Il Genio d'Aristotele' (1866); 'Studii su Leonardo da Vinci' (1871); 'Il senso commune nella filosofia' (1872); 'Sulla dotrina psicologica dell' associazione' (1878); 'la Psicologia di Pietro Pomponazzi' (1877); and in French 'Essai sur l'histoire de la philosophie en Italie au XIXme siècle' (1869); and 'la Psychologie de l'Association depuis Hobbes jusqu'à nos jours' (1883).

Ferric Oxide, or **Sesquioxide of Iron.** See HEMATITE; IRON.

Ferricyanide of Potassium. See HYDROCYANIC ACID.

Ferrier, fĕr'ĭ-ėr, **David,** Scottish neurologist: b. Woodside, near Aberdeen, 1843. In 1872 he became professor of forensic medicine in King's College, London, a chair which he exchanged in 1889 for that of neuro-pathology, specially founded for him. He has gained a wide reputation by his investigations of the structure of the brain, particularly in connection with the localization of its functions. His results are stated in his works on the 'Functions of the Brain' (1876); and 'Cerebral Localization' (1878). His researches necessitated a large number of experiments on living animals, and he has, in consequence, been strongly attacked by the anti-vivisectionists.

Ferrier, Joseph Marie Augustin Gabriel, zhō-zeph mä-rē ō-güs-tăṅ gä-bri-el, French painter: b. Nimes, France, 29 Sept. 1847. He studied under Lecocque Boisbaudran. His work has been recognized as vigorous and elevated. He won the Grand Prix de Rome in 1872, and was decorated with the cross of the Legion of Honor in 1884. Among well-known works of his are: 'David Conqueror of Goliath,' in the Nimes Museum, and 'Saint Agnes, Martyr,' in the museum at Rouen.

Ferrier, Susan Edmonstone, Scottish novelist: b. Edinburgh, Scotland, 7 Sept. 1782; d. there 5 Nov. 1854. She was an intimate friend of Sir Walter Scott and of some of the most eminent literati of her day. She wrote three novels: 'Marriage' (1818); 'The Inheritance' (1824); and 'Destiny, or the Chief's Daughter' (1831). They are vigorous and lively pictures of Scottish life and character, but exhibit a certain hardness and want of sympathy at times.

Ferris, Albert Warren, American physician: b. Brooklyn, N. Y., 1856. He was graduated at the New York University 1878, and at the Columbia University College of Physicians and Surgeons 1882. He became assistant in neurology, Columbia University, 1893, and assistant in medicine in the New York University medical department 1898. He has been an editor of the 'Medical Critic' since 1901.

Ferris, George Titus, American writer on music. His works include: 'Great German Composers' (1879); 'Great Italian and French Composers' (1879); 'Great Singers' (1880–1); 'Great Violinists and Pianists' (1881).

Ferris, George Washington Gale, American engineer: b. Galesburg, Ill., 14 Feb. 1859; d. Pittsburg, Pa., 22 Nov. 1896. He was graduated at Rensselaer Polytechnic Institute in 1881; went to Pittsburg, Pa., in 1892, while in the employ of the Louisville & Nashville Railroad, to inspect the structural work of the railroad bridge at Henderson, Ky. About this time he conceived the idea of a gigantic revolving wheel which he built in Pittsburg and erected for the World's Columbian Exposition in Chicago in 1893. The wheel could hold more than 1,000 passengers, and during the Exposition it was one of the great attractions.

Ferris, Isaac, American Dutch Reformed clergyman and educator: b. New York 9 Oct. 1798; d. Roselle, N. J., 1873. He was graduated at the Reformed Dutch Seminary, New Brunswick, N. J., 1820; was pastor at New Brunswick 1821–4; Albany 1824–6, and New York 1836–53. He was chancellor of the University of the City of New York 1852–70.

Ferris, Mary Lanman Douw, American author: b. Poughkeepsie, N. Y., 22 May 1855. She was married to M. P. Ferris (q.v.) 4 Sept. 1879. She is the founder of the Daughters of the Cincinnati, and was instrumental in establishing the museum in Van Cortlandt Park, New York, now maintained by the Colonial Dames. She is the editor of the 'Bulletin of the Society of American Authors,' and has published: 'Dutch Nursery Rhymes of Colonial Times'; 'Random Rhymes of Old Dutch Times'; 'History of Fort Crails'; etc.

Ferris, Morris Patterson, American lawyer: b. New York 3 Oct. 1855. He is a son of I. Ferris (q.v.) and was graduated from the law department, University of New York, 1876. He is president of the Yonkers Historical and Library Association; secretary of the Sons of the Revolution; secretary of the Colonial War Lake George Monument Committee, secretary of the New York State Historical Association, registrar of the Society of the War of 1812, and treasurer of the Society of American Authors.

Ferro, fĕr'rō, or **Hierro,** yĕr'rō, the most westerly of the Canary Islands, and the smallest of those which are inhabited; longitude of the western extremity, 18° 9'. It is about 18 miles long and 9 miles broad. It is a rocky, volcanic island, rising to the height of over 4,100 feet, and has numerous extinct craters, and a number of warm springs. It is by no means fertile, but good wine and brandy are made, and excellent figs are grown on the island. This island was once considered the most western point of the Old World, and geographers reckoned longitude from it. For this purpose the longitude of Ferro was in France taken as exactly 20° west of that of Paris, though this meridian really passes some miles to the east of the island. German geographers adhered longest to the meridian of Ferro in constructing their maps. Pop. 5,980.

Ferrol, fĕr-rōl', or **El Ferrol,** Spain, seaport in the province of La Coruña; about 12 miles northeast of the town of La Coruña; on the Bay of Betanzos, a few miles from the ocean. The bay forms one of the best natural harbors in Europe, and the narrow channel which leads to it is defended by the forts San Felipe and Palma. Charles III. built here an arsenal for the Spanish navy, which is still in use. The manufactures consist chiefly of swords, cutlery, and military and naval equipments, sail-cloth, and leather. The sardine fishery is also important. The principal imports are coal, iron, timber, cotton, and grain; the chief exports are fish, iron, and vinegar. Pop. (1900) 25,281.

Ferrotype, or **Energiatype,** in photography, a process first made public by Robert Hunt in 1844, in which the negative was developed by a saturated solution of protosulphate of iron, with mucilage of gum-arabic, and fixed by soaking in water to which a small quantity of ammonia or hyposulphite of soda had been added. See PHOTOGRAPHY.

Ferrous Sulphate, Ferrous Compounds. See IRON.

Ferry, Gabriel, gä-brī-el fĕ-rē, the Elder (pseudonym of EUGÈNE LOUIS GABRIEL FERRY DE BELLEMARE, ü-zhen loo-ē gä-brī-el fĕ-rē de bel-mar), French author: b. Paris, France, 30 May 1809; d. 1852. His stories appeared first serially in the 'Revue des Deux Mondes.' He made repeated voyages to the United States; in his last voyage, to California, he lost his life in the burning at sea of the ship Amazon. Among his tales are: 'The Woodranger'; 'Hunting with Cossacks'; 'Costal the Indian'; 'Scenes of Military Life in Mexico'; 'The Squatters.'

Ferry, Gabriel, the Younger, French author, dramatist, and novelist: b. Paris 30 May 1846. He is a son of Gabriel the Elder and employs the same pseudonym. He has written plays: 'Réginah' (1874), being one of the best; while his miscellaneous prose includes: 'The Last Years of Alexandre Dumas, 1864–70' (1883); 'Balzac et ses amies' (1888); 'The Exploits of Cæsar: a Parisian Novel' (1889).

Ferry, Jules François Camille, zhül frän-swä cä mēl fĕ-rē, French statesman: b. Saint Dié, France, 5 April 1832; d. Paris 17 March 1893. He was admitted to the Paris bar in 1854, and speedily identified himself with the opponents of the empire. His hostility was carried into journalism, and a series of articles in the 'Temps' ('Times'), were republished as 'The Fantastic Tales of Haussmann' (1865). In 1869 he was elected to the National Assembly, where he voted against the war with Prussia; and during the siege of Paris by the Germans (1870–1) he played a prominent part as central mayor of the city. He was minister to Athens 1872–3, and in 1879 became minister of public instruction and began an agitation against the Jesuits. Their expulsion was effected, and brought about the dissolution of the ministry in September 1880. M. Ferry then formed a cabinet, which remained in office till November 1881. In February 1883 he again became premier, with a policy of "colonial expansion," involving a war in Madagascar and the invasion of Tonquin, where a disaster to the French troops brought about his downfall in March 1885. In 1890 he was made senator. His 'Discours et Opinions' appeared in 7 volumes (1893–8).

Ferry, Orris Sandford, American statesman and soldier: b. Bethel, Conn., 1823; d. 1875. He was graduated at Yale in 1844. After filling important political places in his native State he was in 1859 elected to Congress as a Republican, and sat as one of the famous Committee of Thirty-Three appointed to consider and report upon the condition and relations of the seceded States. He was colonel of the Fifth Connecticut Volunteer Infantry (1861), and served from 1862 to the end of the war as brigadier-general of volunteers. He was elected to the United States Senate as a Republican in 1866, and re-elected in 1872.

Ferry, Thomas White, American politician: b. Mackinac, Mich., 1 June 1827; d. Grand Haven, Mich., 14 Oct. 1896. He served in the State legislature and from 1865 to 1871 was a Republican member of Congress. He was elected to the United States Senate; and on the death of Henry Wilson was acting Vice-President of the United States from 1875 to 1877.

Fersen, fĕr'sen, **Hans Axel,** Count von, Swedish military officer: b. Stockholm, Sweden, 1755; d. there 20 June 1810. He came to America on the staff of Rochambeau; fought under Lafayette and received from Washington the Order of the Society of the Cincinnati. Later he went to France, where he became a favorite at court, and was the disguised coachman at the flight of the royal family from Versailles during the Revolution. He returned to Sweden, where he was received with honor, and in 1801 was made grand marshal of that country. On suspicion of complicity in the death of Prince Christian of Sweden, he was seized by a mob while marshaling the funeral procession, and tortured to death.

Fertilization of the Ovum. See Embryology.

Fertilizers. Any substance applied to the soil to aid the growth of plants may properly be called a fertilizer. The name has, however, become associated with a class of materials manufactured and sold for this purpose, the handling of which now constitutes an important industry.

The constituents of the plant that it derives from the soil are nitrogen, phosphorus, sulphur, potassium, sodium, calcium, magnesium, iron, aluminum, manganese, silicon, chlorine. Of these, nitrogen, phosphorus or phosphoric acid, and potassium or potash, are the substances most likely to be deficient in the soil, and therefore the ones that are contained in fertilizers. A fertilizer may contain any one or more of these substances.

The chief distinction between the functions of farm manure and commercial fertilizers may be stated in a general way to be that farm manure increases crop production by improving the condition of the soil, while the commercial fertilizers act directly as a plant-food without materially affecting soil structure.

It is evident, therefore, that commercial fertilizers are not an adequate substitute for farm manure or green manures for producing permanent improvement. Their function consists in supplementing the available supply of plant-food in a soil which may be deficient in any one or more of the substances usually contained in fertilizers. On virgin soils commercial fertilizers are generally superfluous; but as loss of plant-food goes on under cropping, restitution must be made and, as this is usually not adequately done with farm manure, fertilizers are finally called upon.

In regions where there is large loss of plant-food from the soil due to leaching, there must be a large excess of potential fertility in order that the growing crop shall at all times be supplied with available plant-food. A deficiency in any constituent will check growth by compelling the plant to depend upon a less readily available supply. Commercial fertilizers are useful by presenting readily available food to the plant when it is beginning growth, and when a deficiency in the supply is likely to produce a permanent injury.

As the price of land increases, as the cost of labor becomes greater, and as the value of the crop augments it becomes more important that maximum crops shall be raised, and for these reasons commercial fertilizers have greatest sale where agriculture is most intensive. There are also many special crops requiring more of one plant-food than of another, and the needs of these can best be met by the use of commercial fertilizers.

Historical.— The value of animal excrements applied to soils on which crops were grown has been appreciated by the husbandman as far back as records go. Why this manure is beneficial, and what relation its constituents bear to those of plants, are matters which have only been worked out during the last century, and knowledge of which has led to the use of fertilizers composed of mineral salts, commonly known as commercial fertilizers.

The earliest record of the use of mineral salts for increasing the yield of crops is contained in a book entitled 'A Discourse Concerning the Vegetation of Plants.' The title page also contains the following announcements: "Spoken by Sir Kenelm Digby, at Gresham College, on the 23d of January 1660. (At a meeting of the Society for Promoting Philosophical Knowledge by Experiments. London. Printed for John Williams, in Little Britain, over against St. Botolph's Church, 1669.)" The author advocates the use of saltpetre to increase the yield of crops, and says: "By the help of plain saltpetre, dilated in water and mingled with some other fit earthy substance, that may familiarize it a little with the corn into which I endeavored to introduce it, I have made the barrenest ground far out-go the richest, in giving a prodigiously plentiful harvest." His dissertation does not, however, show any true conception of the reason for the increase in the crop through the use of this fertilizer. The almost total absence of any knowledge of the composition of plants, and the crude state of chemistry at that time, made this quite impossible.

It was not until 1804 that any light was thrown upon the subject. In that year was published ‘Recherches Chimique sur la Végétation,’ by Theodore de Saussure. This brilliant French investigator was the first to appreciate the significance of the ash ingredients of plants; to point out that without them plant life was impossible, and to show that only the ash of the plant was derived from the soil.

Justus von Liebig is commonly regarded as having laid the foundation upon which the commercial fertilizer industry has been built. Certainly his reports to the British Association in 1840 and again in 1842 made the British agriculturists regard as they had never done before the importance of a sufficient supply of certain readily soluble mineral substances in the soil. He supported the contention of De Saussure regarding the importance of mineral matter in the plant, and its extractions from the soil. He refuted the theory, at that time popular, that plants absorbed their carbon from humus, but made the mistake of attaching little importance to the presence of humus in the soil. He showed the importance of potash and phosphates in manures, and in his earlier writings spoke of the value of nitrogen for fertilizing crops, but afterward made the mistake of denying the usefulness of nitrogenous manures for plants, holding that the ammonia washed down by rain affords a sufficient supply.

By the middle of the 19th century it was well understood that potash, phosphoric acid, and nitrogen were valuable constituents of fertilizers, and that the other mineral elements of plant-food, with the occasional exception of calcium, were always present in sufficient quantity in arable soils. It has since been shown that the family of plants known as the *Leguminosæ* have the ability to secure a large part, at least, of their nitrogen from the air, and that as these plants are very rich in nitrogen they leave a supply of nitrogen in organic matter in the soil when plowed under, or even when the roots alone are allowed to remain in the soil.

Direct and Indirect Fertilizers.— Fertilizers that add to the soil only mineral constituents that are taken up by plants may be called direct manures. However, soil amendments are sometimes used which contain in addition to or in place of these substances certain constituents that increase the crop without adding to the supply of the fertilizing constituents. These may be called indirect fertilizers. Farmyard manure is an example of this, as in addition to the mineral constituents of the plant it adds a quantity of purely organic matter which, through its decomposition, exerts a very beneficial effect upon crop-production.

Complete and Incomplete Fertilizers.— Fertilizers, containing nitrogen, phosphoric acid, and potash, mixed together so that an application of the preparation will result in bringing each of these substances in contact with the soil wherever applied, are called complete fertilizers. The proportions in which the constituents are mixed vary with the different brands and factories. Sometimes a fertilizer of this kind will be advertised for use on a certain crop, and will contain the nitrogen, phosphoric acid, and potash in the proportion in which the manufacturer believes they will produce the best yields of that crop. He has, however, no means of knowing the requirements of the soils on which the fertilizer is to be used.

Incomplete fertilizers contain only one or two of the customary fertilizer ingredients.

Available and Unavailable Fertilizing Material.— The fertilizing constituents in a fertilizer may be present in a readily soluble or a difficultly soluble condition, depending upon the chemical combinations and, to some extent, upon the physical condition in which they are found. Thus phosphoric acid when in the form of phosphate rock as it is taken from the deposits is a very difficultly soluble substance, and plants can avail themselves of it only in small quantities. After the same rock has been treated with sulphuric acid the phosphoric acid is in a form in which it can be readily used by plants. To a more limited extent the same is true of the phosphoric acid in basic slag, which, when the slag is in an unground condition, is not of much use to plants, but when the slag has been finely ground furnishes a valuable form of plant-food.

When the fertilizing material is in a condition in which it can be readily used by the plant it is said to be «available,» and when it can be used only with great difficulty it is said to be «unavailable.» It is important that the purchaser should know in what form the constituents are present in a fertilizer.

Nitrogenous Fertilizers.— Nitrogen is taken up by most plants only in the form of a soluble salt; hence for the cereals and many other crops it is desirable either to have it in this form or to incorporate it in the soil in a condition in which it will readily be converted into a soluble salt. Plants like the clovers, alfalfa, peas, beans, etc., have the power of using the nitrogen of the air, and hence do not require nitrogenous fertilizers in such large amounts. These plants may be used to increase the supply of nitrogen in the soil. Nitrogen is the most expensive constituent of fertilizers, and is extremely important, as it is used in large amounts by plants and is likely to be deficient in soils. The form in which nitrogen is present in a fertilizer may make a great difference in its value and in the way in which it can be best applied. Nitrogenous fertilizers differ in having their nitrogen either in the form of a soluble salt or combined as organic material. Nitrate of soda and sulphate of ammonia are the forms in which soluble nitrogen salts are found on the market.

Ammonium Sulphate.— When coal is distilled a portion of the nitrogen is liberated as ammonia, and is found in the ammoniacal liquor which condenses when the products of distillation are cooled. Coal is distilled for the production of coal-gas for illuminating purposes, and also in the manufacture of coke. Gas-works and coke-oven thus provide a large share of ammoniacal liquor, which forms the raw material for the manufacture of ammonium salts. Another source of ammonia is the liquid condensed from the «water-gas» formed when a current of steam is forced over red-hot coal. The product obtained in any of these processes is a mixture of ammonium sulphide, carbonate, thiosulphate, thiocyanate, and chloride, dissolved in water.

To prepare this for use the liquid is heated and lime is added. The ammonia volatilizes partly as carbonate and sulphide, and partly as free ammonia, and is received in sulphuric acid, forming ammonium sulphate and driving off as gases carbon dioxide and sulphuretted hydrogen. The liquid is then evaporated in leaden pans until it crystallizes.

The world's output of ammonium sulphate in 1900 is placed at 493,000 tons, of which 270,000 tons were used as fertilizer.

Chemically pure sulphate of ammonia contains 21.2 per cent of nitrogen. The commercial product contains about 20 per cent of nitrogen. It is the most concentrated form in which nitrogen can be purchased for use as a fertilizer.

Nitrate of Soda.— This fertilizer now constitutes the principal source of nitrogen in artificial manures, having largely taken the place of Peruvian guano, which was extensively used for many years, and the profitable use of which did much to promote the extensive use of commercial fertilizers. The salt occurs in the crude condition called caliche, in enormous deposits, principally in the province of Tarapaca in northern Chile. The earlier records of these deposits extend back to 1820, but it was not until several years later that they were exploited. The portion of the country in which the deposits lie is a sandy desert where rain never falls. The altitude is 3,000 to 4,000 feet above the sea-level. The deposits are attributed to the action of minute organisms fixing in the soil, through countless ages, the nitrogen of the atmosphere, and leaving the product finally in the form of sodium nitrate that has crystallized out of solution in which it has at some time been held.

The raw product is found beneath a covering consisting of two layers, the upper one of sand and gypsum and the lower of baked clay and gravel. The thickness of the caliche varies from a few inches to 12 feet. It is extracted by boring through the upper layers and introducing a charge of blasting-powder, which, when fired, exposes a considerable quantity of the material. The nitrate is somewhat purified by crystallization before shipping. Iodine is a by-product in the purification process. The nitrate, when ready for shipment, contains about 96 per cent sodium nitrate, or about 16 per cent of nitrogen, 2 per cent of water, and small amounts of sodium chloride, sulphates, and insoluble matter.

The development of the nitrate industry may be appreciated from the fact that the product, which amounted in 1884 to 550,000 tons, increased to 1,000,000 tons in 1890, and to 1,475,000 tons in 1900. The output is exported almost entirely to Europe and the United States. It is held by many persons who have examined these deposits that at the present rate of mining they will be exhausted by the year 1930, in which case a serious deficiency in fertilizer nitrogen will occur, unless a new supply shall meanwhile have been discovered.

Other Nitrogenous Fertilizers.— A method for preparing what promises to be a valuable nitrogenous fertilizer has lately been worked out by a German chemist. The chief point of interest in this fertilizer lies in the fact that the nitrogen it contains is derived from the air, thus making use of an inexhaustible supply of that material. No artificial method for the fixation of atmospheric nitrogen has up to the present time been sufficiently inexpensive to make it a commercial success. The method referred to consists in heating lime and coal in an electric furnace and passing nitrogen gas over them. The product, calcium cyanamide, was tested in pots of soil and in field-tests at the Darmstadt and Posen experiment stations, and found to decompose in the soil with the formation of ammonia and nitric acid, and to furnish plants with nitrogen.

Attempts have been made, especially in recent years, to produce nitrate fertilizers by combining by electrical means the nitrogen and oxygen of the air, but these have so far not been reduced to a practical basis. Experiments with this end in view are now in progress at Niagara Falls.

Organic nitrogenous fertilizers include cotton-seed meal (7 per cent nitrogen when free from hulls), linseed meal (5.5 per cent nitrogen), castor-pomace (6 per cent nitrogen), and a number of refuse products from packing-houses, consisting of red-dried blood (13 per cent nitrogen), black-dried blood (6 to 12 per cent nitrogen), dried meal (13 per cent nitrogen), hoof-meal (12 per cent nitrogen), ground fish (8 per cent nitrogen), and tankage (concentrated 10 to 12 per cent, crushed, 4 to 9 per cent nitrogen), also leather-meal, and wool- and hair-waste, which last two on account of their physical condition are of little value.

There is an evident advantage in the use of the soluble salts where quick action is desired. The nitrogen of sodium nitrate is in a form in which it may be utilized directly by the plant, while ammonium salts, owing to their rapid oxidation in the soil, are almost as available. The nitrate should be applied to the soil only when the crop is planted or is ready to use it, otherwise it is likely to leach out of the soil. Nitrogen in the form of organic matter must undergo chemical changes in the soil before it can be utilized by the plant, and hence such fertilizers should be applied to the soil some time previous to their use by the crop.

As regards the relative value of the nitrogenous fertilizers, an exact rating is difficult to attain, but a summary of the various tests indicates that when nitrate is rated at 100 per cent, ammonium sulphate may be taken as the same; blood and cotton-seed meal, 70 per cent; dried and ground fish and hoof-meal, 65 per cent; bone and tankage, 60 per cent; and leather, ground horn, and wool-waste range from 2 per cent to 30 per cent.

Phosphate Fertilizers.— By the term phosphate fertilizers is meant those substances that are used for manures chiefly because of the phosphorus they contain. The phosphorus is generally present in the form of a phosphate of lime, iron, and alumina mixed with other substances. Some of these phosphates also contain organic matter, in which case they generally carry some nitrogen, which adds something to their value as fertilizers. Phosphates associated with organic matter decompose more quickly in the soil than purely mineral phosphates, and are therefore more readily available fertilizers.

Bone-Phosphate.— The bones of animals have been for a great many years an important form of phosphate manure. Formerly bones were used entirely in the raw condition, either ground or unground. In the ground condition they are a more quickly acting fertilizer. Raw bones contain about 22 per cent phosphoric acid and 4 per cent nitrogen. The phosphoric acid is in the form of tricalcium phosphate.

At the present time most of the bone used as manure is first boiled or steamed. This frees it from fat and nitrogenous matter, both of which are used in other ways. Steamed bone is a more valuable fertilizer than raw bone, as the fat in the latter retards decomposition, and also because the steamed bone is in a better mechanical condition. The form of the phosphoric acid is the same as in the raw bone, and varies from 28 to 30 per cent, while the nitrogen is reduced to about 1½ per cent. Bone tankage, which has already been spoken of as a nitrogen fertilizer, contains from 7 per cent to 9 per cent phosphoric acid, largely in the form of tricalcium phosphate. All of these bone-phosphates are slow-acting fertilizers, and should be used finely ground, and for the permanent benefit of the soil rather than as direct plant-food.

Mineral Phosphates.— There are many natural deposits of mineral phosphates scattered over the earth, some of the most important of which are in America. The phosphorus in all of these is in the form of tricalcium phosphate, but the materials associated with it vary greatly.

Coprolites are concretionary nodules found in the chalk or other deposits in the south of England and in France, the name having been given them on the assumption that they consisted of fossilized animal excrement. They contain 25 to 30 per cent of phosphoric acid, the other constituents being calcium carbonate and silica.

Apatite is found in large quantities in the provinces of Quebec and Ontario, Canada. It occurs chiefly in crystalline form. The calcium phosphate of which it is composed is in one form associated with calcium fluoride, and in the other with calcium chloride. The Canadian apatite contains about 40 per cent phosphoric acid, being richer in this ingredient than that found elsewhere. Phosphorite is another name for apatite, but is chiefly applied to the impure amorphous form.

South Carolina phosphate has been mined since 1868. It occurs in the form of lumps from the size of a pebble to a mass weighing a ton. These are distributed through a deposit varying from 1 to 20 feet in thickness, which occurs both on the land and in the river beds. It contains from 26 to 28 per cent of phosphoric acid, and but a very small amount of iron and aluminum. As these substances interfere with the manufacture of superphosphates from the rock, their presence is very undesirable, rock containing more than 3 to 6 per cent being unsuitable.

Florida phosphates have been on the market since 1888. They occur in the forms of soft phosphate, a whitish product somewhat resembling clay, and largely contaminated with it; pebble phosphate, consisting of hard pebbles; rock or boulder phosphate, consisting as the name implies of rocks or boulders. Soft phosphate contains from 18 to 30 per cent of phosphoric acid, and on account of its being more easily ground than most of these rocks is applied to the land without being first converted into a superphosphate. Pebble rock constitutes the major portion of the Florida phosphate. It contains from 20 to 40 per cent of phosphoric acid, being very variable in composition. Rock or boulder phosphate is much more uniform in composition than the other kinds, but there is less of it. It contains about 40 per cent of phosphoric acid.

Tennessee phosphate was discovered in 1894. It differs from the Carolina and Florida phosphate in that it does not exist as nodules, pebbles, or boulders, but in veins and pockets, and does not need to be washed previous to its treatment. It contains from 30 to 35 per cent of phosphoric acid.

Basic slag, or, as it is also called, phosphate slag, or Thomas phosphate, is a by-product in the manufacture of steel from pig-iron rich in phosphorus. The phosphoric acid present is in the form of tetracalcium phosphate, $(CaO)_4P_2O_5$. It also contains calcium, magnesium, aluminum, iron, manganese, silica, and sulphur. On account of the presence of iron and aluminum, and because its phosphoric acid is more readily soluble than the tricalcium phosphate, the ground slag is applied directly to the soil without treatment with acid. It is produced in large quantities in England, Germany, and France. So successful has it proved as a fertilizer that a product known as "artificial Thomas phosphate" has lately been made in Germany.

Superphosphate Fertilizers.— In order to render more readily available to plants the phosphoric acid contained in bone and mineral phosphates, the raw material, purified by being washed and finely ground, is treated with sulphuric acid. This results in a replacement of phosphoric acid by sulphuric acid with the formation of monocalcium phosphate and calcium sulphate, with a smaller amount of dicalcium phosphate, according to the reactions:

$Ca_3(PO_4)_2 + 2H_2SO_4 = CaH_4(PO_4)_2 + 2CaSO_4$, and $Ca_3(PO_4)_2 + H_2SO_4 = Ca_2H_2(PO_4)_2 + CaSO_4$.

The tricalcium phosphate, being in excess of the sulphuric acid used, a part of it remains unchanged.

In the treatment of phosphate rock part of the sulphuric acid is consumed in acting upon the impurities present, which usually consist of calcium and magnesium carbonates, iron and aluminum phosphates, and calcium chloride or fluoride, converting the bases into sulphates, and freeing carbon dioxide, water, hydrochloric acid and hydrofluoric acid. The resulting superphosphate is therefore a mixture of monocalcium phosphate, dicalcium phosphate, tricalcium phosphate, calcium sulphate, and iron and aluminum sulphates.

In the superphosphates made from bone the iron and aluminum sulphates do not exist in any considerable amounts. However, as long as the phosphoric acid remains in the form of monocalcium phosphate the value of a pound of available phosphoric acid in the two kinds of fertilizer is the same, but the remaining tricalcium phosphate in the bone superphosphates has a greater value as before explained.

The superphosphates made from animal bone contain about 12 per cent available phosphoric acid and three or four per cent of insoluble phosphoric acid. They also contain some nitrogen. Bone-ash and bone-black superphosphates contain practically all of their phosphoric acid in an available form, but they contain little or no nitrogen. South Carolina rock superphosphate contains from 12 to 14 per cent available phosphoric acid, including from 1 to 3 per cent reverted phosphoric acid. The best Florida rock superphosphates contain from 17 per cent downward of available phosphoric acid, part of which is reverted. The Tennessee superphosphates vary from 14 to 18 per cent available phosphoric acid.

Reverted Phosphoric Acid.— On standing, a change sometimes occurs in superphosphates by which a part of the phosphoric acid becomes less easily soluble, and to that extent the value of the fertilizer is decreased. This change, known as «reversion,» is much more likely to occur in superphosphates made from rock than in those derived from bone. It will also vary in different samples, a well-made article usually undergoing little change even after long standing. It is supposed to be caused by the presence of undecomposed tricalcium phosphate, and of iron and aluminum sulphates.

The decrease in solubility of the superphosphate is due to the interaction of monocalcium phosphate and tricalcium phosphate leading to the formation of dicalcium phosphate, and perhaps to the formation of ferric and aluminum phosphates by the action of monocalcium phosphate upon the iron and aluminum sulphates.

Double Superphosphates.— In making superphosphates, a material rich in phosphoric acid must be used, not less than 60 per cent tricalcium phosphate being necessary for their profitable production. The poorer materials are sometimes used in making what are known as double superphosphates. For this purpose they are treated with an excess of dilute sulphuric acid; the dissolved phosphoric acid and the excess of sulphuric acid are separated from the mass by filtering, and are then used for treating phosphates, rich in calcium phosphate, forming superphosphates. The superphosphates so formed contain more than twice as much available phosphoric acid as those made in the ordinary way.

Relative Availability of Superphosphates.— Superphosphates and double superphosphates contain their phosphoric acid in a form in which it can be taken up by the plant at once. They are therefore best applied at a time when the crop is planted, or just before, or they may be applied when the crop is growing. In this respect their use differs radically from that of crude phosphates. Well-made superphosphates contain no free acids, and therefore are not injurious to vegetation unless used in excess.

Reverted phosphoric acid, although not soluble in water, is readily soluble in dilute acids. Its value as a ready source of food for plants has been the subject of much discussion among agricultural chemists. It is now quite generally believed that it furnishes an available supply of phosphoric acid to the plant. The American Association of Official Agricultural Chemists recognized this by adopting a statement of analysis which includes this form in the «total available phosphoric acid.»

Potash Fertilizers.— The production of potash fertilizers is largely confined to Germany, where are inexhaustible beds varying from 50 to 150 feet in thickness lying under a region of country extending from the Harz Mountains to the Elbe River, and known as the Stassfurt deposits. These deposits of potash salts have been mined since 1862, during which time they have constituted the world's principal supply of potash. They are operated by a syndicate comprising all the large owners, and maintaining a uniform price on the output.

Deposits have more lately been discovered in Thuringia, Brunswick, and Mecklenburg. The principal salts placed on the market are sylvine (potassium chloride); sylvinite, a mixture of sylvine, rock-salt, and kainite; carnallite (magnesium chloride and potassium chloride); schoenite (magnesium sulphate and potassium sulphate); kieserite (magnesium sulphate with carnallite); kainite (magnesium sulphate and potassium chloride, or magnesium and potassium sulphates and magnesium chloride); polyhalite (potassium, calcium, and magnesium sulphates).

In 1898 there were 1,330,505 tons of these salts produced, of which 1,056,226 tons were kainite, which is therefore the principal fertilizer produced.

The potash fertilizers contain their potassium either as chloride or sulphate. The chloride has the advantage of being more diffusible in the soil; but in most respects the sulphate is preferable. Potassium chloride has an injurious effect upon such crops as tobacco, sugar-beets, and potatoes. In tobacco the potassium chloride in the ash prevents the proper burning of the tobacco. In the case of clover, corn and grass, however, potassium chloride appears to have no harmful effects.

Kainite.— The potash contained in kainite is in the form of sulphate, but because of the large quantities of other salts it contains, chiefly sodium and magnesium chloride, it has the same effect upon plants as has the chloride. It contains from 12 to 20 per cent of potash, and 25 to 45 per cent of sodium chloride, with some chloride and sulphate of magnesium. Kainite should be applied to the soil a considerable time before the crop which it is intended to benefit is planted. It should not be drilled in with the seed. By this method of application the injurious properties of the chlorides will not affect the crop. Indirectly kainite serves to supply the plant with food other than potash. The salts associated with the potash, particularly the chlorides, aid plant-growth by making other substances in the soil, particularly phosphoric acid, more available to the plant, besides improving the physical condition of the soil.

Sylvinite.— This salt contains its potash both as chloride and as sulphate. It also contains sodium and magnesium chlorides. It contains about 16 per cent potash. Owing to the presence of chlorides it has the same effect as kainite.

Muriate (chloride) of Potash.— This is a more concentrated form of potash than either of those just mentioned. It contains about 50 per cent of potash, making it 80 per cent pure potassium chloride. The impurities are largely sodium chloride and insoluble mineral matter. A purer form of muriate of potash may be obtained which contains 98 per cent pure potassium chloride.

Sulphate of Potash.— High-grade sulphate of potash contains from 49 to 51 per cent of potash. Its advantage over muriate is that it is not, like the latter, injurious to any crops; but it has the disadvantage of being more expensive, and it has not, as has the chloride, indirect plant-feeding properties.

Schoenite.— This is a double sulphate of potash and magnesium. It contains about 26 per cent of potash. The cost of the potash is greater than in the muriate. The sulphate of magnesium it contains is supposed to have a beneficial effect upon the soil.

Other Fertilizing Materials.— There are a number of fertilizers not included in the classes already mentioned. Many of them are very valuable sources of fertility.

Wood-Ashes.— For some time after the use of fertilizers became an important farm practice, wood-ashes constituted a large portion of the supply of potash. They also contain considerable quantity of lime and a small amount of phosphoric acid. The product known as unleached wood-ashes contains 5 to 6 per cent of potash, 2 per cent of phosphoric acid, and 30 per cent of lime. Leached wood-ashes contain about 1 per cent of potash, 1.5 per cent of phosphoric acid, and 28 to 29 per cent of lime. They contain the potash in a readily available form as potassium carbonate. The lime conduces to a good physical condition of the soil.

Guano.— This fertilizer has been formed from the excrement and carcasses of sea-fowl. The composition of guano depends upon the climate of the region in which it is found. Guano from an arid region contains nitrogen, phosphoric acid, and sometimes potash, while that from a region where rains occur contains only phosphoric acid, the nitrogen and potash having been leached out. In a dry guano the nitrogen occurs as uric acid, urates, and in small quantities ammonium salts. A damp guano contains more ammonia. The phosphoric acid is present as calcium phosphate, ammonium phosphate, and as phosphates of other alkalies. A portion of the phosphate is readily soluble in water. All of the plant-food is thus either directly available or becomes so soon after admixture with the soil. The composition is extremely variable. Guano was formerly a very important fertilizing material, but the supply has become so nearly exhausted that it is relatively unimportant at the present time. South America, South Africa, Australia, and certain islands in the Pacific contribute to the supply.

Other fertilizers of less value are powder-waste, agricultural salt, cotton-hull ashes, coal-ashes, seaweed, king-crab, mussel and lobster shells, muck, peat, marl, tobacco stems and stalks, crude fish-scrap, wool- and hair-waste, sewage, street-sweepings, etc.

Lime.— The use of lime, either in the form of quicklime (CaO), air-slacked lime ($CaCO_3$), or gypsum ($CaSO_4$, $2H_2O$), also called "land-plaster," benefits greatly the physical condition of some soils, particularly those of heavy clay structure. Besides operating on the physical condition of the soil, it adds calcium and liberates a certain amount of plant-food held by the soil. Soils that contain free acid are greatly benefited by the application of caustic lime. Another function of lime in any of these forms is that of promoting nitrification.

Home Mixing of Fertilizers.— Fertilizers are ordinarily sold as (1) complete fertilizers containing nitrogen, phosphoric acid, and potash, which in different mixtures are to be found in different relative amounts; and (2) incomplete fertilizers, or raw material containing only one of these ingredients. Authorities at a number of the experiment stations have urged that it is in many cases more profitable for the farmer to purchase the incomplete fertilizers and mix them himself. The arguments advanced in favor of this practice are that the materials can be purchased more cheaply in that form than when mixed by the manufacturer; that they can be used in the proportion desired, which may effect a saving in the amount of some ingredient, and and that the form in which each ingredient is present is then known, which is not always the case when mixtures are purchased.

On the other hand, it is more difficult to obtain the raw materials from the small dealer, and when purchased they are not generally so finely ground as they are in the mixtures; and this in the case of the more difficultly soluble materials is a marked disadvantage.

State Control of Fertilizer Sales.— In most States in which fertilizers are largely used laws are in effect compelling manufacturers or dealers in fertilizers to state the actual amounts of the fertilizing ingredients contained in the fertilizers offered for sale, and also to state in what form each of these ingredients exists. A chemical control is provided and a penalty imposed for any failure to comply with the law. The control authorities publish each year a statement of the commercial value per pound of nitrogen, phosphoric acid, and potash in each of the various forms in which they occur in fertilizers. Fertilizer control is in most States attached to the State agricultural experiment stations, and information concerning the purchase and use of fertilizers can be obtained from these institutions.

Statistical.— The amount of fertilizers manufactured and consumed is increasing in all portions of the crop-producing world; and especially in the United States is there a rapid increase from one decade to another. In 1859 the value of the entire output of the fertilizer factories was $891,344; in 1869, $5,815,118; in 1879, $23,650,795; in 1889, $39,180,844; and in 1899, $44,657,385. Not all of this was used on farms in this country, there being $6,983,186 worth exported in 1899; but, partly to offset this, there was $1,492,019 worth imported. The imported fertilizers consisted largely of nitrate of soda, and potash salts, while the exported fertilizers were animal refuse and phosphate fertilizers. Of the total expenditure for fertilizers in 1899 70 per cent was consumed in the North Atlantic and South Atlantic States lying within 300 miles of the Atlantic seaboard. Nearly one half of the remainder was purchased in four States, Ohio, Indiana, Alabama, and Louisiana.

As is naturally to be expected, the first settled and longest cultivated portion of the country is that using the greatest quantity of fertilizers. This region lies nearest to the large centres of population and hence of consumption; it produces crops of greatest acre value; and it is so situated that the distances which it is necessary to transport fertilizers are generally less than they would be for the non-fertilizer-using portion of the country. It is true in the United States, as it is in Europe, that a large consumption of fertilizers goes hand in hand with a highly developed and intensive system of agriculture.

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Fesch, Joseph, zhō-zef fesh, French ecclesiastic: b. Ajaccio, Corsica, 3 Jan. 1763; d. Rome 3 May 1839. He was half brother to the mother of Napoleon. After Bonaparte in 1801 concluded the concordat with Pius VII. he became in 1802 archbishop of Lyons, and next year a cardinal. He was likewise appointed French ambassador at Rome, and made himself very acceptable to the Pope by his ultramontane tendencies. On the approach of the Austrians in 1814 he fled with his sister, Madame Bonaparte, to Rome, but Napoleon's return brought him back to France, and he acted as a peer during the Hundred Days. When called upon by the Bourbons to resign his episcopal rights he decidedly refused, but in 1825, after a papal brief interdicted him from exercising spiritual jurisdiction, he renounced the office, but retained the dignity.

Fes'cue, the popular name of a genus of grasses (*Festuca*), numbering upward of 80 species. The genus is of wide geographical distribution, but particularly numerous in the temperate regions, where they are among the most important of the pasture and fodder grasses. About 25 species are found in North America, many of them naturalized from Europe. The red fescue (*Festuca rubra*) serves to bind loose soil, and is also a good hay grass. The tall meadow fescue (*F. elatior*, var. *partensis*) is a fibrous-rooted perennial, growing from two to three feet high in low meadows and pastures, where it forms fresh herbage among the earliest of the cultivated grasses. The sheep's fescue (*F. ovina*) is much smaller. Sheep's fescue exists in many varieties in the northwestern States, especially in the Rocky Mountain region. Some of the varieties attain the height of two or three feet, but for the most part they are rarely more than a foot high, producing a large amount of fine herbage, which is valuable for grazing, especially for sheep. Some of the native varieties are well worthy the attention of the agriculturist. All the forms of *F. ovina* are «bunch-grasses,» and are devoid of the creeping roots, the presence of which distinguishes the red fescue (*F. rubra*) from this species. Sheep's fescue is well adapted for cultivation on light, dry soils, especially those which are shallow and silicious. A tall species is the giant fescue (*F. gigantea*), which occurs in shady woods and similar situations, from Maine to New York, adventive from Europe.

Fes'senden, Reginald Aubrey, American electrician: b. Bolton, Quebec, Canada, 6 Oct. 1866. He was chemist-in-chief in Thomas Edison's laboratory from 1887 to 1890 and the two following years an electrician with the Westinghouse Company of Newark, N. J. He was elected professor of electrical engineering in the Western University of Pennsylvania in 1893. He is the author of many inventions in electrical and chemical engineering and has written numerous scientific papers.

Fessenden, Thomas Green, American author: b. Walpole, N. H., 22 April 1771; d. Boston 11 Nov. 1837. He was graduated from Dartmouth College in 1796. He went to London in 1801, and while there published anonymously a satirical poem, 'Terrible Tractoration' (1803). He returned to the United States; did literary work in New York; went to Boston and founded the 'New England Farmer' (1822). Some of his publications were: 'The American Clerk's Companion' (1815); 'The Ladies' Monitor' (1818); and 'Laws of Patents for New Inventions' (1822).

Fessenden, William Pitt, American statesman: b. Boscawen, N. H., 16 Oct. 1806; d. Portland, Maine, 8 Sept. 1869. He was graduated at Bowdoin College in 1823 and admitted to the bar in 1827. He entered politics and soon acquired a national reputation as a lawyer and a Whig. He was elected to the United States Senate in 1854, and a week after he took his seat made a speech against the Kansas-Nebraska Bill which placed him in the front rank of senatorial orators. During the Civil War he was conspicuous for his efforts to sustain the national credit. He was made secretary of the treasury in 1864, and, having placed it on a firm basis, resigned in 1865 to return to his seat in the Senate.

Festa, Costanzo, cōs-tän'zō fes'tä, Italian composer: b. Rome about 1496; d. there 10 April 1545. He became a member of the pontifical choir 1517, and composed much church music, many madrigals for three voices, motets, and litanies, many of his manuscript scores being still preserved in the archives of the pontifical chapel and the Vatican. His 'Te Deum' is sung at the election of new popes, the appointment of new cardinals, and at the Festival of the Holy Sacrament. It was published in Rome 1596.

Festivals. See FEAST.

Festus, Porcius, por'shius fes'tus, Roman procurator in Palestine about 60–62 A.D. It was he before whom St. Paul was accused by the Jews; but the apostle appealing to the emperor, Festus sent him to Rome.

Festus, Sextus Pompeius, sex'tus pompē'yus fes'tus, Roman grammarian of the 3d or 4th century of our era, author of an abridgment of a work by Verrius Flaccus, called 'De Verborum Significatione,' a kind of dictionary, very valuable for the information it contains about the Latin language. The original work of Festus has been preserved only in imperfect MS., now at Naples, but it is more fully preserved in the abridgment made by Paul Diaconus.

Fet, A., the pseudonym of SCHENSCHIN, AFANASSIJ AFANASJEWITCH (q.v.).

Fetial, or **Fecial,** fē'shial, one of a college of priests in ancient Rome, said to have been instituted by Numa, consisting of 20 members, who presided over all the ceremonies connected with the ratification of peace or the formal declaration of war, including the preliminary demand for satisfaction, as well as the actual denunciation of hostilities. Their chief was termed Pater Patratus. When sent to a distance to conclude a treaty, they carried with them certain sacred herbs called verbenæ, or sagmina, which were gathered on the Capitoline Hill, and which were considered indispensable in their rites.

Fetishism, or **Fetichism,** fē'tish-izm, the worship of material things (fetishes) as the abodes of spirits, or more strictly the belief that the possession of a thing can procure the services of a spirit lodged within it. It is the lowest of the unsystematic forms of worship found among uncivilized tribes, and exists especially among the negroes in Africa, but also among the natives of both Americas, the Polynesians, Australians, and Siberians. The word itself is ultimately due to the Portuguese, the first Europeans to trade on the west coast of Africa, who expressed their conception of the religion of the natives by the Portuguese word *feitiçāo*, «magic.» Comte used it as a term to describe what he believed to be a necessary stage in the development of all religions in which all external bodies, natural, or artificial, are supposed to be animated by souls essentially analogous to our own. Any object may become a fetish, provided it is capable of being appropriated literally or metaphorically by an individual. Such objects are flints, shells, claws, feathers, earth, salt, plants, manufactured articles, anything peculiar or unknown or not understood, trees, streams, rocks, and even certain animals, as the serpents of Whydah. It is enough for an object to be accidentally associated with an event for it to be regarded as the cause and even the author of that event, whence its elevation to the rank of a fetish. Fetishes may be natural or artificial. Artificial fetishes are either public, preserved by priests, or private, purchasable from them usually at a very high price. In some countries kings and princes have large collections of fetishes, and every family has at least one. They are hereditary, and either hung up in the dwellings or worn on the neck or elsewhere, and are even fastened on domestic animals. They are made to resemble the human form, and the public fetishes are sometimes of gold and very large. The worshippers provide their fetishes liberally with food, but if prayers are not granted they frequently maltreat them, throw them away, or beat them to pieces. In connection with fetish worship there are festivals and sacrifices. For the latter the victims are oxen, swine, and other animals; but sometimes, when the royal and priestly power are united in the sacrificer, criminals, prisoners, or persons of the lowest classes of the tribe are immolated. The festivals — among which the Yam and Adai festival with the Ashantees, and the festival in honor of Khimavong, the god or divine messenger, are especially celebrated — are generally attended by excess in drinking, thefts, fights, and gross licentiousness. The priests form a separate society, with hereditary dignity, property, and privileges. They have in particular the right of retaining the slaves who come to them, or, as they call it, present their bodies to the fetish. See De Brosses, 'Du culte des dieux fétiches' (Dijon 1760), through whom the terms fetish and fetishism were introduced into the history of religious worship. It must, however, be observed that the limits of the term fetish have not yet been agreed upon, as some exclude from it the worship of forests, mountains, rivers, etc. In the luck tokens of gamblers and other superstitious persons there is an analogy to the fetish of the savage. See FAMILIAR SPIRIT; WITCHCRAFT.

Fétis, François Joseph, frän-swä zhō-zef fā-tēs, Belgian musical composer: b. Mons, Belgium, 25 March 1784; d. Brussels 26 March 1871. He published: 'Histoire générale de la musique'; 'Biographie universelle des musiciens' (1834–44); etc., and founded and edited the 'Revue Musicale.' His most popular opera was 'La vielle' (1826).

Fetor, fē'tôr, a peculiarly offensive odor, usually considered to be due to some sort of animal putrefaction. Fetor of the breath may be due to sores of the tongue, cheeks, or gums, to necrosis of the teeth or abcess of the teeth cavities, to poisoning of mercury and the sordes of scurvy. Diphtheretic and streptococus inflammations of the throat cause bad odors that closely resemble fetor. Gangrene and abscess of the lungs cause the most persistent and penetrating fetor. In various diseases of the stomach and intestines accompanied by the absorption of products of putrefaction, fetor of the breath is common. Fetor of the feet is due to lack of porosity of their leather covering and to uncleanliness and excessive perspiration. These conditions result in a maceration of the skin and if infection with certain forms of bacteria takes place this macerated skin is apt to be infected with putrefactive bacteria and consequent upon this is more or less fetor. The treatment of the condition consists in cleanliness, improvement of the foot-gear and antiseptic washes.

Fet'terolf, Adam H., American educator: b. Perkiomen, Pa., 24 Nov. 1841. He was educated at Ursinus College; became vice-president of Girard College in Philadelphia in 1880, and president in 1882.

Feuchtwanger, foiнt'vang'-ĕr, **Lewis,** American chemist: b. Furth, Bavaria, 11 Jan. 1805; d. 25 June 1876. He early displayed a fondness for natural science and made that study a specialty at the Jena University. In 1829 he came to New York, where he opened its first German pharmacy. He soon won a reputation as a chemist, mineralogist, and manufacturer of rare chemicals. He was the first to introduce the alloy, German silver. His works are: 'Popular Treatise on Gems' (1838); 'Elements of Mineralogy' (1839); 'Treatise on Fermented Liquors' (1858); 'Practical Treatise on Soluble or Water Glass' (1870).

Feudal System. A fee, feud, or fief is a possession, of which the vassal receives the right of use and enjoyment, of disposition and alienation, on condition of fidelity, that is, of affording assistance or counsel, and avoiding all injurious acts, together with the performance of certain services incident to the tenure, while the feudal lord still retains a paramount right. A fief is distinguished from allodial possessions by the circumstance that it cannot be alienated without the consent of the feudal lord, by the services usually due from the vassal, and by a peculiar kind of inheritance. The system originated among the German tribes, and the nature of feudal property is explained by its origin. Such was the passion of the ancient Germans for war, that in time of peace private feuds took the place of public contention; and in default of these the men of military age spent weeks and months and years in adventures, and made incursions into the territory of the neighboring tribes, or took part in the quarrels of the distant ones. In the expeditions of particular adventurers against the adjacent tribes or the Roman provinces, their booty consisted of garments, arms, furniture, slaves. But when the northern hordes broke into the south, and in the partition of the conquered lands large districts fell into the hands of kings or dukes and their subordinates, they gave certain portions of the territory to their attendants to enjoy the possession for life. These estates were called *beneficia* or fiefs, because they were only lent to their possessors, to revert after their death to the grantor, who immediately gave them to another of his servants. From this custom of the ancient Germans arose the feudal system and feudal service, which is purely German. As the son commonly esteemed it his duty, or was forced by necessity, to devote his arm to the lord in whose service his father had lived, he also received his father's fief; or rather, he was invested with it anew. By the usage of centuries this custom became a right; and to deprive one of his paternal fief, though it was prohibited by no law, seemed an act of injustice. This change took place between the 9th and 11th centuries. A fief rendered vacant by the death of the holder was at once taken possession of by his son, on the sole condition of paying homage to the feudal superior. In the case of ecclesiastical fiefs the right of succession belonged, under the same condition, to those who succeeded the last holders in their ecclesiastical office. The castle-fiefs, so called, were a peculiar kind of military fiefs, the possessor of which was bound to defend the castle belonging to his lord. The vassal who directed the defense was called, in the imperial fortresses, a burgrave. Thus the several orders of vassals formed a system of concentric circles, of which each was under the influence of the next, and all moved around a common centre, the king, as the supreme feudal lord. With military vassals another class arose. From the oldest times in the courts of kings and the governors whom they appointed, as well as in those of the bishops, were certain officers who at first performed active service, but were afterward rather a splendid appendage to the court. The four offices of the marshal, the chamberlain, the cup-bearer, and the sewer, are the oldest and most honorable, but by no means the only ones; offices, on the contrary, were as numerous as the employments which could be devised at court. These officers, at a period when money was scarce and the old German notion in full vigor which considered none but landed proprietors as citizens, and none but the owners of large estates as noblemen, were naturally rewarded by grants of land during the time of service; and these estates, like the military fiefs, but somewhat later, certainly not before the time of Frederick I. (1152–90), became by degrees hereditary. The splendor of the court, and the advantages accruing from these services, induced many noblemen to solicit them. They became the first in the new class of servants or ministers which was thus formed; and under them there was a multitude of other servants, particularly on the estates of the nobility.

A refusal to perform feudal serivce, or any other violation of fealty, was styled felony. Upon this and other difficulties incident to feudal property, as in cases growing out of the succession, surrender, alienation, or under-tenure of a fief, the lord decided in a feudal court, filled by vassals, who were required to be of equal rank with the accused. To appear in these courts at the summons of the lord of the manor, and accept the place of an assessor there, was reckoned among the duties incident to a fief. As the relation of lords and vassals (at that time one of the most important relations in life) became more and more widely spread, and the number of vassals increased at the expense of the ancient immediate subjects of the empire, the latter were thrown into the background, and at length nearly forgotten.

In the 10th and 11th centuries no duty due from subjects was known except feudal duties; the whole German empire was one vast feudal possession, and the ideas of feudal lords and national sovereigns were wholly confounded. If any one was neither a lord nor a vassal he was scarcely looked upon as a citizen. Hence few rich landed proprietors ventured to rely upon their own strength, without a feudal connection. And even most of these at last yielded to the spirit of the age, and became royal vassals. The emperor, likewise, used every means to induce them to adopt such a course.

From the feudal system, the only social organization of the European states in the Middle Ages, a new system of civil rank arose. The inferior nobility, a rank intermediate between the higher nobility (princes) and freemen, owes its origin, it is said, to this institution; and a regular scale of rank was formed among the vassals, without detriment, however, to the principle of equal birth. The king formed the first class; the spiritual princes, bishops, and immediate abbots constituted the second; the lay princes, dukes, landgraves, margraves, and immediate counts, the third; those barons, or rich landed proprietors, who owed fealty to no one, but yet, on account of their limited rights or possessions, were the vassals of the emperor, the fourth; those freemen who stood in the same relation to the princes, the fifth; the vassals of the former and the servants of the princes, the sixth; and the possessors of small fiefs, the seventh. Besides these ranks, after some centuries, the order of citizens was formed, as being included under no one of them. The spirit of the feudal system, grounded on the prevalence of landed property, was necessarily foreign to cities which owed their origin to industry and personal property, and founded thereon a new sort of power. The principles of the feudal laws were developed and established by the Lombard lawyers of the 12th century. The collection of feudal laws and customs which is appended to the Roman code under the title of *Libri Feudorum* became the code of feudal law over a great part of Europe.

The feudal form of government, at a period when a spirit of independence and of opposition to despotism was abroad in the land, was well suited to put into the hands of one governor, as supreme feudal lord, the reins of the national power, to be employed against foreign enemies without endangering domestic freedom. But the purity and influence of feudal relations in time became less; and the strength of the national government declined amidst a spirit of disaffection and sedition, which became universal when nobles began to perceive that the feudal government was not naturally dependent on kings, but kings on it. Indeed, the sovereigns had no other security for their subjection than the feudal oath and the menaces of punishment, which the king might not have the ability to carry into effect, when his power was divided in most of his states, either by investiture or by the usurpations of the princes. Thus the vassals of the crown in Germany, Italy, and the older districts of France succeeded in depriving the king of almost all power, even of the external honors of royalty; and never, in the two first countries, and in France only after the extinction of the great baronial families, could he succeed in establishing a new authority independent of the feudal power. See MIDDLE AGES.

Feuerbach, Ludwig Andreas, lood'viн än'-drā-äs foi'ĕr-bäн, German philosopher: b. Landshut 28 July 1804; d. near Nuremberg 13 Sept. 1872. He was the son of Paul Feuerbach (q.v.). He was a Hegelian and materialist whose opinions hindered a professional career, and who devoted himself to metaphysics in retirement. His masterpiece, 'Das Wesen des Christenthums' (1841) was translated by George Eliot into English as 'The Essence of Christianity.' In his 'Theogonie' (2d ed. 1866), he deals with worship from the historical standpoint. Other works of his are: 'History of Modern Philosophy from Bacon to Spinoza' (1833); 'Criticism of the Philosophy of Leibnitz' (1837); 'Pierre Bayle' (1838); 'Principles of the Philosophy of the Future' (1843); 'The Essence of Religion' (1845). See Lives by Beyer (1873); Grün (1874); Starcke (1885).

Feuerbach, Paul Johann Anselm von, powl yō'hän än'zelm fon, German jurist and criminal law reformer: b. Hainichen, near Jena, 14 Nov. 1775; d. Frankfort-on-Main 29 May 1833. Among his best-known works are: 'Critique of Natural Law' (1796); 'Anti-Hobbes' (1798); 'Lehrbuch des gemeinen in Deutschland geltenden peinlichen Privatrechts' (1801); 'Merkwürdige Kriminalsrechtsfälle' (1808–11); 'Kaspar Hauser: An Instance of a Crime Against a Soul' (1832).

Feuillants, fė-yoṅ, in ecclesiastical history, a religious order clothed in white and going barefoot, who lived under the strict observance of the rule of St. Bernard. The name was occasioned by a reform of the order of Cistercians (1577), first made in the abbey of Feuillens, a Cistercian abbey in Guienne. There were also convents of nuns who followed the same reform, called *Feuillantines.* The first of them was established near Toulouse in 1590. Eleven years later the order transferred its headquarters to Paris, and continued to flourish until suppressed, along with other religious orders, by the Revolution of 1789. The monastery was taken possession of by a club celebrated in the political history of France under the name of the Feuillants, and of which Mirabeau was a member. It was a weak rival of the Jacobin club, and fell before the clamor of a mob in 1791.

Feuillet, Octave, ōk-täv fė-yā, French novelist and dramatist: b. Saint Lô, Manche, 11 Aug. 1812; d. Paris 29 Dec. 1890. Between 1845 and 1858 he gained a good deal of notice with his novels and a series of comedies and tales, some of which were published in the Revue des Deux Mondes. In 1857 the appearance of 'Le Roman d'un Jeune Homme Pauvre' raised Feuillet to the first rank of the novelists of the day, and was immediately dramatized by the author himself. Next followed 'Histoire de Sibylle' (1862), and in the year in which it appeared Feuillet was elected to the French Academy, succeeding to the fauteuil of Scribe. Among his other numerous novels are: 'Monsieur de Camors' (1867); 'Julia de Trécœur' (1872); 'Un Mariage dans le Monde' (1875); 'Le Journal d'une Femme' (1878); 'Histoire d'une Parisienne' (1882); 'La Morte' (1886); 'Le Divorce de Juliette' (1884); 'Honneur d'Artiste' (1890). His works have a refined humor, and are free, especially the earlier, from coarseness. His dramas also met with considerable success, but they are on the whole inferior to his novels. Feuillet's 'Théâtre Complet' appeared in 1892–3. He was succeeded in the Academy by Pierre Loti.

Féval, Paul Henri Corentin, pōl oṅ-rē cō-roṅ-tăṅ fā väl, French novelist: b. Rennes 27 Sept. 1817; d. Paris 8 March 1887. His first story, 'The Seals' Club' (1841), and others, having given him some note, he was offered a large sum to write, under the pseudonym "Francis Trollope" (as though an Englishman), a sensational story 'The Mysteries of London,' after the manner of Sue's 'Mysteries of Paris.' It was done in 11 volumes, was immensely successful, widely translated, and put on the stage. He remained a very fertile, spirited, and popular writer, often dramatized, with long runs. Especially successful were: 'The Son of the Devil' (1847); 'The Hunchback' (1858); 'Mrs. Gil Blas'; 'The Last Man Alive' (1873); 'The Wonders of Mount St. Michael' (1879). At first a Free-thinker, in his later years he became an ardent Catholic.

Fever, a condition in which the temperature of the body is above normal. The average daily range of temperature in men is from 98° to 99° F., and in women from quarter to half a degree higher. In children temporary elevation even as high as 100° F. may occur from conditions of excitement and from over-exercise, but this should not be termed fever. Slight daily variations in temperature are usual. Thus the maximum temperature occurs usually from 5 to 9 P.M. There is then, as a rule, during sleep a decrease until a minimum is reached, some time between 2 and 4 A.M. It is probable that diminished muscular activity and lessened food absorption are responsible for much of this variation. Temperature usually rises during strong muscular exercise, and also after a meal. These slight rises are balanced by heat-loss from increased perspiration. The temperature of man in the tropics and in the Arctic zone does not vary more than 1° C. (For discussion of bearable extremes of heat and cold, heat-production, heat-loss, and the nervous mechanism that controls the general phenomena, see Animal Heat.)

Modern pathology teaches that fever is the index of a reaction of the human body in its struggle with some foreign invader, and is brought about by excessive oxidation and diminished heat-loss. Fever is usually accompanied by an increase in the number of respirations, by an increased number of contractions of the heart, raised pulse-rate, an increase in the blood-tension in the blood vessels, and by other symptoms of general malaise. These are headache, dry mouth, dry skin, and at times increased mental excitement. Fever from this point of view is a conservative process, and is nature's own method of overcoming some form of infection or intoxication Fever as a general process should be distinguished from the many special kinds of so-called fevers that are described. Thus the term fever as used in typhoid fever, scarlet fever, lung fever, etc., is a relic of earlier medical teachings, in which the rise in temperature was considered the essential part of the disease. It is now recognized that fever is only one of the features in the general history of the development of the disease-process. The height of the temperature during fever may vary considerably. If the temperature is not above 100° F. (37.7° C.), it is spoken of as light fever; when between 100° and 103° F. (37.7° and 39.4° C.) it is called moderate fever; between 103° and 105° F. (39.4° and 40.5° C.) it is spoken of as high fever; while above 105° F. (40.5° C.) hyperpyrexia is the term that is applied. Temperatures as high as 110° F. have been recorded in patients who have recovered. The course of most fevers is, for purposes of convenience, divided into (1) the initial stage, which usually starts with chilliness and often with a distinct chill; (2) the hot stage, when the temperature has risen and is at a fairly constant normal, during which the blood vessels at the surface are dilated, the skin is flushed and feels hot and dry; this condition perhaps lasting a few hours, or it may be several weeks, according to the disease-processes that produce it; and (3) the terminal stage. This may be ushered in by a previous perspiration, with sometimes increased urination and prompt subsidence of the temperature; or the temperature may slowly sink to normal by a process of lysis (q.v.). Each type of disease-process manifests its own peculiar temperature-variation, and the study of temperature-curves is extremely important in the determination of the disease.

Fever results not so much from an increase in the heat-production alone, but in a disturbance of the heat-regulation or thermotaxis (q.v.); for it is perhaps true that the amount of heat produced by an athlete in a mile run is vastly greater than that produced throughout the entire four weeks of a severe typhoid fever yet the heat-loss keeps pace in the runner with the heat-production. It is the relation between these two factors that is disturbed in fever. Fever is largely a conservative process, and a moderate degree of temperature is believed to be rather beneficial than harmful. The real danger in fever is not the temperature, unless it is excessively high — from 104° to 105° F. — but it is the poison that is being made in the body, either by perverted metabolism or by bacterial or chemical intoxication. Therefore, in the treatment of disease with rise in temperature the reduction of the fever is not the only point to be attained. During fever there is increased oxidation, increased elimination of uric acid, diminution of most of the secretions, notably the saliva, the gastric juice, the bile and, save in the terminal stages, the sweat. The kidney-secretion is also decreased during the hot stage, because more water is being lost through the skin and lungs than usual. Changes in the blood are constant, and usually consist in an increase in the number of leucocytes, or white blood-cells. High temperatures may produce degeneration in a number of tissues of the human body. The most important ones are those of the nerve-cells. These changes may take place if the temperature gets above 105° F., and even lower temperatures acting for a very long time may cause serious structural changes in the nervous system. The treatment of fever, as has been indicated, should mean the treatment of the disease that is causing the fever, and will be considered under each particular topic of fever. Consult: Hektoen, 'American Text-book of Pathology' (1901); Schäfer, 'Text-book of Physiology' (1900). See MALARIA; RELAPSING FEVER; SCARLET FEVER; TYPHOID FEVER; YELLOW FEVER.

Fever-bush (*Benzoin benzoin*), an American shrub of the laurel family (*Lauraceæ*). It grows from 4 to 20 feet high, in moist woods and along streams from Massachusetts, through Ontario, to Michigan, south to Kansas, and eastward to North Carolina. An infusion of the sweet-smelling bark is used as a tonic in fevers. The bright berries of the tree, ripe in August and September, are sometimes ground and used as spice, for which reason it is locally called spice-bush or wild allspice. It is also known as Benjamin-bush. The name fever-bush is also applied to the *Ilex verticillata.*

Feverwort (*Triosteum perfoliatum*), a perennial of the honeysuckle family (*Caprifoliaceæ*), a native of North America, where its dried and roasted berries have been occasionally used as a substitute for coffee; its roots act as an emetic and mild cathartic. The plant grows in rich soil from Quebec westward to Minnesota, and south to Kansas, Kentucky, and Alabama. It has a number of common names, and is known locally as fever-root, horse-gentian, wood ipecac, tinker's root, wild coffee, etc.

Fewkes, fūks, **Jesse Walter,** American anthropologist: b. Newton, Mass., 14 Nov. 1850. He was graduated from Harvard in 1875, and was for 10 years associated with Alexander Agassiz in the Marine Laboratory at Newport, R. I. Since 1895 he has been connected with the Smithsonian Institution, and has written extensively on professional themes, his papers having usually appeared in the 'Proceedings' of the many scientific societies of which he is a member. He edited the 'Journal of American Ethnology and Archæology' 1891-4.

Feydeau, Ernest Aimé, ĕr-nest ā-mā fā'dō, French novelist: b. Paris 16 March 1821; d. there 29 Oct. 1873. His realistic story 'Fanny' (1858) had an unprecedented success. It was followed by 'Daniel' (1859); 'Catherine d'Overmeire' (1860); 'Sylvie' (1861); and 'A Début at the Opera' (1863). Of his later works one only had any marked success, 'The Countess de Chalis, or the Morals of Our Day' (1868).

Feyen, Eugène, ė-zhen fā-yäṅ, French painter: b. Bey-sur-Seille, Meurthe-et-Moselle, France, 13 Nov. 1815. One of the many successful pupils of Paul Delaroche. He was awarded a second class medal at the Salon in 1880, a third class medal at the Paris Exposition 1889, and the cross of the Legion of Honor in 1881. While he began as a painter of portraits and of the nude, he gradually drifted into genre subjects, which are evidently congenial to his talent, and his pictures of the seaside and the fisher folk are distinguished for clever composition and refreshing color. 'The Harvesters of the Sea' (1872), (in the Luxembourg); 'The Bay of Cancale' (1885); and 'The Sailor's Sweetheart' (1890) are his best works.

Feyer-Perrin, François Nicolas Augustin, fräṅ-swä nĭ-kō-lä ō-güs-täṅ fā-yä pē-räṅ, French painter: b. Bey-sur-Seille, Meurthe-et-Moselle, 1829; d. Paris 14 Oct. 1888. He began his career as an artist in the drawing school at Nancy and subsequently attached himself to the studios of Cogniet and Delaroche at Paris. At first he hesitated in choosing a specialty between subjects of poetic allegory, genre subjects, or varying race type, or historic painting. Since 1864 he has confined himself to painting the scenery and people of the seashore, especially in Brittany. His work has been successful, because it is distinguished by poetic feeling, delicate characterization and transparently brilliant coloring. His most famous pictures are in the Luxembourg, namely, 'The Return from Oyster-fishing' (1874) and 'The Fisher-girls of Cancale at the Spring' (1873).

Fez, fĕz, **Kingdom of,** once independent, but now the most northern section of the empire of Morocco; bounded north by the Mediterranean; east by Algeria; south by the river Om-er-begh or Morbeza, which separates it from Morocco proper; and west by the Atlantic. It was conquered and united to Morocco in 1548. See MOROCCO.

Fez, Morocco, city, capital of the province of Fez; 95 miles from the Atlantic, 225 northeast of Morocco. Fez contains over 100 mosques, one, El Carubin, has a covered place for women who may choose to participate in public prayers, something unusual in Mohammedan places of worship. Good public baths are numerous. Its chief manufactures are leather, red caps (fez), and silk shawls. Twice a year caravans go from Fez across the desert to Timbuktu. Fez has always been considered one of the chief seats of Moslem learning. Old Fez was founded in 793 by Edris II., a descendant of Mohammed, and continued the capital of an independent kingdom till 1548, when it was, together with its territory, conquered and annexed to Morocco. Fez has always been held so sacred by the Arabs and others, that when the pilgrimages to Mecca were interrupted in the 10th century, the western Moslems journeyed to this city, as the eastern did to Mecca; and even now none but the Faithful can enter Fez without express permission from the emperor. Pop. (estimated) 140,000.

Fezandié, fā-zäṅ-di-ā, **Clement,** American educator: b. New York 15 Sept. 1865. He has been scientific instructor in New York schools and has published: 'Through the Earth' (1898); 'Two New Jersey Crusoes' (1901).

Fezzan, fez-zän', Africa, a province in the southern part of the Turkish vilayet of Tripoli; area about 150,200 square miles. In the northern part are low mountains, or hills, one of which, Jebel-es-Sudah, or Black Mountain, is composed largely of basalt. Sandy plains and a few fertile valleys are in the southern part. There are no streams of water and but few natural springs; but good water may be obtained at a depth of from 10 to 12 feet. There are a few small lakes, usually covered with a thin crust of carbonate of soda. Rain seldom falls; in some places years intervene between the short periods of rainfall. Jackals, gazelles, and foxes, the ostrich, vulture, and falcon are found in the hills. The manufactures are coarse linen and cotton goods and some ornamental articles made from gold and silver. Trade with neighboring cities is carried on by means of caravans. Pop. (estimated) 50,000.

Fiacre, fē ä'kėr (Fr. pron. fyä kr), or **Fiachrach, Saint,** French monk; d. about 670. He was of Irish birth and settled near Meaux in France, building a small monastery there. From the 9th to the 17th century was famed as a worker of miracles, especially as curing a kind of tumor. His shrine, ultimately deposited in the cathedral of Meaux, was long an object of pilgrimage. The first livery stable in Paris was established in 1641 by the owner of the Hotel de Saint Fiacre. From the fact that a statue of the saint stood above the door the term fiacre, as the name of a public carriage, is derived.

Fiat, fī'ạt, an order of a judge or of an officer whose authority, to be signified by his signature, is necessary to authenticate particular acts; a short order or warrant of the judge, commanding that something shall be done. See 1 Tidd, Pr. 100, 108. Fiat in bankruptcy, in English law, was an order of the lord chancellor that a commission of bankruptcy should issue. Fiats in bankruptcy are abolished by 12 and 13 Vict. c. 116.

Fibiger, fē'bĭ-gėr, **Johannes Henrik Tauber,** Danish poet and clergyman: b. Nykjöbing 27 Jan. 1821. He wrote dramas founded on biblical history: 'Jephtha's Daughter' (1849); 'Jeremiah' (1850); 'John the Baptist' (1857); also a few secular tragedies, the most notable among them being: 'Cross and Love' (1858) and 'The Everlasting Struggle' (1866), which has been very popular; and a narrative poem in 16 cantos, 'The Gray Friars' (1882).

Fibonacci, Leonardo, lā-ō-nar'dō, fē-bō-nä'chē, called **Leonardo Pisano,** Italian mathematician: b. Pisa about 1180; d. about 1228. Little is known of his life except from his writings, which were collected 1857–62 by Prince Boncompagni and include: 'Liber Abaci' (1202); 'Practical Geometriæ' (1220); 'Liber quadratorum' (1225); 'Flos'; 'A Letter to Theodore.' He traveled in Egypt, Syria, Greece, Sicily, and elsewhere, placing himself wherever he journeyed in communication with the leading mathematicians of the region visited. The 'Series of Fibonacci,' sometimes called the 'Series of Lame,' is as follows: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34 — each term being equal to the sum of the two which precede it, indicated algebraically as $\frac{U}{n+2} = \frac{U}{n+1} + \frac{U}{n}$, and having several other remarkable characteristics important in higher arithmetic.

Fibre. Vegetable fibre is derived from the cellular structure or tissue of plants, the cells of which vary in diameter from one three-hundredth to one five-hundredth of an inch, the smaller sizes admitting of 125,000,000 cells to a cubic inch. The walls of these cells are composed of a starch-like substance called cellulose, enclosing the life principle or germ of the plant, known as protoplasm. There are three forms of cells, simple cells, woody cells, and ducts. Woody fibre is formed by the lengthening and thickening of simple cells. The ducts or vessels are large cylindrical cells whose walls have been absorbed and broken away. Wood cells consist of tubes one or two thousandths of an inch in diameter, their ends pointed and overlapping, so that when detached they form a continuous thread of cell structure or fibre proper, such as a filament of flax; and when they occur in the bark of dicotyledonous plants, or exogens, they are known as *bast* fibre. In monocotyledons, like the palms, and the century plant, the fibrous cells are built up with vessels into a composite structure known as "fibrovascular bundle." These bundles of elongated, thickened cells pressed firmly together, and often embedded in soft cellular tissue, so to speak, the bones or structural part of the plant, are called *structural* fibres, sisal hemp being an example. Even the common or simple cells form a valuable fibre material when they are produced on the surfaces of the leaves, stems and seeds of plants, in the form of hairs. This form of fibrous substance is known as *surface* fibre, cotton being an example. In this instance the hairs envelop the seeds produced in the boll or capsule. The "down" on the stems and surfaces of the leaves of plants is another example.

The term fibre is also given to other forms of vegetable growth where the fibrous material is not employed in the form of detached filaments, like flax sisal and cotton. The stems and twigs, and even wood of exogenous trees, divided into splints, and used for basket-making are recognized as fibre; and in like manner the stems and leaves of endogenous plants split or used entire, as rattan, or when coarsely subdivided for plaiting into such articles as hats, mats, etc., are also classed as fibre. The stripped epidermis of palm leaves, such as the raffia of commerce, is considered fibre, yet it is not in any sense filamentous. Even some species of mosses, marine weeds and fungous growths, on account of their economic employment are regarded as fibre substitutes, and are mentioned in the category of fibres. In general terms, however, "fibre" is composed of bundles of bast or fibrovascular tissue in the form of long flexible filaments, such as flax, hemp or manila; or of hairs, such as cotton, capable of being twisted or spun into yarns or threads, to be manufactured into fabrics or cordage.

The following classification illustrates the different forms of fibrous material recognized by experts, and shows the positions of the different fibres in their relations to each other:

All fibrous material is classed in two grand divisions: A, Fibrovascular structure and, B, simple cellular structure. A is again divided into three groups: (1) Bast fibres; (2) Woody fibres, and (3) Structural fibres; B is divided into two groups, (4) Surface fibres, and (5) Pseudo-fibres or false fibrous material.

1. The bast fibres are derived from the inner fibrous bark of dicotyledonous plants, and are composed of bast cells, their ends overlapping to form in mass a continuous filament. Their utility is to give strength and flexibility to the tissue.

2. Woody fibres may be: (a) the stems and twigs of exogenous plants, or (b) the roots of exogenous plants entire, or subdivided into withes for use in basketry or a rough kind of cordage, or for coarse thread for stitching and binding (as in canoe manufacture); or (c) the wood of exogenous trees reduced to layers or splints, for baskets, or for excelsior; or (d) the wood of certain exogenous trees reduced to pulp for paper.

3. Structural fibres are derived (a) from the structural system of the stalks, leaf stems and leaves of monocotyledonous plants (as the agaves and palms) occurring as isolated fibrovascular bundles, surrounded by a pithy, spongy, corky, or often soft cellular mass, covered with a thick epidermis. They give the plants rigidity and also serve as water vessels; or (b) the entire stems or leaves of the same plants, simply split or shredded (such as straw plait); or (c) the fibrous portions of the leaves or fruits of certain exogenous plants when deprived of their epidermis and soft cellular tissue (the vegetable wool from pine needles).

Under division B, simple cellular structure, the (4) Surface fibres are recognized as (a) the hairs surrounding the seeds or seed envelopes of exogenous plants, and usually contained in a pod or capsule (as cotton); (b) hair-like growths, or tomentum, produced on the surfaces of stems, leaves, or leaf-buds of plants (as pulu); or (c) fibrous material produced in the form of epidermal strips from the endogens (as raffia). The (5) Pseudo-fibres, strictly speaking are not fibres, but false fibrous material employed as substitutes for the true fibres. These are: (a) certain mosses, used as packing substances; (b) certain leaves and marine weeds, also used for packing; (c) seaweeds wrought into fish-lines or cordage, and (d) fungus growths employed in some of the economic uses to which true fibres are put.

A review of the uses of fibres in the arts, by man, shows seven general classes of economic employment, each of which may be subdivided, further, to illustrate special utility.

1. *The Spinning Fibres* enter into the highest forms of manufacture, such as the production of cloth and woven or netted fabrics, and they also include the cordage fibres. Among spinning fibres those for the production of fabrics naturally are the most important commercially. The fibres of the first rank, which enter into fine and coarse textures for wearing apparel, house furnishings, awnings, sails, etc., are chiefly cotton, flax, hemp, ramie, pineapple fibre, and the finer manila hemps; those of the second rank, jute, cocoanut fibre and some of the Agaves find use in burlap or gunny, webbing, rough sacks, coarse floor coverings, etc. The netting fibres, also included in the spinning fibres, are derived from a very much wider range of plants, many of which are not in cultivation. Besides cotton, flax and ramie, employed chiefly in laces and knit goods, nets, etc., there are scores of tree basts, Agave, palm and grass fibres, which find use, both commercial and native, in the manufacture of all kinds of nets, hammocks and similar articles. A third group of the spinning fibres comprises those employed in cordage manufacture. They include all of the fabric fibres mentioned above, the so-called hard fibres, Manila and sisal hemps, coir, etc., as well as Sunn hemp, Mauritius, the bow-string hemps, New Zealand flax, Tampico, and many forms of fibre used in the hand manufacture of rope, by natives, in their rude domestic economy.

2. *Tie Material.*— The fibres employed as tie material are legion; many of them can scarcely be called commercial forms as they are largely used by the natives in the countries where they are produced. The tie material is usually the peeled bark of trees rich in bast, stripped or shredded palm leaves, the tougher grasses, and even twigs and roots used with no special preparation, but merely twisted when green, or freshly cut, into rough cordage for the building of huts, enclosures, and even for constructing rope suspension bridges. Raffia, used

FIBRE PLANTS — I.

1. Sisal Hemp.
2. Istle or Tampico Hemp.
3. Cocoanut Plant.
4. Mauritius Hemp.

by nurserymen as a ready-to-hand tying material, is an example.

3. *Natural Textures.*— These are the nature-woven fabrics of tropical countries, which are used as substitutes for cloth, and which are prepared by simply stripping from the plant, in sheets or layers of fibrous substances, and beating. The famous Tappa cloth of the Pacific Islands is an example. Others are the lace barks, the satin-like Cuba bast, employed in ladies' hats, the ribbon-like bast used for cigar wrappers, etc.; also the fibrous sheaths from the bases of the leaf-stalks of palms. The separated and hand-twisted filaments of many of these cloth substitutes are also used for rough cordage.

4. *The Brush Fibres.*—These include such commercial forms as Tampico, Palmetto, Palmyra, Kitool, Monkey Bass, Piassaba, and cocoa fibre, employed in the manufacture of brushes, and as substitutes for animal bristles, as well as the coarser forms, such as broom-corn, broom-root and even twigs and splints as employed in street-sweeping machines.

5. *The Plaiting and Rough Weaving Fibres.*— This is another large group, which includes a wide range of uses not commercial, yet of greatest importance to the natives of the countries where they grow. They are employed in articles of attire and ornament and for use in the domestic economy. The most important commercially are the straw-plaits from wheat, rye, barley and rice straw (the Tuscan and Japanese braids). Other forms are split from palm leaves, such as *Carludovica palmata,* used in weaving Panama hats; plaits are also produced from various fibrous substances used entire, as the tree basts, and even thin shavings of close-grained woods — the «chip» in millinery trimmings. This group also includes the commercial matting fibres produced from grasses and sedges, as well as thatch materials of every description. The basketry fibres are likewise classed in this group, and they are legion, for they include not only the entire range of palm fibres, the grasses, reeds and rushes, yucca fibre, the leaf stems of ferns, etc., but osier and splints from the common woods, pine, ash, hickory and others. Then there are many miscellaneous uses, such as for «willow ware» furniture, chair seats, screen panels, etc., employing bamboo, osier, rattan, rushes, and splints.

6. *The Filling Fibres* are of less importance than any of the preceding, though altogether they form a large group, and include some valuable commercial forms. Their most common employment is in upholstery; wadding, from cotton; feather substitutes for filling pillows and cushions, as the silk cottons («vegetable silk»), «downs,» kapok, and fibrous material from the surfaces of leaves and stems of plants or from their capsules or fruit; mattress and furniture filling, as tow or waste of the spinning fibres (flax, etc.), unprepared basts, straw and grasses; the curled hair substitutes or Spanish moss, Crin végétal, corn husks and others. Oakum for caulking ships, the leaves of reeds or flags used for filling the seams in casks, as well as the fibres used for stiffening mortar, or the staff used in exposition buildings, are included in this category, palmetto fibre and New Zealand flax being examples. Many fibres and fibrous substances are used as packing material, but they need not be enumerated.

7. *Paper Materials.*— This group of fibres might include the whole category of fibrous substances, for there is scarcely a fibre that cannot be made into paper, the expense of preparation being the main question in determining its availability. The *Textile papers* employ the spinning fibres, in the raw state, in the form of waste, tow, jute butts, old manila rope, cotton and linen rags, etc. The *Bast papers* include such eastern fibres as Japanese paper mulberry, the tree basts, etc. The *Palm papers* are made from palmetto, yucca, and many of the tropical palms. The *Bamboo* and *Grass papers* include bamboo, esparto and other grasses, straw and maize; and lastly, the *Wood pulp papers* are made from the cellulose, chemically prepared, from spruce and other native woods.

The employment of fibre in the domestic economy must go back to the most primitive times, for among the uncivilized races of man the world over we find a dependence upon fibre plants for utensils, cordage, clothing, the building and furnishing of their huts, second only in importance to their dependence upon edible plants for food. And these plants supply hundreds of fibres which the inventive genius of the age cannot afford to use commercially. So we have two great groups of fibres, economically speaking. The «native» forms used to supply the common wants of the people of the countries where they grow, and the fibres recognized as commercial forms because they have been found best adapted to certain uses in the industrial world, and have a stated market value. Some of these have come down to us from remote ages, and the larger number long ago established their places because they were proved to be the best for the purposes for which employed, a veritable survival of the fittest. The discovery of many new fibres therefore is hardly a possibility, although we may discover new uses for well-known forms hitherto not largely employed for any purpose. But even such fibres will scarcely find a place among the fibres of first rank, but must fill the places of the better and fully recognized commercial forms as substitutes, and therefore are worth less money.

While the «native» or emergency fibres, that are known, make a list of upward of 1,500 species, the commercial fibres of value to the world would hardly reach two score in number, and those that interest the United States scarcely half that number. Altogether, counting the more unimportant forms, 25 to 30 species may be enumerated, the larger number of which figure as imported kinds, although they are imported in such small quantities, and at such irregular intervals that they cut a small figure indeed. Eight species of imported fibres would include all of the really important kinds representing the material of the great textile industries. They are: Cotton, flax, hemp, jute, manila hemp, sisal hemp, Tampico and coir or cocoanut fibre. The fibres of lesser importance are: China grass or ramie, raffia, Mauritius, Sunn, New Zealand flax, a few of the Mexican Agaves and Yuccas, Piassaba or Brazilian bass, broom root, Esparto, Crin végétal, rattan and vegetable sponge. Straw plait (and its manufactures) are also imported in considerable quantities, and there is some bamboo, kittool and palmyra.

Of native fibres, commercially employed, we use in manufacture slough grass, Spanish moss, two species of Florida palmetto, and the woods of several species of forest trees in basketry and wood pulp, besides straw and maize husks. Many native fibres are used by the North American Indian tribes, but as these are in no way commercial they are not included here. While the fibres of lesser importance are briefly referred to in this article, the references to the more important textile forms will be found alphabetically arranged under their common names, as cotton, flax, hemp, etc. Among spinning fibres of lesser importance are ramie, or China grass, Mauritius and Sunn hemps, and New Zealand flax.

Sunn hemp, *Crotalaria juncea,* is a leguminous shrub which abounds in India and Australia. Synonyms: Conkanee hemp, Indian hemp, Brown hemp and Madras hemp. A bast fibre which takes the place of jute in portions of India, though it is lighter in color and a better fibre, with a tensile strength which adapts it for cordage; used for rope making in this country, present importation less than 300 tons. In India is used for cordage, nets, sackcloth, twine and paper, 50,000 acres having been cultivated in northern provinces in a single year.

Mauritius hemp, *Furcræa gigantea,* is imported from Africa, as its name applies; thrives in the West Indies and Central and South America. Introduced into India, Ceylon and Australia. The plant is closely allied to the Agaves (such as the sisal hemp plant), the fibre being derived from the leaves, which are 4 to 7 feet long and 4 to 6 inches wide. A structural fibre, it is very similar to sisal hemp, and is used for the same purposes. The commercial supply is derived only from St. Helena and Mauritius, where the plant is cultivated. In Venezuela the native supply of this fibre is made into bags, halters, horse blankets, fish nets and cordage, and is known as *fique.*

New Zealand Flax, *Phormium tenax.* A structural fibre derived from the leaves of a liliaceous plant, resembling the flag, native to New Zealand, but found in other portions of Australia. Distributed to the Azores, St. Helena, Algiers, Southern France, and the British Isles. Thrives in California, where its leaves are used as tie material. Its many varieties produced in New Zealand yield fibre capable of manufacture into cloth of the texture of linen, satchels, table mats, sandals, sacks, rugs, and mattings, threads and twines of superior strength, cordage and cables. An inferior grade has been imported into the United States for the manufacture of binding twine. The staff used in the construction of exposition buildings is stiffened with a low grade of this fibre. At the present time 3,000 to 4,000 tons of the fibre is being imported annually, worth from $112 to $128 per ton.

Broom Root, *Epicampes macrura.* Also known as Mexican whisk and *Raiz de Zacaton.* A fibre of a bright yellow color, wavy as though crimped, stiff and harsh, measuring from 10 to 15 inches in length. Is a substitute for Venetian whisk and is used in this country for clothing and velvet brushes, scrub and other household brushes, brooms, etc. The fibre is simply the cleaned roots of a grass which abounds in a wild state in Southern Mexico. We imported last year about 450 tons, worth $85,000.

Piassaba. Two species are represented in the commercial product, the Para fibre, *Leopoldina piassaba,* also known as monkey bass, and *Attalea funifera,* both derived from Brazilian palms. An African species, *Raphia vinifera,* known as West African bass, has been imported to a slight extent in late years. The Bass fibres, from these three species, are stiff and wiry, bright chocolate in color, and are used for very stiff household brushes and brooms, and for street-sweeping machines. The fibre is obtained from the dilated bases of the leaf stalks, which separate into a long coarse fringe; this is collected by the natives, sorted and tied in bundles, and baled for market.

Palmyra, *Borassus flabellifer,* is a similar palm fibre from Ceylon, a little finer, redder in color, and about two feet long. It is obtained from the base of the petioles or leafstalks. It is also found in India, and tropical West Africa; used as a brush material; first came into notice in 1891. Trade name, Cassine.

Kittool, a similar fibre, derived from the jaggery palm, *Caryata urens.* Structural fibre; brownish black, the filaments straight, smooth and glossy, showing considerable tenacity, and capable of twisting as the fibre is elastic. Common in India and Ceylon. We have imported as high as $16,000 worth of kittool in a single year for the manufacture of brushes for brewers use. The fibre is taken from the bases of the leafstalks. For further information concerning this and other fibres briefly mentioned see 'A Descriptive Catalogue of Useful Fibre Plants of the World,' and 'Dictionary of the Economic Products of India.'

Palmetto fibre. Two species of the Florida palmetto supply commercial brush fibre. The fibre from the saw palmetto, *Serrenoa serrulata,* is derived from the macerated stems of the leaves, which are sometimes five feet long. It is a harsh, brittle fibre, white in color when well prepared, and makes a very cheap substitute for bristle brushes. Also used as a substitute for cow's hair in plaster, while the shredded leaves have been employed as mattress filling. The cabbage palmetto, *Sabal palmetto,* yields fibre reddish in color, somewhat resembling cocoa fibre. It is derived from the «boots» or spathes of the leaf-stems which surround the bud or «cabbage,» and in securing the bud the tree is killed. After a process of steaming and crushing the boots, the mass is combed and the softer, tangled fibre extracted, leaving the stiff, straight, coarse brush material, which represents about 25 per cent of the original fibrous substance of a boot. This product goes into cheap brushes for household use.

Crin végétal, or African fibre, *Chamærops humilis,* is derived from an Algerian species of palm similar to the Florida palmetto. The commercial product is produced by shredding the leaves, and as imported resembles twisted ropes of hay. It comes in two colors, a pale greenish (called white) and in black. The twisting crinkles the fibre so that when again opened it retains the «curl,» and in this form is employed as a substitute for curled hair in the filling of mattresses. As the fibre is quite elastic it is a valuable upholstery material.

Spanish moss, *Tillandsia usenoides.* This is a native filling fibre. The plant is parasitic on trees and is seen hanging in dense gray masses

FIBRE PLANTS—II.

1. California Hemp.
2. Sunn Hemp.
3. Louisiana Jute.
4. China Grass, or Ramie.
5. Cabbage Palmetto.
6. Sponge Cucumber.

in many portions of tropical and sub-tropical America. The fibre is the entire plant in mass, after the gray epidermis has been removed. It is black in color, and resembles curled hair, for which it is a tolerable substitute. Manufactured chiefly in Charleston, S. C., and in New Orleans, La.

Pulu, an Hawaiian surface fibre, useful for stuffing pillows, etc., is simply the hairs which grow at the bases of the leafstalks of several species of *Cibotium,* a genus of tree ferns. It is regularly exported from Honolulu to San Francisco. The substance is yellowish in color, and resembles wool. The golden moss of the Chinese is a similar fibre.

Raffia, *Raphia ruffia,* is a palm fibre, imported from Madagascar. The commercial product comes in the form of narrow ribbons of fibrous material, derived from the cuticle of the leaves of an African palm, taken before they are fully expanded, by peeling the leaf on both sides. Imported as a tie material for nurserymen; used also for the manufacture and trimming of ladies' hats; has recently come into extensive use in connection with splints of rattan, for hand-made fancy baskets, the art now being taught in all of our larger cities. Takes dye readily, and can be purchased in several colors.

Another millinery trimming fibre is the Cuba bast, *Hibiscus elatus,* which comes in the form of thin ribbons of bast, which are the separated layers of the inner bark of a large tree. These ribbons or strips are plaited into ladies' hats, either in the flat, or twisted forms, the white color and satiny sheen making the product peculiarly adaptable to the purpose. In this connection may be mentioned the poplar and willow shavings, or thin strips of wood known as "chip," and imported from Germany for the same purposes.

Straw is imported from Italy, Germany and Japan, wrought into "straw plait" or "braids" for the manufacture of hats, fancy baskets, etc. The Tuscan braids are the finest and are produced from wheat straw specially grown, although rye straw is also employed in Italy. The braids from China and Japan are from rice and barley straw, while the Bohemian straw plait is from wheat. Two native American grasses, *Poa pratensis,* and *Sporobolus indicus,* have also, in past time, been employed for the same purpose.

The Eastern or Oriental floor mattings imported into this country are made from several species of rushes or sedges. The Chinese and Korean are produced from *Cyperus tegetiformis;* the Japanese from *Cyperus unitans,* and *Juncus effusus;* the Indian from *C. corymbosus, C. esculentus,* and *C. tegetum.* Other species are also employed, though the above are the most common. The Japanese mat rush industry is very extensive, over $400,000 worth of mats having been exported in a single year. *Cyperus unitans* is the *Shichito-i* of Japan, from which the cheaper, coarser mats, for the common people, are produced, while *Juncus effusus* is the *Bingo-i,* or form employed for the mats of the higher classes, both being cultivated. The technique of mat making is practically the same in China, Japan, India, and Ceylon. The culms are either used entire or split into two or more parts, and woven upon a warp of thread, these often stretched upon the floor, for much of this material is woven by laborious hand methods.

In the United States a new form of floor matting has recently come into vogue, produced from slough grass, *Carex filiformis,* also known as the slender sedge. The material grows wild over vast areas of the river bottoms of the Mississippi, and streams tributary. It is cut in July or August, dried, and by means of special machinery, worked into a continuous strand, bound with thread or fine twine. It is afterward woven into mattings, the warp being cotton yarns in high colors. The grass twine as prepared for weaving is also used as binder twine for grain.

The sponge cucumber or snake gourd, *Luffa cylindrica,* is imported from Japan in considerable quantities as a substitute for the bath sponge. The commercial article is the entire gourd with the epidermis and seeds removed, presenting the appearance of a network of straw-colored fibre. It is extensively cultivated in Japan, for export. Grows in the southern United States, but has never been produced commercially, though used for bath sponge, flesh brush, dish cloths, and even for fancy baskets, and bonnet crowns.

Among high-grade fibres that have been the subject of experiment in the United States, but which are not produced commercially may be mentioned pineapple fibre, from *Ananasa sativa.* Fibre extracted in Florida was found to be fine, soft, flexible and very resistant. The filaments yield to treatment in the alkaline bath and are easily subdivided, producing an admirable spinning fibre. In the Philippines, the fibre is used to some extent in the fabric known as piña cloth, which is becoming known in Europe and America, and may in time become of commercial importance. See Special Report No. 5, Office of Fibre Investigations, Department of Agriculture, Washington, and Bulletin No. 4, Philippine Bureau of Agriculture, Manila, for further information regarding pineapple fibre.

Another valuable but unemployed spinning fibre that might be produced in the United States is the bowstring hemp, *Sansevieriasps.* The plant grows to perfection in southern Florida, and yields a fibre which combines all the good qualities of length, strength, fineness, color and divisibility, which adapts it for employment in the manufacture of fine threads, and even fabrics. The lack of machinery to properly extract the fibre, as well as the fibre of pineapple, is the chief drawback to the establishment of two new industries. There are eight or more species of bowstring hemps, all of which are considered valuable for fibre. The Florida species is *S. longiflora.*

Mexico abounds in fibre plants, many species of Agave and Yucca not recognized as standard commercial forms being employed for rope, coarse bags and mattings. A little of this fibre finds its way to the United States for employment in coarse twine manufacture, though not in appreciable quantities at present. Palma Istle, and Pita Sylvestre are local trade names applied to a harsh, low-grade fibre produced from two species of Yucca. Pita is a Mexican name applied to several Agave fibres, and to some allied species, though pita is generally understood to mean the fibre of *Agave americana.* There are several species of Agave, known in Mexico as Mescals, which produce fibre of good strength, which might be employed in cheaper grades of cordage.

The imports of commercial fibres for the year ending 30 June 1902 amounted to a value of over $30,000,000, though this sum should not be taken as alone representing the consumption of fibre manufactures in the United States, for we import vast quantities in the manufactured form. As an illustration, the importation of flax manufactures in a single year has been seven times greater than the imports of raw and hackled flax for the same period. Probably the ratio of raw to manufactured, as shown by the tables of importation, would stand about one to four, for all classes of fibre, which with the native kinds, not considering paper materials, might give a grand total of upwards of $125,000,000, as the value of the raw and manufactured for a single year. See COIR; CORDAGE; CORDAGE INDUSTRIES; COTTON; FLAX; HEMP; ISTLE; JUTE; MANILA HEMP; MATTING; RAMIE; SISAL HEMP.

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Fibre Plants. See ESPARTO; FIBRE; FLAX; JUTE; RAMIE; SISAL; etc.

Fibrin, fī'brin, the chief substance formed in the coagulation of the blood-plasma. It may also be found in coagulation of lymph and in other fluids that contain fibrinogen. It is usually taken from the blood by whipping it with a bunch of wire or glass rods as it falls into a vessel, before it has had time to coagulate into a solid mass. When obtained from fresh blood in this way, fibrin is a stringy substance while wet, and dries to a glue-like mass. It is a proteid, and consists of at least two globulins, one coagulating at 50° C., the other at 56° C. Under the action of pepsin these are converted into acid albumin, proteoses, and peptones. Blood yields from .2 to 4 per cent of its weight of dry fibrin. See BLOOD; FIBRINOGEN.

Fibrinogen, fī'bri-nō-jen, a substance found in the plasma of the blood, and which brings about spontaneous coagulation of that fluid. It is also found in the lymph and in a number of other fluids of the body. Fibrinogen may be precipitated from the blood-plasma by the addition of magnesium sulphate or sodium chloride. It is soluble in dilute alkalies, and is precipitated from solutions in these weak alkalies by acetic acid. Fibrinogen is probably not a simple substance, but a mixture existing in loose combination of at least three substances. These as given by Schäfer are fibrinogen proper, coagulating at 56° C., a globulin, described by Hammarsten, and termed fibrino-globulin, and a nucleoproteid. The relationships of fibrinogen and fibrin and the blood-ferment are expressed by Schäfer as follows: «(1) That the coagulation of blood, that is, the transformation of fibrinogen into fibrin, requires for its consummation the interaction of a nucleoproteid (prothrombin) and soluble lime salts, and the consequent production of a ferment (thrombin); (2) that either nucleoproteid is not present in appreciable amount in the plasma of circulating blood, or that the interaction in question is prevented from occurring within the blood vessels by some means at present not understood; (3) that the nucleoproteid (prothrombin) appears, and the interaction occurs, as soon as the blood is drawn and is allowed to come into contact with a foreign surface, the source of the nucleoproteid being in all probability mainly the leucocytes (and blood-platelets?); (4) that, under certain circumstances and conditions, either the nucleoproteid does not appear in the plasma of drawn blood, or it appears, but the interaction between it and the lime salts is prevented or delayed; (5) that the nucleoproteid (prothrombin) appears in the plasma of circulating blood under certain conditions, being in all probability shed from the red blood-corpuscles; and that when shed out under these conditions from the corpuscles, or when artificially injected into the vessels, it tends to interact with the lime-salts of the plasma and to form fibrin ferment (thrombin), intravascular coagulation being the result; (6) that, under other conditions, either the shedding out of nucleoproteid from the corpuscles, or its interaction with the lime-salts of the plasma, may be altogether prevented and the blood rendered incoagulable, unless nucleoproteid be artificially added, or unless a modification of the conditions is introduced which will permit of the interaction of the nucleoproteid with lime to form ferment; (7) that the nucleoproteid (prothrombin) is incompetent, in the entire absence of lime-salts to promote the transformation of fibrinogen into fibrin; but, as a result of its interaction with lime-salts, it becomes transformed into a ferment (thrombin), which, under suitable conditions of temperature and the like, produces fibrin; (8) that either the place of nucleoproteid in coagulation may be taken by certain albumoses, such as those found in snake-venom, and by certain artificial colloidal substances, such as those prepared by Grimaux, or that such substances may act by setting free nucleoproteid from the leucocytes and other elements in the blood or from the cells of the blood vessels, and thus indirectly promote coagulation.» See BLOOD; COAGULATION; FIBRIN.

Fibro Cartilage. See CARTILAGE.

Fibrolite. See SILLIMANITE.

Fibroma. See TUMOR.

Fibropsammoma. See TUMOR.

Fibrosarcoma. See TUMOR.

Fibula. See ANATOMY; OSTEOLOGY.

Fichel, Eugène, ė-zhen fē-shel, French painter: b. Paris 30 Aug. 1826; d. there 1 Feb. 1895. He was a pupil of Delaroche, but painted very much more under the inspiration of Meissonier, whose exquisite handling is recalled in numerous small canvases of his which by their refined technique and vivid action recall the characteristic intensity and directness of composition which belong to the painter of 'Friedland.' The principal works of this painter are of a high order of genre, and include, 'The Violin Player'; 'A Festival in the Year 1776'; 'The Capture of a Spy'; 'The Wandering Singers'; and the following historic pictures, which have the freedom and imagination of pure genre: 'The Night of August 24, 1572'; 'Founding of the French Academy.'

Fichte, Immanuel Hermann von, im-mä'-noo-āl hār'män fon fĭн'tĕ, German philosopher: b. Jena 18 July 1796; d. Stuttgart 8 Aug. 1879. He was a son of Johann Fichte (q.v.), and in his philosophy was a mystic theist. Among his writings are: 'Speculative Theology' (1847); 'System of Ethics' (1850); and 'The

JOHANN GOTTLIEB FICHTE.

Soul Question: A Philosophic Confession' (1859).

Fichte, Johann Gottlieb, yō'hän gōt'lēb, German philosopher: b. Rammenau, near Bischofswerda, Upper Lusatia, 19 May 1762; d. Berlin 27 Jan. 1814. He studied at Jena, Leipsic, and Wittenberg, passed several years as a private tutor in Switzerland and Prussia, and in Königsberg enjoyed the society of Kant. His 'Versuch einer Kritik aller Offenbarung' (Essay toward a Criticism of all Revelation) (1792) attracted general attention, and procured him the professorship of philosophy in Jena in 1793. In 1800 he was one of the most prominent professors of that university during its most brilliant period. Here he published, under the name of 'Wissenschaftslehre' (Theory of Science), a philosophical system, founded at first on the system of Kant, from which, however, he gradually deviated. On account of an article, 'Ueber den Grund unseres Glaubens an eine Göttliche Weltregierung' (On the Reasons of our Belief in a Divine Government of the Universe), which appeared in his 'Philosophisches Journal' in 1798, he fell under the suspicion of atheistical views. This gave rise to an inquiry, and Fichte resigned his professorship. In 1805 he was appointed professor of philosophy at Erlangen, and in 1810, on the establishment of the university of Berlin, was appointed professor of philosophy there. Fichte's philosophy, though there are two distinct periods to be distinguished in it, is a consistent idealism, representing all that the individual perceives without himself, or, rather, all that is distinguished from the individual, the *ego*, as a creation of this *I* or *ego*. His 'Ueber den Begriff der Wissenschaftslehre' (1794); 'Die Wissenschaftslehre in ihrem allgemeinen Umrisse' (1810); and the 'Anweisung zum seligen Leben' (1806) contain the substance of his teaching. His practical is purer than his theoretical system. His idealism led him to represent the life of the mind as the only real life, and everything else as a mere delusion, and to believe in an almost absolute omnipotence of the will. To excite his pupils to the highest virtue and self-denial was his constant aim as a teacher, and his influence was great, not merely through his power of expression and the originality of his ideas, but through the conviction with which he inspired his hearers of his full belief in, and entire devotion to, his principles. His heart was open to every noble and good feeling. Unshaken integrity, constant friendship, devoted love of what he conceived to be true and good, were his characteristic traits. When Germany was suffering under the wounds of war he, like his countrymen in general, considered Napoleon as the source of the whole distress of his country, and in his 'Reden an die deutsche Nation' (Addresses to the German Nation), published in Berlin while it was still in the hands of the French, he boldly called upon his countrymen to rise and throw off the foreign yoke. The more popular works of Fichte, known in English through the translations of W. Smith, consist of: 'The Vocation of the Scholar'; 'The Nature of the Scholar'; 'The Destination of Man'; 'The Characteristics of the Present Age'; and 'The Way toward the Blessed Life.' His complete works were edited by his son in 8 volumes (1845–6).

Fichtelgebirge, fiн'tel-gĕ-bĕr'gĕ, a mountain range, chiefly situated in the northeast of Bavaria, once covered with pines (*Fichte*, "pine"), and constituting a watershed between the head-feeders of the Elbe, the Rhine, and the Danube. The average elevation of the peaks ranges from 2,700 to 3,200 feet. The highest summits are Schneeberg (3,461 feet) and Ochsenkopf (3,334). In their northern extremities the Fichtelgebirge are connected by intermediate chains, on the one hand with the Erzgebirge, and on the other with the Thuringian Forest. They are composed principally of granite and primitive crystalline slates, with bands and intrusions of gneiss, micaceous slates, basalt, and some strata of the Tertiary Age (*Oligocän*). Snow lies on the summits as a rule from October to May. The chief industries are those connected with mining iron ore, quarrying of marble, manufacturing glass, and getting of timber from the forests. Of recent years the Fichtelgebirge have come much into vogue with tourists. Consult: Ruchdeschel, 'Hand-book of Bavaria.'

Ficino, Marsilio, mar-sē'lē-ō fē-chē'nō, Italian philosopher of the Platonic school: b. Florence 19 Oct. 1433; d. Careggi 1 Oct. 1499. His early display of talent attracted the notice of Cosmo de' Medici, who induced him to translate the writings of Plato and of the Neo-Platonists into Latin; he afterward employed him to aid in establishing a Platonic Academy (about 1460). Ficino engaged in this plan the more readily, because he viewed the Platonic philosophy as a sort of preliminary to, and confirmation of, the Christian faith. In his accounts of this philosophy he did not always make an accurate distinction between Plato and the New Platonists, as appears from his 'Theologia Platonica; de Immortalitate Animorum ac æterna Felicitate,' in which he particularly defends the immortality of the soul against the Aristotelians of his age. Mystic and fanciful views are interwoven with this defense; astrological doctrines, for example, which he afterward rejected. At the age of 40 he was presented by Lorenzo de' Medici with the rectorship of two Florentine churches, and a canonry in the cathedral. His Latin works were first published complete at Basel (1561).

Fick, Adolf, ä dölf fik, German physiologist: b. Cassel 3 Sept. 1829; d. 1901. He was professor at Würzburg and published: 'Die medizinische Physik'; 'Kompendium der Physiologie.'

Fick, August, ow'goost, German philologist: b. Petershagen, Westphalia, 5 May 1833. He studied at Göttingen 1852–7, becoming professor of comparative philology there 1876, and occupying the same chair at Breslau 1888. He is an authority on the primitive Indo-Germanic languages and Greek philology. Among his works are: 'Die ehemalige Spracheinheit der Indogermanen Europas' (1873); 'Vergleichendes Wörterbuch der Indogermanischen Sprachen,' his masterpiece (1874–6); 'Die griechischen Personennamen' (1877); and 'Die homerische Ilias nach ihrer Entstehung betrachtet und in der ursprünglichen Sprachform wiederhergestellt' (1885).

Fiction, in law, is an assumption made for the purposes of justice, though the same fact could not be proved, and may be literally untrue. There are many fictions in the civil law, and a fiction in law is said by civilians to be the assumption of an untruth for a truth, in a thing possible to have been done, but which was not done. The declaring that a note or bond made in a foreign country was made in the county where a suit is commenced upon it, is an instance of a very common fiction, adopted on the ground that suits can be brought in the county only on causes of action existing within its limits; and so the practice has been introduced of declaring that the contract on which an action is brought was made in the county, though the fact seems to be entirely immaterial; for transitory actions follow the person, and it is only of such that the fiction is admitted. The fictitious characters of John Doe and Richard Roe for the purposes of various actions are well known. It is a rule that a fiction of law shall work no wrong; and the fictions in use generally come within this rule.

Fiction in America. While the art of fiction writing in America is scarcely more than 100 years old, its genesis may be traced far back into the records of literature. Prior to 1798, when Charles Brockden Brown laid the foundations of his fame with the writing and the publication of 'Wieland,' the art of writing fiction in this country was scarcely known. Novels were published, imported and read, but they were largely the work of English writers or translations from foreign languages. With the advent of Charles Brockden Brown, however, imaginative literature began to gain a foothold, and the literary man to secure a standing in the professional world. Brown has usually been styled the precursor of the American novelist and the founder of American fiction. There had been isolated attempts at fiction writing before his day, but the results were meagre both in quantity and in quality. The list is virtually complete with 'The Pretty Story,' by Francis Hopkinson; 'The Power of Sympathy,' by Mrs. Morton; 'The Foresters,' by Jeremy Belknap; 'Modern Chivalry,' by Hugh Henry Brackenridge; 'The Algerine Captive,' by Royall Tyler (who also holds position as one of the early American dramatists); 'History of a Corporation of Servants,' a satirical romance, by John Witherspoon; 'Female Quixotism: the Romantic Opinions and Extravagant Adventures of Dorcasina Sheldon,' by Mrs. Tabitha Tenny; and 'The Coquette,' by Mrs. Hannah Foster. Of these early novels 'The Foresters,' by Jeremy Belknap, was the most important. The poet Bryant describes it as «a work which sought to embellish our literature with the charms of wit and humor.» Susannah Rowson's 'Charlotte Temple' can scarcely be accounted an American novel, for it was first published in England and its author was of English birth and residence, although she lived for a considerable length of time in this country.

It is a somewhat curious fact that Charles Brockden Brown (q.v.) reveals in his work little of the American character, the American temperament, and the American people. On the other hand, he shows in his own trend of thought and choice of subjects that longing for the mysterious in life which was later to find its fullest expression in Poe and in Hawthorne. He was a student of the mystic and his novels presage the beginnings of modern psychical research. His 'Wieland,' 'Ormond,' 'Arthur Mervyn,' 'Edgar Huntley,' 'Clara Howard,' and 'Jane Talbot' were varied expositions of experiences now classed exclusively as psychical phenomena, although by him they were treated merely from the curious and spiritual points of view. His life ended 22 Feb. 1810, before he had reached the age of 40, and so slow was the growing interest in American fiction that little advancement had been made prior to his death. With the advent of Washington Irving (q.v.) and James Fenimore Cooper (q.v.), the imaginative literature of America proved the force and might of its English heritage. As early as 1809 appeared Irving's 'Knickerbocker History of New York,' which may fairly be classed as a romance if not as a novel. It was Irving's second published work, his first being the volume of reprinted miscellany called 'Salmagundi,' which had appeared the year before. Surrounded by a group of brilliant men, Irving settled down to a life of literary leisure, and in time 'The Sketch Book,' 'Bracebridge Hall,' and 'Tales of a Traveler' took their place in literature. James Kirke Paulding (q.v.), his friend and comrade, shared the honors of the 'Salmagundi' essays with Irving, and in 1813 his 'Diverting History of John Bull and Brother Jonathan' led the way to a continuous flow of volumes in fiction, poetry and essay which did not cease until his death 6 April 1860. 'The Dutchman's Fireside' was his most important novel.

It was not, however, until 1821–2 that the novel of American life written by a typical American author began its vogue. In that year, with the publication of 'The Spy,' the fame of James Fenimore Cooper had its beginning. He had already written 'Precaution' (1820); but that novel was a romance of English society life, and does not form a part of Cooper's most characteristic work. After 'The Spy,' came 'The Pioneers'; 'The Pilot'; 'Lionel Lincoln'; 'The Last of the Mohicans'; 'The Bravo'; 'The Prairie'; and 'The Red Rover'; and for 30 years, until his death 14 Sept. 1851, Cooper was the pre-eminent American novelist who was equally expert in chronicling the life of the Indians and in writing the narratives of perilous adventures by sea. During this period the American novel and the American novelist proved that their position was secure. John Pendleton Kennedy, with his 'Swallow Barn'; 'Rob of the Bowl'; and 'Horseshoe Robinson'; Dr. Robert Montgomery Bird, with his 'Nick of the Woods'; William Ware with his 'Zenobia' and 'Julian'; Herman Melville with his 'Typee'; 'Omoo'; and other remarkable sea stories; William Gilmore Simms, next to Cooper the most voluminous American novelist, with his many revolutionary and border romances; Charles Fenno Hoffman with his many romances of historical and legendary lore; Mrs. Caroline M. Sedgwick with her 'Redwood'; 'Hope Leslie'; and 'The Linwoods'; are among the few names of novel writers who flourished during the period following the advent of James Fenimore Cooper. One name alone — the greatest of them all — has been omitted, but Edgar Allan Poe's (q.v.) work covered so many branches of literature and the man himself is so absolutely one of the world's great writers that he needs no more than passing mention in this review of American fiction. As a master of the short story and as a writer of some of the finest tales known to any language — 'The Murders in the Rue Morgue'; 'The Tell Tale Heart'; 'The Fall of the House of Usher' — Poe's rank is secure. His achievements in other fields are fully outlined in the article in this work devoted especially to him.

Fittingly after Poe comes the name of Nathaniel Hawthorne (q.v.), for it was in 1850, the year following Poe's death, that 'The Scarlet Letter' was published. This was the first if not the only great American novel. There had been nothing like it in American literature, and scarcely anything like it in the world's literature. At the time of its publication, Hawthorne was 45 years of age, he had been writing since boyhood. and his name had been known for 15 years as that of a novelist and short-story writer of peculiar style, extraordinary gifts and sombre tendencies. 'The Scarlet Letter,' however, immediately showed the unique and unapproachable power of his genius, and with 'The House of the Seven Gables' (1851), 'The Blithedale Romance' (1852), and 'The Marble Faun' (1860), which followed, it placed Hawthorne among the greatest of the world's great fiction-writers. During this era of Hawthorne's progress the art of writing fiction was growing apace. In 1852, 'Uncle Tom's Cabin' achieved three things: it made Mrs. Harriet Beecher Stowe (q.v.) a famous woman, it aroused an enormous public sentiment against slavery, and it created a desire for novel reading among hundreds of thousands of people who could not before have been persuaded even to look into a work of fiction. Mrs. Stowe, as was to be expected, never repeated the triumphant success of 'Uncle Tom's Cabin,' although during her long life she wrote many novels. Nathaniel P. Willis, at this time at the height of his unique fame, was turning out volume after volume of fantastic work in poetry, fiction, and essays. George William Curtis' long and versatile career covered both the ante-bellum and the post-bellum periods, his 'Prue and I,' his 'Potiphar Papers,' and his 'Trumps' being simply imaginative wanderings into a form of fiction and social satire somewhat apart from his general literary interests. Susan Warner had in the very year of the publication of 'The Scarlet Letter' gained for herself an extraordinary popularity with 'The Wide, Wide World,' a story still in extensive demand at public libraries, and Mrs. Mary Jane Holmes, Mrs. E. D. E. N. Southworth and Mrs. Ann Sophia Stephens were beginning that long series of sensational novels which, while not a part of literature, deserve record because of the place they hold in the hearts of the reading public and because they have helped to create a reading habit which has led to better things. At this time, too, there appeared the first American historical novelist, Jeremiah Clemens, of Alabama, who wrote and published 'The Rivals' (1859), and other novels. To this period also belongs Rev. J. H. Ingraham, who from writing many lurid, sensational novels, turned in his latter days to sacred history and evolved 'The Prince of the House of David.' In the sixties, Theodore Winthrop, a descendant of an historic family, a brave young soldier and a gifted writer, began a career in letters which was untimely cut short by his death in the Civil War. He was only 33 years of age, but his 'Cecil Dreeme,' his 'John Brent,' and his other stories published after his death gave evidence of the power he might have become in American literature.

As early as 1839, the poet Longfellow (q.v.), returning from a European trip which had filled his receptive brain with Old World fancies and mediæval legends, wrote his 'Hyperion,' a romantic tale, the heroine of which was Miss Frances Appleton, of Boston, whom he married in 1843. Ten years later Longfellow again turned his thoughts to prose romance, producing in 'Kavanagh' a story remarkable more for its psychological elements than for any of those active phases of thought which should characterize a notable work of fiction. His success was so slight, however, and he was so keenly criticised for his venturesomeness in attempting to leap the bounds of his own field of poetry into an untraveled highway, that thereafter he was content to express his romantic feelings wholly in verse. Among the other American poets whose versatility led them to the writing of novels, Oliver Wendell Holmes (q.v.) is the best known. His famous 'Breakfast Table' series is a compound of romance, essay and poesy, and its four volumes of genial miscellany and philosophy will doubtless live long after his two novels — 'Elsie Venner' (1861), and 'The Guardian Angel' (1867) — are forgotten. It was also in the same decade that Bayard Taylor (q.v.) added his first work of fiction to his rapidly lengthening list of works in almost every branch of literature. His novels comprise: 'Hannah Thurston,' 'John Godfrey's Fortunes,' 'The Story of Kennett,' and 'Joseph and His Friend,' all published between 1863 and 1870. Contemporary with Bayard Taylor was J. G. Holland, who wrote 'Seven Oaks,' and John Townsend Trowbridge, whose 'Neighbor Jackwood,' 'Cudjo's Cave,' and 'Coupon Bonds' are prominent in a long series of works largely made up of poetry and juvenile fiction. Trowbridge stands at the head of a long line of writers who have devoted their energies to the production of books for the young, his position among writers for boys being paralleled by Louisa May Alcott with her 'Little Women,' 'Little Men,' and other clever stories for girls. Other voluminous authors of juvenile fiction during the generation following 1860, when the creation of a special form of literature for boys and girls was at its height, were William T. Adams (Oliver Optic), Horatio Alger, Jr., Elijah Kellogg, and Harry Castlemon. They all of them obviously tried to instruct as well as to amuse their youthful readers, a double purpose attained with less success by that pioneer of juvenile authors, Jacob Abbott, whose chief claim upon posterity he owes to the famous 'Rollo' books which have been burlesqued and parodied ever since their career began about the year 1840.

The modern epoch of American fiction begins with the close of the Civil War, and henceforth romance writers and novelists multiplied rapidly. The post-Civil War writers, those whose reputations were established prior to 1880 and after 1865, are meagre in numbers compared with those who became popular during the last 20 years of the 19th century. Of the writers who arose in the latter period, four names naturally come to mind — William Dean Howells, Thomas Bailey Aldrich, Bret Harte and Henry James the younger. Their names are here given in the chronological order of their appearance before the public. Mr. Howells, who through his facility as a writer and his ability to adapt himself to many varied forms of composition — the novel, the essay, the poem and the play — has practically become the most distinguished, if not the greatest American man of letters, began his apprenticeship in the exacting field of journalism. After the publication of 'A Chance Acquaintance' (1874), he turned his attention to the making of realistic novels, and it was not long before he was accepted as the exponent of a distinctive school of American fiction whose chief claim is its dictum that the commonplace and generally ignored facts of life shall form the true province of the novelist. His books written in pursuance of this method followed one another in rapid succession, the most notable of them being: 'A Foregone Conclusion,' 'A Modern Instance,' 'The Rise of Silas Lapham,' 'The Minister's Charge,' 'April Hopes,' and 'A Hazard of New Fortunes.' Although Mr. Howells has been extraordinarily active in all phases of literary work, it is distinctly as a "realistic" novelist that he is now known and will be remembered by posterity. As Mr. Howells is the exploiter of a theory in fiction, so Bret Harte was the discoverer and creator for literary purposes of an undiscovered country, the California of 1849. He was pre-eminently a short story writer, and it needs only a knowledge of 'The Luck of Roaring Camp,' 'Tennessee's Pardner,' of 'M'liss' and a hundred more of his tales to realize how thoroughly his art was restricted and how its very perfection made it impossible for him to succeed with 'Gabriel Conroy,' and the other long novels he attempted. Thomas Bailey Aldrich, singularly enough, became a novel writer through the vogue of a juvenile tale, 'The Story of a Bad Boy,' published in 1869, after serial appearance in a monthly magazine. Mr. Aldrich has published 'Prudence Palfrey,' 'The Stillwater Tragedy,' and many volumes of short stories. Although Henry James, Jr., has resided in England for many years, he still holds his position as an American author of unique style and genius. He makes no bid for popularity, being content to express his own individuality and thought, and to expound his philosophic views of literature and life to a public which is able to understand and appreciate such novels as 'The American,' 'Daisy Miller,' 'The Bostonians,' and 'The Tragic Muse.' Although Edward Everett Hale and Thomas Wentworth Higginson antedate the foregoing writers almost by a score of years, they practically belong to the same literary epoch, for it is since the Civil War that they have contributed liberally to the supply of American fiction, mainly in the form of short stories. For 20 years or more E. P. Roe's name was held high in the esteem of a large class of fiction readers who delighted in the placid commonplaces of 'The Opening of a Chestnut Burr,' and its companion tales, but his repute was ephemeral and he is now almost forgotten. With the mention of Frank R. Stockton, who wrote 'The Lady or the Tiger,' Edward Eggleston, George W. Cable, Elizabeth Stuart Phelps, Joel Chandler Harris, Francis Marion Crawford, Albion W. Tourgee, Lew Wallace (whose 'Ben Hur' became immediately popular upon its publication in 1881), Hamlin Garland, Harold Frederic, and Sarah Orne Jewett, the story of American fiction is brought down to a time when the beginnings of present-day reputations may be remembered by the youngest reader. Of Mark Twain and his work much could be said, for his later years were productive of famous novels: 'The Prince and the Pauper,' 'Jeanne D'Arc,' 'Pud'nhead Wilson,' 'Tom Sawyer,' and his other classics of American humor rank him among the great literary figures of the present era.

The leading note of contemporary American fiction is sounded from the West. With the exception of Howells, Wallace, Mark Twain, and one or two others, the first 80 years of our fiction is concerned wholly with writers native to the eastern and the southern portions of the United States. But toward the close of the 19th century, the western country began to develop writers of fiction. About the same time Mary E. Wilkins arose in the East, and James Lane Allen in the South, and each have gained no little reputation for the skilful manner in which they have set down the mingled characteristics of their own localities. Miss Wilkins has brought the short story into high estate through her picturesque handling of commonplace incidents and through her delineations of New England character, while Mr. Allen has been especially adept in his analysis of the human soul. The numerous novels written by Julian Hawthorne show the influence of heredity, and it is altogether likely that the son of Nathaniel Hawthorne might have made a higher position for himself in his chosen profession had he not been obliged to remain in the shadow of his father's great reputation. Frances Hodgson Burnett, although of English birth may be ranked through her long residence in this country as an American author. 'That Lass o' Lowrie's,' 'A Lady of Quality,' and the juvenile 'Little Lord Fauntleroy,' are evidence that she is not lacking at least in exceptional versatility. In 'The Prophet of the Great Smoky Mountains,' 'In the Clouds,' and other volumes of lengthy novels and short stories, Mary N. Murfree (Charles Egbert Craddock) has made herself the historian of the Tennessee mountain region. In 1888 Margaret Deland's 'John Ward, Preacher,' attracted wide attention to a writer, the excellence of whose work has ever since been kept at high standard. Robert Grant, with his 'Confessions of a Frivolous Girl,' and 'Unleavened Bread,' may be called the novelist of the social East, and Henry Harland, although his long residence in England has caused him to lose something of his American identity, is well known by such fantastic stories as 'The Cardinal's Snuff Box,' and 'The Lady Paramount.' Paul Leicester Ford, historian and bibliographer, wrote 'The Honorable Peter Stirling,' an artistic novel of political life notable from every point of view, and 'Janice Meredith,' a popular flamboyant novel.

The modern extravagant vogue of the historical novel has been stimulated and fostered especially by Mary Johnston and Winston Churchill. In the late nineties Booth Tarkington achieved a veritable *tour de force* with a remarkable little story called 'Monsieur Beaucaire.' The story of American fiction may fittingly be brought to a close with the name of Edith Wharton, whose genius as expressed in

‹The Touchstone,› ‹The Greater Inclination,› and ‹The Valley of Decision,› gives her unquestioned place among modern novelists.

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Literary Editor Boston Transcript.

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Fiddle-beetle. See FUNGUS-EATERS.

Fiddler-crab, the American name for the small and active crabs of the genus *Gelasimus,* called «calling crabs» by the English, who say they are waving the enormously developed front claw on the right side in beckoning, while the Americans imagine them to be fiddling. This great claw is brightly colored, and is used by the males not only as a weapon, but to be displayed as an attraction before the females. These crabs throng in thousands in salt-marshes near high-water mark, where they dig burrows.

Fides, fī'dēz, the Roman goddess of faith and honesty. Numa was the first who paid her divine honors.

Fiduciary, a law term signifying a relation of trust and confidence, generally by one acting as trustee, executor or administrator, or a director of a corporation.

Field, MRS. **Caroline Leslie,** American author: b. Milton, Mass., 10 Nov. 1853. She is a daughter of Mrs. A. D. T. Whitney (q.v.), and has published: ‹High Lights,› a novel (1885); ‹The Unseen King, and Other Verses› (1887); ‹Nannie's Happy Childhood› (1889); etc.

Field, Cyrus West, American merchant: b. Stockbridge, Mass., 30 Nov. 1819; d. New York 12 July 1892. He was the son of Rev. D. D. Field (q.v.). He early attained an important position in the mercantile world, and began to interest himself in ocean telegraphy. Having obtained a charter giving him the exclusive right for 50 years of landing ocean telegraphs on the coast of Newfoundland, he organized an Atlantic telegraph company for the purpose of laying telegraph cables across the ocean. Attempts to lay cables were made in 1857 and 1858, but without permanent success, though ships had been provided by the English and the American governments. The scheme was interrupted by the outbreak of the American Civil War, but a renewed attempt to lay a cable was made in 1865, the Great Eastern now being engaged in the work. About 1,200 miles had been laid by that vessel when the cable parted; but at last, in 1866, a cable was successfully laid by the Great Eastern, and the broken one recovered and completed. Mr. Field subsequently took an active part in establishing telegraphic communication with the West Indies, South America, etc., and was connected with various important enterprises.

Field, David Dudley, American Congregational clergyman: b. East Guilford (now Madison), Conn., 20 May 1781; d. Stockbridge, Mass., 15 April 1867. He was graduated at Yale in 1802; in 1804–18 held a pastorate at Haddam, Conn.; and in 1819–37 at Stockbridge, Mass. In 1837–51 he was again at Haddam. In addition to sermons he published: ‹History of Middlesex County, Conn.›; ‹History of Berkshire County, Mass.›; ‹Life of David Brainerd.›

Field, David Dudley, American jurist: b. Haddam, Conn., 13 Feb. 1805; d. New York 13 April 1894. He was a son of the preceding; was admitted to the New York bar in 1828; and practised till 1885, distinguishing himself especially by his labors in the direction of a reform of the judiciary system. In 1857 he was appointed by the State to prepare a political, civil, and penal code, of which the last was adopted by New York, and all have been accepted by some other States. In 1866, by a proposal brought before the British Social Science Congress, he procured the appointment of a committee of jurists from the principal nations to prepare the outlines of an international code, which were presented in a report to the same congress in 1873. This movement resulted in the formation of an association for the reform of the law of nations, and for the substitution of arbitration for war, of which Mr. Field was the first president.

Field, Edward, American antiquarian: b. Providence, R. I., 4 Oct. 1858. He was for years a school commissioner of Providence and served as city auditor pro tem. He was made clerk of probate 1889, and record commissioner of Providence 1891, is a member of several historical societies, and is historian of the Rhode Island Society of the Sons of the American Revolution. He has published: ‹Tax Lists of the Town of Providence during the administration of Sir Edmund Andros and his Council 1686–1689› (1895); ‹Revolutionary Defenses in Rhode Island› (1896); ‹The Colonial Tavern› (1897); ‹Esek Hopkins, Commander-in-Chief of the Continental Navy During the American Revolution 1775–1778› (1898); etc.

Field, Eugene, American journalist: b. St. Louis, Mo., 2 Sept. 1850; d. Chicago, Ill., 4 Nov. 1895. By his poems and tales in the press he won a high reputation in the West, which before his death had become national. His poems for children are admirable in their simplicity and in their sympathetic insight into the child's world of thought and feeling. His more important works comprise: ‹Culture's Garland› (1887); ‹Love Songs of Childhood›; ‹A Little Book of Western Verse›; ‹A Little Book of Profitable Tales› (1889); ‹A Second Book of Verse›; ‹The Holy Cross, and Other Tales›; ‹The Love Affairs of a Bibliomaniac.› In collaboration with his brother, R. M. Field (q.v.), he published translations from Horace, ‹Echoes from the Sabine Farm.›

Field, Henry Martyn, American clergyman and scholar: b. Stockbridge, Mass., 3 April 1822; d. there 26 Jan. 1907. He was graduated at Williams College, and was ordained to the ministry in 1842. In 1854 he became editor and proprietor of the New York ‹Evangelist.› He was a lifelong traveler. Among his works are: ‹Summer Pictures from Copenhagen to Venice› (1859); ‹History of the Atlantic Telegraph' (1866); 'From the Lakes of Killarney to the Golden Horn' (1876); 'From Egypt to Japan' (1878); 'On the Desert' (1883); 'Among the Holy Hills' (1883); 'The Greek Islands and Turkey After the War' (1885); 'Our Western Archipelago'; 'The Barbary Coast'; 'Old Spain and New Spain'; 'Gibraltar'; 'Bright Skies and Dark Shadows.'

Field, Marshall, American merchant: b. Conway, Mass., 18 Aug. 1835: d. New York City 16 Jan. 1906. He received a common school and academic education in the intervals of labor on his father's farm. At 17 he entered a dry goods store in Pittsfield, Mass., as clerk, soon mastered the details of the business, and in 1856 removed to Chicago, where he entered the employ of Cooley, Wadsworth & Co., a pioneer mercantile house. In 1860 he was admitted to a junior partnership in the firm, which then became Cooley, Farwell & Co., and later Farwell, Field & Co. On the dissolution of this partnership the firm of Field, Palmer & Leiter was formed in 1865, and on the retirement of Palmer, two years later, the firm name became Field, Leiter & Co. In 1881 the Leiter interest was purchased by Mr. Field and the business was afterwards continued under the firm name of Marshall Field & Co. Prior to the Chicago fire of 1871 the sales amounted to $12,000,000 annually, but have since steadily increased to more than $60,000,000, the firm being now the largest dry goods house in the world. The single large building, which it occupied before the fire, has been replaced by one much larger devoted to the retail trade, the wholesale business being carried on in an immense building covering an entire block. In addition to these two vast establishments the house has offices in New York, England, France, Germany, Switzerland, and Japan. Avoiding ostentation Mr. Field was a liberal and discriminating giver. In addition to the Field Columbian Museum (q.v.) given by him to Chicago, he bestowed gifts upon the University of Chicago, and to his native town of Conway he gave and endowed a public library, at a cost of $200,000, in memory of his parents.

Field, Mary Katherine Kemble, American author and lecturer: b. Saint Louis, Mo., 1838; d. Honolulu, Hawaii, 19 May 1896. Among her books are: 'Planchette's Diary' (1868); 'Ten Days in Spain' (1875); 'History of Bell's Telephone'; 'Life of Fechter'; 'Haphazard'; etc. Consult Whiting, 'Kate Field.'

Field, Stephen Johnson, American jurist: b. Haddam, Conn., 4 Nov. 1816; d. Washington, D. C., 9 April 1899. He was the second son of the Rev. David Dudley Field (q.v.), and a brother of David Dudley Field (q.v.), jurist and law reformer and of Cyrus W. Field (q.v.), the inventor of the Atlantic cable. When he was 13 years of age young Field journeyed to the East with his brother-in-law, who was a missionary, and spent three years in Smyrna and Athens, studying Greek and other languages. After returning to America he graduated at Williams College, and for a time thereafter studied law in New York city. In 1848, soon after he was admitted to the bar, he went to Europe where he remained for one year. In 1849 he joined the rush of easterners to the new gold diggings in California, and settled at the mining camp known as Yubaville, since called Marysville. Here he was elected first alcalde under the old Mexican law of that region, holding office until the organization of the judiciary under the Constitution of the State. In 1850 he was elected to the State Legislature and was placed on the judiciary committee. He drew up several bills providing for articles in the State Code and some of his laws for miners and mining were afterward adopted by other States. In 1857, he was elected judge of the supreme court of California and two years later succeeded Judge Davis S. Terry (q.v.) as chief justice. The decisions of Justice Field in the next few years had much to do with the law of real property and large areas of disputed property was assigned to legal ownership through his decision. In 1863, President Lincoln appointed him an associate justice of the Supreme Court of the United States, which important position he held until 1897. Among his important decisions and opinions were those of the income tax cases, test oath cases and legal-tender cases. He became eminent as one of the most celebrated authorities on constitutional law. In 1876 he was a member of the famous electoral commission which decided the Presidency in favor of Rutherford B. Hayes of Ohio, as against Samuel J. Tilden of New York. His service on the bench of the Supreme Court was the longest in the history of that learned body.

Field of the Cloth of Gold, a spot in the valley of Andren, between the English castle of Guisnes and the French castle of Ardres, celebrated for the meeting between Henry VIII. of England, and Francis I. of France, attended by the flower of nobility of both nations. The meeting took place 7 June 1520, and had been planned by Cardinal Wolsey, to enable the two kings to come to an understanding as to an alliance against Charles V. of Spain.

Field, Columbian Museum, a scientific institution of Chicago, Ill., established through gifts by Marshall Field (q.v.) and other citizens, and opened in 1894.

Field Cricket, a large European cricket (*Gryllus campestris*), found in hot, sandy localities, where it burrows. See CRICKET.

Field Dogs, a general name applied by sportsmen to such dogs as assist them in field sports, such as pointers, setters, spaniels, and the like. See DOG.

Field, Magnetic, or **Field of Magnetic Force,** a term introduced by Faraday to designate any space possessing magnetic properties. A space may possess magnetic properties either on account of magnets in its vicinity, or on account of currents of electricity passing through or round it. See ELECTRICITY; ELECTRO-MAGNETISM; FARADAY; MAGNETISM.

Field-marshal, the highest military dignity in Great Britain, Germany, and other European countries. George II. introduced the title into England when, in 1736, he created the Duke of Argyll and the Earl of Orkney field-marshals, but it had been long in use in the German armies, and is of German origin. In Great Britain the dignity is conferred by selection and is held by but few officers, and chiefly for distinguished services or on the ground of royal descent.

Field Mice, or **Voles,** any wild mouse, dwelling in fields and open places, may be called a field mouse; but the name applies more strictly to the robust, short-tailed mice of the arvicoline group of the family *Muridæ*, representatives of which occur throughout the north temperate zone, and are known in Great Britain as «voles.» The same group includes the lemmings, muskrats and other vole-like mice dwelling in the woods. The common field-mice of the United States and Canada are of the genus *Microtus*, and the common eastern «meadow-mouse» (*M. pennsylvanicus*) is distributed over the whole continent, showing many local variations in color and form. It is 5½ inches long, with the tail 1½ inches; grayish brown with chestnut tinges, blackish on the spine, and hoary below. A near relative of the upper Mississippi valley is the prairie meadow-mouse (*M. austerus*), which is larger and more uniformly gray; and another is the southern pine-mouse (*M. pinetorum*), whose coat is rusty brown, short, dense and silky. Other species are distinguished on the Pacific coast. These mice feed mainly upon seeds and bark, and often do vast damage in grain fields, where they not only eat or shake down a large percentage of the crop, but occasionally overrun the country in vast hordes suitably described as «plagues.» This has happened repeatedly in Europe, where the offending species was the very common field-vole (*M. agrestis*), whose inroads have sometimes nearly produced famine in southern Russia. In winter these pests of the farmer are likely to nibble the bark from young fruit-trees until they have been fatally girdled. These mice dwell in shallow burrows, or make nests of grass in various hiding places, being especially fond of working their way into grain stacks and storage-cellars. They pass the winter in these retreats, sustained by a store of seeds, etc., but hibernating only during the severest weather. The best way to combat them is not to kill off their natural enemies, the hawks, owls, harmless snakes and small carnivores. To the unwise destruction of these is due most of the «plagues» of mice. Consult Audubon and Bachman, ‹North American Quadrupeds› (1846); Godman, ‹Natural History› (1834); Kennicott's papers in the Annual Report of the U. S. Department of Agriculture for 1857; Ingersoll, ‹Wild Life of Orchard and Field› (1901); and Stone and Crane, ‹American Animals.›

Field Plover, a sportsmen's name for several different shore-birds, most commonly meaning the upland or Bartramian sandpiper (*Bartramia longicauda*), which resembles a killdeer (q.v.) in habits, but is not a true plover. It is 12 to 13 inches long, light-brownish, marked with ochraceous and blackish; throat nearly white, and tail-feathers mostly marked with white. It is related to the European ruff.

Field Spaniel. See Dog.

Field Sparrow, a small familiar sparrow (*Spizella pusilla*) of North American fields and meadows, closely related to the garden chipping-sparrow (q.v.), from which it differs in being slightly larger and much paler in colors. Its song, however, more resembles that of the song-sparrow. It nests on the ground, and lays white eggs speckled with reddish and purple.

Fieldfare, a European thrush (*Turdus pilaris*) prevailingly grayish-brown with darker markings and lighter under parts. It breeds in Scandinavia and northern Russia, making nests in companies in trees, and visits Great Britain and southern Europe in winter, where it is largely shot for market.

Fielding, Anthony Vandyke Copley, English painter in water colors: b. about 1787; d. Worthing, Sussex, 3 March 1855. He early attracted attention by his water-color landscapes; gained also considerable reputation as a teacher, and for many years before his death was president of the Society of Painters in Water Colors. His pictures are chiefly taken from English scenery, the various features of which, both in rich woodland and open plain, he has represented with great delicacy and truth.

Fielding, Henry, English novelist: b. Sharpham Park, near Glastonbury, in the county of Somerset, 22 April 1707; d. Lisbon, Portugal, 8 Oct. 1754. His parents were Lieutenant Edmund Fielding and his wife Sarah, daughter of Sir Henry Gould. It is believed that in the characters of Lieutenant Booth and Amelia, Fielding long afterward revived the figures of his young father and mother. By an old legend, put into magnificent form by Gibbon, the novelist was supposed to have descended from the Hapsburgs, but their connection with the ancient family of the Earls of Denbigh, to which the novelist certainly belonged, is now exploded. The Fieldings of Sharpham, though of moderate means, were well connected; the novelist's cousin was the famous Lady Mary Wortley Montagu. In 1710 his parents removed, on the death of Sir Henry Gould, to East Stour in Dorsetshire, where Sarah Fielding (1710–1768), Henry's sister and the gifted author of ‹David Simple,› was born. To his childish adventures by the «pleasant banks of sweetly-winding Stour» Henry gives due record in ‹Tom Jones.› He was 11 years of age when the family moved again, after the death of Mrs. Fielding in 1718, and Henry was transferred to Eton. There is no record of his residence in the registers of the school, so that he was probably an oppidan. Murphy tells us that Fielding, when he left Eton, about 1726, «was said to be uncommonly versed in the Greek authors, and an early master of the Latin classics;» Fielding himself tells us that he knew Italian and French, could write Latin and could read Greek. The early idea that he was a poorly-educated man was based on prejudice and ill-will. Pitt and Fox were among his comrades at Eton. Before he left school, he fell in love with Sarah Andrew, a young lady of Lyme Regis, and even planned her abduction, but the affair was discovered by her guardians, who prevented the romantic act, although, as the archives of the town still record, going in fear of their lives «owing to the behavior of Henry Fielding and his attendant, or man.» This Miss Andrew was said to be the original of Sophia Western.

From Eton Fielding proceeded to study law at Leyden for two years, which he did «with a remarkable application.» He settled in London early in 1728, doubtful whether to adopt, as

Austin Dobson says, the profession of hackney-writer or that of hackney-coachman; his father could no longer support him, and it was necessary for him to subsist upon his wits. He determined to turn playwright, but his earliest drama, the comedy of 'Love in Several Masques,' had no great success. It is difficult to trace the history of Fielding further during the next two years, but in 1730 he brought out another comedy, 'The Temple Beau,' and an extravaganza, 'The Author's Farce.' These were not unsuccessful, and they opened a long series of dramatic performances, by means of which it would seem that Fielding obtained a precarious livelihood for the next seven years. The very entertaining burlesque of 'Tom Thumb' (1730), especially in its extended form as 'The Tragedy of Tragedies' (1731), deserves a high position among these plays, most of which were of somewhat ephemeral importance. In 1732 Fielding produced 'The Modern Husband,' 'The Covent Garden Tragedy,' 'The Debauchees,' and 'The Mock-Doctor;' the last-mentioned comedy was highly successful, and so was 'The Miser,' of 1733, but Fielding's share in the profits of these pieces cannot have been large. He lived, no doubt, on what he could borrow, earn, or beg; sometimes in a London garret, sometimes in the country-house of a wealthy acquaintance. A satirist of the period describes him at this time as a "rough play-house bard," and "clad in coarse frieze," while his best biographer infers that his daily life must have been more than usually characterized "by the vicissitudes of the eighteenth-century prodigal." 'The Intriguing Chambermaid' was Fielding's principal contribution to 1734, but the prolific dramatist was now beginning to find that the town had become sated with his light any spicy confections. The date on which Fielding married Miss Charlotte Cradock, a respectable lady of independent means living at Salisbury, to whom he had for some years been attached, was long unknown, but it has recently (1906) been discovered that the marriage took place, by license, in the church of Saint Mary's, Charlcombe, close to Bath, on 28 November, 1734. It is at this time, and on Miss Cradock's money, that he has been believed to have begun "immediately to vie in splendor with the neighboring country squires," and to have maintained a large retinue of servants, "all clad in costly yellow liveries." This story has been criticised, and, in some of the particulars with which Murphy adorns it, it must be inexact in detail, yet it probably gives not an unfair impression of the lavish way in which, for about a year, Fielding lived in Dorsetshire in a magnificence far beyond his means. His cousin, Lady Mary, said that Henry Fielding "would have wanted money if his hereditary lands had been as extensive as his imagination," and in a few months he was back in London, again obliged to work for a precarious living. He returned to the drama, and in 1736 took the little French Theatre in the Haymarket, where he produced the successful burlesque of 'Pasquin,' by which he made more money than by any of his previous efforts. His career as a dramatic author, however, was checked by a Bill of 1737, in which Parliament restrained the license of the stage, and reduced the number of playhouses. The rest of the few and slight puppet-shows and farces which Fielding wrote need not be named here. His plays (they are 25 in number) although skilful and sprightly, have not the value of his novels, nor anything like their originality, and they are read to-day, if they are read at all, because they are Fielding's, and not because of their intrinsic merit.

When his company of actors was dispersed, Fielding turned to the law as a profession, and in November 1737, became a student of the Middle Temple. According to Murphy, he studied with great assiduity, but little is known of his life at this time. He eked out his legal work with the writing of "a large number of fugitive political tracts," which were probably anonymous, and have disappeared. Late in 1739 he started a newspaper, the 'Champion,' on the model of the 'Tatler,' and in this journal he wrote much, until June 1740, when he was called to the Bar. He traveled the Western Circuit, and "assiduously attended the Wiltshire sessions." He seems to have taken his duties as a barrister very seriously, but they did not prevent him from writing, and publishing in February 1742, the novel of 'Joseph Andrews.' This began as a parody of the popular 'Pamela' of Richardson, but soon passed on into an independent and highly entertaining study of contemporary manners. The fresh and breezy genius of Fielding mocked at the sentimentalities and the wire-drawn psychology of his predecessor, but he soon got beyond the point where it was enough for him to ridicule Richardson. He created two magnificent comic figures of his own, and he enriched English literature forever with Parson Adams and Mrs. Slipslop. It was thus that, at the age of 35, Fielding discovered, as it were by accident, the nature of the genius which he possessed. He did not, however, at once perceive the value of the discovery, but returned to his plays and his pamphlets. It was now that he published two early farces, 'Miss Lucy in Town' (1742), and 'The Wedding Day' (1743), as well as a much more important work, his 'Miscellanies,' in three volumes. This was a collection of Fielding's shorter writings up to that date, and included his poems, occasional and satirical, his essays, his 'Journey from this World to the Next,' some of his farces, and the remarkable ironic novel called 'Jonathan Wild.' The 'Journey' is a Lucianic allegory, full of wit and observation, but unfortunately left unfinished by the languor of the author, who evidently became weary of his design. 'Jonathan Wild' is a work of far greater importance. It takes for its hero a notorious rogue who was hanged at Tyburn in 1725, and there is internal evidence that although not printed until 1743, it was written some years before. It is probable that it preceded 'Pamela,' and ought to take its place as the earliest of the novels of the new school of romance. It is a powerful and painful book, "a picture of complete vice, unrelieved by anything of human feeling," and more unflinching than anything else which Fielding has left. It is a curious thing that from this date until 1749 we have a period of six years, during which Fielding was at the height of his powers, and was not without a certain measure of celebrity, yet which have left scarcely any mark at all upon his history. How was this great man engaged from his 37th to his 44th year? Strange as it sounds, we cannot tell. Austin Dobson has brought forward arguments to show that it was a time of poverty, darkened by successive bereavements, particularly that of the loss of his wife, to whom he was most tenderly attached. A remarkable preface, prefixed to the second edition of his sister's 'David Simple,' appeared in 1744; in this he denies his authorship of the work itself. He describes himself as applied to the legal profession "with so arduous and intelligent a diligence" that he has no time for the practice of literature. He wrote a little, however, for 'The True Patriot' and other journals. In November 1747 Fielding married for the second time, and took a house at Twickenham; Mary Daniel, the second Mrs. Fielding, is said to have been her predecessor's "cook-wench." Fielding had by this time secured an invaluable friend in George, afterwards the first Lord Lyttelton (1709–1773), who procured for him, in December 1748, the office of a Justice of the Peace for Westminster. Up to this date he had been a wanderer on the face of England, now at Salisbury, now at Twiston, at Hagley, at Twickenham, but in January 1749 he settled for good in London. John, Duke of Bedford lent or rented to him a house in Bow Street, under terms which were described as a "princely instance of generosity." But Lyttelton was the closest of all Fielding's influential friends, and there is a remarkable passage in which the novelist states that he partly owed to Lyttelton his existence during a great part of the time spent in the composition of 'Tom Jones,' a book which, without Lyttelton's help, "had never been completed." It used to be stated that 'Tom Jones' was written at Bow Street, but this is impossible; it was evidently the work of the desultory months of poverty which preceded Fielding's appointment as a magistrate. The famous novel was published, as 'The History of Tom Jones, a Foundling,' on 28 Feb. 1749, in six volumes, at the price of 16 shillings a set. It had an instant success, so great that, three month later, Fielding had already received £700 from Millar, the publisher. That this did not much alter the random habits and easy negligence of the author seems to be proved by a picturesque although spiteful description given by Horace Walpole, in May 1749, of Fielding dining at the house in Bow Street "on some cold mutton and a bone of ham, both in one dish, and on the dirtiest cloth," in the company of some very questionable persons. It is well to look at the other side, and to remember, with Murphy, that Fielding "kept his table open to those who had been his friends when young, and had impaired their own fortunes." It is certain, moreover, that he was increasingly respected by those who could overlook the carelessness of his habits and his easy nonchalance of manners.

In May 1749 he was unanimously elected chairman of Quarter Sessions, and his magisterial charges were received with all the respect which their gravity and courage demanded. How seriously he took the duties of his office is seen in his 'True State of the Case of Bosavern Penlez' (1749), in which he vindicates the severity of the law against rioters. This was a time of great lawlessness among the London lower classes, and Fielding eminently distinguished himself by his vigilance against violent criminals and by his plans for reform. But his health was already failing; he had lived too hard and too fast, and on Hurd, who met him in 1751, the novelist produced the impression, at 44 of "a poor, emaciated, worn-out rake." There was, however, no intellectual decline, and, at the close of this same year, there appeared the very vigorous and pathetic romance, 'Amelia.' This novel has had its enthusiastic admirers, but, to the charge that it is less broad and fresh than its immediate predecessor, there is no reply. As Fielding's best biographer has said, "Behind 'Tom Jones' there was the author's ebullient youth and manhood; behind 'Amelia' but a section of his graver middle-age." There is a remarkable sense of decline in the juvenile vigor which was so irrepressible in 'Tom Jones'; the author of 'Amelia' writes philosophically, and like an elderly man. In the figure of the heroine, however, there was no evidence of declining powers; here is the most exquisite figure of a woman that Fielding ever painted. In 1752, Fielding, although so much occupied, found the energy to start the bi-weekly, 'Covent Garden Journal,' which led him into acrimonious controversy with Smollett and others; and to collect the narratives of peculiar cases of the detection of murder which had come under his notice as a magistrate, in 'Examples of the Interposition of Providence.' In 1753 he was deeply interested, like all his contemporaries, in the mysterious case of Elizabeth Canning, who professed to have been kidnapped, and he published a pamphlet on the subject. But he was by this time greatly reduced by successive attacks of the gout, and in August of that year was ordered to retire to Bath. His going, however, and the proper treatment of his disease, were delayed by his great wish to break up a congeries of gangs of street robbers, who were committing murders in London so frequently as to alarm the government itself. But when, in December, he had at length completed this public duty, his was "no longer a Bath case," and he was so much weakened by jaundice, dropsy and asthma, that he looked upon his condition as almost desperate. He struggled through the winter, and in June 1754 started, in search of relief, for Portugal. The tediousness and multiplied discomforts of the transit are described, with a great deal of heroism, in the 'Journal of a Voyage to Lisbon,' which was the latest and one of the best written of Fielding's works. He traveled with all his family, and they arrived in the Tagus in August. No further particulars have been preserved, but that Fielding died at Lisbon, on 8 Oct. 1754, and was buried in the beautiful cemetery of Os Cyprestres, opposite the Church of the Estrella.

With regard to the importance of Fielding's work in the development of English literature there is a complete unanimity of opinion among all competent critics. Indeed, there is scarcely a reputation which is less liable to be challenged than his. Without insisting on the title of "Father of the British Novel,"— which must belong, if it be given to anyone, to Defoe or to Richardson,— we cannot but admit that it was Fielding who first in Europe foresaw the full scope of the "comic epic poem in prose," and that his own efforts in that direction have, at their best, never been excelled. The symmetry of his books, particularly of that matchless work of art, 'Tom Jones,' has not been surpassed, and this is the more wonderful because, until his day, no one had perceived the fact that a work of prose fiction needs to be symmetrical.

He relieved the excessive strain of feeling, which, in the case of Richardson, had sometimes amounted to a positively distressing tension, by introducing breaks of witty observation, ironic illustration, or entertaining episode, but he did this with a care for the balance of parts which makes the study of his technique extremely interesting. Byron called Fielding "the prose Homer of human nature," and in so doing he indicated the extraordinary range of sympathy which marks his delineation. There is nothing unnatural or extravagant about the incidents which he introduces, but they are such as might be expected inevitably to happen to such very natural characters as the novelist depicts.

It has been said that Fielding lacked the imaginative faculty. It would be more correct to say that he distrusted the fantastic and preposterous parts of invention, since, if imagination is the power to bring up before one's own mental vision, and to reproduce for others with fidelity a consistent chain of phenomena, then Fielding was fully endowed with that gift. His pictures are remarkable for their brightness, their freshness, the sharpness and illumination of their outline. His invention occupied itself, not with the unusual, but with the obvious scenes of life, which in his day were, fortunately, still unhackneyed. He wrote slowly and finished late; he did not hasten to exhaust the stores which adventure and experience had given him; he had warmed both hands before the fire of life, and he gave back to the world in his books what he received from it in his own rough-and-tumble youth. From Fielding we must not look for pathos or romantic sentiment,— although even these are not wholly missing,— but we must look for humor, breadth of sympathy, a genial buoyancy, a wholesome recognition of the appetites, a philosophic consideration of the limitations of human frailty, and these we find in his wonderful novels to a degree which we may without fear of exaggeration confess to be elsewhere unparalleled.

Bibliography.— Fielding's earliest biographer was Arthur Murphy (1727–1805), who prefixed an essay on his life and genius to the first collected edition of his 'Works' (1762). Murphy's inexactitudes were pointed out by Lawrence in 1855, and by Keightley in 1858, but by far the most accurate and dispassionate life of Fielding is that published by Austin Dobson in 1883. Subsequent editors and biographers have been content to borrow the main part of their information from this admirable monograph, which has been corrected by the author in successive editions, and is now not likely to be superseded as the standard authority on the life and bibliography of Henry Fielding.

Edmund Gosse,

Author of 'History of 18th Century Literature'; 'History of Modern English Literature'; etc.

Fielding, Sarah, English novelist: b. East Stour, Dorsetshire, 8 Nov. 1714; d. Bath, Somerset, April 1768. She was the third sister of Henry Fielding (q. v.). She was the author of the novel 'David Simple' (1744); 'The Governess' (1849); 'The Cry, a Dramatic Fable' (1757); Xenophon's 'Memoirs of Socrates,' translated from the Greek; 'The Countess of Delwyn'; 'The History of Ophelia'; 'The Lives of Cleopatra and Octavia'; etc.

Fielding, William Stevens, Canadian statesman: b. Halifax, Nova Scotia, 24 Nov. 1848. He was educated in Halifax; for 20 years was connected with the Halifax 'Morning Chronicle,' becoming managing editor; but resigned that position to enter public life. From 1882–96 he represented the city and county of Halifax in the Provincial Legislature, soon after his election becoming a member of the Cabinet and from 1884–96 Prime Minister. In 1896 he resigned to enter the Cabinet of Sir Wilfred Laurier as Minister of Finance. He also represents the electoral district of Shelburne and Queen's in the Dominion Parliament. He represented Canada at the Colonial Conference, London, 1902, and is a governor of Dalhousie University. Among other important works, he has readjusted the Canadian tariff, submitted to Parliament, the British preferential tariff, and later the measure imposing a surtax on German products, and legislation regarding the so-called "dumping" system.

Fields, Annie, (Adams), American poet and essayist, wife of James T. Fields (q.v.): b. Boston, Mass., 6 June 1834. She has long been prominent in charity organizations and has published: 'Under the Olive,' poems (1881); 'Biography of James T. Fields' (1884); 'How to Help the Poor' (1885); 'The Singing Shepherd'; 'Authors and Their Friends'; 'A Shelf of Old Books' (1896); 'Life and Letters of Harriet Beecher Stowe' (1897); 'Whittier: Notes of His Life and Friendships'; 'Nathaniel Hawthorne' (1899); 'Orpheus a Masque' (1900).

Fields, James Thomas, American publisher and author: b. Portsmouth, N. H., 31 Dec. 1817; d. Boston 24 April 1881. He went to Boston in 1834, becoming junior partner of the firm of Ticknor, Reed & Fields in 1839, later known as Ticknor & Fields, and Fields & Osgood. He edited the 'Atlantic Monthly' 1862–70; and was an acceptable lecturer on literary subjects and authors. He published: 'Poems' (1849); 'A Few Verses for a Few Friends' (1858); 'Yesterdays with Authors' (1872); 'Hawthorne' (1875); 'Old Acquaintance: Barry Cornwall and Some of His Friends' (1875); 'In and Out of Doors with Dickens' (1876); 'Underbrush' (1881), Essays; 'Ballads and Other Verses' (1881): and (with E. P. Whipple) edited 'The Family Library of British Poetry' (1878).

Fieri Facias, fī'ē-rī fā'shĭ-as, in law, is a judicial writ of execution issued on a judgment, by which the sheriff is ordered to levy the amount of the judgment on the goods and chattels of one party, for the benefit of another. Abbreviated to *fi. fa.* See Execution.

Fieschi, or **Fiesco, Giovanni Luigi de,** jō-vän'nē loo ē'jē dē fē-es'kē or fē-es'kō, Count of Lavagna, Italian conspirator: b. Genoa 1523; d. there 2 Jan. 1547. He became master of a large patrimony at the age of 18, and being surrounded with dependents and flatterers, and really possessing considerable talents and eloquence, was readily induced to aim at that power and distinction in the state which was then possessed by the family of Doria, headed by the famous Andrea Doria, doge of Genoa. He attempted to kill the doge and overthrow the government, but was unsuccessful in both endeavors, and in his efforts to seize the public galleys was accidentally drowned.

Fieschi, Giuseppe Maria, fe-es'ke, Corsican conspirator: b. Corsica 3 Dec. 1790; d. Paris 16 Feb. 1836. Having conceived a hatred for the French king, Louis Philippe, he constructed an infernal machine of about 100 gun-barrels fixed in a frame, which he discharged simultaneously, by means of a train of gunpowder from a house in the Boulevard-du-Temple, during a review of the National Guard 28 July 1835. The king escaped unhurt, but Marshal Mortier and 17 people were killed, and many more wounded. Fieschi and his accomplices, Pepin and Morey, were guillotined.

Fiesole, Fra Giovanni Da. See FRA ANGELICO.

Fiesole, fē-ā'sō-lĕ (ancient FÆSULÆ), Italy, city about four miles northeast of Florence. Under the name of Fæsulæ it was one of the 12 Etruscan cities, and a place of importance. It submitted, with the rest of Etruria, to the Roman power (90 B.C.), and was colonized by Sylla. In the commencement of the 11th century it was destroyed by the Florentines, and a number of its inhabitants transported to Florence. It contains many interesting Etruscan ruins; but it is noted as being the place where Fra Angelico (q.v.) lived for a number of years. Pop. 5,000.

Fiévée, Joseph, zhō-zeph fyā-vā, French journalist: b. Paris 10 April 1767; d. there 7 May 1839. His experiences during the French Revolution were not happy, largely in consequence of his work: 'On the Necessity of a Religion' (1795); but the Napoleonic rule proved more favorable to him. He subsequently wrote two novels, 'Suzette's Dowry'; and 'Frederick'; besides historical works on aspects of the republic, consulate, and empire.

Fife, a wind-instrument, known from very early times and used chiefly in military music. It resembles a small flute in its form and method of performance, seldom having any keys, and never more than one. It has six finger holes. Fifes are of several kinds. Those tuned to the key of C are shortest and highest, and are much oftener used; they have a compass of two octaves. The instrument is characterized by a clear and piercing tone.

Fifer, Joseph W., American soldier and public man: b. Staunton, Va., 20 Oct. 1840. When a boy he went with his parents to Illinois, and enlisted in the Union army in 1861; he was wounded at the battle of Jackson in 1863, but rejoined his regiment and served until 1864. After the war he was graduated from the Illinois Wesleyan University, studied law, and was admitted to the bar. He was corporation counsel for the city of Bloomington in 1871, and State's attorney for McLean County 1877–80. In 1880 he was elected to the State senate and served four years; in 1888 he was elected governor of Illinois on the Republican ticket, but in 1892 was defeated for re-election by Altgeld. In 1904 he was appointed a member of the Interstate Commerce Commission.

Fifteen Decisive Battles of the World, a noted work by Sir Edward Shepherd Creasy, published 1852. It describes and discusses (in the words of Hallam) "those few battles of which a contrary event would have essentially varied the drama of the world in all its subsequent scenes." The volume treats, in order: The Battle of Marathon, 413 B.C.; Defeat of the Athenians at Syracuse, 413 B.C.; The Battle of Arbela, 331 B.C.; The Battle of the Metaurus, 207 B.C.; Victory of Arminius over the Roman Legions under Varus, 9 A.D.; The Battle of Châlons, 451; The Battle of Tours, 732; The Battle of Hastings, 1066; Joan of Arc's Victory Over the English at Orleans, 1429; The Defeat of the Spanish Armada, 1588; The Battle of Blenheim, 1704; The Battle of Pultowa, 1709; Victory of the Americans over Burgoyne at Saratoga, 1777; The Battle of Valmy, 1792; The Battle of Waterloo, 1815.

Fifth, one of the five equal parts into which any unit may be divided. In music, it is a distance comprising four diatonic intervals, that is, three and a half tones. It is the second of the consonances in the order of their generation. As consecutive fifths do not produce a good effect, they are not allowable in harmony. There are three kinds of fifths: namely, the perfect fifth (C — G), consisting of three whole tones and a semitone; the flat, diminished, or imperfect fifth (B — F), consisting of two whole tones and two semitones; and the extreme sharp, or superfluous fifth (C — G sharp), composed of four whole tones.

Fifth Monarchy Men, a set of politico-religious enthusiasts who sprang up during the Protectorate of Cromwell. They believed that the four great kingdoms mentioned by Daniel, the Assyrian, the Persian, the Grecian, and the Roman, were to be followed by the descent of Christ, to establish a fifth monarchy, which was to be of world-wide extent. They thought that this advent was close at hand, and that physical force should be employed to pave the way for Christ's reign. When the sect, who were of the extreme republican type, fancied Cromwell was aiming at the royal title as well as power, they raised a conspiracy against him (1657), which was quickly discovered. Their leaders were thrown into prison, and were only liberated on the death of the Protector. The sect became extinct shortly after the Restoration.

Fifth Nerve, the chief sensory nerve of the face, also called trigeminus, or trifacial. It is one of the fifth cranial pair of nerves. The fifth nerve is one of the most important sensory nerves of the body, its name trafacial meaning that it has three large divisions which are distributed to the face, and its name trigeminus being given because it has three roots inside the skull. It is really a mixed nerve containing both motor and sensory fibres. The motor root rises from a group of cells lying deep in the floor of the fourth ventricle. The sensory portion arises in a series of ganglia, the Gasserian ganglion being the most important one. The ophthalmic and Meckel's ganglia are also smaller ganglionic centres. The chief branches go to supply the entire area of the skin of the face and head, and neuralgias and neuritides of the face and head are due to affections of this nerve. The chief division is the first or ophthalmic division, which supplies the region over the superior surface of the nose, forehead and eye, running as far back as the top of the head. The second branch is the superior maxillary, which supplies the teeth and the region of the skin beneath the orbit, the upper lip, and the region of the temple. The superior maxillary nerve constains a few motor fibres. The third branch, the inferior maxillary, or mandibular, is the largest branch of the fifth nerve, and contains most of the motor fibres. It supplies the surface of the skin of the lower jaw, front of the ear, and temporal region, lying close behind the area supplied by the maxillary. The muscles of the jaw, the masseters, temporals and buccinators are supplied by the motor fibres of this branch. See CRANIAL NERVES; FACIAL NEURALGIA; NEURALGIA.

Fifty-four Forty or Fight, the slogan of the Northern Democrats in 1844; meaning the insistance upon the line of lat. 54° 40′ N. as the southern limit of English possession, even at the price of a war. The Ashburton Treaty of 1842 had created great dissatisfaction as a surrender of American rights (and in England as a surrender of British rights), and the hot-heads wished to abrogate it. But the Southern leaders did not wish to make war for the increase of free territory, and instead diverted the war sentiment against Mexico, forcing on the Mexican war of 1847.

Fig, the fruit of the *Ficus carica,* a native of Asia, Africa, and the south of Europe, which has been cultivated from remote antiquity in the countries surrounding the Mediterranean, where figs form a principal article of food in many places. It belongs to the natural order *Artocarpaceæ,* sub-order *Moreæ.* The male and female flowers are mixed indiscriminately on the inside of a fleshy receptacle, which is concave in form, with its edges drawn together into a narrow opening. What are called the seeds in the ripe fig are the pericarps, each containing a single seed. The fig-tree is distinguished from almost all others by the extraordinary property of producing two crops of fruit in the same year on distinct shoots, in climates congenial to its growth. The shoots formed by the first or spring sap put forth figs at every eye as soon as the sap begins to flow again in July and August. These figs which form the second crop of the year ripen in their native climate during the course of the autumn, but rarely if ever come to perfection in England. The shoots formed by the second flow of sap, commonly called midsummer shoots, put forth figs in like manner at every eye, but not until the first flow of sap in the following spring. These last-mentioned figs, which form the first crop of each year, ripen in warmer climates during the month of June and July, but not in this country before September or October. The fig-tree, in its wild state, is a low, distorted shrub, bearing fruit destitute of any agreeable flavor. Dried figs are easier of digestion and more nourishing than the fresh fruit, and form a considerable article of commerce. The best come from Turkey, Italy, Spain, and Provence; those of the Archipelago are inferior in quality. Dried figs, with barley bread, are now the ordinary food of the lower classes in Greece and the Archipelago. While the edible fig of commerce can be raised over the whole United States south of Philadelphia, fig culture was never considered a practical venture until a few years ago. American figs even in such a climate as California were shrunken and sour for the most part, and the dried Smyrna fig was still imported to the United States to the value of about $700,000 a year. As the price of other kinds of native fruit decreased, because of overproduction, many Californian orchardists and horticulturists turned their attention to the fig, which is among the costliest of dried fruits, being valued at from $200 to $400 a ton in the New York market. Cuttings of the Smyrna fig were imported to this country as early as 1880, but the fruit proved shrunken and tasteless. It was found necessary to start from seedlings and for this process caprification (q.v.) was necessary. In 1891 a consignment of *Blastophaga grossorum* was brought to this country. It was received by James Shinn of Niles, Cal., who had planted a caprifig tree in his orchard as a hospice for the insects. He failed of success through the lateness of the season at which he made the experiment, which, however, was repeated by George C. Rœding of Fresno, Cal., who met with complete success, and now Smyrna figs are produced in California as large and highly sugared as those which can be imported.

Fig-eater, a beetle of the genus *Allorhina* harmful to figs. See JUNE BEETLE.

Fig Fertilization by Insects. It was known to the ancients, according to Pliny and others, that the cultivation of certain varieties of figs was dependent for fertilization (technically termed caprification), upon the friendly aid of a minute hymenopterous insect termed the fig-wasp (*Blastophaga grossorum*). Beginning about 1890 numerous attempts were made to introduce the Smyrna and caprifigs in fig-growing sections of America. Recognizing our inability to fertilize the female varieties which were introduced, experiments were made with mechanical pollination the following year on the Smyrna fig by Dr. Gustav Eisen. Attempts were then made to introduce the Blastophaga, but without success, until the United States Department of Agriculture succeeded in establishing the insect in 1899 in the fig-orchard of Geo. C. Rœding, at Fresno, Cal. The principle of the fertilization is that the Blastophaga in its native home in the Mediterranean region breeds naturally in the wild or caprifig. The Smyrna fig does not mature fruit unless the flowers are cross-pollinated by hand methods or through the agency of the Blastophaga, which carries pollen from the male caprifig to the female Smyrna fig, hence both the caprifig and the Blastophaga are necessary in order that the commercial fig bear edible fruit. The results of the introduction of this fig-fertilizing insect have exceeded the most sanguine expectations. In 1900 a large crop of Smyrna figs was raised, dried, and placed on the market, and tests made by experts showed that California figs fully equal the imported product, and that they contain a larger percentage of sugar, a superior flavor, and are cleaner and more attractive in appearance. With this introduction a new horticultural industry of great future value to the country has been established. The United States Department of Agriculture has published much information on this subject, two important papers being Howard's ‘Fig-culture in the United States’ (1900); and Eisen's, ‘The Fig, Its History, Culture and Curing’ (1901).

Figaro, fē′gä-rō, a noted dramatic character, brought by Beaumarchais on the stage in Paris, about 1785, in his two dramas, the 'Barbier de Seville,' and 'Mariage de Figaro.' Since that time, Mozart, Paesiello, Rossini, and others, have made the name celebrated in classic operas; and now the term is frequently used to denote an adroit and cunning accomplice. *Figaro* is also the name of a Paris journal founded 1826 but suspended from 1833–54, when it was revived by Villemessant (q.v.).

Fighting-fish (*Betta pugnax*), a small fish of the climbing perch family (*Anabasidæ*), a native of the southeast of Asia, remarkable for its pugnacious propensities. In Siam these fishes are kept in glass globes for the purpose of fighting, and extravagant gambling takes place on the result. When the fish is quiet its colors are dull, but when irritated it glows with metallic splendor. The king of Siam derives a considerable revenue from the licenses for fish-fights.

Fighting Joe Hooker, a nickname popularly applied to Gen. Joseph Hooker (q.v.).

Fighting Parson, The, a nickname given to William Gannaway Brownlow (q.v.), in reference to the vigorous anti-secession leaders written by him for his newspaper, *The Whig,* of Knoxville, Tenn.

Figig, fē-gēg, a town of considerable importance in Morocco; situated on the east bank of the Wady Zusfava, which separates Algeria from Morocco. Figig is several hundred miles from the seacoast.

Figueras y Moracas, Estanislao, ās-tän-is-lä′o fē-gā′räs ē mō-rä′käs, Spanish statesman: b. Barcelona 13 Nov. 1818; d. Madrid 11 Nov. 1882. He studied law at Madrid and early in life began political activity in the Republican party. He was elected deputy from Barcelona 1851, becoming a leader of his party, but was exiled for participation in the plot against Narvaez for a few months in 1867. After the fall of Queen Isabella he continued to oppose actively the restoration of the monarchy. Upon the abdication of Amadeus in 1873 he became president of the council of ministers, but after the restoration of the monarchy in December 1874, took no further part in public affairs.

Figueras, fē-gā′räs, Spain, town, in a plain 21 miles north-northeast of Gerona. It is defended by a fortress, considered the strongest in Spain. It is large enough to accommodate 20,000 soldiers. It has some manufactures, chief of which are woolen and linen fabrics, leather, soap, corks, etc., and a trade in these and in grain, oil, and liquors. Pop. 11,912.

Figueroa, Francisco de, frän-thēs′kō dā fē-gā-rō′ä, Spanish poet: b. Alcala de Henares 1540; d. 1620. He was called by his contemporaries "the Divine Figueroa," and at Rome he won the poet's crown. He wrote verse with equal facility and elegance in Castilian and Italian. When dying he burned all his verses; but they were published — including the celebrated volumes of eclogues in blank verse, the 'Tirsi' — from copies in the hands of his friends.

Figueroa, Francisco, Mexican annalist: b. Toluca 1730; d. City of Mexico 1800. He was a Franciscan priest and taught and lectured acceptably, but his great service to literature consisted in the compilation of materials for a history of Mexico, among them a 'History of the Conquest of New Galicia,' by Mota Padilla, besides diaries and letters.

Figueroa, Francisco Acuña (ä-koon′yä) **de,** Uruguayan poet: b. Montevideo 1791; d. there 6 Oct. 1862. A civil-service post afforded him leisure to prepare his 'Poetic Mosaic' (1857), a verse collection, and his more notable 'Paraphrases of the Psalms'; and 'The Toraidas,' a series of Paraguayan notes. He has been assigned a high rank by competent European critics; lofty inspiration and sonorous diction being his characteristics, as exemplified in the 'National Hymn of Uruguay.'

Figuier, Guillaume Louis, gē-yōm loo-ē fē-gyā, French scientist: b. Montpellier 15 Feb. 1819; d. Paris 12 Nov. 1894. He was for a time professor in the School of Pharmacy of his native town, and in 1853 was appointed to a post in a similar school at Paris. Among his works are: 'Exposition et Histoire des Principales Découvertes Scientifiques Modernes' (6th ed. 1862); 'Histoire du Merveilleux dans les Temps Modernes' (1859–62); 'L'Alchimie et les Alchimistes'; 'Vies des Savants Illustres depuis l'Antiquité jusqu'au XIX. Siècle' (2d ed. 1875); 'Les Grandes Inventions'; 'Le Tableau de la Nature' (1862–73); 'Le Lendemain de la Mort' (10th ed. 1894); etc. Several of his works have been translated into English, including different sections of the 'Tableau,' such as 'The Mammalia'; 'Birds and Reptiles'; etc.

Figurate Numbers, or **Figurate Series,** in mathematics, a series of numbers which may or do represent some geometrical figure, in relation to which they are always considered, as triangular, pyramidal, hexagonal, etc., numbers. The general term of each series is

$$\frac{n(n+1\,(n+2)\quad.\quad.\quad(n+m)}{1.2.3.4.\quad.\quad.\quad.\quad(m+1)},$$

in which m determines the nature of the series and n is dependent upon the place of the required term of the series. Figurate series are divided into orders: when $m=0$, the series is of the first order; when $m=1$, the series is of the second order; when $m=2$, the series is of the third order, and so on. The figurate series of the first order is the series of the natural numbers, 1, 2, 3, 4, 5 . . . . n. The figurate series of the second order has for its general term $\frac{n(n+1)}{1.2}$, and the several terms are deduced from this by making in succession $n=1$, 2, 3, 4, etc. The resulting series is

$$1,\ 3,\ 6,\ 10,\ 15,\ 21\quad.\quad.\quad.\quad.\quad\frac{n(n+1)}{1.2},$$

etc. The numbers of this series are called triangular numbers, because they express the number of points which may be arranged in triangles, thus:

etc. The series of square numbers is 1, 4, 9, 16, 25, 36, 49, etc. The series of pentagonal numbers is 1, 5, 12, 22, 35, 51, etc.; and of hexagonal numbers 1, 6, 15, 28, 45, 66, etc.

Figure, in arithmetic, a character employed to represent a number. The Arabic figures are 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, by combinations of which any possible number can be represented. (See NOTATION.) In logic, the form of the syllogism with respect to the position of the middle term. In music, a form of melody or accompaniment maintained throughout the phrase in which it is suggested. In a melody, figure is called sequence. In harmony, a figure relates to the rhythmical observance of a certain form in all the accompanying chords to the melody. Also a musical phrase, or a florid melody.

Figured Bass, in music, a bass having the accompanying chords suggested by certain numbers above or below the notes. It is at present the most satisfactory system of musical shorthand. The whole of the notes are not always indicated by a corresponding number of figures, because one number generally implies two or more to complete the chord. When there is no figure, it is understood that the common chord of such a note is to be used as its harmony.

Figured Counterpoint, in music, is where several notes of various lengths, with syncopations and other ornamental lengths are set against the single notes of the canto fermo.

Fiji, fē'jē, or **Viti** (vē'tē) **Islands,** a large group of islands in the South Pacific, situated between lat. 15° 48' S. and 20° 4' S. and between lon. 177° 51' E. and 178° 38' E. There are 255 islands great and small, of which about 80 are inhabited. The uninhabited islands scarcely rise above the level of the sea. Including Rotumah, which belongs to the same jurisdiction, they have an area of 8,045 square miles, of which the main island Viti Levu takes up 4,250 square miles, and Vanua Levu 2,600 square miles. Suva, on the south coast of Viti Levu, is the capital, with a population (European) of 1,073. The whole group is of coral formation, and all the islands seem originally to have formed portions of Viti Levu, some of them probably of Vanua Levu. The conformation of the main island is volcanic and side by side with volcanic deposits are granite, diorite, gabbros and syenite. The silent craters are most numerous in Taviuni. Among valuable metals found in the islands are gold, copper and iron. The islands lie in the track of the monsoons, which blow strongly from April to November, rendering the islands exceedingly healthy; there is an abundant rainfall, and the average temperature for the 12 months is 58° F.; the coldest month (July) has an average of 57°, and the hottest month of 59°. The flora of the Fijis is very like that of the East Indian mainland. Up to the summits of the volcanic peaks stretches a luxuriant growth of tropical vegetation. The forest has little underwood, but abounds in palms, tree ferns, bamboo, and orchids of tree-like dimensions. The fauna belongs to the south Australo-polynesian group; bats and rodents are the only mammals in the islands. There are about 50 species of birds of which the most notable are doves and parrots. The native population is gradually decreasing. The Fijians were once idolators, but since the arrival of English Wesleyan preachers in 1835 they have turned to Christianity. There are 10,402 Roman Catholics in the islands and 103,829 Protestants. There are three newspapers in Suva, and one in Levuka. The principal occupation of the people is agriculture; the sugar, maize and cocoa culture is prosperous, but cotton growing has declined. Tropical fruits are exported to Australia and New Zealand. In 1901 there were in the island 2,455 horses, 24,320 horned cattle, 1,210 sheep, and 14,860 goats. Many herds of swine run wild in the forests. There seems a promising improvement recently noticeable in the prosperity of the islands. In 1901 the total exports, consisting principally of sugar, copra, fruit, distilled spirits, bêche-de-mer, maize and vanilla amounted to $2,744,025, and imports, of which the principal item is under the heading of "drapery," $1,755,910.

The Fiji Islands was constituted a British colony in 1874. The governor is appointed by the crown; he is assisted by an executive council of three; and laws are passed by a legislative council, of which the governor is president. Consult: Cumming, 'At Home in Fiji'; Smythe, 'Report on Fiji Islands'; Seeman, 'Report on the Vegetable Productions and Resources of the Fijian Islands.'

Filament, in botany, the stem of a stamen, supporting the anther. (See FLOWER.) It is usually filiform, but sometimes curiously modified.

Filander, fĭ-lan'dėr, a small kangaroo (*Macropus bruni*), native to New Guinea. It was the first of the kangaroos (q.v.) known to Europeans.

Filangieri, Gaetano, gä-ā-tä'nō fē-län-jā'rē, Italian political economist: b. Naples 18 Aug. 1752; d. 21 July 1788. His great work, entitled, 'The Science of Legislation,' notwithstanding it was never completed according to his original design, attracted great attention, from its bold and original views and the liberality of its sentiments. In 1787 he was made a member of the supreme council of finance.

Filarete, Antonio, or **Antonio Averulino,** än-tō'nē-ō ä-vā-roo-lē'nō fē lä rā'tē, called ANTONIO DE FIRENZE: b. Florence about 1400; d. Rome about 1469. He worked under Ghiberti on the famous baptistery gates. Pope Eugene IV. gave him a commission to make the bronze doors for St. Peters in Rome, and he began their execution with assistants about 1439, finishing them 1445, the whole being a feeble imitation of Ghiberti, in bad taste, and entirely lacking in spontaneity. He also made a bronze reduction of the equestrian statue of Marcus Aurelius for the Capitol, now at Dresden, and a mausoleum of the Cardinal of Portugal which disappeared in the 17th century. He is, however, more noted as an architect. Banished from Rome 1449, on the accusation of stealing relics, he entered the service of the Sforza family at Milan, drawing plans for a great hospital in the antique style, only one wing of which he finished. He is the author of a remarkable book, 'Tratto di Architettura,' written before 1665, a treatise on architecture in 25 volumes, a sort of a verbose and finical romance of which the motive is the construction of an ideal city, called Sforzinda. The undercurrent of the work is a mixture of pagan and Christian philosophy and ethics and an inculcation of didacticism in art.

Filariasis, fil-a-rī'a sis, a group of diseases caused by nematode worms (see NEMATODA) of the genus *Filaria,* some species of which are parasitic in man and domestic animals. The *Filariæ* are very slender worms, mostly parasitic in subdermal connective tissue and in serous cavities. The developmental history is not entirely elucidated, but they seem to undergo indirect development in the body of some crustacean or insect, species of mosquitoes notably serving as intermediary hosts. Under the term *filariæ sanguinis hominis,* old authorities include the species *F. bancrofti, F. diurna,* and *F. perstans,* the last the parasite to which the sleeping-sickness of the negroes in Africa has been attributed. The most important one of these is *F. bancrofti,* whose numerous embryos enter the blood through the lymphatics, and are present at night in the blood, although usually absent in the daytime. This worm (the male) is about 1½ inches long and from 1-10 to 1-12 of an inch broad. The female is almost twice this size. This parasite may be present in the blood without giving rise to any symptoms, but frequently they block the lymph-channels and produce the conditions of elephantiasis. These forms of lymph-scrotum, and of hæmatochyluria, exist very extensively in Asia and Africa, and within recent years have been found in cities in the southern United States. (For lymph-scrotum and elephantiasis, see ELEPHANTIASIS.) In hæmatochyluria the patient, while in excellent health, suddenly passes a large amount of urine of a peculiar whitish or milky-whitish appearance, occasionally bloody; or frequently a fluid resembling chyle, which on settling shows the presence of a blood-clot. This chyluria seems to be intermittent, the patient being well for weeks or months at a time, and then passing large quantities of this modified urine. The embryos are to be found in this urine. Occasionally there are symptoms of uneasiness in the loins and lumbar region, but as a rule the general health is not affected. The treatment is prophylactic solely.

Another form of filariasis is "guinea-worm," a disease produced by *F. medinensis.* It has been known from time immemorial, and it has been fancied that the plague of fiery serpents which afflicted the children of Israel in the wilderness was really an irruption of such worms. This worm is thought to be bred in the body of some minute aquatic crustacean, as *Cyclops,* and thence to enter its final host, which may be the horse, dog, wildcat, or jackal, as well as man, by the drinking of the water. The form of disease brought about by *F. medinensis* is extremely common among African negroes. In certain provinces of India sometimes nearly one-half the entire population are affected; and it is known in Russia, Turkestan, and Hindustan. The adult female worm usually finds its way into the subcutaneous connective tissue, generally in the lower extremities, especially in the feet or ankle. It has also been found in the arm, eyelid, tongue, perineum, scrotum, and trunk. The presence of the worm is not apparent until it bores its way to the skin. Here it produces a painful swelling which later becomes irritable and sore, and finally there develops a suppurating sinus. The worm may be expelled spontaneously from the sore, or it may be taken out in native fashion. *F. loa* is a similar species, limited in its distribution to the west coast of Africa, where it is not uncommon, and is introduced into man by means of drinking-water. It is an active worm, passing rapidly through the connective tissue, and is very frequently found in the region of the eye, where it bores its way to the conjunctival surface.

Consult: Buck, 'Reference Hand-Book Medical Sciences'; article, 'Nematodes'; Manson, 'Tropical Diseases'; Nuttall, 'The Role of Insects, etc., in the Spread of Parasitic Disease'; (Johns Hopkins Hospital Reports, Vol. VIII., No. 1); Braun, 'Thierichen Parasiten' (1902).

Filbert. See HAZLENUT.

Fil'des, Samuel Luke, English portrait and genre painter: b. Lancashire 1844. His first Academy picture was 'Nightfall' (1868), and since then he has exhibited: 'The Loosened Team' (1869); 'The Empty Chair' (1871); 'Fair, Quiet, and Sweet Rest' (1872); 'Simpletons' (1873); 'Applicants for Admission to a Casual Ward' (1874); 'Betty' (1875); 'The Widower' (1876); 'Playmates' (1877); 'The Return of the Penitent' (1879); 'The Village Wedding'; 'Venetian Life'; 'The Al-fresco Toilette'; 'The Doctor' (1892). Several of these, particularly his famed 'Casual Ward,' show powers of realism in painting not unlike those of Dickens in fiction, but his later works are more striking from their color-effects. Latterly he has taken a distinguished place as a painter of portraits. His wife is also known as a painter, some of her pictures being: 'The Cottage Door' (1877); 'Peeling Potatoes' (1878); and 'A Berkshire Cottage' (1878).

File-fishes, the fishes of the plectognath family *Monacanthidæ,* so-called from their skins being roughened by minute rough scales. The species are numerous, small, plain in color, herbivorous, lean and not good for food; and are mainly found in the tropical seas. The best known American species is *Alutera schœpfii,* which ranges as far north as Cape Cod, and often shows a decided orange tint upon its olive-gray sides. It reaches a length of 24 inches, as also does its relative the unicorn-fish (*A. scripta*) of the West Indies. A different and much smaller file-fish is the widely distributed "leather-fish" or "fool-fish" (*Monacanthus hispidus*). The Spanish-American fishermen give the name "lija" to all these fishes. These fishes were formerly classified with the trigger-fishes (q.v.) in the family *Balistidæ,* from which they differ conspicuously in having but one erectile dorsal spine. Consult: Gunther, 'Study of Fishes' (1859); Goode and Bean, 'Oceanic Ichthyology' (1895).

Files and File-making. The file is one of the oldest of hand tools. It is mentioned in the Old Testament scriptures, and probably came into use not very long after man began to work iron. Files were commonly made by hand until about 1850, when machine-made files became general. The first machine proposed for making files was suggested to the French Academy of Sciences in 1702, but it was not until 1812 that the first United States patent on a file-making machine appeared, being taken out by Morris P. Belknap. The files in ordinary uses are made of high-grade steel, from 6 to 14 inches in length being the most common sizes. The pointed end that fits into the wooden handle is called a tang, and the corner formed by the junction of the tang to the body of the file is called the heel. Occasionally they are made with a tang at both ends. The cutting face or faces of a file are formed by the blows of a chisel struck in the file-blank, while the steel is still soft. The closeness and depth of these cuts determines the character of the file, as rough, middle-cut, bastard, second-cut, smooth and dead smooth. When the cuts are crossed so as to form teeth, as in the more common styles, it is a double-cut file. When the spacing between the chisel cuts is varied it is "increment cut." Files are also named from their cross-section, as round (usually tapered, for enlarging holes), half-round, square or flat. Files for sharpening saws take their names from the kind of saw whose teeth they are shaped to fit, as cross-cut file, cant-saw file, pit-saw file, etc. Dentists' files are made with the handle in the centre, and the filing surface on either end. They are styled bicuspid file, plug file, stump file, etc., according to use. A somewhat similar file, only larger, with bent ends, is called a riffler. The files most commonly used by combmakers are called slitting and topper files.

Double or checkering files, used by cutlers, gunmakers, etc., are practically two files riveted together, with the cutting teeth so placed that one is half way ahead of the other. These are used to produce the checkered effect peculiar to gunstocks. The files used by watchmakers are exceedingly small, fine and delicate, many of them being of less section than a fine sewing needle, and about half the length. These are named according to the part of a watch or clock on which they are used, as clock-pinion file, balance-wheel file, barrel-hole file, etc. The file proper is not a rubbing or abrading tool, as many non-technical persons suppose, but a true cutting tool, whose teeth point in one direction, and which can be used effectively only in that direction, that is when pushed away from the user. The horseshoer's rubber and the ordinary rasp are kindred tools that perform their function by being rubbed back and forth, but the file is not intended to be used in that way.

In the case of a rasp, a pointed tool is used to indent the surface of the blank, and this raises prominences on the surface that make it useful as a rubbing or rasping tool. In making files, the blank is first stamped or drop-forged from a high-grade steel, inferior or blistered steel being usable only for rubbers. The file-blank in a soft, unannealed condition, is fixed on the reciprocating carriage of a file-making machine, on a surface of lead designed not to injure the cut side of a file when down. The blank is passed slowly forward under a reciprocating chisel, whose blows descend on the blank at distances determined by the speed at which the carriage moves. In a common type of machine the chisel is moved upward by a cam and thrown down to deliver its blow or cut by a powerful spring. The cuts may be deepened by running the blank through the machine a second time. Old files may be recut in the same way. After the cutting, the file is hardened by tempering, and is then ready for use. In using a file the filer takes the handle in his right hand, with the back of the hand downward. He takes a firm hold of the point with the left hand, placing the thumb or ball of the thumb on top; or he may reverse the hands to rest his muscles. He advances the file, that is, pushes it away from him, with a parallel motion, bearing down as the file goes forward, and brings it back without pressure. The learner always has a tendency to see-saw or rock the file, which can be overcome only by practice. Unless the file is kept level, the surface cannot be cut down to a level. The use of the file in machine work has been much superseded during recent years by the introduction of the emery wheel, operated by power, against which the work is held and ground down with much reduced labor. But the emery wheel will not accomplish a great many things that can be done with the hand file, hence its manufacture is not endangered by the increased use of the wheel. See HARDWARE TRADE IN AMERICA.

Filibusters (Sp. corrupted from Dutch *vrijbuCter*, our "freebooter"), originally the West Indian buccaneers; in the 19th century and now, any lawless band who attack a foreign country not at war with their own. Especially, the United States companies who used to make descents on the Spanish-American states or colonies, either from personal ambition tempted by their anarchic state, or to annex them to the Union as slave territory. Burr's Southwestern Empire was to have been the fruit of the most stupendous filibustering expedition of modern times (1806-7); Texas actually was the fruit of another, disguised as colonization. The later ones, 1850-60, were all of the second type. One of their chief promoters was J. A. Quitman of Mississippi, and in 1850 he aided the adventurer Lopez to fit out abortive expeditions to Cuba, for which both companions were arrested but acquitted. In August 1851 Lopez sailed from New Orleans with 500 men, and landed in Cuba, but the Cubans would not rise. Lopez's force was routed and scattered to the mountains, and he was caught and garroted. Pierce's proclamation of 31 May 1854 showed that the government would tolerate no more of this against Spanish territory; Mexico was too strong to attack privately; and Central America being the only available North American section left, William Walker (q. v.) raised a California company in 1855 and assailed Nicaragua. He defeated the government troops, captured Granada the capital, executed his antagonists and set up a government recognized by Pierce, which re-established slavery and invited Southern immigration. But his performances raised an insurrection, helped by other Central American states, and by a United States corporation he had foolishly plundered, and he was driven out in April 1857. On a second expedition in November, he was seized and brought back; a third was stopped by the government; with a fourth he landed in Honduras 27 June 1860, and was defeated, court-martialed, and shot. There was no more filibustering till after the War; but from 1868 till the Spanish war of 1898 there was more or less, in co-operation with the Cubans. The most noted case was of the Virginius (q.v) in 1873, which the Spanish captured and shot the commander, Fry, with 36 of the crew.

Filibustering enterprises when they meet with failure entail loss of life and of liberty, as well as denunciation from the nation in whose aid they were organized, whereas in case of success filibusters are acclaimed as national heroes.

Among modern filibusters may be mentioned Dr. Jameson (q.v.) and his raiders in South Africa. Had Jameson and his followers been successful in overthrowing the Boer government in 1895, they would doubtless have been hailed as heroes. As it was, their lamentable failure left the English government no alternative but to denounce and treat them as filibusters. After having been condemned to death and to terms of imprisonment by the Boer government, they were eventually turned over to the English authorities for punishment, and taken to trial in London, were convicted and fined and deprived of their liberty.

Perhaps the most noted filibuster in modern times was the Italian patriot Garibaldi (q.v.). In 1862 the Italian government was compelled to arrest him at Aspromonte in order to prevent him from carrying out his project of an armed expedition against the papal states, with which King Victor Emmanuel was then at peace, and in 1867, having managed to evade the watchfulness of the Italian authorities, he actually invaded the papal states, defeating the Pope's troops at Monte Rotonda, being afterward himself routed at Mentana by the French military force that occupied Rome. For this violation of the Italian laws on the subject of filibustering he was arrested by the Italian government after his retreat from Mentana and imprisoned for a time in the fortress of Alessandria. Other modern filibusters were M. De Mayrena, the Parisian clubman and counterpart of Alphonse Daudet's 'Tartarin de Tarascon,' who established himself as King of the Sedangs, and who died as such in his palace in the island of Tio-Man, in the Indo-China Seas, and the Franco-American soldier of fortune and Parisian journalist "Baron" Harden Hickey, who figured for a time as prince and ruler of the island of Trinidad, on the Brazilian coast. See BUCCANEERS; FREEBOOTER; PIRATE.

Filicaia, Vincenzo do, vēn-chen'tzō dā fē-lē-cä'yä, Italian lyric poet: b. Florence 30 Dec. 1642; d. there 25 Sept. 1707. Some of his patriotic sonnets are famous; but his verse, though not without beauty and spirit, is disfigured by the rhetorical tricks and false conceits of the period. An edition of his works appeared at Florence in 1864.

Filigree Glass, one of the kinds of ornamental glass for which Venice was formerly celebrated, the manufacture of which has been recently revived. Small filigree canes of white and colored enamels are drawn, made of the required lengths, arranged in clusters in a cylindrical mold of the required shape, and then fused together. The canes are then aggregated by flint glass at a welding heat, and the mass twisted if a spiral ornament is desired. Vases or other objects are made of ornamental masses of this glass, blown in the usual manner.

Filigree Work, a kind of ornamental work in fine gold or silver wire, wrought delicately, and generally more or less varied by the intermixture of grains or small beads of the metal, and of bands, strips, or bars, to give greater strength. An immense variety of patterns can be produced, the wire being made to assume the forms of arabesques, leaf-work, etc., the parts being joined together by gold or silver solder with the use of the blow-pipe. Working in filigree is one of the most ancient and widely spread arts. Specimens have been obtained from ancient Egyptian, Greek, and Etruscan tombs, and in various parts of Asia articles in filigree have been made from the remotest times down to the present day, as in China and India. In the latter country the wire-work bears much resemblance to the old Greek filigree. An exquisite frosted effect marks the surface of some of the Greek work. After the method of producing this frosting had been lost it was revived or rediscovered. Greek filigree work was especially fine during the 4th or 5th centuries. Among the Celts, Anglo-Saxons, and Scandinavians, excellent specimens of filigree were early produced, being employed in such articles as bracelets, ear-rings, brooches, etc. Old Irish filigree work was of especially high quality, particularly during the 10th and 11th centuries. The Byzantine workers in filigree were also famous, and the influence of their work was widely felt in Europe during the Middle Ages, books, reliquaries, etc., being ornamented in this manner. At Venice, and in several of the French and German towns, elegant specimens of this delicate art were manufactured as early as the 12th century. In the 17th century the art was carried to its highest perfection in Italy. The Italian peasantry, as well as those of other countries, still produce filigree work for personal adornment; and the Malta filigree is world-famous. The Chinese filigree, made mostly of silver, has not the extraordinary delicacy of some of the Malay and other eastern work. Filigree objects of great beauty of workmanship are produced in the United States.

Filioque, fĭl-ĭ-ō'kwē ("and from the Son"), a phrase inserted in the creed of Nicæa, or rather the Nicæo-Constantinopolitan creed, as an expression of the Catholic Church's teaching concerning the relation of the Third Person of the Holy Trinity to the Father and the Son. Before the insertion of *Filioque* that creed, in its Latin version, contained these words, *Et in Spiritum Sanctum . . . . qui ex patre procedit* (and in the Holy Ghost . . . . who proceeds from the Father). The addition of *Filioque* (and from the Son) after *procedit,* appears to have been made first in the churches of Spain as early as 447; it was commanded by the Synod of Toledo 653. But the addition was not adopted or approved by the Roman Church till as late as the 9th century; this, not because the *Filioque* imported into the creed a doctrine not accepted in that Church, but simply because it was not considered wise to add anything to the ancient formula of Catholic belief. The Greek Church never accepted the addition till in the Council of Florence, 1439, the large number of Greek bishops and metropolitans, with the patriarch of Constantinople at their head, who attended that council, solemnly subscribed to the Nicæo-Constantinopolitan *symbolum* as amended by insertion of *Filioque,* and thus effected, as they believed and as the Latin bishops believed, a reunion of the Eastern and Western Churches. At the same time the bishops representing the Latin Church in the same council, signed a solemn declaration that the formula which had been used by the Greeks, "proceeding from the Father *through* the Son" was thoroughly orthodox and consonant with the *Filioque.* The Greek Church itself did not ratify the action of its representatives in the Florence council until 1452, when they were acknowledged and promulgated in the Church of St. Sophia at Constantinople; but in a council held by the Greeks in 1472 the acts of the council of Florence were formally repudiated, and the act of re-union canceled. The two Churches have ever since been separate.

Filipino, fil-ĭ-pē'-nō, a native of the Philippine Islands. The Filipinos form a very mixed population, and seem to represent almost every type of the human race. Some of the tribes have become more or less civilized, others live in the same barbarism as prevailed before the Spanish occupation. In the make-up of the composite Filipino, the darker substratum has been supplied by the Negrito, the Papuan and the African negro. A copper tint has been added by the Malay and Polynesian. This infusion of fierce blood has given to the islanders their fighting qualities. There exist among them certain arts of life, and a skin of a paler hue, inherited from Japanese, Chinese and Cambodian sources. Hamite, Semite and Aryan are each said by ethnologists to contribute some elements to the life, physical, intellectual, and religious, of this strange people, and two centuries of uninterrupted commerce between the archipelago and South America has introduced also a strain of American Indian blood into the Filipino race.

When we come to analyze the tribes, as far as they are at present known to scientific men, it appears that the Indios, the more or less civilized natives of the archipelago, divide themselves naturally into four groups, namely, Tagals, Vicols, Visayas, and Llocanes. The Tagals are palpably the most advanced in the arts of life, and number about a million and a half. Most of them live in the island of Luzon, preferring to settle in the low-lying plains, or near streams and on the seacoast. From Luzon they extend southward, in scattered groups, through Mindoro, Marinduque, and smaller islands farther south. They cultivate the soil, raise large quantities of rice, and are bold and skilful fishermen; and this active industrious life shows itself in their vigorous physique, and powers of endurance. The Tagalog language is more widely spoken than any other Filipino dialect. The Llocanes occupy territory in the extreme northern peninsula of Luzon. They form but a small tribe, and seem to be distinguished from the Tagals merely by the dialect they use. The island of Visaya is wholly occupied by the tribe from which it takes its name, and the Visayas are said to number some two millions and a half and to speak a distinct language which separates them from the other Malayan races of the archipelago. The Vicols number about 400,000 and are scattered over the Camarines peninsula, and occupy also the islands of Catanduanes, Burias, Ticao, and half of the Masbate. In physical type and habits of life they largely resemble the Tagals. The Sulu chain of islands, which stretches between Mindanao and North Borneo, is peopled by the Moros, who are also found on the southwest coasts of Mindanao, and Balabec, as well as on the south coast of Palawan, or Paragua Island. Their original seat was undoubtedly Borneo, from which they have derived their Mohammedan faith, and most of their social usages. They have nothing in common with the peoples farther north and have stoutly resisted all attempts to Christianize them. They were once the fiercest pirates of the archipelago and lived by ravage and robbery. The natives of the northern islands, upon whom they once preyed, as they learned from the Spaniards the use of firearms, and modern methods of warfare, were able successfully to repel the raids of the Moros, whose primitive weapons could not cope with repeating rifles and Gatling guns.

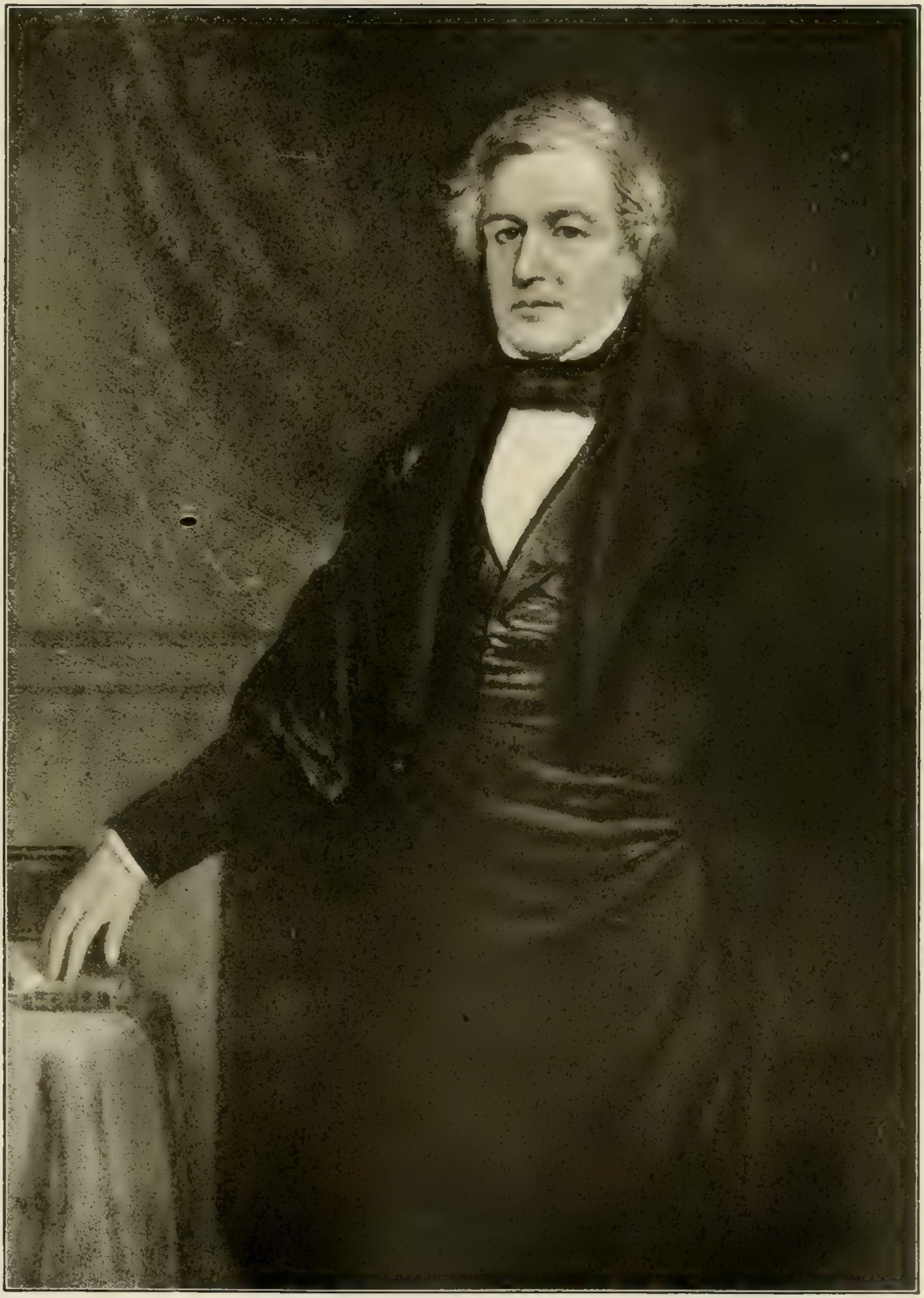
As the mountains are the last refuge of liberty in a conquered country, so also are they the last lurking place of savagery and barbarism. The interior of Luzon and several other islands is mountainous and uncultivated; here lurk the savage tribes whom two hundred years of Spanish rule have failed to civilize or even subdue. These are reckoned at half a million souls, have many languages and dialects, and are in greatest force among the mountain fastnesses of central Mindanao. While some of these tribes are peaceful and inclined to commerce and industry, a large section shows the warlike spirit that urges them to live on rapine. The Negritos, or Little Negroes, dwell in the higher ranges of Luzon and Negro; they are black in skin, and dwarfish in stature; they are evidently a degenerate race, doomed to early extinction.

The Spaniards appear to have done very little to investigate the antiquities of the Filipino races. There is a vast field of exploration open to ethnologists and archæologists in this remarkable archipelago, which possesses a literature of its own in poetry and folk-lore, and has derived from Malay and Indian invaders such arts as metallurgy and weaving, in both of which arts many of the tribes are exceedingly expert. The ethnologists of the Smithsonian Institution have already turned their attention in this direction, and the United States Treasury Department is putting every possible facility in the way of those who are trying to unravel the story of the savage navigators who first cruised in the channels of the Philippine archipelago. See PHILIPPINES.

Filix. See FERN, MALE.

Fillans, James, Scottish sculptor: b. Wilsontown, Lanarkshire, 27 March 1808; d. Glasgow 12 Sept. 1852. After acquiring some local celebrity in Paisley by his portrait-busts, he proceeded to Glasgow. He subsequently visited Paris to improve himself in his art, and in 1836 took up his abode in London. A life-size group in marble, the 'Blind Teaching the Blind,' was exhibited by him in Glasgow, and produced a great sensation. Other admirable works of his are: 'The Boy and Fawn,' a statue of Sir James Shaw (in Kilmarnock), and a bust of Prof. Wilson.

Fillet (1) In ordinary language, a narrow band of metal, linen, or ribbon worn round the head. Sacred fillets were those worn by the priests of Greece and Rome. Also portions of meat or fish removed from the bone and served either flat or rolled together and tied. (2) In architecture, a small flat face or band used principally between moldings to separate them from each other in classical architecture; in the Gothic, Early English, or decorated styles of architecture, it is also used on larger moldings and shafts. Also the projection between the



MILLARD FILLMORE.

THIRTEENTH PRESIDENT OF THE UNITED STATES.

flutes of a column. (3) In anatomy, that part of the sensory nervous tract lying in its passage from the decussation of the sensory columns to the internal capsule. Disease or disturbance of the fillet usually results in a form of generalized anæsthesia. See APOPLEXY; HEMIANÆSTHESIA; HEMIPLEGIA.

Fill'more, Millard, American statesman, 13th President of the United States: b. Summer Hill, Cayuga County, N. Y., 7 Feb. 1800; d. Buffalo 8 March 1874. He studied law in his native county and in 1821 removed to Erie County, and pursued his legal studies in the city of Buffalo. In 1827 he was admitted to the bar and in 1829 commenced his political career as a representative of Erie County in the State legislature, and in 1832 he was elected to the Congressional House of Representatives. For a number of years he alternated between political life and the exclusive practice of his profession, rising steadily in the general estimation as an able lawyer and consistent and promising leader of the Whig party. Elected in 1847 comptroller of the State of New York, he enjoyed in 1848 the still higher honor of being elected by his party as Vice-President of the United States. The new President, Gen. Taylor, entered on his office in March 1849, and on his sudden death in July 1850, Fillmore became, in virtue of his office, President of the United States. He was installed in the White House at what was, in several respects, a critical moment in the history of the Union. It was the era of the Lopez expedition against Cuba; and of a more than usual bitterness in the relations between North and South on the slavery question. Fillmore made Daniel Webster his secretary of state, an appointment which strengthened and popularized his administration. President Fillmore's messages favored the fugitive slave law, and recommended a protective, but not a prohibitory, tariff. Under his presidency California was admitted as a new State into the Union. He was the candidate of the American party for the presidency in 1856, but he received a very small minority of votes. After his retirement from public life he resided in Buffalo, N. Y.

Film, a transparent, flexible substance used as a substitute for glass plates for portable photographic work. It consists of a strip of celluloid which is treated with a sensitized coating, the same as is used on plates (see PHOTOGRAPHY). This strip is wound on rollers, and so placed in the camera that it may be unwound from one roller, exposed, and rolled on another. The film is made from liquid cellulose, formed by dissolving gun-cotton in amylacetate, or other solvent. It can be made in any length desired by stripping the liquid from a polished surface by a revolving wheel.

Fil'mer, SIR **Robert,** English political writer of the Caroline age: d. 1653. He was educated at Trinity College, Cambridge, and became an active Royalist. He wrote in advocacy of the divine right of kings, and was knighted by Charles I. His uncompromising defense of absolution made him a marked man, and his views were strongly controverted by Algernon Sidney and Locke. Undoubtedly his most important work is 'Patriarcha; or the Natural Power of Kings' (1680).

Filmy Ferns. See *Filicales* (7), under FERNS AND FERN ALLIES.

Filon, Auguste, ô-goost fē-lôṅ, French historian: b. Paris, France, 7 June 1800; d. there 1 Dec. 1875. A commanding point of view and alluring style are conspicuous throughout his 'Comparative History of France and England' (1832); 'The Spiritual Power in its Relations with the State' (1844); 'History of the Roman Senate' (1850); 'History of the Athenian Democracy' (1854); and several other important historical works.

Filon, Pierre Marie Augustin, pēār mä-rē ô-goo-stăṅ fē-lôṅ, French critic: b. 1841. He is the son of A. Filon (q.v.), and was tutor of the Prince Imperial 1867–70. He is the literary editor of the 'Revue Bleu' and is the author of 'Guy Paton' (1862); 'Les mariages de Londres' (1875); 'Histoire de la littérature anglaise' (1883); 'Prosper Mérimée' (1894); 'English Profiles.'

Filter and **Filtration.** In chemical technology the process of filtration consists in passing a liquid through a porous or fibrous solid, for the purpose of removing certain elements of the liquid. In chemical analysis in the wet way, filtration is resorted to continually, in order to separate precipitates from the liquids in which they are suspended. The filters used for this purpose consist of sheets of a special kind of bibulous paper, which should consist of almost absolutely pure cellulose, so that it will leave practically no ash when burned. The precipitate, when it has all been deposited upon the filter paper, and has been thoroughly washed, is transferred, together with the paper, to a platinum crucible, in which it is heated until the paper has become entirely burned away, and nothing is left but the precipitate that is to be weighed. Gelatinous precipitates filter very slowly, and for this reason it is usual for chemists to pay careful attention to such little details of manipulation as tend to cause the precipitate to take as granular a form as possible, so that the filtration may be performed rapidly. When the object of the filtration is merely to remove solid particles that are suspended in a liquid, and a quantitative estimate of these solids is not desired other materials than paper are often used as filtering media with advantage. Thus the liquid may be passed through plugs of asbestos fibres, or of glass wool, these particular substances being very useful when the liquid to be filtered is of a corrosive nature, like a strong mineral acid. Filtration through porous plugs is often hastened by creating a partial vacuum on that side of the plug toward which it is desired that the liquid shall flow, and aspirators, or special filter pumps, are constructed for this purpose. When it is desired to remove such minute bodies as bacteria from a liquid in which they are suspended, it is common to pass the liquid through a solid septum of unglazed porcelain, though it has been found that nearly all such bodies can be removed by filtration through a sufficiently thick mass of sand. Cities which must obtain their drinking water from rivers polluted by sewage from other towns and cities are now supplied with water of very good quality by filtering the river water through beds of sand some feet in thickness, and statistics, in such cases, have shown that the installation of such filtration plants is often attended by an almost incredible decrease in the death rate from typhoid fever and other analogous diseases. See WATER PURIFICATION.

Filth-disease, an old term of little scientific meaning at the present time. Modern theories of disease predicate definite infecting agents. Dirt and filth of themselves are not necessarily associated with any known disease. If perchance collections of filth become contaminated with the dejecta of people suffering from infectious diseases, then the filth, through the agency of flies or other insects, may become a source of infection. See CONTAGION; HYGIENE; INFECTION.

Fin de Siecle, făn dē sī-ā'-kl ("the end of the century"), supposed to particularly mark the close of the 19th century, regarded as a period of emancipation from the traditional moral and social state of disorder.

Finance relates to the revenues and expenditures, the pecuniary resources and disbursements of a nation, state, corporation, or individual. It is a word of ancient usage, introduced into England through Normandy, and derived, according to Littré, from an old and now obsolete French verb, *finer*, which was used, in its restricted sense, to signify arriving at a final settlement by payment of money, or finding the ways and means thereto. In Berner's 'Froissart' 1523 occurs the word finance: "So he was put to his fynanse to pay XXII. thousande franks of France and the companyons of the Englysshe garysons in Champaigne payed the sayd ransaume."

The prosperity of nations has often depended on the ability, tact and wisdom of their financial ministers. In France, Colbert and Necker; in England, Godolphin and Peel; in America, Hamilton, Gallatin, and Chase have been regarded as showing eminent ability in finance. The principal object in the study of finance is to arrive at the fundamental principles that should govern the taxes, customs, and income, the credit, loans, and currency, and all that is connected with the revenues and necessary expenditures of a people. This may perhaps be best obtained from the experience of the past as told in history. There we find that practical and sound finance must have due regard to the laws of trade,— which like the laws of nature are never opposed or disregarded with impunity,— that it must insist upon the faithful execution of contracts, and see that taxes are never allowed to injure the source of income. Hume wrote that "one of the chief causes of the destruction of the Roman empire was the alteration which Constantine introduced into the finances, by substituting an universal poll-tax in lieu of almost all the tithes, customs, and excises which formerly composed the revenues of the empire. The people in all the provinces were so oppressed by the publicans (tax-gatherers) that they were glad to take refuge under the conquering arms of the barbarians."

Colonial Finance.— The colonial history of America is replete with interesting problems and experiments in finance. To find ways and means to support the necessary expenses of their respective governments and to carry on the Indian wars was perplexing to all the colonies. Taxation was not a right of sovereignty. The early settlers held and handed down the principle (a principle which Lord Chatham in his speeches in Parliament stated had long been acknowledged in England) that taxes are a voluntary donation from the people to the government. The early settlers declared emphatically that there should be no titles of nobility, no prerogatives, that no man's property should be taken for the public use without his being indemnified. They claimed that every man should bear his portion of the public expenses, but if expenses were incurred for purposes in which the individual and his property were not benefited, for such he could not be taxed. Money was scarce, trade was frequently carried on by barter and it is not, therefore, surprising that the colonies resorted to the issue of paper money. Massachusetts was the first to set the example and the other colonies soon followed, with the result that whatever coins existed in the country disappeared, in obedience to the rule that the poorer currency drives out the richer. Another instructive lesson in the financial history of the colonies was the legislative attempts to fix the prices at which commodities should be bought and sold and labor employed. These regulations were in conflict with the laws of trade and proved futile or disastrous.

Finances of the Revolution.—"The first financial operation of what was to become the United States," was a loan of £6,000 obtained in 1775 by the Continental Congress "for the use of America." Franklin (q.v.) urged that Congress should continue to raise money by loans rather than resort to the issue of paper currency, but the majority of the delegates thought otherwise. "Do you think, gentlemen," cried one, "that I will consent to load my constituents with taxes, when we can send to our printer and get a wagon-load of money, one quire of which will pay for the whole?" The first issue of paper was $3,000,000, and in December 1775 $3,000,000 more were ordered. The certificates or notes were to be redeemed by the States during the four years beginning with 1783.

In December 1777 John Adams (q.v.) wrote to Elbridge Gerry (q.v.), "The man who lent another £100 in gold four years ago and is paid now in paper cannot purchase with it one quarter part in pork, beef, or land of what he could when he lent the gold." Two years later he could not have purchased one thirty-eighth part.

The rapid decline in the value of this currency caused great distress and suffering, reduced many persons from affluence to poverty, and is said to have injuriously affected the moral ideas of the people. After declining from 100 to 1, it ceased in 1781 to pass as money and "barber shops were papered in jest with the bills." The amount of this paper money issued by Congress was stated by Franklin to have been $200,000,000, but Dewey in his recent 'History of the Financial History of the United States' says the total amount issued exceeded $240,000,000. As the bills had been poorly printed, they were easily counterfeited and the counterfeits were so numerous and perfect (some, it is alleged, were manufactured in England) that the redemption of the genuine notes would have been difficult even if the means to redeem them existed.

In the meantime, after other attempts to raise money by appeals to the States and confiscation of the property of Tories with small results, Congress again resorted to loans. In 1783, the loans of the United States amounted to

$42,000,000, of which $7,885,085 were obtained abroad. To meet the interest on foreign loans, money was borrowed in Europe. Home creditors at that time received no interest, and some sold their claims at one tenth of the face value. After the adoption of the Federal Constitution these claims were paid at their full face value by Hamilton.

On 20 Feb. 1781, Robert Morris (q.v.) was made superintendent of finance. He took the office with the stipulation that he should have full power to remove all whom he thought unfit for their positions in the Treasury Department. He began his reform by curtailing expenses and opposing unnecessary expenditures. He introduced system and order, improved the foreign credit, established a bank that was of great service to the government, and when all other sources of income failed, he used his own credit. He remained in office about three years, and for five years thereafter chaos is said to have reigned in the treasury. A decade had not passed after America's experience with continental paper money before France began the issue of *assignats* which had results even more disastrous.

On the organization of the Federal government in 1789, Alexander Hamilton (q.v.) was appointed secretary of the treasury. The public credit was at that time in the lowest state of depression; its fiscal resources were unknown, as no statistical account of the resources of the country had been attempted. He organized the Treasury Department, with a treasurer, comptroller, register, and auditor, and introduced the system of warrants which exists to-day. When he made his first report to Congress and inquired whether he should make it verbally or in writing, they replied that they would receive it in writing, and so all secretaries have submitted written reports. His official reports are considered masterpieces. He established the public credit on a firm basis and retired, after being secretary somewhat more than five years, with the reputation of being one of the greatest financiers of the age.

Among the salient points in American finance is the administration of Albert Gallatin (q.v.). To his suggestion, when he was a member of the House, was due the first formation of the Committee of Ways and Means. Appointed secretary of the treasury by Jefferson in 1801 and continued in office by Madison in 1809, he served the long period of 12 years. He was zealous in the cause of economy and reduced the public debt from $83,000,000 in 1801 to about $50,000,000 when he retired in April 1813, and he had provided funds for the purchase of Louisiana and for the early expenses of the War of 1812. He held that expenses incurred for war should be paid from loans and that taxes should not be imposed except to meet the annual expenses of the government on a peace basis and interest on the public debt, and that the debt would gradually be paid from the surplus revenue caused by the development and growth of the country.

In 1835 the United States stood in the remarkable position of a nation without debt. In that and the following year, nearly $40,000,000 came into the treasury from the sales of public lands. Congress voted to distribute to the States all the surplus over $5,000,000. About $28,000,000 were distributed, but before the balance was paid a severe panic spread over the country; the banks, including those that held the government deposits, suspended, and the government found itself on the verge of bankruptcy. The law authorizing further distribution was repealed.

The law establishing the independent treasury, often called the sub-treasury, was enacted July 1840 and was repealed 13 Aug. 1841. August 1846 the law was re-enacted. The independent treasury now exists with an assistant treasurer in Washington, New York, Boston, Philadelphia, New Orleans, Charleston, St. Louis, Chicago, and San Francisco.

During the panics of 1857 the United States government, having its money in the independent treasury, was able to meet all its obligations promptly and has been enabled in later panics to afford relief to the community by purchase of United States bonds or prepayment of interest. Although sound finance seems to require that the government should interfere the least possible in the affairs and business of the people and that it should not assume paternal functions, there are times when its brief assistance appears justifiable.

Finances of the Civil War.— Salmon P. Chase (q.v.) became secretary of the treasury 7 March 1861. In the beginning it was thought that the War would be of short duration, and when Congress was convened in special session in July 1861 attention was given to obtaining money by loans, rather than by any great increase of taxation. Accordingly, Congress authorized a loan of $250,000,000 in 3-year 7-30 treasury notes and in 20-year bonds with interest not to exceed 7 per cent, or in lieu of a portion of said loan the secretary was authorized to pay salaries or other debts or exchange for coin, non-interest bearing treasury notes payable on demand and receivable for all public dues, to the extent of $50,000,000. Clothed with this authority, Mr. Chase invited representatives from the banks of New York, Boston, and Philadelphia to meet him in New York. The result of the conference was an agreement by the banks of the three cities to advance to the government at once, or as wanted, on the secretary's drafts in favor of the assistant treasurer, $50,000,000 in consideration of which the secretary agreed to appeal to the people for a subscription to a national loan on 3-year notes bearing 7-30 per cent interest, and to pay over the proceeds of the subscriptions to the banks and to make good any deficiency by delivering to them 7-30 notes. The agreement was faithfully fulfilled. Books of subscription to the national loan were opened in all parts of the loyal States and the people responded with enthusiasm and alacrity. About $45,000,000 were thus subscribed and paid to the banks and the remainder was made good by the delivery of the promised 7-30s. This operation enabled the banks to make a second advance of $50,000,000 nearly on the same terms. They attempted to furnish a third $50,000,000 in exchange for the 20-year bonds, but the market price of the bonds declined, the banks were unable to sell them, and 30 Dec. 1861, the banks of New York suspended specie payments and their example was followed throughout the country. On 25 Feb. 1862, Congress authorized the issue of $150,000,000 of legal tender notes. The measure met with great opposition; bankers and members of the boards of trade of different cities hastened to Washington to use their influence against it, and the press very generally denounced it. But the suspension of the banks made it certain that the government could no longer obtain coin on loans. Secretary Chase had wished to avoid the necessity of making notes of any kind a legal tender and with that object had proposed to the banks several plans including a national banking system; but they were slow to give their unanimous consent. As the secretary had not, in any report made by him to Congress, suggested the expediency of making the notes of the United States legal tender, some of the members of the House desired to be assured of his views before voting on the measure; and the Committee of Ways and Means formally asked his opinion as to the necessity and propriety of the immediate passage of the bill. Mr. Chase replied:

> It is not unknown to the Committee that I have felt nor do I wish to conceal that I now feel a great aversion to making anything but coin a legal tender in payment of debts. It has been my anxious wish to avoid the necessity of said legislation. It is, however, at present impossible, in consequence of the large expenditures entailed by the war and the suspension of the banks, to procure sufficient coin for disbursements, and it has therefore become indispensably necessary that we should resort to the issue of United States notes. The making them a legal tender might, however, still be avoided if the willingness manifested by the people generally, by railroad companies and by many of the banking institutions to receive them and pay them as money in all transactions were absolutely or practically universal, but unfortunately there are some persons and some institutions which refuse to receive and pay them and whose action tends not merely to the unnecessary depreciation of the notes, but to establish discriminations in business against those who, in this matter, give a cordial support to the government, and in favor of those who do not. Such discriminations should if possible be prevented and the provision making the notes a legal tender, in a great measure at least, prevents it by putting all citizens in this respect on the same level both of rights and duties.

After the reading of this letter in the House the bill was passed. On 11 July 1862 Congress authorized another issue of $150,000,000, and by acts of 17 January and 3 March 1863 a third issue of $150,000,000, making a total issue of $450,000,000. The issue of these legal tender notes was followed by a great rise in the prices of food and other commodities. Gold went to a premium and fluctuated from day to day. In 1862 $100 in gold sold for $130 in paper, and in 1863 the variations were between $125 and $160. On 17 June 1864 a bill was enacted to prevent speculation in gold. It declared unlawful any contract to purchase or sell gold to be delivered on any day subsequent to that on which the contract was made, or any contract for sale and delivery of gold coin or bullion, of which the person making such contract was not in actual possession at time of making the contract. This legislation, designed to reduce, had the effect of advancing the price of gold. On 17 June gold was selling at $195, by 30 June gold was $250, and 2 July, 15 days after its passage, the law was repealed.

California alone of the loyal States continued throughout the War on a gold basis, her people refusing to accept paper money.

In 1863 the National Bank Act was passed with the beneficial results of establishing a uniform bank currency in place of the currency of State banks, which often circulated with difficulty and at a discount outside the limits of their respective States. As the act required the national banks to hold a certain amount of United States bonds and to pledge United States bonds at Washington as security for the bank circulation, it made an extra demand for the bonds. See BANKS AND BANKING.

In the creation of debt by loans or otherwise, Mr. Chase kept four objects steadily in view: (1) moderate interest; (2) general distribution; (3) future controllability; (4) incidental utility.

At the close of the war Secretary Hugh McCulloch (q.v.) urged the resumption of specie payments, holding that the legal tender acts were only a war measure. In April 1866 Congress authorized the retirement of $10,000,000 within six months, and not more than $4,000,000 any one month thereafter,— $44,000,000 were thus retired when further reduction was suspended by act of 4 Feb. 1868. The legal tender notes thus reduced to $356,000,000 were increased in 1873–4 by Secretary Richardson, who issued $26,000,000 in purchase of bonds. In 1874 Congress passed a bill to increase the amount of legal tender notes to $400,000,000, but President Grant (q.v.) vetoed the bill in his memorable message of 22 April 1874.

Silver Currency.— In the meantime the product of silver mines in the United States was increasing at a remarkable rate. In 1861 the annual product, at its coining value, was $2,000,000; in 1864, $11,000,000; in 1871, $16,000,000; in 1875, $31,700,000; in 1901 it was $71,388,000. The act of 28 Feb. 1878, which became a law notwithstanding the President's veto, authorized the coinage of standard silver dollars and made them legal tender at their nominal value for all debts and dues, public and private, except where otherwise expressly stipulated in the contract, and authorized the holders of silver dollars to deposit the same in sums not less than 10 dollars and to receive therefor silver certificates which shall be receivable for customs, taxes, and all public dues, and when so received may be reissued. The secretary was also directed to purchase silver bullion at the market price, not less than $2,000,000 nor more than $4,000,000 per month and coin the same into silver dollars.

Four years later in 1882 in order to increase the output and circulation of silver dollars, Congress authorized the secretary of the treasury to transport, free of charge, silver coins when requested to do so, provided an equal amount in coin or currency was deposited in the treasury by the applicant.

Under the act of 1878 and prior to 14 July 1890 the

Total amount of bullion purchased was....	$308,199,162
Total dollars coined......................	378,166,793
Seigniorage or gain to U. S. government..	$ 69,967,631

The act of 14 July 1890 authorized the purchase of silver bullion at its market price, at the rate of 4,500,000 ounces per month to be paid for by legal tender treasury notes redeemable "in coin." Said notes when redeemed to be reissued. Upon the demand of the holder of any of these treasury notes, the secretary was directed to redeem these notes in gold or silver at his discretion "it being," so the act reads, "the established policy of the United States to maintain the two metals on a parity with each other upon the present legal ratio or such ratio as may be provided by law."

During the 14 years ended December 1892 $450,000,000 new paper currency ($325,000,000 of silver certificates and $116,000,000 of treasury certificates) had been put in circulation. Under this great volume of currency, the year 1893 commenced with great expectations of increasing business prosperity, but in the spring doubts and distrust spread over the country, people began to hoard gold and one of the greatest panics of the century followed.

To meet the expenditures of the war with Spain in 1898 a loan of $400,000,000 in 3 per cent bonds was authorized by act of 13 June 1898, and a long list of stamp and special taxes imposed, including for the first time in Federal taxation the very un-American tax on legacies.

Of the 3 per cents $100,000,000 were at once issued as a popular loan, directly to the people, preference being given to subscribers of small amounts, $500 or less. The loan was largely over-subscribed and the bonds went immediately to a premium. The war lasted only four months.

The important act 14 March 1900, enacted that the gold dollar of 25.8 grains of gold, 0.9 fine, shall be the standard unit of value, and all forms of money issued or coined by the United States shall be maintained at a parity of value with the standard, and it shall be the duty of the secretary of the treasury to maintain such parity; it also provided that the United States notes and treasury notes issued under act of 14 July 1890 shall be redeemed in gold coin, and authorized a reserve fund of $150,000,000 in gold coin and bullion to be used only for redemption purposes.

The accumulation of moneys in the treasury was in 1903 a matter of much concern to the administration and the secretary, under the sanction of law made a large number of the national banks throughout the country United States depositaries, and there were in August 1903 on deposit in these banks $117,000,000 of United States funds.

The revenues of the government of the United States from all sources (by warrants) for the fiscal year ended 30 June 1902 were:

From internal revenue	$271,880,122.10
From customs	254,444,708.19
From profits on coinage, bullion deposits, etc.	10,979,506.57
From revenues of the District of Columbia	4,217,841.43
From sales of public lands	4,144,122.78
From fees — consular, letters patent, and lands	4,085,229.87
From navy pension, navy hospital, clothing, and deposit funds	2,019,850.25
From Indian labor, sales of Indian lands, etc.	1,775,832.63
From tax on circulation of national banks	1,643,454.73
From payment of interest by Pacific railways	1,564,554.71
From sales of government property	829,314.15
From customs fees, fines, penalties, etc.	828,971.35
From immigrant fund	747,217.15
From miscellaneous	556,153.94
From Soldiers' Home permanent fund	536,045.62
From judicial fees, fines, penalties, etc.	334,233.95
From sales of ordnance material and powder	330,438.53
From deposits for surveying public lands	316,579.23
From sale of naval vessels and army transports	313,948.98
From sale of lands and buildings	272,422.72
From tax on seal skins	231,821.20
From trust funds, Department of State	222,061.94
From depredations on public lands	107,995.58
From license fees, Territory of Alaska	95,805.61
From Postal Service	121,848,047.26
Total receipts	$684,326,280.47

The expenditures for the same period were:

For the civil establishment, including foreign intercourse, public buildings, collecting the revenues, District of Columbia, and other miscellaneous expenses	$111,067,171.39
For the military establishment, including rivers and harbors, forts, arsenals, seacoast defenses, and expenses of the war with Spain and in the Philippines	112,272,216.08
For the naval establishment, including construction of new vessels, machinery, armament, equipment, improvement at navy-yards, and expenses of the war with Spain and in the Philippines	67,803,128.24
For Indian Service	10,049,584.86
For pensions	138,488,559.73
For interest on the public debt	29,108,044.82
For deficiency in postal revenues	2,402,152.52
For Postal Service	121,848,047.26
Total expenditures	$593,038,904.90
Showing a surplus of	$ 91,287,375.57

The changes in the amounts of the several kinds of money of the United States outside the treasury between 1 Nov. 1901 and 1 Nov. 1902 are shown in the table below:

The estimated population of the United States 1 Nov. 1901 was 78,211,000, and the per capita supply of money outside the treasury was $28.72. The estimated population and the per capita supply of money 1 Nov. 1902 were 79,572,000 and $29.36, respectively.

The finance reports of the Treasury Department show receipts and expenditures from the beginning of the government to the present time, and contain much information. From them it appears that the expenditures for the navy did not annually amount to $10,000,000 until 1853. In 1902 they were $67,000,000. The most striking feature in the national expenditures during recent years has been the pensions. In 1875, ten years after the close of the Civil War, the amount of pensions was $29,450,000. The increase was steady till 1890, when they amounted to $87,000,000. In that year a new "dependent pension" law was enacted and they jumped to $107,000,000. In 1893 they reached their highest

THE CHANGES IN THE AMOUNTS OF THE SEVERAL KINDS OF MONEY, ETC.

Classes	In circulation 1 Nov. 1901	In circulation 1 Nov. 1902	Decrease	Increase
Gold coin	$633,858,471	$624,373,645	$9,484,826	
Standard silver dollars	73,113,520	77,517,158		$4,403,638
Subsidiary silver	83,999,351	91,899,715		7,900,364
Gold certificates	281,678,659	342,756,194		61,077,535
Silver certificates	441,810,337	463,170,438		21,360,101
Treasury notes, act of July 14, 1890	41,384,614	25,748,278	15,636,336	
United States notes	338,781,028	343,639,082		4,858,054
National bank notes	351,674,562	367,007,482		15,332,920
Total	$2,246,300,542	$2,336,111,992	$25,121,162	$114,932,612

point, $159,000,000. In 1902 they were $138,000,000.

Customs have been the main source of revenue. The tariff first enacted in 1789 was simply for revenue, but afterward became also a system of protection to home industries. The total receipts from customs since the organization of the government are over $8,800,000,000 and exceed all other taxes. The amount received from sales of land is $304,000,000.

The ordinary expenditures of the States are comparatively small, limited mainly to legislative expenses, salaries of officers, expenses of the militia, educational and charitable purposes, with extraordinary expenditures for buildings and public works. Palgrave records that in 1890 the six largest States in the Union spent $28,859,010.

Municipal corporations — cities, towns, and villages — have been so extravagant that it has been found necessary in many States to restrict their indebtedness to a percentage (varying under the laws of different States from 3 to 10 per cent) of the taxable property, as determined by the assessors, but excepting from such limitation debts incurred for supplying the inhabitants with water, for manufacturing gas and electricity, and for temporary loans in anticipation of taxes. The tendency of modern times is to increase the exceptions. How far a city or town incorporated for the purpose of providing its citizens with good government should use its revenue in any business for profit-making is a question of the day. Such use makes the citizen and taxpayer, whether so disposed or not, share in the risks, and contribute and pay for any losses, blunders or errors, while he is without redress and claim for damages which the inhabitants would have were the business done under a proper contract with responsible parties.

As there is no uniformity in the accounting systems of different cities, it is difficult to compare their revenues or expenditures. Public interest in their financial reports would be increased were they only based on a uniform system, simple and comprehensive, separating ordinary receipts and payments from the extraordinary, with sufficient detail to show the actual purpose for which the money is expended.

The finances of corporations and individuals have assumed governmental proportions. The recent combination of different companies under one management with a capital of more than a billion of dollars has suggested new ideas of the possibilities of finance when applied to consolidations of business enterprises. The financial transactions between the bankers of the different cities of the world are conducted almost with the facility of local transactions.

The statesman who suggested the protection of a man's property in his inventions through patent laws, must have been one of the most far-sighted of financiers. The great resources of the country are in a large degree the result of inventions made in consequence of those laws. To those inventions are due the agricultural contrivances that have made possible the great harvests of the West; the colossal engines that draw the trains; the mechanical safeguards that facilitate and protect transportation; much of the machinery that enables the mills and manufacturing establishments to compete with the world; the drills that open the mines; the telephone, telegraph, and a vast number of industries throughout the land; all contributing directly and indirectly to the public revenue. And the

COMPARISON OF REVENUE PER CAPITA BY SOURCES IN 1900.

Data from Bulletins of United States Department of Labor, compiled by H. S. Chase.

	Boston	New York	Average Ten cities	Chicago	Philadelphia	St. Louis	Baltimore	Cleveland
Population	561,000	3,437,000	560,500	1,699,000	1,294,000	575,000	509,000	382,000
Wealth per capita, valuation at 100 per cent	$2,012.79	$1,458.27	$1,028.86	$1,177.17	$877.87	$1,014.51	$1,109.70	$784.13
Property tax	$28.72	$21.69	$11.42	$8.41	$14.07	$11.43	$11.38	$9.33
Liquor licenses	2.63	1.65	1.25	1.87	1.33	1.74	78	1.21
Other licenses	09	15	36	32	49	89	11	04
Fines and fees	32	23	25	31	51	49	10	34
Franchises	10	16	29	20	....	27	67	19
Water-works	4.57	2.09	2.00	1.94	2.48	2.79	1.86	2.00
Special assessments	63	99	98	1.91	....	34	10	1.76
Docks and wharves	....	72	02	01	03	11	07	....
Gas-works, electric light plants, ferries and bridges, markets, cemeteries, bath-houses and other	8.31	2.65	1.53	85	1.48	2.07	4.10	1.80
Total revenue (excluding loans)	$45.37	$30.33	$18.10	$15.82	$20.39	$20.13	$19.17	$16.67

COMPARISON OF BORROWED MONEY PER CAPITA IN 1900.

Borrowed money (loans, including temporary tax loans)	$17.08	$25.59	$5.21	$3.02	$5.09	....	$12.34	$9.87

SONG FINCHES.

1. Hawfinch. 2. Greenfinch. 3. Linnet. 4. Chaffinch 5. Mountain Finch

great corporations, even the monopolies, are working in the service of the people, for, in the proportion that they satisfy that service, lies their profit. The creation of banks reduced the rate of interest; that of railways the cost of travel; that of great industrial combinations the price of commodities. The greater their service the greater their profit. They are compelled by the unwritten laws of trade to reduce charges to the point that will bring the largest net returns.

A French writer on Finance has with reason stated that no advantage is to be derived from a comparison of the financial systems of America with those of France, nor even in comparing those of the different European countries with each other.

Each nation seeks its prosperity in accordance with its environment and the habits and requirements it has inherited from the past.

It may be interesting, but not very useful, to an American to know that the octroi duties on articles of food and other commodities, collected at the gates of a French city,— a system that has come down from the Middle Ages — amount to much more than half of the ordinary revenue of the city; and it is not apparent that any benefit can come from comparing the relative percentage of the national to the local expenditures of the different countries, although the figures vary greatly; nor in comparing the pensions of foreign nations, frequently, as in Germany and France, paid by employment or minor offices, with the pensions of the United States which are always paid by a treasury check.

The income taxes as levied in England are no longer possible in the United States under the Constitution and the decisions of the Supreme Court. They were tolerated during the great Civil War only as a war measure.

The theories of German Socialists, who would make a government one great industrial corporation, are incompatible with the individual liberty and self-reliant character, with the freedom of industry and of labor inherited by American people. See BANKS AND BANKING; BANKS, SAVINGS; COINAGE; MONEY; TAXATION; TRUST COMPANIES; TREASURY, UNITED STATES.

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FRANKLIN HAVEN,
Pres. Merchants' National Bank, Boston.

Finance, United States Superintendent of. See FINANCE.

Finback, a whalebone whale of the genus *Balænoptera,* having the dorsal fin, which in most whales is small or altogether wanting, well-developed. This genus is widely distributed and contains a number of species, which include the largest cetaceans known. The special finback or "finner" of the eastern coast of the United States (*B. musculus*) is from 30 to 70 feet in length. Other species are described elsewhere, as Sibbald's whale, sulphur-bottom, etc. Despite their huge size, finbacks yield so little oil, and such inferior quality of whalebone that they are little sought for.

Finch, Francis Miles, American poet and jurist: b. Ithaca, N. Y., 9 June 1827; d. there, 31 July 1907. He was graduated at Yale; and wrote the well-known lyrics: 'Nathan Hale' and 'The Blue and the Gray,' and a popular college song beginning: 'Floating away like the fountain's spray.'

Finch, one of the small, seed-eating birds, typical of the family *Fringillidæ* (q.v.). The term as now commonly used refers to the smaller, more ornately dressed genera and species, and especially to those generally kept as cage-birds, as the canary, chaffinch, goldfinch, hawfinch, greenfinch (qq.v.), and similar well-known kinds of the Old World. In the United States the name is reserved for the American goldfinch and its greenish relative of the north, the pine-finch; for the purple finch (q.v.), the rosy finches (q.v.) of the genus *Leucosticte;* the house-finch (q.v.) of California; and especially for the small gaudily colored southern birds of the genus *Cyanospiza,* represented in the Northern States by the indigo-bird (q.v.). In these little seed-eaters, such as the nonpareil (*C. ciris*), the lazuli finch (*C. amœna*), and the Mexican varied (*C. versicolor*), the plumage of the male abounds in the richest tints of changeable blue and green, varied by other colors in pleasing contrast. All utter sweet and varied notes, and are prized not only as garden visitors but as cage-birds. The name is also commonly given in the northeastern United States to the "grass-finch," more properly a sparrow (*Poocætes gramineus*), a brown bird which breeds and spends its life in open fields, singing most sweetly at dusk, and easily recognized by the fact that when it takes flight it exhibits a white feather on each side of the tail.

Finch-falcon, one of a genus (*Microhierax*) of tiny falcons, or "falconets," of the East Indies. One, *Microhierax cærulescens,* is found in the Himalayas and Burmese countries. Not one of these little hawks is seven inches in length; they are said to be used by native chiefs for hawking insects and button quails, being thrown from the hand like a ball. They sit solitary on high trees, and, according to native accounts, feed on small birds and insects.

Finck, Henry Theophilus, American musical critic: b. Bethel, Mo., 22 Sept. 1854. He was graduated at Harvard in 1876; and from 1878 to 1881 studied physiological psychology at Berlin, Heidelberg, and Vienna. He is musical critic of the New York Evening *Post.* His works include: 'Wagner and His Works'; 'Romantic Love and Personal Beauty' (1887); 'The Pacific Coast Scenic Tour' (1890); 'Chopin, and Other Musical Essays'; 'Lotos Time in Japan' (1895); 'Spain and Morocco'; 'Paderewski'; 'Primitive Love' (1899); 'Songs and Song Writers' (1900), etc.

Finder, (1) In astronomy, a small telescope fixed to the tube of a larger one, the axes of the two instruments being parallel. The finder has a larger field of view than the principal instrument, and its purpose is to find an object toward which it is desired to direct the larger telescope. (2) As a military term: The finder invented by Lieut. Fiske, of the United States navy, is now being constantly used experimentally and may be called complete. It consists of a telescope mounted high enough to sweep the sea. In front of it is the high stone wall of the fort. Or the finder is placed along shore behind rocks or trees to screen it from the enemy's observation. When the enemy's ship comes within sight the telescope is slowly turned until aimed full at the ship. At the same time the hand moves along, pressing a button, after a certain mechanical method, by which the telescope and the button correspond. As soon as they come within the same focus an electric button, connected with a submarine mine lying in the harbor, is pressed, which blows up the ship.

Finding of Goods. See Lost Property.

Find'lay, Ohio, city, county-seat of Hancock County, Ohio; on the Toledo & O. C., the Lake E. & W., the Ft. W. & W. and other railroads; 44 miles south of Toledo. It is in the heart of the oil and gas fields of Ohio. It contains Findlay College, electric lights, electric railroads, several banks, and numerous daily, weekly, and monthly periodicals. Findlay is widely known on account of its phenomenal yield of natural gas. In November 1888 the Tippecanoe gas well was drilled and yielded 31,000,000 cubic feet of gas per day. In the vicinity are rich beds of clay and large deposits of gravel and sand. There are manufactories of glass, pressed bricks, furniture, wooden implements, nails, and an oil refinery, machine shops, foundries, extensive potteries, and rolling-mills. Pop. (1900) 17,613.

Findlay College, a coeducational institution in Findlay, Ohio; founded in 1882 under the auspices of the Church of God; reported at the close of 1900: Professors and instructors, 12; students, 222; volumes in the library, 1,300.

Fine (probably from Latin *finis*), in English law, formerly signified "an income or a sum of money paid at the entrance of a tenant into his land; a sum paid for the renewal of a lease; and an assurance by matter of record founded on a supposed previously existing right. In every fine which was the compromise of a fictitious suit, and resembled the *transactio* of the Romans, there was a suit supposed, in which the person who was to recover the thing was called the plaintiff, conusee, or recognizee, and the person who parted with the thing the deforceant, conusor, or recognizor. Besides the specific uses above referred to, fine has the signification in general law, in America as well as in Europe, of a pecuniary penalty exacted either in punishment of, or in compensation for, an offense, whether committed against an individual, in contravention of the laws of the community, or against the community itself. Fines in this sense are of very ancient origin, and have been sanctioned by the practice of all nations, ancient and modern, from the lowest to the highest degree of civilization. In the earlier stages of society fines form, for an obvious reason, one of the principal modes of punishment. Prisons and artificial restraints impose a burden on society which it is not yet able to bear, and demand an organization which it has not reached. There remain only fines, corporal chastisements, and death. The last is suited only for the gravest offenses; the second is rendered impracticable in the case of many offenses by the dignity of the offenders; the first in many others by their impecuniosity.

In the most civilized nations of antiquity, Greece and Rome, fines were numerous and frequently excessive. In the early period fines were imposed in cattle, the highest amount of the mulcta or damnum being 2 oxen and 30 sheep. The ancient Germans, being a people who highly valued freedom, admitted hardly any punishment but fines, and their influence extended the use of this penalty among other European nations. A murder was commuted by a payment to the family of the deceased. In the ancient French law fines were divided into two classes, according as they were fixed by law or left to the discretion. This distinction has been abolished since the Revolution by the fixing of maximum and minimum limits for all fines. In England the common law recognizes fines, but does not determine their amount, and this is usually fixed in particular statutes, with a discretion to the judge. The rule in England from an early period, and which was incorporated in Magna Charta, was that no man should be amerced beyond his circumstances and personal estate, leaving to the land owner his land, to the merchant his stock, and to the husbandman his wainage or team and instruments of husbandry.

Fine Arts is the generic term for those arts intended primarily to affect the emotions, such as sculpture, painting, music, etc., as distinguished from the *useful arts* which serve the physical needs of life. Art in general may be defined as the exercise of the creative faculty through some form of material activity controlled and inspired by the intellect. All industries are therefore included under the category of the arts in precisely the degree in which they involve the creative activity of the intellect. The products of the useful arts are designed for purposes external to themselves, to serve the needs of daily life; in other words, they are made to be used. The products of the fine arts, on the other hand, are created for their own sake; they are an end in themselves, or — to be more accurate — they exist for the sake of the emotions they are designed to express and to arouse. A chair, however superbly carved, is a work of useful art, because made primarily to be sat on; but a picture is painted for its own sake, not to be used but to be looked at and to excite pleasurable emotions by its beauty of subject, of drawing, of color; it is a work of fine art. So also a poem or a symphony is produced for the sake of the æsthetic emotions it arouses, not for that of any practical or material use to which it is to be put; it is a work of fine art. The fine arts, then, are those whose appeal is to the æsthetic emotions; and just to the extent in which any work of art does so appeal does it enter within the domain of the fine arts. Painting, sculpture, music and poetry belong obviously in this domain; pottery, weaving, building, metal-working are as obviously useful arts. Architecture stands on the borderland of both domains, being the noblest of the useful arts, and yet, in all those elements in which the architect seeks after pure beauty as distinguished from mere utility or fitness, entering into the field of the fine arts, and summoning painting and sculpture to serve it as sister arts.

Besides these major fine arts, there are certain minor arts which minister to the lower forms of æsthetic pleasure. Dancing belongs in this category, when practised not as a social diversion, but as an artistic sequence of beautiful and rhythmic movements, as in the ancient Greek choral dances, the modern Samoan dances, and the higher forms of the operatic ballet. Fireworks are also a form of fine art, having no other purpose than to delight the æsthetic sense by beautiful combinations of luminous form and color. Landscape gardening is a higher branch of the fine arts, in which we may also include as a subdivision all decorative and artistic water-works such as fountains and artificial cascades.

The industrial arts, again, are divisible into two classes; those in which utility or the consideration of the function of the product predominates, and which are called distinctively the *useful* arts, such as pottery, ironwork or carpentry; and those in which the idea of beauty predominates, and which are called the *decorative* arts, such as carving, embroidery, inlay and mosaic, painting (other than that of easel pictures), stained-glass work and the like. The decorative arts closely approach the fine arts, and there is indeed a wide borderland which is common to both, in which the fine arts, especially painting and sculpture, are employed for the embellishment of structures or of movable objects, losing thus somewhat of their independent *raison d'être*. Into this borderland enter such decorative arts as mosaic, glass-staining and carving, in which the product possesses high artistic value independently of the object or structure to which it is applied. Whether, therefore, a given work belongs among the fine arts or the decorative arts is really a question of how far it has been created for its own sake, and how far its artistic value and merit can be dissociated from the object or structure which it embellishes. Thus the sculptures of the Parthenon pediments, although ostensibly created as decorations for a temple, are really of such surpassing merit as works of sculpture, quite apart from their architectural setting, that they are universally recognized as masterpieces of pure sculpture. On the other hand, the charming figures of nymphs of the Seine carved in low relief by Jean Goujon, in the Fountain of the Innocents of Paris, are so evidently designed for the special places they occupy in that structure and lose so much of their value and significance when detached from it, that they are universally recognized as masterpieces of decorative art.

In the appeal which works of fine art make to the emotions there is nearly always a large element more or less purely intellectual, which must be distinguished from the purely æsthetic quality of the work. Thus a picture represents a scene or an episode; a poem tells a story or extols a religious or moral conception; a statue presents the effigy of a hero, or the embodiment in allegorical form of some abstract conception; a song expresses an idea of love, patriotism or war; a building excites admiration by its bold construction and logical planning. Each of these works addresses itself in these particulars rather to the mind than directly to the feelings. In judging them, therefore, as works of art, we must eliminate the element of purely intellectual satisfaction from our judgment in order to weigh correctly the purely æsthetic excellence of the work. A picture æsthetically beautiful may be uninteresting from the intellectual point of view; still more often does it happen that a picture appeals powerfully to the reason, and even reaches the emotions through the intellect, and is nevertheless totally lacking in æsthetic excellence. Thus a political cartoon or a clever caricature may produce a powerful emotional impression upon the public mind, although execrable as a drawing and destitute of artistic excellence. Its effect is produced by a primary appeal to the intelligence, and the emotions which are aroused as the final but secondary result are the moral and intellectual emotions rather than the æsthetic. The appeal of a work of fine art to the æsthetic emotions — to those emotions which are stirred by beauty, by harmony, rhythm, balance, form and proportion — is a direct appeal. It is often difficult to separate the two classes of emotions and to distinguish between the direct æsthetic effect of a work of art and its indirect appeal to the emotions through the intellect, but the distinction is important in any close analysis or detailed criticism, and the failure to recognize it is the root of many erroneous judgments and criticisms by writers on art. This error is frequent in Ruskin's writings, for instance, where moral and intellectual appreciations often dominate what are advanced as purely æsthetic judgments. (See CRITICISM.)

It does not, however, by any means follow that those are the highest forms of art which appeal most exclusively to the æsthetic sense. Instrumental music, dancing and pyrotechny are the branches of art most completely free from intellectual and non-artistic elements, but they can hardly be classed as the "highest" forms of art. On the contrary, intellectual satisfaction is a natural accompaniment of the pleasure we experience in a work of art; and, other things being equal, the higher the form and grade of the work, the higher will be the intellectual satisfaction experienced. The artist who can at once touch our deepest emotions and appeal to our highest intelligence while he delights our æsthetic sensibilities, has reached a higher plane of art than one whose work makes no such intellectual impression. And while it is true that any philosophical analysis of a work of art and of the impressions it produces must make the distinctions above set forth, it is also true that in the enjoyment of those impressions the spectator seldom or never makes such distinction and is in no wise called upon to do so. The philosophical analysis of art is one thing, the subjective enjoyment of it is another. The total impression it makes is very complex, and not easy to divide into its constituent elements. In general, the highest art is that which makes the deepest impression by reaching and touching the highest as well as the deepest phases of our emotional being, alike through the senses and the intellect; not that whose appeal is most purely and exclusively æsthetic, nor that whose execution and technic are the most finished and perfect.

Principles and Technic.— The underlying principles of all the fine arts are the same; the *application and development* of these principles vary with the art, its medium of expression, the purpose of the work, the personality of the artist, the time and place in which he lives and many other circumstances. The application and development of the underlying principles in a given form of art constitute its *technic;* the shape and direction imposed upon this technic by external conditions of time and place, and the resulting characteristics or habits and manner of design, constitute its *style*. It is of course impossible to lay down in a brief *exposé* like the present article, the laws which are recognized as common to all the arts. We can only observe that they relate to *composition*, which deals with the general plan of the work and the relations of its various parts in that plan or scheme, determining the sequence, balance, proportion and rhythm both of the whole and of its parts; and to *expression* or the manner in which the underlying sentiment, conception or idea of the work is developed and made clear and effective. Thus in every perfect work of art, whether of music, poetry, drama, painting, sculpture or architecture, there should be a fundamental *theme*, a dominant idea or conception which runs through the whole, giving coherence and significance to all its parts. The æsthetic conception is to be distinguished from the *subject* of the work. Thus (for instance) in Millet's 'Angelus' the subject of the painting is two peasants ceasing work for a few moments to pray in the field at the sound of the Angelus. The artistic conception embodied in the treatment of this subject is that of distance, of the soft glow of early evening, of quietude and rest; the picture expresses the dreaminess of gathering twilight by the use of the simplest of themes — two peasant figures outlined against the sky and field — using for this purpose the subject indicated by its title. In giving form to the underlying conception the artist must secure predominant *unity* of character or spirit, *harmony* in the assemblage and relation of all the parts, and such *variety* in details as to avoid the danger of wearisome monotony and secure that pleasurable æsthetic emotion which comes from changes not too rapid or violent. This variety may, and generally should, introduce the element of *contrast*, but discreetly, so as not to destroy the harmony and general unity of the whole. *Proportion* should be just, giving to each part and to the whole suitable relative amounts and dimensions; and the whole work should possess both *rhythm* and *balance*. Balance is equilibrium between features or groups of features, an equilibrium of size, of intensity of color or tone, of importance or of accent; rhythm is the ordered succession of variations of accent or emphasis.

Expression depends, as has already been said, upon many elements — the sentiment or conception to be expressed, the medium of expression, the technical resources of the art, and the personality of the artist being the chief. Music is peculiarly expressive of moods, of emotions apart from definite mental concepts; poetry of lofty moral and spiritual ideas; painting of the beauty of nature as interpreted through the artist's personality; architecture of sublimity, splendor, grace and elegance revealed in the triumph of mind over matter; sculpture of feeling revealed in the form and attitude of living beings. Each art has its own range and capacity for expressing feelings, emotions and definite ideas which it carries over from the mind of the interpreting artist to that of the spectator or listener, so that expression is always measured by impression. In general, if the inquiry be limited to the strictly æsthetic field, what is expressed is not a categorical idea capable of statement as a proposition, but rather an abstract emotion, sentiment, or quality, as of grandeur, elegance, power, sublimity, grace, pathos, or the like. In works of representative art, such as painting and sculpture, fidelity to nature enters largely into this power of expression. This is a different thing from the photographic mimicry of nature which is sometimes admired by undisciplined minds, and which often characterizes the periods of decline in the history of art. This close mimicry is an affair of skilful technic, not of high art. To paint a key hanging on a nail so that the spectator shall mistake it for a real key is clever painting, but little more. A great painting is one which seizes most completely and conveys through the eyes to the soul most effectively the essential truth, the deep underlying aspects of a scene, subordinating to this end whatever details would interfere with the force and completeness of this impression. These aspects and this impression must first exist in and possess the artist's mind: he can put into his work only what he himself possesses; he must be himself inspired if his work is to be inspiring, for a truly great work cannot be produced by accident, nor by an inferior artist. Great works of art may be marked by flawless technical execution, but this perfection of technic is not essential to their greatness. It is, indeed, oftener found in decadent art than in the periods of greatest inspiration; for it is when inspiration flags that technical finish begins to be exalted into the place of first importance.

Style.— It would at first seem as though the works of the artist, who has in all ages sought to clothe his conceptions in the forms that seem to him most suitable and expressive, would in every case be stamped with so personal and individual a character that classification by styles, periods and epochs would be impossible. But as a matter of fact, however various the moods, emotions and conceptions of artists of different races and ages, and however manifold the forms in which they are expressed, the men of any one land or period are in general so conditioned by like circumstances and environment, by similarity of customs, traditions and education, by widely-prevailing ideals and aspirations and even by popular taste and fashion, that they are unconsciously constrained into certain similarities of subject and of manner by which the art of their time and place is clearly distinguishable from that of any other. The social, religious, political and intellectual forces of the age inevitably mould the products of its art, and the resulting predominant manner, form of expression, quality and habit of design we call the *style* of that age and place. The most daringly original artist cannot wholly escape the influence of his environment and education, and those who succeed most completely in disregarding these influences are so few in number that they rarely affect the general set of the art-currents of their day, though they may sometimes prove to be the heralds of new ideas and methods — that is, of a new style — which comes into recognizable existence at a later date. Styles are therefore not mere fashions, nor can they be created or abolished. They are growths, the natural characteristic interpretation of the spirit of the age. The fine arts are therefore rightly studied as the true exponents of the civilizations which produced them. Greek art differs from Roman art as Greek civilization differed from that of Rome. Gothic art differs from that of the Renaissance, French from American art, the art of the end of the 19th century from that of its beginning. The phenomena of style are true of all the arts — of literature and poetry as unmistakably as of music and sculpture, of painting and architecture. It is, however, in the last named art that styles are most clearly distinguished, not only because of the definiteness and permanence of its forms, but also and chiefly because architecture touches the daily life and habits of a people at more points than any other art, and deals with materials and technical processes which of necessity vary widely in different lands and ages. (See ARCHITECTURE.)

History.— A history of the fine arts is really a history of the rise, growth, decay and succession of styles in the various arts, with special mention of those masterpieces which embody in the highest degree the qualities and characteristics of those styles, or which mark the various stages of their development. It is manifestly impossible within the limits of this article even to sketch in outline the historic developments of the several fine arts; for this, the reader is referred to the histories of art mentioned in the bibliography at the close of this article, and to the briefer notices in this encyclopædia under the several titles: ARCHITECTURE; DANCE; DRAMA; MUSIC; PAINTING; POETRY; SCULPTURE. All that can be here attempted is a brief review of the general movement of the fine arts from the earliest beginnings to the present time. Music and poetry, as the subjects of separate treatment in detailed articles will be omitted or only incidentally alluded to in this brief sketch.

Primitive and Savage Art.— The fine arts, properly speaking, have no existence in primitive society. The artistic instinct of man is in the earlier stages of civilization confined to efforts to imitate natural forms, especially human and animal, to which he attributes supernatural powers and which he worships; and to the decoration of his weapons and implements of daily life. Primitive art is therefore primarily symbolic or fetishistic (see ANTHROPOLOGY; FETISH), or else industrial. But in this early art, and particularly in that which has a religious or symbolic character, lie enfolded the germs of a higher development, out of which in a higher stage of civilization come the true fine arts, in which the artist seeks to realize ideals, and the beautiful, sought after for its own sake, begins to take the place of the grotesque and terrible. Very little remains to us of the products of truly primitive mankind, but these few relics, consisting chiefly of chipped flint tools and weapons and engraved or carved ivory and bones, coming down to us from the Stone Age (both palæolithic and neolithic) are of great value as evidence of the observation of nature and of the decorative instinct of the men of preglacial times. The art of modern savage and barbarous tribes is generally treated as exemplifying various stages of the evolution of art from the most primitive beginnings, but it has not yet been demonstrated beyond question that modern savages really offer us a picture of truly primitive conditions. There is much in the life and customs of many savage peoples that is quite as suggestive of degeneracy as of primitive simplicity, and it is next to impossible to find a tribe that has not in some way — direct or indirect — felt the contact of other peoples and been thereby lifted or degraded measurably from its own original status.

Early Oriental Art.— The most ancient works of developed fine art known to us are those of the two great historic cradles of civilization, the valleys of the Nile and of the Tigris-Euphrates. The works which preceded the developed art of those valleys, previous to 4000 or 5000 B.C., are not yet sufficiently known to reveal clearly the stages by which this art grew up from its primitive beginnings, or to prove whether it was indigenous or sprung from roots to be sought in other soil. We know that in each of these valleys a wonderful civilization existed thousands of years before the Christian era, producing works of art of a high order in poetry, in painting and sculpture, and in architecture. That of Egypt was on the whole more advanced than the Chaldæan, especially in sculpture and architecture — for which arts, indeed, it enjoyed the advantage of abundant granite and limestone, syenite and basalt, while the art of the Chaldæans was restricted by the scarcity of stone and even of good timber in the broad, flat basin of the Tigris and Euphrates. Clay and its derivatives — brick, tile and terra-cotta — were the chief resource of the Chaldæan artist, and his libraries of clay-tablets and cylinders, his stupendous palaces of sun-dried brick lined with stucco and enameled tiles, and the skilful use he made of his scanty limestone and alabaster for sculptural decorations and pictures in low relief, show how strong was the artistic instinct of that people. In their pictorial art, displayed in the low-relief of their alabaster slabs, they showed greater fidelity to nature and greater freedom from conventional traditions, than the Egyptians. The foregoing remarks apply equally to the early Chaldæan monarchy and to the great Assyrian empire which finally, about 1200 B.C., overthrew and absorbed it. The art of Egypt was, however, incomparably richer. Its resources were vastly greater, and the pyramids (see PYRAMIDS) and tombs — the chief remaining monuments of the earlier dynasties from the first to the 12th (about 5000–2100 B.C.), the magnificent temples of the later dynasties, and the great relief-pictures and colossal portrait-statues with which they were adorned, are highly impressive examples of fully developed arts. Grandeur, impressive dignity of scale and monumental simplicity of line and mass characterize the temple architecture of the Egyptians and their monumental sculpture; they achieved also remarkable results in portrait sculpture, and the pictures painted in their tombs and carved or engraved as well as painted on their temple walls and columns, give graphic representations of Egyptian life and religious conceptions. The Egyptians also excelled in the decorative and industrial arts, using color in ornament and in pictorial decoration with skill and good taste. Religious conceptions dominated all this art, and symbolism, verging on primitive fetish-magic, pervaded all its manifestations, while its forms of expression were so controlled by hieratic traditions that it never emerged from conventionalism as did Greek art later. Architecture was the one independent art to which the other arts were subservient. In Chaldæo-Assyrian art the religious idea is less exclusively predominant, war and personal luxury dividing with religion the control of the arts. The art of these two great centres — Egypt and Chaldæa — jointly influenced all the early art of the Mediterranean basin; of Crete and later of Rhodes and Cyprus, of the early Greek culture in Mycenæ and Tiryns, of Phœnicia and later of the Persian empire which overthrew both Egypt and Assyria. But in none of these centres was a great art ever developed except in Greece and Persia. In the other centres the decorative and industrial arts are more important than the fine arts; in Persia there was developed in the 6th century an impressive palatial architecture accompanied by remarkable work in decorative relief sculpture, but the style was short-lived and exerted no lasting influence on art in general, passing away with the decline of the Achæmenian dynasty.

Greek Art.—The Aryan Greeks, who migrated from Central Asia in successive waves to Greece, the Ægean islands, southern Italy and Sicily, and the sea-coast provinces of Asia Minor, developed a culture essentially different from that of Egypt or Assyria, less exclusively dominated by religious conceptions than the one, far less inspired by the pursuit after splendor than the other, but animated from the start by the instinctive reaching out after ideals of pure beauty of form. Sculpture early displayed the effort to imitate the perfection of nature, unhampered by conventional restrictions, and in its highest development in the 5th century B.C. gave to the world, in countless statues and reliefs of gods and goddesses, heroes and athletes, superb models of an idealized perfection of human beauty which have never been surpassed and seldom equaled. Greek architecture, serving the gods and the state alike, developed a few simple varieties of the column and entablature (see ARCHITECTURE), into a style of the utmost elegance of proportion and refinement of detail, which continued in use for over five centuries. In this style (for all Greek architecture may be considered as constituting a single style) three forms of columns each with its special entablature, were successively evolved, the Doric, the Ionic and the Corinthian, the first being the most severe, the last the most ornate in character. (See ARCHITECTURE, PARTHENON.) Greek poetry, drama, oratory and prose literature, inspired by a new spirit of inquiry, by the highly-developed civic patriotism of the Greeks, and by their love for perfect rhythm and proportion, reached a nobility of style which has made them the study and in large measure the model of all succeeding ages. We know little of Greek music or of Greek painting, but the highly-developed decorative art of the Greeks, as revealed in their vases, their coins, and whatever else has come down to us of the appurtenances of their daily life, displays everywhere the same pursuit of ideal beauty, the same love of harmony, proportion, balance and rhythm, which we observe in their literature, sculpture and architecture, and which found another medium of expression in their sacred dances.

Greek art in its origins drew freely from Egyptian, Assyrian and Mediterranean art, especially in its decorative motives, but early began to transform the motives and ideas it borrowed, so that it became the most original and creative art of all antiquity, reacting upon later Egyptian art and contributing to Roman art its most vital elements. The age of Pericles, succeeding the Persian wars, was the age of its highest development; during the 4th century (sometimes called the Alexandrian Age), it declined in purity and sought after splendor, sinking thereafter gradually into insignificance. But it came to new life in its inspiration of Roman art, and in some of its provincial manifestations in Syria and the Byzantine empire, after the time of Constantine. See GREEK ART.

Roman Art.—While Greece was declining, Rome was rising to the political-military mastery of the world. The Roman civilization was practical and material rather than artistic and philosophical like the Greek. The Romans were soldiers, organizers and engineers, not artists and theorists. But with the conquest of the Greek states in the 3d and 2d centuries B.C. the Romans began to acquire a taste for the splendors and refinements of Greek art. Greek philosophy and literature were cultivated; Greek statues and bronzes adorned the villas of the wealthy and the fora and public buildings of the capital; Greek artists were employed to copy the great works of Greek sculpture, to carve and decorate and even to design and erect temples and palaces for the Romans. This new Græco-Roman art was, however, entirely unlike the Greek art whose forms it adapted to new purposes. It was inferior to the Greek in every department but one — that of architecture, and in this it differed so radically in principle from the Greek that comparison is hardly possible. The Roman skill in engineering construction and the Roman love for grandeur, for vastness of scale and splendor and for sumptuous beauty of materials, constrained architecture into new paths, resulting in the creation of new and varied types of buildings, in which details borrowed from the Greek columnar style, and often executed by Greek artists, were adapted to new uses in conjunction with the arch and vault which the Greeks had never employed. The spaciousness and imposing splendor of the Roman temples — as exemplified, for instance, in the still extant and superb temple known as the Pantheon (q.v.), built about 124 A.D. — and of their baths, amphitheatres and basilicas, were such as had never before been realized in any land or age. The decorative arts of carving and mosaic, of stucco-relief ornament and marble incrustation, as applied to architecture — we might almost say the whole art of architectural decoration as distinguished from pictorial painting and sculpture applied to buildings — were first developed systematically by the Romans. To the three Greek "orders" of architecture — the Doric, Ionic and Corinthian — which they adopted and modified, they added two others: the Tuscan, a survival of the rather primitive Etruscan form of column, and the Composite, a variant of the Corinthian. Roman sculpture was inferior, attaining little distinction except in some of the imperial portrait-statues and busts. Painting was more highly developed and, although practised chiefly as a decorative art and by Greek artists, as shown by the ruins of Pompeii (q.v.) and Herculaneum, produced in various parts of the empire works of portraiture and of ideal representation of a high order. (See PAINTING.)

Early Christian and Byzantine Art.— The age of Constantine (330 A.D.) witnessed a great transformation, not only in the political organization, but also in the religion and art of the civilized world. Christianity, triumphing over three centuries of proscription and persecution, was recognized as the religion of the empire, and Roman art, which had shared in the decline of the imperial power, found a new field in the service of this religion. In all the symbolism of Early Christian Art we trace the survival of pagan Roman symbols invested now with new meanings, and the architectural types of the Roman basilicas and tombs were modified for the building of Christian churches and baptisteries. Sculpture suffered for centuries from the proscription which resulted from its association, in the mind of the early Church, with pagan deities and idol-worship; but painting took on new life in the service of the Church, especially in the derivative form of mosaic (see MOSAIC) and in the illumination of ecclesiastical manuscripts. The field of the arts was a narrow one, and none of them rose to very high or independent development except in the Byzantine empire. Here, especially in Constantinople (which, after the fall of Rome before the Goths in 476 became, and for a considerable time remained, the most enlightened, prosperous and conspicuous city in Christendom) (see CONSTANTINOPLE), the arts flourished; architecture developed new forms and applications of the vault and especially of the dome (see DOME), and produced in the great church of the Divine Wisdom (ἡ Ἁγία Σοφία, commonly called Santa Sophia) at Constantinople (532–38) a stupendous masterpiece, never surpassed in its way. Byzantine architects, mosaic-workers, decorators and manuscript-illuminators were in demand throughout the Christian world of the 6th to the 11th centuries; the superb church of St. Mark at Venice (about 1070 A.D.) is one monument of their employment in foreign lands, and Ravenna is full of Byzantine art. The highly decorative though conventional ecclesiastical style of painting of the Byzantines, dominated by the types of face, figure and symbolism employed in the mosaics, frescoes and altar-pieces of their churches, was carried not only into Greece, Russia and the Balkan provinces, where it has survived to this day, but also into Italy, Germany and southern France, as we shall see later. In Syria there grew up, concurrently with the earlier Byzantine style a strong local school of architecture which has left impressive ruins, quite distinct in style alike from the Byzantine and Roman.

Moslem Styles.— During the Dark Ages which succeeded the fall of Rome, the lamp of culture burned brightest in Constantinople and in the Moslem states. The Arabs had extended their conquests during the 7th and 8th centuries over Syria and Persia, northern Africa, Spain and Sicily. Destitute themselves, at the outset, of artistic culture, they rapidly absorbed that of the nations they conquered, and the experience of Rome in the conquest of the Greek states was repeated. The new art that grew up was wholly different in spirit and detail from that of any of the conquered peoples, although largely executed by artists from their ranks. It was applied to different uses and expressed a different order of ideas and sentiments. The Moslem hatred of idolatry led to an almost absolute proscription of painting and sculpture and this restriction upon two of the highest forms of artistic expression may in part account for the extraordinary development in their stead, of the decorative arts in Moslem lands. These, without the all-pervading symbolism of ancient Egyptian art, reached a very high power of expression or suggestion of moods and feelings which — if we may believe some students of these arts — raises them almost to the plane of music and places them clearly among the fine arts. Unlike western art, in which *form* has always been paramount, Moslem art, like all Asiatic art, excels in the treatment of *color*. The Persians were the only Moslems to develop the art of painting, and with them it was practised chiefly in the form of miniature pictures and manuscript illustration, in which — as in the semi-naturalistic floral decorations of their tiles and fabrics, they showed considerable observation of nature. In architecture the Moslems have always excelled on the decorative side, and the buildings of the Arabs and Moors seldom display boldness of construction or largeness of scale. In Turkey, however, where Byzantine models were followed, and in Persia and India, where the Aryan element is dominant, the Mohammedan mosques, tombs and gates are often of imposing grandeur of scale and admirable in structural design.

Mediæval Art.— Meanwhile as Europe emerged slowly from the chaos and barbarism of the Dark Ages, with the development of new nationalities, chiefly Celtic and Germanic, a new Christian civilization and new art were taking shape, dominated by the Church of Rome, whose institutions, both monastic and hierarchic, were established throughout all Europe except the Byzantine empire, where the Greek rite prevailed. The Church absorbed all activities not occupied in the warfare of feudalism, and the arts were practised almost wholly in her service. The centuries from the 5th to the 11th were the Dark Ages when throughout northern, central and western Europe chaos and ignorance were universal; but with the dawn of the 11th century order began to emerge from the chaos, and the wealth and power of the monastic orders began to show themselves in the building of great abbey-churches and monasteries, as well as in the copying of manuscripts and the study and teaching of the narrow scholasticism of the Church. In some places — notably in France — the episcopal authority was hostile to that of the monasteries; but elsewhere the two were in harmony, and between them they developed a very active and prolific architecture of abbeys, cathedrals, churches, monasteries and hospitals, at first crude, powerful, massive (see ROMANESQUE ART); later developing its structural system experimentally along logical lines, towards greater loftiness, lightness, elegance, refinement of detail and splendor of decoration, the ribbed vault, pointed arch and flying buttress being the characteristic features of this system; stone window-tracery, stained-glass windows, lofty spires and pinnacles, and a marvelous wealth of symbolic and grotesque and floral carving, the leading elements in the decorative dress of this architecture. The earlier massive style is called the *Romanesque;* the later, completely developed style the *Gothic* (about 1160–1500). As sculpture had been the mistress art of Greece, so was architecture that of the Middle Ages; painting and sculpture wrought chiefly in her service. Yet the sculpture of the Middle Ages, although chiefly executed for the decoration of churches is — especially in France — so important for its own sake, so intrinsically noble and beautiful, as to claim with justice an independent rank. Painting, however, remained a subordinate art, formally decorative and adhering in great measure to Byzantine traditions (see above). For decorative work, for mural painting, which only in the 14th century, in Italy, began to cast off the fetters of this tradition (see CIMABUE; GIOTTO; PAINTING). And for stained glass in large windows, this formal and conventional style served well; but it stood in the way of any independent progress in painting. Architecture first, and sculpture in the second place, were the great arts of the Middle Ages; but poetry and the drama were also practised. War and chivalry were the chief inspiration of poetry, although a few truly noble hymns were born of the religious consciousness of the Middle Ages: the drama existed chiefly in the form of "miracle-plays," "mysteries," and "moralities," of minor importance as literature, although interesting as the germ of the great dramatic art of the Renaissance.

Renaissance Art.— The conspicuous characteristics of the mediæval Christian world may be summed up in a few words as follows: War and religion were the controlling forces, the feudal system and the Church the institutions through which these worked; obedience to authority the universal rule of life. Under these conditions the individual was submerged in the mass, and only under the pressure of external authority. But this condition could not last forever. The love of personal liberty, the longing for self-expression, though long repressed, were not extinct nd began to assert themselves with increasing earnestness and effectiveness, in proportion as civilization advanced, and external authority ceased to be the only synonym of protection and safety for the individual. Independence first began to develop by the introduction of the idea of voluntary obedience to an authority constituted by those subject to it, in the place of involuntary and compulsory subjection to powers claiming authority directly from God or from some other mysterious and external source. This new conception appeared in the industrial and artistic guilds of many mediæval cities; in many "free towns" which claimed certain immunities and privileges as direct inheritances from Roman times and exercised and regulated these through elective governing bodies chosen by the burghers; and in the free republics of Italy, like Florence and Venice. Through the 14th century this idea was germinating, especially in Italy, where it received a powerful stimulus from the revival of the study of the classics, which kindled admiration for the freedom of classic culture and for the beauty of classic art and literature, and aroused a new spirit of secular study, research, and inquiry. This led to the Humanist movement, which was on the one hand a movement for individual culture and on the other a movement of protest against the narrowness and asceticism of ecclesiastical authority. Not only the dictates but the very foundations of authority began to be questioned. Men began to reach out into new fields of thought, to explore nature and antiquity alike, and the beginnings of modern science are to be traced back to this new spirit of independent investigation. This revival of classic learning, this intellectual awakening, is known as the Renaissance — the new birth of free thought and individual culture. The fine arts soon felt its influence. In painting, the study of nature, the pursuit of ideal instead of conventional types, broke the long dominion of the Byzantine ecclesiastical traditions. The Florentine and Siennese schools inaugurated the triumphant course of Italian painting, which led from Cimabue and the great innovator Giotto finally to the superb masterpieces of Raphael, DaVinci, Michelangelo, Titian, Veronese, and Tintoretto. In this triumphal progress of the art of painting it rose from a subordinate ecclesiastical decorative art to the leading position among the arts, the invention or discovery of the process of painting in oils (see PAINTING; VAN EYCK) being a potent contributory factor in this progress. Sculpture had already in the works of Niccolò Pisano (q.v.) felt the inspiration of the study of classic models, but its development was less important than that of either painting or architecture. It remained long subordinate to the latter, although within this relatively limited field many of its products, especially in Italy and France, were of a very high order and some of them unsurpassed. It did not, however, attain complete independence until Michelangelo (q.v.) in the 16th century, made it the medium of expression of his mighty conceptions, rivaling in power and grandeur, if not also in beauty, the noblest masterpieces of Greek art.

Architecture underwent a complete revolution. The Gothic style had never been in Italy anything but a foreign importation, an imitation of French and German details with no assimilation of the structural ideas on which the Gothic style was based. With the new passion for classic study, architecture was on its decorative side made a medium for the expression of this taste by the adoption and imitation of the decorative details of classic Roman ruins. The secularizing tendency of the age and the rapidly growing love of personal luxury, led to the building of palaces, villas and stately gardens, and to the erection of tombs of pompous and imposing magnificence, while churches were built with barrel-vaults and domes in place of the ribbed vaults of Gothic design, and were adorned with the columns, pilasters, and entablatures of the Roman orders, with Roman scrolls, arabesques and arcades. The lofty dome, crowned with a lantern and borne on a high drum encircled with columns and pilasters, became a feature of the later churches, and St. Peter's (q.v.) at Rome, the largest of all churches, embodies in the most magnificent fashion this new type (1503–1629). In all the arts of the Renaissance it is the artist as an individual that claims our attention; although we class the works of the Renaissance by schools and periods — because even individuals feel the constraint of their environment — the personal element is always conspicuous in a manner unknown in mediæval art, in which relatively few names of artists have come down to us.

Poetry and literature felt with the other arts the transforming influence of the classic revival, not only as to form but also as to subject-matter. The drama outgrew the naïve puerilities of the miracle-plays and took on the dignity of an independent fine art, reaching its highest development in the Elizabethan and particularly the Shakespearian drama at the close of the 16th century.

The movement of the Renaissance spread from Italy to the north and west, but found — so far as art was concerned — in France, Germany, Great Britain, and the Low Countries the Gothic style so highly developed and so firmly intrenched that the transformation of taste and of style was very gradual in these countries. In France the Renaissance in art was inaugurated by Italian artists imported by Charles VIII., Louis XII., and Francis I. after their several campaigns in Italy between 1483 and 1525, and manifested itself first in the châteaux and in the tombs of royal and princely or noble families, but the style was very far from resembling the Italian. It was not till the reign of Louis XIV. (1645–1715) that architecture, sculpture, and painting took on the Italian Palladian (see PALLADIO) or classic character in any marked degree. There was constant strife between the distinctively French and classic elements. In Germany and England the Italian manner was even later in asserting itself; throughout the 16th and much of the 17th century the persistence of local, national, and mediæval conceptions and forms resulted in great variety and picturesqueness in architecture, the final disappearance of which in the 18th century was hardly compensated for by the more stately but less original formally classic style that replaced it. Sculpture hardly flourished outside of France, but painting developed in Germany and the Netherlands three important schools in the 16th and 17th centuries — the German, the Flemish, and the Dutch, whose most celebrated representatives were respectively — among many others almost equally famed — Hans Holbein the Younger, Rubens, and Rembrandt. A strong Spanish school also grew up, and in England in the 18th century portraiture and landscape-painting reached a high level. But meanwhile architecture was declining in power and originality; sham and pretense, pomp and affectation were taking possession of society, and taste was corrupted at the fountain-head. The first third of the 19th century — indeed the first half — was a period of artistic poverty and destitution, in all the arts and throughout the civilized world. From this deplorable condition the arts have risen under the impulsion of new forces, social, intellectual and economic, due to the extraordinary changes and the marvelous progress of the last 50 years.

Bibliography.—The bibliography of the fine arts is enormous; only a few of the most familiar and available works can be here specified. The reader is advised to consult Ile's 'Bibliography of the Fine Arts.' Among general hand-books: Lübke, 'History of Art' (in German or in English); 'College Text-books on the History of Art,' edited by Prof. J. C. Van Dyke ('Architecture' by Hamlin; 'Painting' by Van Dyke; 'Sculpture' by Marquand and Frothingham); Kugler, 'Hand-book on Architecture' (German or English); Statham, 'Architecture for General Readers'; 'Modern Architecture'; Fergusson, 'History of Architecture in all Countries'; 'Indian and Eastern Architecture'; 'Modern Architecture'; Fletcher, 'A History of Architecture'; Mitchell, 'Ancient Sculpture'; other books on ancient sculpture by Murray and by Perry; Gardner, 'Greek Sculpture'; Perkins, 'Italian Sculptors'; 'Tuscan Sculptors'; Marshall, Eidlitz, Raymond, Ruskin, Viollet-le-Duc, on æsthetics and art criticism, works by Hegel. On painting works almost innumerable: there exists no one general history of painting of important dimensions (note Van Dyke as above), but numerous books on special schools and epochs: *cf.* Champlin, 'Cyclopædia of Painters and Painting.'

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Finfoot, one of the extraordinary tropical birds of the family *Heliornithidæ,* now considered near allies of the rails, so called on account of the broad scalloped webs along each toe. The best known one is *Heliornis fulica* of northeastern South America, which is about 13 inches long, and mainly brown, with a white throat, red bill, and feet banded with yellow and black. Other larger species belong to Africa and the Malayan Peninsula. These birds, which frequent the swamps or rocky streams of inland woods, fly heavily, and push themselves out of the water with their feet. They swim and dive well, and run swiftly on land.

Fingal, fing-gal, a once popular epic by James Macpherson, which appeared in 1762. The poet being a favorite, 'Fingal' had an immense sale. The subject of the epic is the invasion of Ireland by Swaran, king of Lochlin, Denmark, during the reign of Cormac II., and its deliverance by the aid of the father of Ossian, King Fingal of Morven, on the northwest coast of Scotland. The poem opens with the overthrow of Cathullin, general of the Irish forces, and concludes with the return of Swaran to his own land. See OSSIAN; MACPHERSON, JAMES.

Fingal's Cave, a curious cavern formed of basaltic columns, in the Isle of Staffa, one of the Hebrides, on the west coast of Scotland, 25 miles from Oban. See STAFFA.

Finger. See HAND.

Finger-grass, a crab grass (*Panicum sanguinale,* Linn.), a well-known annual, common in nearly all parts of the United States, growing in cultivated fields and about dwellings. It is a weed in gardens and among hoed crops. In grain fields after harvest it frequently springs up in such quantity, particularly in the Southern States, as to yield one or even two good cuttings of hay. This spontaneous growth affords excellent pasturage, as well as hay of first quality if properly cured. The stems are much branched, and in good soil attain a length of 3 to 4 feet. This grass contains little fibre, and dries quickly when cut, but if after cutting it is wet by rains or heavy dews its value for hay is almost wholly destroyed.

Finger Notation, a method of representing numbers by the position of the fingers or hands, analogous to the digital language of deaf mutes. The system is an ancient one and has had three distinct ramifications: (1) The obsolete one of mere numerical representation, to retain the numbers erased during operations on the sand abacus, and probably on the other forms as well (see ABACUS); (2) the one leading to a kind of international language, helpful in bargaining at the great fairs of antiquity and the Middle Ages, and still used in the East; (3) that of actual computation, the so-called finger reckoning, still somewhat used in certain parts of the world. Of these three the first was the most important, and with the second it resulted in a number language quite as international as the Hindu-Arabic numerals (see NUMERALS) which led to its decay. The antiquity of the system in Egypt, Greece, and Rome is attested by several classical writers, Juvenal, for example, speaking of the aged Nestor as numbering his years upon his right hand, that being the one used for numerals exceeding 99. Herodotus, Pliny, Macrobius, Plautus, Seneca, Suetonius, and probably Aristophanes and Solomon (Proverbs iii. 16) are among the other witnesses to its use among the common people in ancient times. In the early centuries of the Christian era it was well known, for it is mentioned by Tertullian (c. 200 A.D.), St. Ambrose (c. 375 A.D.), and St. Augustine (c. 400 A.D.). To the Venerable Bede, however, we are indebted for our most definite knowledge of the mediæval system in the West, and to his treatise, 'De loquela per gestum digitorum,' in his 'Opera omnia,' (Paris 1862, tomus I., p. 689), the student should refer for the best description extant. The same notation, not so fully explained, appears in a work written about 800 A.D., although assigned to Cyril of Alexandria ('Liber de computo S. Cyrilli Alexandrini,' published by L. A. Muratori in his 'Anecdota,' Napoli 1776), and in one by Radulph of Laon, c. 1100 A.D. (consult 'Abhandlungen zur Geschichte der Mathematik,' Bd. V., p. 91). The international character of the system is further evident from two poems, one in Arabic (Marre, 'Manière de compter des anciens avec les doigts des mains, d' après un petit poëme inédit arabe de Chems-Eddin el Mossouli,' in the Boncompagni 'Bulletino,' t. I., p. 309), and the other in Hebrew, by Samuel ibn Abbas (Steinschneider, 'Die Mathematik bei den Juden,' in the 'Bibliotheca Mathematica,' Ser. II., Vol. X., p. 81), and from a description by Nicholas Rhabdas of Smyrna. In his 'Epistles on Arithmetic,' written about 1341, Rhabdas gives the digital notation as it had probably been used in Asia Minor for many centuries, and, aside from Bede's description, this is our best source of information. For a brief digest, consult Gow, 'History of Greek Mathematics' (Cambridge 1884, p. 24). For the Greek text, with French translation by Tannery, consult 'Notices et extraits des manuscrits de la Bibliothèque nationale,' t. 32, p. 147 (Paris 1886). The system had not yet died out in Europe when printing was invented, and Paciuolo (q.v.) sets it forth in a page of illustrations in the first great modern treatise on mathematics ('Sūma de Arithmetica Geometria Proportioni & Proportionalita' . . . vinegia . . . . M.cccc.lxliiij, fol. 36, v.). Several arithmeticians of the 16th century gave descriptions of the method, including Recorde (q.v.), the author of the first arithmetic printed in English. The accompanying illustration is from the most elaborate treatise on the subject, that of Aventinus ('Abacvs at qve vetvssissima, vetervm latinorum per digitos manusq numerandi (quin etaim loquendi) cosuetudo, Ex beda cu picturis et imaginabus . . . Ratispone . . . 1532), a work enough esteemed to warrant an edition as late as 1710.

The most common form of finger reckoning was that involving multiplication, the factors being between 5 and 10, thus rendering the table beyond 5×10 superfluous. This form is very old, and is not yet obsolete. For example, to multiply 9 by 8, think: 5 and 4 are 9 (raising 4 fingers on one hand); 5 and 3 are 8 (raising 3 on the other hand); $4 + 3$ (raised fingers) = 7 tens; 1×2 (bent fingers) = 2 units; $70 + 2 = 72$.

In addition to the sources above cited, consult: Stoy, 'Zur Geschichte des Rechenunterrichtes,' dissertation (Jena 1876); Treutlein, in the 'Abhandlungen zur Geschichte der Mathematik,' Bd. I., p. 21; Bombelli, 'L' antica numerazione Italica' (Roma 1876, p. 102); Günther, 'Geschichte des mathematischen Unterrichts im deutschen Mittelalter' (Berlin 1887, p. 12), and 'Untersuchungen zur Geschichte der mathematischen Wissenschaften' (Leipzig 1876).

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Finisterre, Cape. See CAPE FINISTERRE.

Fink, Louis Maria, American Roman Catholic prelate: b. Triftersberg, Bavaria, 1834. He came to the United States in 1852, was ordained priest 1857, and was successively stationed at Bellefonte, Pa.; Newark, N. J.; Covington, Ky.; and Chicago. Later he became prior of the Benedictine monastery, Leavenworth, Kansas, and vicar-general of that State. He was appointed Bishop of Leavenworth 1871.

Finland, Grand Duchy of (called by the natives, Suomen-maa, "land of marshes"), a country of northern Europe, including, with the exception of part of Lapland, the extreme northwestern portion of the Russian empire; bounded on the north by Russian Lapland; east by the provinces of Archangel and Olonetz; south by Lake Ladoga, the province of St. Petersburg, and the Gulf of Finland; and west by Sweden and the Gulf of Bothnia; length, 600 miles; average breadth, about 240 miles; area, 144,255 square miles.

Topography.— Finland, which is divided into 8 provinces, consists principally of a tableland from 400 to 600 feet above the level of the sea, and interspersed with hills of no great elevation. In the north, however, the Manselka Mountains have an average height of between 3,000 and 4,000 feet. The coasts, particularly on the south, are surrounded by a vast number of rocky islets, separated from the mainland and from each other by intricate and narrow channels, rendering the shores of the country easy of defense in case of hostile attack by sea. The chief natural feature of Finland is its many lakes, which extend like a network over a large proportion of its surface; some of them being of very considerable size. The greater number of these are in the south and east; several of them have intercommunication and generally abound with islands. There are numerous rivers, but none of much importance.

Climate.— The climate is rigorous. Even in the south the winter lasts from six to seven months, and in the north from eight to nine months. Dense fogs are very frequent; heavy rains take place in autumn, and in May and June the thaws put a stop to nearly all traveling. In the north the sun is absent during December and January; but during the short summer, while the sun is almost constantly above the horizon, the heat is often very great; and near Uleaborg, in about latitude 65°, the corn is sown and reaped within six or seven weeks. Crops in all parts of the duchy are exposed to the double danger of being destroyed by sudden frosts, and by the ravages of a variety of caterpillar called turila by the natives.

Various.— The principal geological formations are granite, which very easily disintegrates, hard limestone, and slate. The soil for the most part is stony and poor. Iron, copper, marble, and sulphur are the chief minerals. Rye, oats, and barley are grown. The most important products are timber, potash, pitch, tar, and resin, which are extensively exported. Next to agriculture, stock breeding and fishing form the leading occupations of the inhabitants. The chief imports are salt, grain, and articles of clothing. In 1902 Finland's imports amounted to $45,000,000 and its exports to $39,000,000, giving a total foreign commerce of $84,000,000.

History.— The Finns were pagans and most aggressive. They frequently attacked the neighboring countries, but especially Sweden. They continued to live under their own independent kings till the 12th century, about the middle of which the country was conquered by Saint Eric, the king of Sweden. When he subdued Finland, sent to them Saint Henry, the bishop of Upsal, to preach Christianity to the people. The province of Wiborg was conquered and annexed to Russia by Peter the Great in 1721; the remainder of the country became part of the Russian dominions (also by conquest) in 1809. Ever since that period the Russian government has endeavored, by conciliating the Finnish party, and promoting objects of national importance, to attach the bulk of the population to its interests; but in this it is said not to have been eminently successful. Abo (the ancient capital), Wasa, and Wiborg are the places where law courts are held. In 1640 a university was established at Abo, but it was removed later to the present capital, Helsingfors. The majority of the people are Lutherans, but many belong to the Greek Church. The emperor of Russia nominates the 18 members who constitute the highest administrative body possessing authority over Finland. The states, composed of the representatives of four social orders, that is, nobles, clergy, burgesses, and peasants, are convoked by the emperor; and no new laws can be enacted, nor new taxes imposed, without their sanction. These four orders form the Diet, which meets every few years for the transaction of business. The governor-general of Finland, who represents the emperor, is president of the senate, usually a Russian, and is appointed by the emperor. The ordinary procedure of the courts of law is in accordance with the forms in existence under Swedish rule.

Language and Literature.— The language of the Finns (Finnish or Chudic) belongs to the northern division of the Ural-Altaic family of languages, and is most nearly allied to the languages of the Esths, Lapps, Mordvins, Voguls, and Hungarians. It possesses all the German vowels, *a, e, i, o, u, ä, ö, ü,* which again give 8 double vowels and 12 diphthongs. Like the other Altaic languages it adheres to the "law of harmonic sequence of vowels," according to which the vowels are divided into two classes, heavy (*a, o, u*) and light (*e, i,* etc.), and only vowels of the same class can occur in the same word. The language is remarkably rich in declensional forms, there being as many as 15 different cases expressing such relations as are expressed in English by *near, to, by, on, in, with, without, along,* etc. By this means these cases are made to express the relations of space, time, cause, etc. There is no distinction of gender in Finnish nouns. The possessive pronoun is indicated by suffixes. The verb resembles the noun in its capability of taking on different shades of meaning by corresponding modifications, and is in this respect a remarkable philological phenomenon. The Finnish proper is divided into three principal dialects, the Karelian or eastern; the Savo in central Finland; and the Tavastian in the west. This latter was used in the original translation of the Bible, and thus became the parent of the literary Finnish.

Finnish literature is valuable chiefly for its rich stores of national poetry, which has been collected only in modern times. Longfellow's 'Hiawatha' is, in style, an imitation of the Finnish epic. The old and popular poetry of the Finns, as it appears in the various *runor* or ballads, is governed by rules of "quantity" as in that of the Greeks and Romans, not by accent; rhyme occurs only rarely; alliteration is employed as a rule. These poems, which had been preserved by oral tradition, were collected by Lönnrot, and in 1835 he published them, under the title of 'Kalevala,' with a second enlarged edition in 1849. He also published in 1840 'Kanteletar,' a collection of 592 ancient lyric poems and 50 old ballads; the 'Suomen kansan sanalaskuja' (1842), a treasury of 7,077 popular proverbs; and 'Suomen kansan arwoituksia' (1844), a collection of 2,188 riddles. Another work that deserves notice is Eero Salmelainen's collection of legends and stories in prose, 'Suomen kansan satuja ja tarinoita' (4 vols. 1854-62). The first book in the Finnish language was printed at Abo in 1544, its author being Michael Agricola, afterward bishop of Abo, who also translated the New Testament and part of the Old into Finnish. A complete Finnish Bible appeared in 1642. Lönnrot's Finnish-Swedish dictionary has been published by the Finnish Literary Society, and Dr. Donner has a dictionary of the Finno-Ugric languages in German. Finnish is becoming more and more the vehicle for imparting instruction. There are many establishments for the higher education of both sexes in which the Finnish tongue is used, and about half of the 800 students at Helsingfors University speak Finnish. Works on science and history, as well as poetry, have been written in Finnish in recent times, and there are now a considerable number of Finnish newspapers. Pop. 2,483,249. Pop. of Helsingfors, the capital, 77,500.

Consult: Topelius, 'Finland Fræmstalldt i Teckning'; Gerschau, 'Versuch einer Gesch. Finland'; Brown, 'Finland in Archaic Times' (1893); Finnish authors, 'Finland in the Nineteenth Century'; Clive-Bayley, 'Vignettes from Finland' (1895); Tweedle, 'Through Finland in Carts' (1903).

Finland, Gulf of, an arm of the Baltic Sea, on the east side, having Finland on the north, and the Russian governments of Esthonia and Saint Petersburg on the south. The length of the gulf from east to west is about 250 or 260 miles; breadth at the entrance or narrowest part, 40 miles; toward the head, where it is widest, about 80 miles. It receives but few rivers, and none of them, with the exception of the Neva, which enters it at its upper extremity, of any great size. It contains numerous islands, of which Kronstadt (q.v.) is the largest. There are various cities and towns of considerable importance along its shores, Saint Petersburg on its eastern extremity.

Fin'lay, Charles John, American physician: b. Puerto Principe, Cuba, 3 Dec. 1833. He studied at the Rouen Lycée, France, and was graduated from the Jefferson Medical College, Philadelphia, in 1855. In 1881 he was delegate from Cuba to the international sanitary conference at Washington, and in 1903 to the sanitary congress also held there. In 1902 he was made chief sanitary officer of Cuba. Finlay was the first to set forth the theory of the transmission of diseases by the agency of mosquitoes, which he advocated in connection with the yellow fever as early as 1881.

Finlay, George, English historian: b. Faversham, Kent, 21 Dec. 1799; d. Athens, Greece, 26 Jan. 1875. Fired with enthusiasm on behalf of Greece he went to that country to help it in shaking off the Turkish yoke, and spent some time at Missolonghi in close intimacy with Lord Byron. He purchased land in Attica, and henceforth lived chiefly in Greece. His great work on Greek history came out at intervals between 1844 and 1861, and shortly after his death it was published as thoroughly revised and greatly improved by himself, entitled 'A History of Greece from its Conquest by the Romans to the Present Time, 146 B.C. to 1864 A.D.' It has been described as the greatest historical work in English since Gibbon's 'Decline and Fall.'

Finley, John Huston, American educator: b. Grand Ridge, Ill., 19 Oct. 1863. He was graduated at Knox College, taking a post graduate course at Johns Hopkins University. He served as secretary of the State Charities Aid Association of New York 1889-92, founding and editing the 'State Charities Record' and 'The Charities Review.' He was president of Knox College 1892-9, editor of 'Harper's Weekly' for 1899, and editor of 'McClure's Magazine' 1900. He was appointed professor of politics at Princeton 1900, and became president of the College of the City of New York in 1903. He collaborated with R. T. Ely (q.v.) in writing 'Taxation in American States and Cities.'

Finley, John Park, American meteorologist: b. Ann Arbor, Mich., 11 April 1854. He was educated at the State Normal School and State Agricultural School. In his position as chief of the Signal Service Bureau of the Pacific Coast he has given much attention to the phenomena of meteorology, and has written extensively upon the subject. His works include: 'Tornadoes' (1887); 'Manual of Instruction in Optical Telegraphy' (1889).

Finley, Martha (pseudonym of MARTHA FARQUHARSON), American writer for girls: b. Chillicothe, Ohio, 26 April 1828. She has published: 'Elsie Dinsmore' (1868); 'Wanted — A Pedigree' (1872); 'The Thorn in the Nest' (1886); 'Twiddledetwit' (1898); etc. She is best known by her 'Elsie Books,' over 25 in number, and 'The Mildred Books.'

Finley, Samuel, American Presbyterian clergyman: b. Armagh, Ireland, 1715; d. Philadelphia 17 July 1766. Arriving in America in 1734, he was licensed to preach in 1740. The first part of his ministry was much occupied with itinerant labors in promoting the revival of religion, at that time so remarkable throughout the country. His zeal at one time brought him into unpleasant circumstances; for preaching in New Haven, Conn., contrary to a law of the colony forbidding itinerants to enter parishes of settled ministers without their consent, he was seized by the civil authority and carried as a vagrant beyond its limits. In 1744 he was settled at Nottingham, Md., where he remained for seven years, and where, in addition to his ministerial duties, he carried on an academy which acquired a high reputation. In 1761 he became president of the College of New Jersey, now Princeton University.

Fin'ney, Charles Grandison, American Congregational minister: b. Warren, Conn., 29 Aug. 1792; d. Oberlin, Ohio, 16 Aug. 1875. He went to Oneida County, N. Y., in early life and was ordained minister 1824, becoming professor of theology at Oberlin College in 1835 and its president in 1852. He was one of the most famous of American revivalist preachers. Among his works are: 'Lectures on Revivals' (1835; new edition 1868); 'Lectures to Professing Christians' (1836); 'Sermons on Important Subjects' (1839); 'Lectures on Systematic Theology' (1847); 'Autobiography,' and 'Sermons on Gospel Themes' (1876).

Finns, in their own language called *Suomalainen,* and by the Russians *Chudes,* are in the narrower sense a race of people inhabiting the northwest of European Russia (governments of Archangel and Olonetz), but especially the Grand-duchy of Finland. In a wider sense Finnic is the name applied to one of the five chief branches of the northern or Ural-Altaic family of peoples and languages. These peoples were formerly spread over the whole north of Asia and north of Europe, and they are divided into the five families, the Tungusic, Turkic, Mongolic, Samoiedic, and Uralo-Finnic or Finnic family proper. The last or most westerly family still forms the population of north Europe and northwest Asia, and formerly covered the greater part of Scandinavia. It is again divided into four groups or branches (1) the Ugric, to which the Ostiaks, Voguls, and Magyars belong; (2) the Bulgaric or Volgaic, consisting of the Tcheremisses and the Mordvins; (3) the Permic, composed of the Permians, Sirianes, and Votiaks; and (4) the Chudic or Baltic group. To the last belong, besides the Finns proper, the Esths of Esthonia and the Lives or Livonians, the Chudes (in the narrower sense), that is, Karelians, Vepses, and Votes, in the governments of Novgorod and Olonetz, and the Lapps in Archangel and the northern parts of Finland, Sweden, and Norway. The Finns proper are divided into two branches: the Tavastians in the southwest, and the Karelians in the east of Finland. The Finns may properly be identified with the Scythians, and their earliest seats appear to have been the Ural Mountains and the neighborhood of the Caspian Sea. They originally led a peaceful nomadic life, but subsequently practised agriculture and adopted settled habits. They seem to have been compelled to migrate more to the northwest about the beginning of the Christian era, by the pressure of the Gothic tribes, and the country west of the Ural Mountains, more particularly the region where the Great and Little Volga unite, became their second home. From this the bulk of them had again to remove to their present abodes, though considerable numbers were left on the Volga, Oka, Kama, about the sources of the Dwina, in the Ural, and others again spread eastward, some of them as far as the Altai Mountains. The Finns are a serious people, and their so-called amusements show this trait. They are educated, and have most decided opinions as to «Woman's rights»; coeducation is the rule. Although Finland has been united with Russia, or a part of Russia, since 1809, yet the better educated Finns speak the Swedish language. The emperor encourages the use of the Finnish language. The Finns are communicative on business matters and often do not hesitate to tell what other people might call «family secrets.» They ask freely about the affairs of others. They have choirs and musical societies in Finland, and where found in other countries they show a love for music, although their music lacks all suggestion of joyousness. See FINLAND.

Finot'ti, Joseph Maria, American Roman Catholic clergyman and author: b. Ferrara, Italy, 1817; d. Denver, Col., 1879. He studied theology in the Jesuit College, Rome, and in 1845 removed to the United States. In 1852 he left the Jesuit Society and became literary editor of the Boston 'Pilot.' His works include: 'A Month of Mary' (1853); 'Italy in the 15th Century,' 'The French Zouave' (1863); 'American Catholic Bibliography' (unfinished).

Fins (of Fishes). See FISH.

Finsen, Neils R., Danish physician, scientist and discoverer of the method of curing lupus or tuberculosis of the skin, and other skin diseases, with light rays: b. Iceland in 1860; d. Copenhagen, Denmark, 24 Sept. 1904. Prof. Finsen's great discovery, that sunlight and electric light rays contain properties that can be used to cure skin diseases and blemishes, was the outgrowth of his experiments begun as a student in the Copenhagen University. In a small attic room of the old surgical academy building the investigation started. A fellow student, Sophus Bang, shared Finsen's enthusiasm for a complete reform in therapeutics. When ill-health came to both young students, Bang sought refuge from his disease in Switzerland, and since has become one of the foremost anatomists of Europe. Finsen remained at home to carry on his investigation in the foggy and cold climate of Copenhagen.

In 1890 Prof. Finsen was graduated from the Copenhagen University, receiving his doctor's degree. Three years later he published in a medical journal an article on 'The Influence of Light on the Skin,' which aroused general attention because of his assertion that cases of smallpox could be cured by putting red curtains at the windows of the sick-room. This was the beginning of the final triumph. Smallpox became epidemic in 1894 in Copenhagen and the new method was put to the test. The red-room treatment became popular with both the medical profession and the public, for by it not only was the disease cured, but the red rays prevented suppuration and left the patient unmarked by the dreaded scars.

The red-light treatment was but one application of Prof. Finsen's theory that light rays contained healing, and at the best it was but a negative result; it cured only when the disease had run its course. To develop the positive element of the light-ray cure, Prof. Finsen began experimenting with artificial light rays. Soon he found it possible to concentrate rays of the ordinary electric light in such a way as to cure a lupus patient who for eight years had tried every known method. The cure attracted great attention, and both moral and financial support came to the young investigator and discoverer. In 1896 the municipal hospital of Copenhagen gave room on its ground for several small buildings, in which Prof. Finsen's experiments continued on an increasing scale. Then the Danish government came to the support of the institution and it was enlarged and removed to Rosenvaenget, a pleasant suburb of Copenhagen. Many cures of cases previously deemed hopeless were made through the new and enlarged apparatus, the high-power Finsen lamp, which was used under the direction of a staff of physicians of national renown, expert electricians, and specially trained nurses, headed by Prof. Finsen.

Prof. Finsen claimed his invention was prior to that of Prof. Roentgen by about a year. To Finsen is due also the discovery that certain rays of the sun's spectrum are bacteria-destroying, while others are of a healing and curative nature. In December 1903 Prof. Finsen received the Nobel medical prize from the Norwegian parliament. Institutions for the use of the rays are now established in every civilized country.

Few scientists have been recognized as has Prof. Finsen. In April 1904, when King Edward and Queen Alexandra were in Copenhagen, they personally called on Prof. Finsen, and at his bedside expressed their sorrow at his illness. They also congratulated him on his wonderful success.

At his funeral two kings were present, King Christian of Denmark and King George of Greece, and almost every European ruler was personally represented, while princes and high ministers of state and leading scientists paid a last tribute to the dead man.

Wreaths carried by special representatives came from Emperor William, King Edward, Queen Alexandra, and Count Von Bulow, the German imperial chancellor, and the Crown Prince of Denmark; Princes Waldemar, Karl, and Hans were present at the church. See Finsen Light; Phototherapy.

Finsen Light, Finsen ray, blue light, actinic ray, violet and ultra-violet ray, light cure. The Finsen Light takes its name from its discoverer, Prof. Niels R. Finsen. There is a distinction between the "Light Cure" and the Finsen Light Treatment. Sunlight possesses therapeutic properties, and its beneficial effects on animal and vegetable life have been known from time immemorial. But simple exposure to ordinary sunlight will not cure any of the diseases amenable to the Finsen Light Treatment. Prof. Finsen discovered that the actinic rays, those represented in the blue, indigo, violet and ultra-violet sections of the solar spectrum, possess strong bactericidal power, and when concentrated and applied, they will destroy bacteria in five or six minutes.

While the bactericidal features of the violet rays were known experimentally in 1877, lacking the scientific basis, believing the discovery to be a cure-all, "the blue light" was laughed at as quackery. It remained for Prof. Finsen to make a practical application of the facts in treating certain diseases previously supposed to be incurable.

The Finsen Light is a large, specially constructed arc lamp of 40,000 candle power, or forty times stronger than an ordinary arc street lamp, and uses from 60 to 80 amperes of current of 110 voltage. This lamp burns a specially made carbon. In the upper holder is a large carbon, while a smaller one is used in the bottom holder. When properly adjusted for arcing, a maximum number of violet and ultra-violet rays are produced.

The light from this lamp is so intense it is impossible to look at it with the naked eye, and it is necessary for all the attendants and patients to wear smoked glasses while the lamp is in operation. An aluminum hood about two feet wide surrounds the lamp, which hood is fringed on its lower border with a deep crimson-colored paper skirt to further aid in excluding the diffused light from the patient. The concentrated rays are carried from the arc to the patients through four telescopic tubes, known as converging tubes, suspended at an angle of 45°. Each tube contains a series of rock crystal lenses, which are very expensive, but are used because they absorb a greater amount of heat rays, but do not interfere with the passing of chemical rays. These rock crystal lenses are so arranged that reservoirs for running water exist between them. By means of these water screens and the rock crystal lenses, all rays but the violet are eliminated. These rays are converged, concentrated and filtered, thus vastly increasing the healing and bactericidal effects. The heat from the original arc is so intense, that to prevent cracking of the lenses, a stream of cold water is kept constantly circulating through the upper reservoirs or water screens.

To further concentrate and cool the rays a compressor is provided which consists of two rock crystal lenses so arranged in a brass band that a chamber for running water exists between them. This part of the apparatus is used to compress the affected area and make it bloodless during treatment, which facilitates deeper penetration, as the red blood corpuscles have a tendency to obstruct or absorb the actinic rays.

Its advantage over other lamps is due to the greater number of violet or chemical rays produced; its advantage over sunlight is because the atmosphere absorbs a large percentage of the sun's chemical rays. The treatments are given while patients recline on couches, which offer every facility for comfort and quick rearrangement of position. The affected area is placed about 10 inches from the distal end of the converging apparatus, and the treatments, or seances as they are called, take about one hour daily in lupus and rodent ulcer, and in other skin diseases from 10 to 20 minutes, depending upon each individual case. The treatment causes no pain; a red erythematous spot, or blister, appears some hours after the treatment has been given. In a few hours these blisters dry up and a scab forms; in five or six days the scab falls off and the ulcer is healed beneath, leaving the skin free from scar or cicatrix, but red. The redness, however, after a short period fades and leaves the skin white and uncontracted, except where there has been a loss of tissue from the disease before treatment.

The Finsen high power apparatus has maintained its supremacy unrivaled in the treatment of deep-seated affections. None of the cheaper apparatus, such as the London Hospital Lamp, the Dermo Lamp, and the apparatus of Lortet and Genou, Bang, Foveau and Trouvet, Broca-Chatin, or any of the imitation lamps now made in America, have succeeded in producing the therapeutic actinic rays of sufficient strength to cure deep-seated diseases of bactericidal origin, and only in the institutes equipped with Finsen's High Power Apparatus has any positive success been achieved in the treatment of these dread diseases.

The Finsen light treatment has an advantage over the X-ray, in that there is absolutely no danger of burning and consequent sloughing. In the thousands of cases treated by the Finsen light there is not one case recorded that has suffered any ill effects. Such cannot be said of the X-ray treatment, for hundreds have been severely and permanently injured by use of this treatment. The reason for this is, in using the Finsen light treatment we are dealing with a known quantity, while with the X-ray we have an unknown quantity of uncertain action.

On 10 Dec. 1903 the Norwegian Parliament awarded the annual Nobel prize of $40,000 to Professor Finsen, for making the most notable discovery in medical science during the year. To-day, no name in the scientific catalogue is better known than that of Professor Niels R. Finsen, of Copenhagen, Denmark. Since the discoveries of Pasteur, the Roentgen rays are, perhaps, the most wonderful addenda to the history of medicine. But while the latter may be termed the search-lights of the modern surgeon and his class, Professor Finsen stands absolutely alone in the particular field he has selected. Professor Finsen claims that his discovery has priority over the X-ray by about one year. While it has been demonstrated that the Finsen light treatment is a positive cure for lupus (skin consumption), it is now known by recent experiments that it has a much greater range of usefulness than was originally claimed for it. It is now used with decided success in cases of epithelioma (skin cancer), acne vulgaris, acne rosacea, psoriasis, eczema, alopecia-areata (baldness), chronic ulcers, naevus (birth-mark), and tubercular affections involving bone.

If physicians the world over would do nothing more than apply the Finsen light in the removal of birth-mark, such as port wine stains, the discovery would have justified itself by its results. It has been found that the actinic rays can penetrate the human thorax, and this being the case, there is no reason to doubt the conclusion that the Finsen light treatment will later be recognized as a valuable aid in the eradication of the great white plague.

After the cure of Niels Morgenson, of a disease pronounced incurable, Finsen had done what doctors and surgeons would have laughed at as a mad impossibility; he had cured a case of lupus with electric light, using an ordinary hand lens to concentrate the actinic rays. In the fall of 1895, success followed success until the Danish government recognized the value of Finsen's discovery and subsidized the Finsen Medical Institute at Copenhagen. During a period of nine years this institute has grown from a small shed, where they were only able to treat one patient at a time, to a magnificent institute where they are now treating 400 patients daily. Other European nations sent special representatives to Copenhagen to investigate this new "light cure," and the result was that institutes were established, one in London by the queen of England, another in Saint Petersburg, Russia, by the princess of Russia, and others in Manchester, England; Paris, France, and Chicago, Ill. These various institutes are carrying on a work similar to that of the parent institute at Copenhagen.

The great cost of installing and maintaining Finsen's high power apparatus has prevented many communities from receiving the benefits of this treatment. It is to be hoped that science may yet find a more simple and less expensive method of producing and applying the chemical rays in such quantity and of such therapeutic power that Professor Finsen's discovery may be denied to none. Statistics which have been compiled by the different institutions using the Finson high power apparatus are as follows: At Copenhagen, of 1,367 cases treated up to May 1904, 86 per cent were cured, over 1,000 of which were lupus vulgaris; at the London hospital, 78 per cent of all cases were cured, 10 per cent improved, and 12 per cent disappeared from observation. The Manchester hospital report 92 per cent of cured or improved, 8 per cent disappeared from observation. The Finsen Light Institute of America, located at Chicago, Ill., up to 1 Aug. 1904, reports on 493 cases treated: 82 per cent cured, 9 per cent decidedly improved, 9 per cent failures. In the United States consular reports on file in Washington, D. C., under date of 5 Feb. 1904, will be found the official report of the Hon. R. R. Frazier, United States consul at Copenhagen, regarding the work of the parent Finsen Light Institute.

Prof. Finsen goes so far as to say that in Lupus Vulgaris cures can be obtained in 97 per cent of all cases even where the entire face is involved. In conclusion the author would state, that as a result of the investigations and experiments now being made, we may hope for and reasonably expect that the near future will clear up many a doubtful point and show greater possibilities of the light treatment in the curing of disease. There is no doubt that the Finsen light treatment has taken an exalted position in the field of surgery and advanced therapeutics.

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H. John Stewart, M.D.
Vice-Pres. Finsen Light Institute of America.

Fionni, Matteo, māt-tā'ō fē-ōn'nē, Italian geographer: b. Felizano, Piedmont, August 1827; d. Bologna 1901. He was instructor in the University of Turin 1848–60, then becoming professor of geodesy at the University of Bologna. Among his works are: 'Le Allusione' (1878); 'Le Proiezioni della carte geografiche' with atlas (1878); 'Note ipsometrische sopra la regione bolognese' (1883); 'Mesure offerte delle carte geografiche' (1887); 'Le Projezione cuneiformi' (1889).

Fiord, or **Fjord,** the Norwegian name for a long and comparatively narrow bay or inlet. In North America on the coast of Maine and the coasts of British Columbia and of southern Alaska are bays of this type. Fjords are found on coasts where the land, having been deeply carved either by streams of water or glaciers, is now slowly sinking. In the Norwegian and Alaskan fjords much if not the greater part of the erosion was by ice.

Fir, a name sometimes used as co-extensive with the term pine, and including the whole genus *Pinus*. In a narrower and stricter sense it is the name of a genus of trees (*Abies*) belonging to the order *Coniferæ,* and the sub-order *Abietineæ,* having solitary leaves growing round the branches. The fir is thus distinguished from the pine, the leaves of which grow in twos, threes, fours, or fives; and from the cedar and the larch, both of which have the leaves fasciculated. The term fir, thus limited, is applied only to the different varieties of the silver fir and the spruce fir. The silver firs are distinguished by having the cones erect, scales deciduous, and leaves flat. The common silver fir is the *Abies picea* of botanists, the *Pinus picea* of Linnæus. It is a native of the middle and south of Europe. The finest trees of this species are found in southern Italy; but the largest forests are those on the slopes of the Pyrenees, especially on the French side. It always prefers mountainous regions, and is sometimes found at a height of nearly 6,000 feet. The height of the trunk is sometimes 150 feet, and the diameter above 6 feet. It is the *sapin* of the French, and the *abies* of the ancient Romans. It is from this tree that Strasburg turpentine is procured; and its wood is of great use in ship-building (for masts, yards, and spars), in house-carpentry, etc. To this genus also belong the *A. sibirica,* found on the Altaian Mountains; the Indian silver fir, a native of the slopes of the Himalaya Mountains; and the *A. canadensis* or hemlock spruce fir. Other species of *Abies,* found in western North America (as also in the Himalayas), are trees sometimes rivaling in size the Douglas fir (mentioned below), and likewise yielding excellent timber. Among them are *A. grandis,* a Californian tree of 170 to 200 feet in height; *A. amabilis,* a species much resembling it; *A. nobilis,* a majestic tree, which forms vast forests on the mountains of northern California; *A. bracteata,* a Californian species remarkable for its slender stem, which rises to a height of 120 feet, and yet is only about one foot in diameter at the base, and likewise for the manner in which the middle lobe of each bractea of its cones is produced so as to resemble a leaf. Very similar to the silver fir, but generally of much smaller size, and indeed seldom much above 30 feet high, is the balm of Gilead fir (*A. balsamea*), a native of North America from Virginia to Canada. The wood is of little value, but the tree yields Canada balsam (q.v.).

The spruce firs have the cones pendulous, scales persistent, and leaves tetragonous. Of this division the common or Norway spruce fir (*A. excelsa*) is the most important. It gets the name of the Norway spruce from the fact that in that country it constitutes the principal timber; but it is also extensively cultivated in the middle of Europe, and is found all over Siberia to lat. 70° N. The average height of the tree is from 80 to 150 feet; and it attains its maturity in about 70 or 80 years. The branches, regularly arranged round the main stem and gradually diminishing toward the top, give the tree a pyramidal form. Nearly every part of this tree is of use. The wood (white or Christiania deal) is adapted to various ordinary purposes; the longest and thinnest stems are very valuable in ship-building for making masts; and the stems of those trees that are found at a great height, and in which accordingly the yearly rings are very narrow, are eagerly sought by musical instrument makers for sounding-boards. The bark is used in tanning; the young buds or shoots are used in making the drink known as spruce beer; and the resin which exudes from the tree supplies the common frankincense, and the Burgundy pitch of commerce. The so-called Scotch fir is really a pine (q.v.).

The *Pseudotsuga douglasii,* closely related to the firs, and often regarded as a fir, is named after the Scotch botanist David Douglas, who visited the Pacific coast during the first half of the 19th century, and is known as the Douglas fir or spruce, red fir, yellow fir, Oregon pine (q.v.), etc. It is one of the most important trees of western America, especially of the Pacific States and British Columbia. It is a noble tree, often attaining a height of more than 250 feet, and forms immense forests, especially from lat. 43° to lat. 52°. The bark, when the tree is old, is rugged, and is from six to nine inches thick. The tree abounds in a clear, yellow resin. The timber is heavy, firm, and valuable, and the growth of the tree is very rapid.

Fir'bolgs, or **Fir-Bolgs** (fir-man; bolg'-bag; bag-men), a name given to the descendants of one of the colonies of Nemedians, who fled from Ireland to Greece in about 1900 B.C. Nemedia, or Neimheidh, and his wife Macha, his 4 sons, 34 ships with 30 persons in each ship went from Greece to Ireland because some of the lineage of Nemedia had some years before gone from Greece to Ireland. They found in possession of the country Africans called Fomorians or Fomharaighs, and sometimes pirates. After several conflicts between the Nemedians and Fomorians, the Nemedians were reduced to slavery or flight; they chose the latter. Simon Breac led a colony to Greece, where they were also persecuted and made to serve the people whom they found in the country. One of their tasks was to dig "in the low deep soil," and carry the earth in leathern bags to cover and improve the barren places. From this labor came the name Fir-Bolgs or bag-men. After some years of bondage they again took flight to Ireland, no less in number than 5,000 men and women, under five leaders. See IRELAND.

Firdausī, fēr-dow'-sē, Persian poet: **b.** Schadab, near Tūs, in Khorassan, about 935; d. there 1020. With the name of Firdausī in the 10th century of our era, modern Persian poetry may be said to begin. Firdausī, however, really forms only one link in the long chain of Iranian literature which extends over more than 25 centuries, and whose beginnings are to be sought in the Avesta, 500 years before the birth of Christ.

The Mohammedan conquest of Iran by the Arabs somewhat resembles, in its effect upon Persian literature, the Norman conquest of England. Hardly two centuries had elapsed before an Iranian renaissance is begun to be felt in Persia. Firdausī comes 300 years after the battle of Nihāvand, in which the eagle of the Persian military standard sank before the crescent of Allah's prophet and the Mohammedan sword; just as Chaucer followed the battle of Hastings by 300 years.

Such was the literary situation at the end of the 9th century. Firdausī was the poet in whom the wave of the national epos culminated in the 10th century. But as there were English poets who struck the note before Chaucer, so in Persia, Firdausī had his literary predecessors. Abbas of Merv (809) was one of these earlier bards. Of greater repute was Rūdagī (died 954) who is said to have composed no less than a million verses. But Firdausī's direct predecessor and inspirer in the epic strain was Daqīqī, cruelly murdered when he had sung but a thousand lines. Yet these thousand verses are immortal, as Firdausī has incorporated them into his poem and has thus happily preserved them. They are the lines that describe the founding of the religion of Zoroaster, priest of fire. There was possibly a certain amount of tact on Firdausī's part in using these, or in claiming to employ Daqīqī's rhymes: he thus escaped having personally to deal with the delicate religious question of the Persian faith in the midst of the fanatical Mohammedans, who are said to have assassinated Daqīqī on account of his too zealous devotion to the old-time creed. With Firdausī, then, the new Persian era is auspiciously inaugurated in the 10th century; its further development through the romantic, philosophic, mystic, didactic, and lyric movements must be sought under the names of Nizāmī, Omar Khayyām, Jalāl-ad-dīn Rūmī, Sa'dī, Hāfiz, and Jāmī.

Firdausī is pre-eminently the heroic poet of Persia. His full name seems to have been Abulqasīm Hasan (Ahmad or Mansur); the appellative "Firdausī" (Paradise), by which he is known to fame, was bestowed upon him, according to some accounts, by his royal patron the Sultan Mahmūd. Firdausī's native place was Tūs in Khorassan. By descent he was heir to that Persian pride and love of country which the Arab conquest could not crush. By birth, therefore, this singer possessed more than ordinary qualifications for chanting in rhythmical measures the annals of ancient Iran. He had undoubtedly likewise made long and careful preparation for his task, equipping himself by research into the Pahlavī or Middle Persian sources, from which he drew material for his chronicle-poem. From statements in the 'Shāh Nāmah' itself, we may infer that Firdausī was nearly 40 years of age when he made the real beginning of his monumental work. We likewise know, from personal references in the poem, that he had been married and had two children. The death of his beloved son is mourned in touching strains. One of the crowning events now in the poet's life was his entrance into the literary circle of the court of Sultan Mahmūd of Ghazna, who ruled 998–1030. To Mahmūd the great epic is finally dedicated, and the story of Firdausī's career may best be told in connection with the masterpiece.

The removal of the heroic bard Daqīqī by fate and by the assassin's dagger had left open the way for an ambitious epic poet. Firdausī was destined to be the fortunate aspirant. This poet laureate lived long in the sunshine of the court, and was promised a gold piece for each line he composed. The liberality of Sultan Mahmūd's favor called forth from Firdausī a splendid poetical panegyric, that is only eclipsed by the fierce savageness of the scathing satire which later the poet poured out against his royal patron, when disappointed in old age of the promised reward that was to crown his great work.

Tradition narrates that Firdausī was a septuagenarian when he finished the last line of the 60,000 rhyming couplets that make up the 'Shāh Nāmah.' He now looked for the reward of his life's work. But jealousy and intrigue against him had not been idle during his long residence at court. The grand vizier appears to have induced the sultan to send Firdausī 60,000 silver dirhems, instead of the promised gold. Firdausī is said to have been in the bath when the elephant laden with the money-bags arrived. On discovering the deception, the injured poet rejected the gift with scorn, and dividing the silver into three portions, he presented one of these to the bath steward, the second to the elephant-driver, and he gave the last to the man who brought him a glass of cordial. He then wrote the famous satire upon Mahmūd, and fled from the city for his life. For 10 years the aged singer was an exile, and he would have been a wanderer but for the friendly protection extended to him by a prince of Irāq, who apparently also tried, without effect, to reconcile the sultan and the aged poet. Enjoying the solace of this prince's shelter, Firdausī composed his last work, the 'Yusuf and Zulīkha,' a romantic poem nearly as long as the Iliad, on Joseph and the passionate love of Potiphar's wife for him.

But Firdausī was now advanced to his 80th year, and he seems to have longed to visit his native town of Tūs once more. A sad story is preserved of his death of a broken heart. It is also told that Mahmūd relented and sent to the city of Tūs a magnificent caravan conveying gifts and robes for the aged singer, and bearing likewise the 60,000 gold pieces that had once been promised. But all too late. The treasure-laden camel procession met at the city gate the funeral cortège that was conducting the dead poet's body to the grave. Firdausī's death occurred in 1020. His tomb at Tūs is still a place of pious pilgrimage.

The story of the 'Shāh Nāmah,' — Book of Kings,— may be described in briefest words as the chronicle-history of the empire of Iran, from the moment of its rise in legendary antiquity and during the golden reign of King Jamshīd, through its glorious ascendency under the majesty of the Kayanian rulers, and down to the days of Zoroaster; thence onward to the invasion of Persia by Alexander the Great. The poem from this point follows the various fortunes and changes of the Persian sovereignty, until its downfall and ruin before the Mohammedans and Islam. Firdausī naturally treats his subject as a poetic chronicler, not as a historian;

but there is history in the poem, and he has given a certain unity to his long epic by keeping sight of the aim that he had in view, which was to exalt the fallen glory of Iran. The epic is written in a style befitting the theme. A word must also be bestowed upon Firdausī's romantic poem 'Yusuf and Zulīkha,' in which the biblical story of Joseph, as narrated in the Koran, was his source. This poem was in great measure the work of his old age, as it was written after he was 70; but in the episode of Joseph and Potiphar's wife the luxuriousness of color, the richness of imagery, the lavish exuberance, and the passion, might in some degree allow of comparison with Shakespeare's 'Venus and Adonis,' or with Marlowe's 'Hero and Leander.'

Translations of Firdausī should be mentioned. There is an English abridgment of the 'Shāh Nāmah' with versions in prose and in rhyme by James Atkinson — 'Shāh Nāmah' (1832; cheaply reprinted in the 'Chandos Series,' New York 1886). Several versified selections are found in Robinson, 'Persian Poetry for English Readers' (privately printed; Glasgow 1883). There is a standard French prose translation of the entire 'Shāh Nāmah' by Jules Mohl, 'Le Livre des Rois' (7 vols. Paris 1876–8). An Italian prose rendering, also complete, has been made by Italo Pizzi, 'Firdusi, Il Libro dei Re' (8 vols. Turin 1886–9); and Pizzi has given extensive metrical renderings in his 'Storia della Poesia Persiana' (Turin 1894). In German there is a running paraphrase of the story by Görres, 'Heldenbuch von Iran' (2 vols. Berlin 1820). Spirited renderings of selections have also appeared in German; by A. F. von Schack, 'Heldensagen des Firdusi' (3 vols. Stuttgart 1877); and by Rückert (unfinished), 'Firdosi's Königsbuch Schahname' (ed. Bayer, 3 vols. Berlin 1890–5). Of the 'Yusuf and Zulīkha' (complete) there is a German translation into rhymed verse by O. Schlechta-Wssehrd, 'Jussuf und Suleicha' (Vienna 1889).

A. V. Williams Jackson.

Fire, the agent of purification; one of the so-called four elements which burns, inflames, warms, or heats; the igneous principle; heat and light emanating visibly, perceptibly, and simultaneously from any body; caloric; the effect of combustion. The terrific energy of fire, the most important agent of civilization, the similarity of its effects with that of the sun, its intimate connection with light, its terrible and yet genial power, and the beauty of its changeful flame, easily account for the reverence in which it was held in ancient times. At a period when cause and effect, form and essence, were not distinctly separated, fire became an object of religious veneration, a distinguished element in mythology, an expressive symbol in poetry, and an important agent in the systems of cosmogony. It gained a place among the elements, and for a long time was believed to be a constituent part in the composition of all bodies. At a later period, fire, under the name of phlogiston, was considered to be the source of all chemical action. See Combustion; Heat.

Fire-alarm, an apparatus, mechanical, electric, and telegraphic, used for detecting fires, and for giving instantaneous notice of an outbreak. See Electric Signaling.

Fire Annihilator, or **Extinguisher,** an apparatus for extinguishing fire. It is charged with water and a mixture of dried ferrocyanide of potassium, sugar, and chlorate of potassa. It is set in action by a blow on a glass bottle containing sulphuric acid, which flows over the charge and liberates gas, which, with the water, is emitted at a nozzle and expended upon a fire to quench it. The earliest of modern fire-extinguishers seems to have been that invented by W. A. Graham, of Virginia, about 1837. It consisted essentially of a contrivance by means of which carbonic acid gas dissolved in water under pressure could be liberated and directed upon burning objects. Many subsequent improvements have made Graham's fire-extinguisher more useful. The Babcock extinguisher consists of a vessel filled with a solution of bicarbonate of soda. In the upper part of the vessel there is a smaller one containing sulphuric acid, suspended by pivots below its centre. When not in use the inner vessel is kept upright by a rod passing through the stopper of the larger vessel, but in case of fire the rod is withdrawn, thus permitting the inner vessel to topple over and mingle its contents with the bicarbonate of soda. The result, of course, is that carbonic acid gas is at once liberated. Many automatic fire-extinguishers, intended to be brought into operation by the rise of temperature caused by fire, have been used with more or less satisfactory results.

Fire Armor, a device to protect firemen and others from the effects of smoke, gas, etc. The first patent for a device of this kind given in the United States was granted to W. H. James in 1828. In this, air was supplied from the receiver worn round the waist, to a mask which enclosed the wearer's face, care being taken to prevent too great pressure from the air. Another one called the "eye and lung protector" was first used in 1873, and was adapted to protect the eyes from the effect of dust, smoke, etc., with plates of transparent mica for vision. To protect the lungs, a certain kind of porous cloth covered the lower part of the face, which held a wet sponge against the mouth and nostrils. This was used with very satisfactory results. In 1888 a method of supplying a fireman with fresh air was devised by forcing air to the fireman's mask through a pipe carried along the hose. Improvements on this plan have since been made.

Firearms, a general term for all sorts of cannon, guns, rifles, fowling-pieces, pistols, etc., which effect their discharge by the combustion of gunpowder or other explosive. They originated in the East, from which they passed to Europe, cannon being the first firearms to be generally employed. The rifle, originally invented in Leipsic in 1498, was first brought into general military use in America during the Revolutionary War. The riflemen in Kentucky, Tennessee, and the other wildernesses of the United States had long been accustomed to the use of this firearm, and so far as they could be procured, rifles were the arms of the American soldiers in that struggle. In 1813 G. H. Hall suggested that the rifle be loaded at the breech, so that the ball and powder, united in one cartridge, might be inserted without delay, and the piece loaded and fired as rapidly as the muzzle-loading smooth-bore. Hall's idea did not attract much attention in the United States. The army, for the most part, was supplied with flint-locks, and it would have involved considerable expense to change them all over. He also proposed to manufacture the locks and other pieces of the guns by machinery, so as to make the parts of the different guns interchangeable. He was employed at the government armory at Harper's Ferry to introduce the latter idea and experiment with the former. In this he was successful, and the interchangeable system was soon introduced into all the armories of the United States. In 1827 100 of Hall's guns which had been sent to Springfield in 1824 were brought back to Harper's Ferry and placed with 100 guns of current make. The 200 were taken apart, the pieces thoroughly mingled, and the guns then remounted from pieces picked up at random. The whole 200 fitted perfectly. They attracted much attention abroad, and England afterward obtained machinery in the United States, so that she might introduce the system in her factory at Enfield. Prior to 1853 every gun made in England was manufactured by hand. The percussion-cap was proposed by Shaw, of Bordentown, in 1817, and was really an indispensable part of any improved system of firearms.

The principal weapon of a new type brought out a little before the Mexican war was a purely American invention, namely, the repeater. Samuel Colt, a seaman, while on a voyage to Calcutta, devised a six-barreled revolver to be used with percussion-cps. In 1835 he improved upon this and perfected a six-barrel rotating breech. Prior to this there were two common types of pistol: one the small pistol, suitable for use on a small object at 30 yards; and the other the large horse-pistol, which was almost equal to a gun. Patents were issued to Colt for his revolver, and the manufacture commenced in 1835. He turned out 60,000 weapons a year. The large sales brought many competitors into the field, including the manufacturers of the Allen, Derringer, Volcano, Pettinger, Whitney, Smith & Wesson, and Lowell. The pistol was very much employed during the war, and many are even yet sold. Hall's idea of a breech-loading rifle was never put into general use, but in 1852, Stark, of Philadelphia, invented a breech-loading rifle that met with great success. The first of a new class of rifles to come into notice was the Spencer, the chief idea of which was applied to other American guns. This was a repeating rifle, but was almost too heavy to be successful. It was too great a burden for the men to bear in addition to their other accoutrements. The Remington, which has acquired great success, is produced at a factory at Ilion, N. Y., founded in 1825 by Eliphalet Remington. One great cause of the growth of the industry was the War of the Rebellion. The capital invested in 1840 did not exceed $200,000; in 1870 it was over $3,000,000, while at the present time it is about $10,000,000. The annual output of rifles is 1,000,000, and the same number each of shotguns and revolvers. The United States takes precedence in the manufacture of sporting rifles, metallic ammunition, and revolvers. Firearms include:

Pistol.— A small firearm having a curved stock or butt to fit the hand. Of this type there are many varieties, such as single- and double-barreled and revolver. They came into use early in the 16th century. The revolver consists of a tube, or barrel, and a revolving chamber which carries the loaded cartridges, together with the firing mechanism and handle. After firing, the loaded chamber is automatically revolved, by the action of cocking the piece, thus bringing the loaded cartridges successively opposite the barrel and firing mechanism.

Rifle.— A weapon fired from the shoulder, the stock being so formed as to rest against the shoulder when brought into aiming and firing position. The musket used to be so fired; in modern times it has been superseded by the rifle. The modern magazine gun has a much smaller bore than the old musket, and is also shorter in the barrel, yet its carrying power is much greater. This is owing to the improvements made in explosives in recent years, as well as to the rifling, or grooving of the barrel. The rifling consists of a number of spiral grooves cut inside of the gun barrel, the twist or spiral increasing toward the muzzle of the piece. This imparts to the ball a rapid spinning or rotary motion, which prevents its turning over and over endwise, and not only increases the accuracy with which it will follow the aim, but at the same time presents less surface for atmospheric resistance. The term rifle is applied to any musket or gun barrel which is grooved so that the projectile may have a rotary motion on its own axis. The rifling may be polygroove, as in the Armstrong and other guns; with only two grooves, as in some of the early weapons; with the two grooves with the angles rounded away so as to produce an

Nation	Gun	Weight		Caliber, inch	Number of rounds
		lbs.	ozs.		
Austria	Mannlicher	8	3	0.315	5
Belgium	Mauser	8	9	0.301	5
China	Lee	9	0	0.433	5
Denmark	Krag-Jörgensen	9	8	0.315	5
England	Lee-Metford	9	4	0.303	8
France	Lebel	9	4	0.315	8
Germany	Mauser	9	0	0.311	5
Italy	Mannlicher-Carcano	8	6	0.256	5
Japan	Murata	9	0	0.315	8
Portugal	Kropatschek	10	4	0.315	8
Russia	Mouzin	8	13	0.30	5
Spain	Mauser	8	13	0.276	5
Norway	Krag-Jörgensen	9	8	0.30	5
Sweden	Remington, new	8	13	0.315	
Switzerland	Schmidt-Rubin	9	8	0.296	12
Turkey	Mauser	8	9	0.301	5
United States Army	Krag-Jörgensen	9	8	0.30	5
United States Navy	Lee			0.236	5

oval and yet twisted bore, as in the Lancaster guns; or with three or more grooves, as in the most modern weapons. The grooves are of varying size, form, width, and of different degrees of twist in the length of the barrel itself, that of the Henry rifling being one turn in 22 calibres or widths of the bore. The bullet is made to fit the bore either by expansion of the base of the lead bullet, or, as in the early pattern, by having the ball "belted," so that the belt should take the groove and so emerge from the muzzle with a rotary motion.

Carbine.—A short firearm used by cavalry, similar in bore and mechanism to, and carrying the same ammunition as, the infantry rifle.

The preceding table gives data relative to the rifles used by the principal nations.

It will be noticed that the American gun, the Remington, has been adopted only by one foreign power, and that nation the rather small one of Sweden. See ARMS AND ARMOR; ARTILLERY; ORDNANCE; GUN; MUSKET; RIFLE; etc.

GEORGE H. POWELL.

Fire-back, or **MacCartney Cock,** any of the small Malayan pheasants of the genus *Acomus*, or of the Indo-Chinese genus *Lophiura*, in which the plumage of the back or rump displays glowing metallic reds. The rest of the plumage is very gorgeous, especially in the cocks, which, in *Lophiura*, are adorned with a magnificent crest. See PHEASANT.

Fire-balloon, a balloon whose ascensional power is derived from a body of heated air rising from a fire beneath the open mouth of the bag.

Fire-balls, (1) Balls filled with powder or other combustibles, intended to be thrown among enemies, and to injure them by explosion, or to set fire to their works. (2) A popular name applied to a certain class of meteors which exhibit themselves as globular masses of light moving with great velocity, and not unfrequently passing unbroken across the sky until lost in the horizon. They differ from ordinary meteors, probably, more in volume and brilliancy than in any other distinctive characteristic. They are not to be confounded with another class of meteors, that explode in their passage and appear to let fall a dull-red body (meteorolite) to the earth. See METEORS.

Fire-bar, a grate bar in a furnace resting on a frame, called the fire bar frame; inside the fire box in a locomotive engine, wedge-shaped iron bars fitted to the fire box with the thick side uppermost, to support the fire; the ends rest on a frame; they are inclined inward, with an air space between each, to promote combustion, and are jointed at one end, and supported by a rod at the other, so that the rod being withdrawn, the bars fall, and the fire box is emptied.

Fire-bellied Frog. See FIRE-TOAD.

Fire Boat, a small steamboat equipped with apparatus for extinguishing fires that may occur on the wharves or among the shipping. Used in many large cities, they have proved of great service. See FIRE PROTECTION.

Fire-brick, a brick capable of sustaining, without fusion, the extreme action of fire. They are used for lining furnaces, and for all kinds of brick-work exposed to intense heat which would melt common bricks. They are made from a natural compound of silica and alumina, which, when free from lime and other fluxes, is infusible under the greatest heat to which it can be subjected. Oxide of iron, however, which is present in most clays, renders the clay fusible when the silica and alumina are nearly in equal proportions, and those fire-clays are the best in which the silica is greatly in excess over the alumina. When the alumina is in excess, broken crucibles, glass-house pots, and old fire brick, ground to powder, are substituted for the common siliceous sand used in the ordinary processes of brick making, but which, in this case, would be injurious, as having a tendency to render the clay fusible. Fire-clay being an expensive article, it is usual, when making fire brick at a distance from mines, to mix with it burnt clay, for the sake of economizing the clay and diminishing its contraction. See BRICK.

Fire Brigades. See FIRE PROTECTION.

Fire Chief or **Marshal,** an officer in some of the larger American cities who has the supreme command of the fire department of the municipality, and who directs the work of extinguishing fires. He is generally clothed with large powers of discretion, and has also police authority.

Fire-clay is distinguished from ordinary clay by its refractoriness and infusibility, which render it an excellent material for bricks, crucibles, glass pots, retorts, and similar vessels which are to be exposed to a constant and very high temperature, at which ordinary bricks and clay vessels would fuse and become vitrified. This difference is due to the purity of fire-clay, or at least to the absence from it of iron, lime, magnesia, and alkalies, in appreciable quantities. It consists of hydrated silicate of aluminum almost entirely, but may contain traces of organic matter, and of some of the bases mentioned above. Fire-clay belongs to the coal formation, and always forms a stratum immediately below the coal. It seems, indeed, to be part of the soil on which the coal vegetation flourished and died. See also CLAY.

Fire-damp, the name given by coal miners to carburetted hydrogen or marsh-gas, CH_4. It is an inflammable gas, lighter than air, and is often found in coal mines, it being one of the products of the retarded decay of plant remains. A mixture of fire-damp and air in certain proportions is highly explosive; hence many frightful disasters with great loss of life mark the history of coal mining. See COAL MINING; METHANE; SAFETY-LAMP.

Fire-drill, a term introduced by Tylor to describe the instrument used by peoples of low culture, especially the Australians and Tasmanians, for producing fire. They take two pieces of soft dry wood; one is a stick of about eight or nine inches long, the other piece is flat; the stick they shape into an obtuse point at one end, and, pressing it upon the other, cause it to revolve quickly between both hands. By this method fire is produced in less than two minutes. See FIRE-MAKING.

Fire-eaters, in United States history, the violent, swaggering, and defiant Southern extremists before the War, threatening vengeance on Northern interferers with slavery or government interferers with the slave States. The name is used in a general sense for a blustering hot-head, especially a professional duelist.

Fire Engines. See FIRE PROTECTION.

Fire-escape, the name applied to any means of escape from a burning building. Many suggestions have been made for contriving the means of effecting this, some of them being for apparatus to be used in the interior of a building, and some to be used from without. Of the contrivances to be used within a building the simplest are a rope firmly attached to something near a window, or a rope sliding over a pulley fixed to the window-sill, and the like. And of the different machines that have been made for use from without, that which is found to be the most useful is the one invented by Wivell, and consists of a wheel-carriage supporting a long ladder with a net underneath. The ladder consists of extensions, the main ladder and the upper ladders, the upper folding over the main ladder. When used the ladder is set to the window of a building which is burning; the attendant mounts it, and assists those who are in danger to descend it.

Fire Extinguishers. See FIRE ANNIHILATOR; FIRE PROTECTION.

Fire-flies, any of various forms of nocturnal insects belonging to different orders having the power of voluntary self-luminosity, usually more or less intermittent and exhibited in flashes. After the death of the insects the luminous segments, at least in many forms, can be distinguished by their paler usually yellow color which contrasts with the darker color of the remainder of the insect. The true fire-flies, commonly termed also «lightning bugs,» are found in the family *Lampyridæ*, and particularly in the genus *Photinus*. Throughout a considerable portion of our country, including the District of Columbia and vicinity, *P. pyralis* is the most prominent form of fire-fly. Farther north *Pyractomena borealis* and related species are the more common fire-flies, while a large species, *Photuris pennsylvanica,* extends from north to south. One of the most remarkable forms of fire-flies is found in the genus *Phengodes,* in which the females are wingless and larviform; the males are not luminous. The historic and poetic «glow-worm» is the wingless female of the European *Lampyris noctiluca.* In America the glow-worms are scarce, and are usually the larvæ of the genera which have been mentioned, most of which are luminous in both sexes. In other countries various other insects are reported to have the power of luminosity, among which are the lantern-flies of South America (*Fulgora lanterneria* and *candelaria*). The luminous power of the lantern-fly, however, is doubted. In Central America and the West Indies and in South America the most abundant fire-flies belong to the genus *Pyrophorus*, large snapping-beetles (*Elateridæ*), in which the luminous portions of the body are on the sides of the thorax in the form of two large pale eye-like spots. Numerous other forms of insects, including another genus of *Elateridæ*, an Asiatic buprestid beetle, some forms of poduras, the maggots of certain flies, especially of the fungus gnats (*Mycetophilidæ*), are luminous; but next after the *Lampyridæ* perhaps the myriapods are most remarkable for the possession of this power of self-illumination. The luminous or photogenic organ is regarded by Wielowiejsky and also by Emery «as morphologically a specialized portion of the fat-body, being a plate consisting of polygonal cells, situated directly under the integument, and supplied with nerves and fine tracheal branches»; while Lang, in writing of the physiology of insect-phosphorescence, briefly states that «the cells of this luminous organ secrete, under the control of the nervous system, a substance which is burnt during the appearance of the light; this combustion takes place by means of the oxygen conveyed to the cells of the luminous body by the tracheæ, which branch profusely in it and break up into capillaries.» Emery, writing of the luminosity of females of *Luciola,* states that its use appears to be a means of defense, a warning or danger signal against insectivorous animals, but there is little doubt that it also serves to attract the sexes, especially in the case of the wingless females whose powers of locomotion are so limited, while the males fly freely. Prof. S. P. Langley, secretary of the Smithsonian Institution, has made considerable study of the «cucujo» or *Pyrophorus,* as has also Heinemann, the latter reaching the conclusion that the light depends on a process of oxidation. The cucujos are the most interesting of all the fire-flies, and they are much used by the South and Central Americans in furnishing amusement for the children, while the ladies employ them as ornaments for their evening toilet, fastening great numbers of them to their ball dresses.

The literature of this subject is very extensive, but a list of important articles compiled by A. S. Packard may be found in the 'Journal of the New York Entomological Society,' Vol. IV., 1896.

Fire Insurance in America. Although during the last half century the business of fire insurance has undergone a larger development in the United States than in any other country, it seems, when considered historically, to have been a means of self-protection, which did not readily commend itself to the judgment or confidence of our early predecessors. The expediency, not to say need, of endeavoring by means of co-operative action to minimize the individual loss and suffering incident to the destruction of property by fire made itself felt in England after the great fire in London in 1666, and there is reason for thinking that in a somewhat crude manner the practice of insuring property against possible destruction by fire had obtained years before that time in some of the countries of continental Europe. But although the early dwellers on this continent had given to them, during the 16th and 17th centuries, many serious and painful illustrations of the misfortune which came to those whose property was wholly or in part suddenly destroyed by fire, it was found impossible, before the advent of the 19th century, to arouse any general interest in enterprises of this character.

Joseph Marion, a notary public of Boston, advertised in the 'News-Letter' of that town, on 18 Nov. 1728, his plan of «erecting an insurance office for insuring houses and household goods from loss and damage by fire by the name of the New England Sun Fire Office of Boston,» and 20 years later, in June 1748, published a similar announcement; but the public co-operation needed to make the attempt a successful one does not appear to have been given to him on either occasion. This was the earliest recorded effort made to introduce this method of co-operative protection against losses by fire to the American people. Prior to that time, and for many years after — indeed, until well into the 19th century— it was the common practice in American communities, for the friends and neighbors of a citizen whose house or shop had been destroyed by fire, to give him such sums of money as they could afford to contribute to make good the loss that he had sustained. It was realized that the calamity was one to which all were liable, and that as each in his turn might suffer from a similar visitation, the contribution given was one which would justify the giver in asking for corresponding assistance if, later on, his material possessions were destroyed in the same manner.

Judged of in the light of modern business methods this system of paying voluntary premiums after a fire for the purpose of assisting others appears to be a thoroughly unsatisfactory proceeding; but in estimating its practical value it is necessary to remember, that at that time such wealth as the community possessed was distributed with considerable evenness among its members; that there were no large aggregations of property which were liable to be destroyed by a single fire, that in these relatively small American towns the financial resources of each citizen were reasonably well known to all of his fellow citizens so that there could be no deception as to possible suffering, and that the people were much more nearly than at the present time bound together by homogeneity of race and interests. These conditions may partly explain why it was that the American people, in spite of the English experiences in fire insurance, and of their own practices of insuring vessels and cargoes against loss at sea, could not for many years bring themselves to realize the advantage to them of the system of fire insurance.

In the year 1752, under the instrumentality of a Deed of Settlement, an organization to carry on the fire insurance business was formed in Philadelphia. Benjamin Franklin was one of its active promoters. This, with a local and rival association which was soon after formed, were for many years the only regularly organized fire insurance offices in America. The business carried on by these appears to have been exceedingly limited in its dimensions, although at the time these two offices were established, there were in England quite a number of fire insurance companies carrying on an extensive business and having large financial resources.

Toward the close of the 18th century the need of some form of protection against losses by fire seems to have made itself generally evident in this country. In 1787 the Mutual Assurance Company of New York was organized for the purpose of insuring local property against fire losses. This association was formed under a deed of settlement which was drawn up, as was also the form of policy that the company adopted, by Alexander Hamilton, who was one of the directors. In 1794 the Baltimore Equitable Society, formed on the same plan, was organized in Baltimore, and in the same year the Mutual Assurance Society of Virginia was organized in Richmond. These were all mutual companies, confining their operations to the towns in which they were organized, and even in these restricting their writings to two or three of the least hazardous classes of risk. But from 1794 to 1810 the legislatures of the leading States of the Union gave permission for the incorporation of fire insurance companies on the stock plan, and in that term of years quite a number of these companies were formed in Boston, New York, and Philadelphia.

In the year 1795, after a delay of years, through failure to obtain legislative authorization, the Massachusetts Fire Insurance Company, with a capital of $300,000, was formed in Boston. This company soon after opening its office announced its intention of writing fire risks all over the United States, being in this respect the first American fire insurance company to adopt the method now in general use, of scattering its liabilities to loss by covering the widest possible area of business, a corporate policy which was adopted the next year (1796) by the Insurance Company of North America, which had been incorporated in Philadelphia in 1794. The Boston effort does not appear to have been a strikingly successful one, for after three years of active exertion the company had written only a little over 1,000 policies, or allowing for annual writing, had insured the property of not more than 400 persons. This discouraging progress led the directors of the company to petition and receive permission from the legislature to enter into the field of marine insurance as offering larger opportunities of profit, a class of business from which its Philadelphia contemporary doubtless derived much the larger part of its income. In the case of Boston in the year 1800, when the town had about 25,000 inhabitants, the estimated amount that the various fire underwriters had at risk was but a little over $2,000,000, this probably representing the conditions as they then existed in the other principal centres of population on this continent.

With the opening of the 19th century insurance companies organized to write fire risks were formed in quite a number of the business centres of this country; but for many years the efforts of their officers had to be directed to the work of explaining to the American people the advantages which might be expected to result from taking out fire insurance policies. As late as 1823, the directors of a prominent insurance company issued an address to the public in the form of a printed circular, in which they say that "presuming the subject of fire insurance has fallen under the consideration of comparatively few persons, they trust no apology will be thought necessary" for their publication. They then go on to add: "He who loses his all at sea by not insuring, instead of sympathy meets with reproach for his temerity. He who suffers by fire, although equally chargeable with rashness and imprudence, not only claims exemption from reproach, but appeals with confidence, and often with success, to public sympathy. The distress and misery resulting from this misfortune have been so often witnessed and felt, as to render it unnecessary to enlarge on the subject. It is sufficient to refer to the frequent appeals to public charity. Probably in no country in Europe is there so great a proportion of the property uninsured as in this country. There, more particularly in Great Britain, it is a very general custom to insure furniture and houses as well as merchandise and stores." It will be seen from the above quoted appeal that the need of the protection of fire insurance on business grounds was the basis upon which this now universal custom was first built. As the manufacturing, commercial and trading interests of the States increased in magnitude and value, the manufacturers and merchants were compelled more and more to have recourse for credit accommodations to the banks, which in the last years of the 18th and the early years of the 19th century were established in ever increasing numbers in all of the business centres of this country. The practice then sprung up on the part of the lenders of money of insisting that the borrower should, for the protection of the loan, keep his property insured against loss by fire. This soon came to be a common condition on the granting of credit by the banks. The merchant might be indifferent to loss by fire so far as his dwelling and its contents were concerned; but he was forced by the compulsory action of those from whom he borrowed money to protect his business property from this class of sudden loss. This banking practice was strengthened by the experiences of the great fire in New York in 1835, which destroyed fully $15,000,000 worth of property and strained to the point of insolvency the greater number of the fire insurance companies that were then doing business in that city.

During the early years of the last century the fire underwriters carried on their business, so far as official supervision is concerned, in no way different from the dealers in merchandise; but in 1837 the legislature of the State of Massachusetts passed a law, which has since been adopted by all of the other States of the Union, compelling the insurance companies wishing to do business within their respective boundaries, to first obtain authorization so to do, and second, to file with the State officials, annually or more frequently if requested, a detailed report of their financial condition, the extent of their liability, the amount of premiums received and the sums paid out in losses. It is not improbable that the experience in New York, referred to above, led to the adoption of the plan of State supervision, for that great fire made it evident that a number of the fire insurance companies had been writing risks with a freedom which indicated little or no regard for possible consequences, either to stockholders or policy holders. This form of paternalism then adopted, while in some respects safeguarding public interests, has led in other respects, as will be pointed out later on, to results which are somewhat questionable so far as public advantage is concerned. During the last 25 or 30 years the growth of the fire insurance business of the United States has been in close correspondence with the increase in this country of insurable property, and hence at present instead of not realizing the advantages of this form of protection against loss, it is probable that the American people of all classes have the destructible property that they may own better insured against loss by fire than have the people of any other country.

The business of fire insurance in the United States may be roughly divided into three classes — that carried on, first by the stock companies, second by the mutuals, and third by the factory mutuals. By far the greater part of the risks insured are written by the companies in the first of these classes. As there is no one State in the Union in which all of the fire insurance companies, both foreign and American, carry on a regular business and hence make official reports, it is not possible to determine the exact volume of business transacted. Of the State reports those issued by the insurance superintendent of the State of New York are probably the most comprehensive, and from these compilations it appears that in the year 1902 the companies that were then authorized to do business in that State, almost entirely stock companies, had written risks in the United States to the total amount of $21,320,333,036. This report of the year 1902 did not include the writings of quite a number of stock companies having their offices outside of New York, and carrying on a local rather than a general business, nor did it include, to any great extent, the writings either in New York State or elsewhere, of the ordinary mutuals or the factory mutual fire insurance companies. If these several additions were made it is not improbable that the aggregate writing in this country of all of the insurance companies during the year 1902, would be found to be between $23,000,000,000 and $24,000,000,000, a sum which must represent a very considerable percentage of the value of all the property in the United States that is liable to destruction by fire.

There were in 1902 approximately 150 stock insurance companies that reported to the insurance superintendent of the State of New York. Of these 36 were European companies that had agencies in this country and the remainder were domestic corporations. The tendency in the development of the fire insurance business in the United States appears to be toward concentration under the control of a relatively few large corporations, these located in special financial centres. During the decade of 1871–80, many more fire insurance companies reported to the New York insurance superintendent than reported to that official in 1902, although in the interval the volume of annual writings increased more than threefold. Those American companies that have the largest share in this business are corporations having their chief offices in New York, Philadelphia, and Hartford, the capitalists of the last-named municipality showing an aptitude for this class of business, as clearly specialized as is that of the manufactures of Fall River or Pittsburg.

Under present conditions a stock fire insurance company organized to carry on a profitable as well as safe business has to cover in its writings a widely extended field of operations. One of the large companies of New York which in 1902 reported the value of risks written at more than $1,000,000,000, had only a little over $200,000,000 at risk in the State of New York, the rest being scattered in thousands of cities and towns between the Atlantic and Pacific oceans. To successfully carry on a business of this magnitude and detail requires a carefully arranged organization. By the method commonly adopted the country is divided by State or sectional lines into the desired number of districts, each of which the company places under the control of a salaried official who has his headquarters at some convenient and central point in the designated territory. The duties of this manager or special agent are chiefly those of supervision. The company has its local agents, whose remuneration usually consists of a commission based on the premiums received for risks written by them.

But the desire to secure premiums, upon which commissions can be earned, may lead the local agent to take risks on behalf of his company, that the shareholders of the latter might afterward discover were far from profitable, hence the duty of the special agent is to check this possible recklessness, as his standing with his company superior is determined less by the volume of premiums that the company receives, than by its relatively small loss ratio in the district over which he exercises supervision. The risks written by the local agents have commonly to undergo the supervision of the special or general agent, and the criticism of the supervising officials at the home office before they are permanently accepted; for the ability to judiciously cancel policies that local agents have written is a factor in the line of corporate success quite equal in its results to the ability to secure desirable business.

Under existing conditions the business of fire insurance as carried on by the stock companies is largely speculative in its character. To say nothing of such tremendous conflagrations as that at Chicago in 1871 and that at Boston in 1872 — catastrophes which involved such immense losses as to completely defeat any scientific attempt to establish an average of outgo — the fire losses of the United States from year to year show wide variations. The New York State reports indicate in the experience of the companies covered by it, that the average for a long series of years has been a loss of .48-cents for each $100 of insurance written by the reporting companies, a record which cannot materially differ from the experience of the entire country. When the average loss of the different years is considered it is found that this has varied from .39-cents in 1897 to .57-cents in 1893, for each $100 of insurance that the companies have had at risk. This fluctuation is altogether too great to admit of a satisfactory scientific classification of rates. But even if the gross amount of fire loss maintained a more constant relation than it now does to the amount of insurance written, the adequacy or inadequacy of the rate charged for insuring any particular risk, or class of risks, would still rest in uncertainty because of the great variation in loss on special classes of property.

Almost all of the fire insurance companies doing business in this country keep what they term their tables of experience, upon which corporate policy is largely based. In the case of companies doing a large and diversified business, such loss records must be of great value, and yet it is well known that there is a material want of uniformity in these experiences. The records of one company may show that it has made an extraordinary profit by insuring woodworking risks, while the experience of another company, doing a business of equal magnitude and diversity, may be wholly the reverse of this, and indicate a loss ratio in this class far in excess of the entire premiums received for insuring these risks. While efforts have been made to combine the experiences of a number of the leading fire insurance companies, it cannot be said that the data thus obtained can be depended upon to do more than serve as guides for general action. A property which might for a variety of reasons be considered extremely hazardous in one place,— as, for example, a distillery in a locality where public sentiment strongly opposed the use of intoxicating liquor — might in another district be thought a highly desirable risk for a company to have upon its books. Fires occur with great frequency in consequence of human carelessness and shiftlessness, which are not only individual, but sectional in their manifestation; for as a rule, those in this country who live in the northeastern States are found to be more careful in keeping the premises that they occupy in good order than are those who live in the southern or western States. Then what may be fairly termed the element of luck enters largely into the complications, as it often happens in local experience, where two insurance companies are represented by the same agent, that the loss ratio of one will be exasperatingly high, while that of the other will be phenomenally low, although the agent may have exercised his best judgment in writing the risks for each of the two corporations that he represents. It will thus be seen that in determining the question of cost, that is, what constitutes an adequate rate to be charged for insuring a risk, the fire insurance companies cannot depend as the life insurance companies can, upon fairly well-settled bases of liability. They have nothing that corresponds in scientific accuracy to the actuaries' tables of mortality. The most hazardous risk may never burn, the one which appears least hazardous may be destroyed by fire within a few hours after the policy upon it has been issued, and there has not yet been formulated any generally accepted table of loss averages.

Life insurance companies establish a certain standard of physical health to which those to whom they issue their policy must conform. To those who successfully pass the medical examination which the life companies require, policies are issued at a uniform rate of premium. The companies thus have upon their books insurance upon selected lives, while their rates are commonly based upon the expectance of life of the entire community, including the weak as well as the strong. The fire insurance companies have in all cases their lists of prohibited risks, though there is no uniformity in these prohibitions, for in practice nearly all risks can be insured in one company or another; but they do endeavor to make the rates that they charge correspond to what they believe to be the probability of loss. This, under the most favorable conditions, is largely a rule of thumb, for though schedules for rating mercantile risks and special hazards have been prepared, drawn up as the outcome of combined personal experiences, it cannot be said that these are based upon entirely reliable data. The rates arrived at by these schedules are no doubt far superior to the personal guesses of the earlier underwriters; but they lack in a large degree the scientific certitude of life insurance rates determined by actuaries' tables of mortality. One advantage which has come from the use of the schedule system of rating, in addition to the effacement of personal prejudice in rate making, is the penalization of recognized defects in the risks thus classified.

For example, in the construction of buildings certain bad methods, such as the maintenance of vertical openings through the floors, or in the processes of manufacture the use of explosive or largely inflammable materials, can be prevented if heavy, specific charges are imposed in the insurance rates for such needless hazards. The schedule charges ordinarily made for such defects are presumably greatly in excess of the real hazard, and are intended to bring about correction, rather than an adjustment of rates to actual conditions.

These movements toward uniformity and system are only made possible by the union of the larger part of the fire insurance companies in local and national organizations. The practice of corporate combination, in agreeing on a scale of prices, seems inevitable in a business where the cost of the service rendered can never be predicted in any individual instance, and only roughly so in a great aggregation of instances. A company may receive $100 for agreeing to indemnify a property owner to the extent of $10,000 for any loss by fire that he may sustain during a year, and may not during the term of the policy be called upon for a penny of contribution, the premium in this case representing unqualified profit. But another policy, written under the same conditions, might lead to a demand upon the company for a payment a hundred times greater than the amount of the premium. Thus the speculative character of these transactions, when considered individually, is alarmingly great, and it is only by collective action that it is possible to bring them within the range of a reasonable business system. The necessity of co-operation through combination has been recognized wherever the business of fire insurance has been carried on, in the countries of the Old World no less than in the United States. In this country boards of underwriters have been organized whenever the property to be insured has been sufficient to justify the formation of more than one locally incorporated fire insurance company, or to warrant the establishment of local agencies by a dozen or more insurance companies having their corporate headquarters in other places.

The obvious reason for the establishment of these associations is the need that exists that their members should write such policies as they may issue upon a uniform and determined basis of rate. In some of the States of the Union the creation of insurance combinations for the purpose of regulating rates of premium to be charged for insuring property is prohibited by special statutes; but even in these States the paramount need of common action has led the representatives of the fire insurance companies to accept and use so-called advisory rates prepared by expert underwriters, these nominally selling their advice or opinions to those who care to buy the information. The fact that the general business of fire insurance all over the United States is limited to less than 150 insurance companies, that the largest and strongest of these corporations are members of what is in effect a national organization, make it all but impossible to effectually enforce State statutes prohibiting combinations for the purpose of regulating local transactions; while, as has already been pointed out, unrestricted competition would lead, from the highly speculative character of the business, to very general corporate insolvency.

The large and well established companies that have premium incomes of millions of dollars a year upon which by investment interest can be earned, are in a much better position to carry on the fire insurance business than are the newly organized companies that have not and cannot for years expect to obtain these large incidental sources of revenue. This tendency toward monopoly is strengthened by the now usual system of State supervision, which places a serious handicap on efforts to form new and competing companies, by imposing conditions on these which ordinarily lead to a more or less speedy impairment of capital, a result which is held to justify the public authorities in compelling the companies thus afflicted to discontinue issuing policies. Thus, while the insurable property of the country is constantly increasing in amount and value, while most of the well established companies have greatly enlarged their net assets during the past decade, the number of stock fire insurance companies has not increased and such attempts as have been made to establish new companies have commonly ended in failure.

From the New York State reports referred to above, it is found that for a series of 43 years, from 1860 to 1902 inclusive, the loss rates of all of the reporting companies was 58.87 per cent of their premium receipts, though this included the two great conflagrations of 1871 and 1872. The expenses of the business during the same term of years were 35.12 per cent of the premiums, and the rates of dividend paid to the stockholders of the American companies were on the average 11.14 per cent on the capital of these corporations; this representing a liberal return, when it is taken into account that many of the successful companies have, in addition, set aside large sums of money to increase their surpluses. It is quite possible that the cost of the business, amounting in the case of the 145 companies that reported to the New York superintendent in 1902, to $66,286,000, is excessive, and that in time this will be cut down, as it represents a great many million dollars paid out in commissions to brokers, who in modern business economy may be looked upon as needless factors, and who would doubtless be dispensed with, if it were not for the competition to get business that now exists between the companies. The amount of fire premiums received by these companies in the year 1902 was $245,563,426, making the charge $1.16 for each $100 of insurance written. The fire losses paid by these companies for the same year amounted to $94,176,595.

It is the business practice of all of the companies that insure fire risks in this country to insist that the assured shall either insure his property to eight tenths of its value or shall pay an increased rate for the protection that his policy gives to him. This rule does not, however, apply to dwellings and their contents which are ordinarily considered an exceptionally desirable class of property to insure.

The usual term of a policy is one year. If written for a shorter time the rate charged is considerably higher than what would be the pro rata of the annual rate. In the case of buildings, and dwellings and their contents, it is often the case that policies are written for a term of five years, the rates in these cases varying, according to local custom, from three to four times the annual rate. In Philadelphia, and possibly elsewhere, the custom has been in use for many years past of insuring dwellings by what are called perpetual policies, the company insuring these agreeing, in consideration of a capitalized payment of premiums, to insure the property forever without calling for a further contribution on the part of the assured.

When compared with other countries the aggregate of annual fire loss in the United States is exceedingly large. Although there are not accurate statistics either here or elsewhere, it is safe to say that the yearly fire loss of this country is greater than the combined fire losses of the United Kingdom, France, Germany, Austria and Italy. This exceptional experience is due to our defective building laws, to the poor enforcement of those that we have, to the greater recklessness of our people, and to the tendency to accumulate large values in merchandise in buildings of great and undivided areas, thus permitting one fire to damage or destroy property worth enormous sums of money. That this record of loss is to quite a degree needless, or at least preventable, is shown by the experience, given later on, of the factory mutual fire insurance companies. So far as the influence of the underwriters connected with the stock fire insurance companies of America has been brought to bear in the direction of reducing fire losses, it has been of public value; but it is possible that collectively they have not yet exerted themselves along these lines to the extent that they might or as they may find it expedient to in the years that are to come.

Considered in its broader aspect, all fire insurance is carried on upon the mutual basis, for the stock companies do not intend to pay fire losses from their capitals, which are held as reserves to meet some great catastrophe. The stock underwriter collects premiums from a large number of property owners and uses these for the purpose of paying the fire losses which come to a few of those whom he insures. Under the purely mutual system the companies have no capitals belonging to stockholders, for all of the corporate assets are the property of the policy holders for the time being, who when they take out their policies obligate themselves to pay upon demand, in addition to whatever premium they then pay, such further sums as may be necessary to make good their share of any exceptional loss that the company may sustain, this contingent liability being usually limited so as not to exceed two, three, or four times the sum of the original premium. If the business transactions of the company are carried on upon a low loss ratio, the profits, after deducting the expenses and salaries of the company officers, are paid back to the policy holders in proportion to their original premium contributions.

This is an entirely equitable method, and when the business carried on is confined to isolated risks of a non-hazardous character, the result has frequently been eminently satisfactory. By this means the expense of fire insurance has been reduced to what it has actually cost, and when limited to a few classes of risks, such as dwellings and their contents, or unexposed buildings occupied for stores and dwellings, it has been possible to establish rates of premium which have been reasonably fair to all participating policy holders. When, however, the mutual method has been more widely extended, so as to take in a great variety of risks, the possibility of very large losses, and the uncertainty of whether each policy holder has contributed his fair and proper share to the general fund, has militated against the efficacy of the plan, and in many instances has brought about the bankruptcy of the too adventuresome corporation. There are successful companies of this mutual type to be found in all parts of the United States, but for obvious reasons their range of business is greatly circumscribed.

The system of fire insurance applied by the so-called factory mutual companies is a distinctly American outgrowth of the ordinary mutual method of providing indemnity for fire losses. The first company of this type established was the Providence Manufacturers' Mutual Fire Insurance Company, which was incorporated in 1835; but there are now 19 companies of this class in the eastern section of the United States, and others which somewhat correspond to them in the South and in the Mississippi valley area. These companies were the outgrowth of the belief on the part of certain manufacturers that the stock companies were charging for insurance protection unwarrantably high rates, and that it would be better for these manufacturers to try the plan of insuring each other. If they had restricted their services within the then understood range of insurance work, their operations would not have been attended with material consequences. But from the outset, and with increasing earnestness as time has gone on, the officers of these companies have insisted, that the duty of paying fire losses was only one, and the less important function which these companies had to perform, and that the work of preventing fire losses was the service to which attention should chiefly be given.

The results which a consistent enforcement of this theory have secured, have been unparalleled in the experiences of fire insurance, either in this country or elsewhere. The risks protected by the policies of the factory mutual companies would be ordinarily classed as specially hazardous. Cotton, woolen, and paper mills, rolling mills, iron foundries, and the like, are not hazards that the stock underwriter ordinarily views with favor, and yet as the result of thorough, periodical inspections, of bringing to the attention of the manufacturers the advantages of certain improvements and of securing the cooperation of the latter in introducing and applying these, the probability of fire loss in these risks has been brought down nearly to the level of the fire hazard in ordinary dwelling houses. In the year 1902 these 19 companies issued their policies to the gross sum of $1,080,468,237, and on these paid a total fire loss of only $654,170. The experience of some of the companies was relatively better than would appear by this showing. Thus the Boston Manufacturers' Mutual Fire Insurance Company, of which Edward Atkinson is president, gave their average cost of insurance per $100 per year for the three years 1900–02, at 7.36 cents. The significance of this showing is brought out by recalling that while practically all classes of property in this country, as determined by insurance rates, are much more liable to fire loss than similar property in Europe, the mills in the United States under the factory mutual system show a smaller average fire loss than any similar risks in any other part of the world.

The obvious deduction to be drawn from this showing is that by combining fire insurance with supervision of risks it is possible to reduce the enormous fire waste of the United States to reasonable proportions. The lesson taught by the factory mutuals has not been overlooked by the stock companies, which have, when it has been possible, applied a similar system of inspection to the risks which they have written. The disadvantages which they labor under are that risks which they take are not usually under a single control or ownership, are not isolated or unexposed by other hazards, and in most instances have such a restricted value that the entire fire premium would not be sufficient to pay the expense of careful periodical inspections. But with the larger risks the system of frequent inspections is quite generally applied, while the increasing use of automatic fire sprinklers — the most effective fire preventive device ever invented — and the scientific regulation upon safe principles of all new mechanical devices by the Underwriters' Laboratory which the stock companies have established, give promise that in the future the needless losses by fire will be greatly reduced in number and volume to the great ultimate benefit of all classes of insurers.

Osborne Howes,
Boston Board of Fire Underwriters.

Fire Island, the most westerly end of a strip of the Great South Beach, Suffolk County, New York, 40 miles long, averaging one half mile wide, off Long Island, between Great South Bay and the Atlantic Ocean. It is reached by ferry from Babylon. The beach took its name from the fires built there as signals to vessels during the war with England in 1812. Between the beach and the mainland, in Great South Bay, are five small islands. About 45 miles east of the inlet to the bay Great South Beach joins the mainland. The entire strip is dotted with popular watering-places; the air here is said to be a specific for hay fever. There is a large hotel on Fire Island Beach, and within a few rods to the east a lighthouse 185 feet high with a revolving light. Margaret Fuller Ossoli, her husband, and child, were drowned on this beach 19 July 1850.

Firelock, a musket or other gun, with a lock furnished with a flint and steel, by means of which fire is produced in order to discharge it; distinguished from the old matchlock, which was fired with a match. See Musket.

Fire-making, the art of producing fire. It was believed by the ancients that man was without fire till Prometheus stole some from the chariot of the sun, but the whole story has a mythical look. Plutarch says that in his time there were fireless races of mankind, and the geographer Pomponius Mela indicates Ethiopia as the locality of one of these. A certain Eudoxus, however, taught them how to produce it. This story cannot be tested now, but Edward Tylor, after passing in review the alleged modern instances of fireless races, rejects them one and all. He believes that there was a time when man was without fire, but it now everywhere appears to have passed away. The oldest method known of making fire is the South Sea Island one by means of a stick and a groove. There followed next, it is believed, the method of striking fire by means of a flint, a piece of iron pyrites and tinder. This process was known to the ancients, which is the reason why they called one of the two minerals used pyrites — that is, fire-stone. The Greeks, in the time of Aristophanes, knew how to concentrate the sun's rays by a burning-glass, and the Romans in the age of Pliny (23–79 A.D.), effected the same result by concave mirrors. In the case of the need-fire, a superstitious rite connected with sun worship, and of which an instance occurred near Perth as late as 1826, fire was obtained by the revolution of a windlass in the hole of an oaken post smeared with tar. The preceding generation remembered the time when fire was obtained by flint, steel, and a tinder box, till superseded by the lucifer match.

Fire Philosophers, certain religionists, who in the 16th and 17th centuries attempted by the aid of fire to penetrate to the primary elements of things. They attributed little to human reason and reflection, but nearly everything to experience and divine illumination. One of the most notable among them was Jacob Boehme, a shoemaker, of Gorlitz, whom his patrons called the German theosophist. He lived in the 17th century. The others were also called theosophists.

Fire Protection, the means employed toward extinguishing fires once they are under way, which is quite distinct from avoiding the outbreak of fire, the latter being termed "Fire Prevention." The scourge of fire has been feared, and combated by different methods, and with varying degrees of failure and occasional success, since the early ages. Water has been the almost universal extinguishing medium employed. In fire protection the theory of combustion is an important matter for consideration. A substance "burns" when its temperature has been raised to or above its ignition point and provided it is in the presence of sufficient oxygen to support the combustion. The burning of all so-called inflammable substances, or those having a comparatively low ignition point, acts to quickly raise the temperature of similar adjoining substances to a point where they in turn burn, thus continuing or spreading the fire. In fires which concern the protectionist, the required oxygen is supplied from the air, and combines with the inflammable substances at their varying ignition points. The resultant chemical action produces heat and fire results. This action also produces gases which, when burning, constitute flame, the smoke consisting of particles of the material which have not been consumed, which are borne away by the hot air currents. In subduing a fire, one of two courses may be pursued, namely, to reduce the temperature of the material below its ignition point, or to exclude the air. The importance of checking the spread of fire in its early stages cannot be overestimated, and to-day all intelligent effort is directed to this end; otherwise, such an amount of combustibles may become afire at one time as to quickly overtax all fire fighting facilities which the most prodigal would provide. To illustrate: one pound of wood fuel will evaporate about one gallon of water. There are in this country innumerable buildings, each containing tons of combustible material, and, should a considerable part of any such building and its contents become afire, it can be readily seen that the thousands of gallons of water per minute necessary to reduce the temperature of the mass below its ignition point would seldom be available, particularly if combated through hose streams, as it is generally conceded that but a small portion of the water thus thrown ever reaches the seat of a fire. This waste is variously estimated at from six tenths to nine tenths of the water discharged. The loss of efficiency is due to the impossibility of approaching closely to the seat of a fire once it has gained good headway. Smoke, heat and flame prevent by holding the fire fighters at a distance and by concealing the precise location of the fire; yet the water must penetrate the smoke and flame and reach the heart of the fire before the temperature can be reduced sufficiently and the fire extinguished. It is, therefore, important to bend every energy toward assailing the fire during the early moments of its existence, and to realize that many buildings once thoroughly aflame cannot be saved by the most powerful facilities known. In such events, the fire department's chief occupation must be the saving of adjoining properties, thus preventing spread of the fire. Conflagrations and large fires represent conditions where blame should attach for allowing a state of affairs which makes them possible, rather than that they are not successfully combated when once under way. In the United States, the inflammable construction and large areas of buildings have compelled advanced fire protection, which is particularly noticeable in the highly organized, quick acting public fire department, and the even more rapid automatic sprinkler equipment — the latter is the most efficient known method of fire fighting. Both systems have received their chief development in this country.

Up to the 18th century, special and efficient types of fire apparatus were not in general use. It is true that Hero, about 150 B.C., describes the construction of a small two-cylinder, single-acting, hand-brake, force-fire-pump, and Pliny speaks of force pumps used in fire extinguishment. Apparently, such pumps were little used, but their early origin is most interesting. Syringes, or "squirts" discharging water — some of them large enough to require several men for operation — seem to have been used by the ancients and up to the 19th century. Chemical extinguishers of slight efficiency were used in the 18th century, as for instance, hollow clay balls containing powdered alum and a charge of gunpowder connected with a fuse, all of which was to be thrown into the fire. The hand-pump, draughting from a trough of water, mounted on wheels, was in use in England, Germany, the United States, and elsewhere during the middle and latter part of the 18th century, and represented the first machine of importance, having an extinguishing power radically in excess of the public bucket brigade. This type of apparatus was developed into the well-known hand-brake, which was the immediate forerunner of the modern day steam fire engine. The first of the latter was built in London 1829, and the first in the United States in 1853.

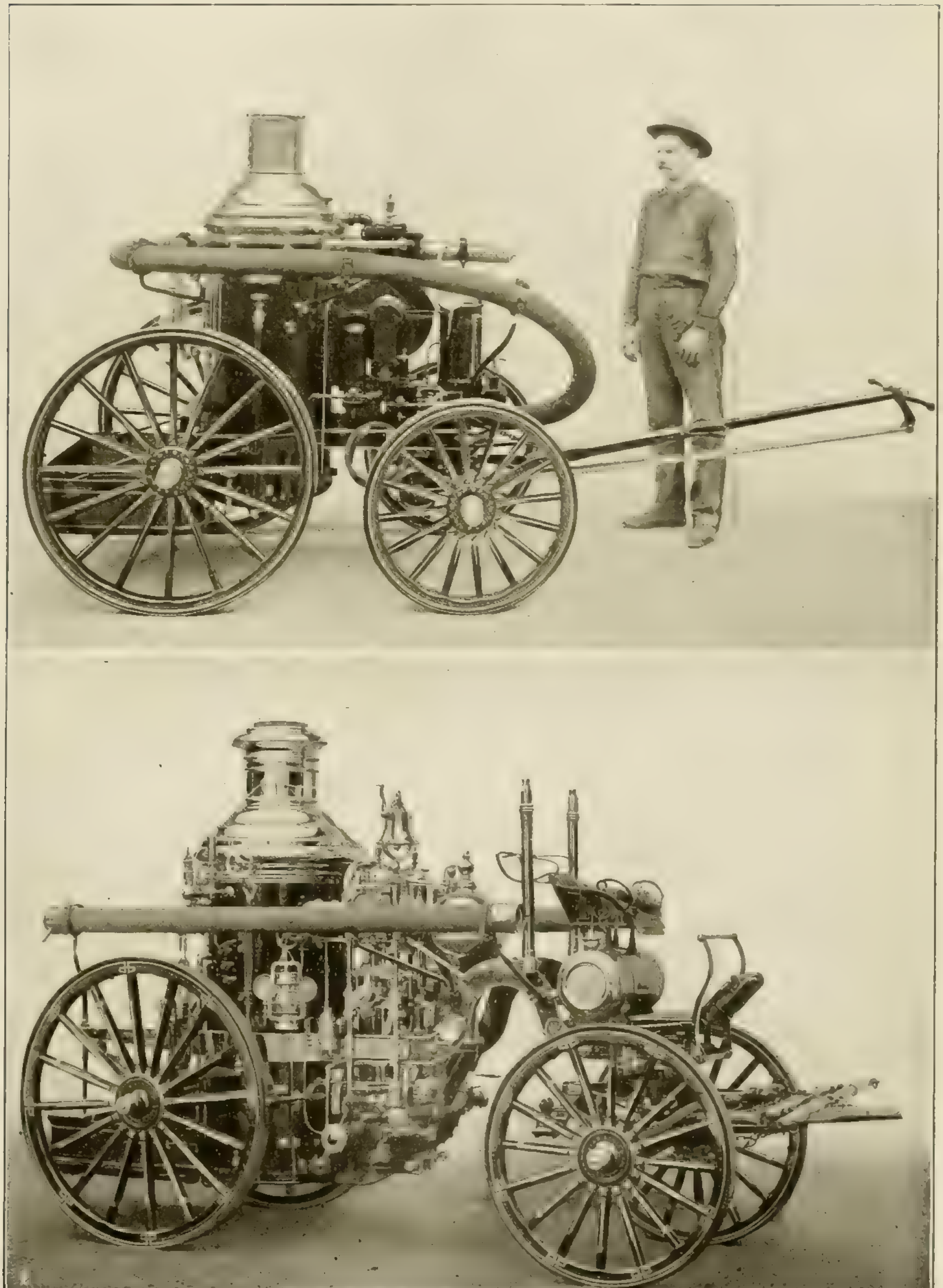
In all this time water has constituted the only extinguishing means of any importance and has been put into use chiefly by the hand-pail or bucket, the hand-pump and the stationary or mobile steam-pump.

It should be pointed out that all devices and materials used for fire extinguishment, many of them consisting of more or less complicated mechanism, possess the great disadvantage of not being in constant or daily use, as is, for instance, the machinery of a mill used in the daily production; and when called upon are liable to be used immediately, without time for preparation and up to the maximum efficiency,— perhaps also by those unskilled in their manipulation and laboring under excitement. It is, therefore, necessary that all such be designed and built, not only in a manner which would be adequate under normal working conditions, but with a much wider margin of safety and excess of strength and excellence to provide for such abnormal demands. It is important that proper rules be framed for the construction, installation and care of all fire protection devices, and, in the United States this work, so far as private fire protection is concerned, is carefully specified by the National Board of Fire Underwriters, who maintain extensive laboratories for such purpose.

Public fire departments have been developed in this country to a remarkable degree. The scope of the organization and the types of apparatus to be employed are to be determined by the area, height and character of the buildings to be protected and the nature of the water supplies available. The apparatus of a public department usually consists of steamers, fire hose and play pipes carried on carts and laid in folds for quick removal, ladders for gaining access to the various floors and roof of a building from the exterior (these include extension ladders operated by hand, hydraulic, steam and electric power), chemical engines drawn by horses and discharged through lengths of hose carried into a building in same manner as the larger hose streams from the steamers, hand chemical extinguishers of the carbonic acid gas type, water towers for projecting powerful hose streams within a building from points opposite upper story windows, and also numerous and varied minor and subsidiary devices. All effort is made to bring the department into action on the scene of the fire at the earliest possible moment, to which end are used the electric fire alarm systems, both automatic and manual. Quick hitching apparatus is employed for almost instantaneously adjusting harness to the horses in the houses in which the apparatus is maintained. The horses are trained to take their places at the pole on alarm of fire, at which time an electric device releases their stall fastenings. The main doors are opened by the operation of a release mechanism, and the firemen sleeping on the floors above the apparatus have their garments so designed and arranged that, in event of a night fire, they can clothe themselves almost instantly, and, descending to the main floor by sliding poles, take their positions on the apparatus and emerge from the house in a few seconds. In thus promptly reaching the fire, and giving it little chance to extend beyond the point of control, our public fire service deserves greatest credit.

One portion of the apparatus above mentioned must be specially pointed out as regards its efficiency. From 50 to 75 per cent of the fires of record controlled by public departments are to-day extinguished by the small chemical engine, whose great efficiency in the hands of a

FIRE ENGINES.



1. Small Fire Engine for a Country Place.
2. Engine for a City Fire Department.

fire department is due to the fact that the apparatus is light, and in responding to a fire is prompt in arrival. The hose is small and easily handled under the extra high pressure which prevails and hence is the first to be taken into the building, reaching the scene of the fire early enough in most cases to bring about the remarkable percentage of successes above noted.

Discipline and thorough training and organization of a department are of utmost importance, and it is a great regret that these do not prevail in all places. The rank and file of American firemen are well above the average as regards bravery and intelligence, but can never be brought into a satisfactory state of efficiency until politics have absolutely no influence in the organizations.

Pails.— Galvanized iron, of 12-quart capacity, are generally used, either round or flat bottom, the round being designed to prevent the pail being set down on the floor or commonly used, that it may thereby be reserved for fire purposes only. Metal covers may be used to keep out lint or dirt. They are to be hung on posts or set on shelves at frequent intervals throughout a room and kept full of clean water. In places where quantities of paints, oils, grease, etc., are used, or in electric stations, at least a portion of the pails are to be filled with dry sand. Complicated sealed-top pails filled with unknown solutions are not advised. Fibre pails or wooden pails are not apt to last as long or be as desirable as those above recommended.

Casks.— Stout wooden or metal casks to hold a reserve supply of water are useful in conjunction with pails or buckets. A quantity of lime may be slacked in such barrels, and common salt dissolved therein to retard fouling in hot weather, or freezing during the cold months.

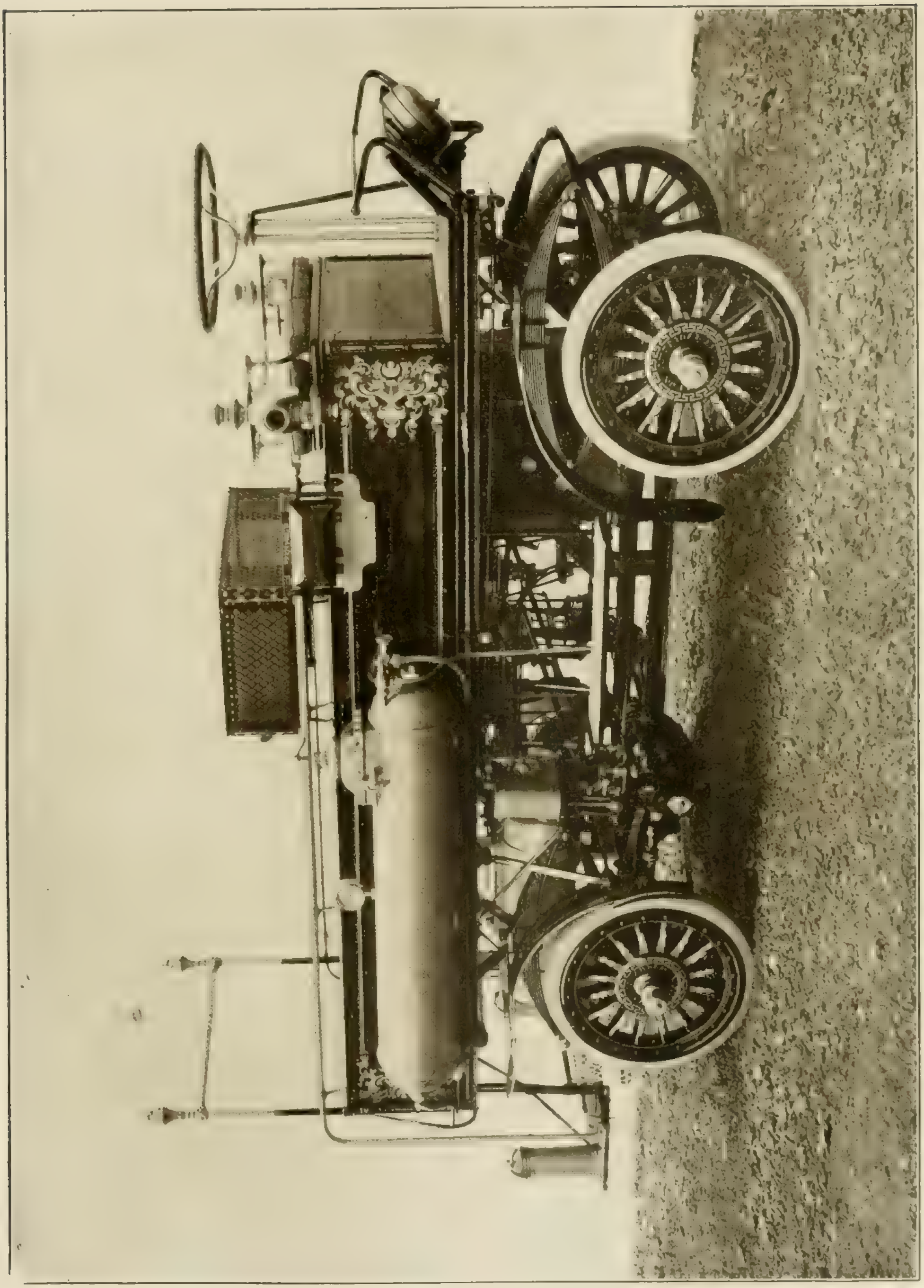
Flexible hose as used for fire protection was invented by Jan Van der Heide, of Amsterdam, in 1672. It was made of leather with sewn edges. About 1808, a Philadelphia manufacturer improved this method by using copper rivets in lieu of sewing the seams. Fire hose of hemp was made in Germany in 1720. Leather was, however, generally used until rubber hose was introduced in England in 1827, and for many years after until replaced by the modern woven, or knit-cotton, rubber-lined hose. For private hydrants, 2⅝-inch cotton rubber-lined hose of best quality should be used. The underwriters' requirements enter into most minute particulars as regards the construction of this hose, and only that tested and "approved" should be purchased. For public fire department use, hose of 2½-inch to 3-inch, either cotton rubber-lined, extra jacketed, or the all rubber type is used, as this hose is subject to rough and frequent usage. Hose used within a building on standpipes should be of best quality woven linen, from ¾-inch to 1½-inch in diameter, frequently connected that lengths may be short. Smooth bore brass nozzles of ¾-inch diameter should be used for this hose, and it is preferred not to connect large diameter hose within a building, the small, so-called "hand-hose" being light and easily manipulated by the inexperienced even under high pressure, and if abandoned, as inside hose often is, does not leave a large quantity of water running to waste. Play pipes for 2½-inch hose and larger should have perfectly smooth tapering tubes, and there are precise specifications for the underwriters' type, which, briefly described, is 30 inches long, wound and painted, has swivel handles at its base, and is provided with a 1⅛-inch smooth bore tip or nozzle. In places where the temperature falls below freezing even for a short time and at rare intervals, only the best quality frost-proof hydrants should be used, these to be of "post" pattern, that is, extending above the ground where they are instantly available for operation and hose connection. The refinements of hydrant construction are specified by the underwriters, and a material improvement in their construction is being effected at the present time. Water discharge outlets, called "monitor nozzles," connected directly with the supply piping without the intervention of hose are often advised, as at roof locations. They are arranged to be revolved by hand and the nozzle raised or lowered. For most practice, tar-coated, cast-iron pipes should be the only type used for underground work. Wrought-iron pipe when laid underground, deteriorates much more rapidly, aside from being more difficult to keep tight at the joints. Much cast-iron pipe on the market is imperfect, and very likely has been discarded by large purchasers who make careful tests. It is, therefore, important that such pipe should be most carefully specified and built in strict conformity with the requirements of the underwriters. Furthermore, much good pipe is injured in shipping or unloading, and, perhaps the most important feature of all is in laying and calking, which should always be entrusted to men experienced in this line of work. All such pipe systems should be submitted to a searching hydraulic test after completion, the precise procedure for which is minutely laid down by the underwriters.

Public Water Supplies.— The most reliable and satisfactory method of obtaining water for extinguishing fires, either through the medium of hose streams or automatic sprinklers, is the reservoir, inexhaustible under both domestic and fire consumption, of unfailing supply in season and out, and of sufficient elevation to give the required hydraulic head. Many buildings in a majority of towns, villages and cities require for satisfactory service a pressure of not less than 75 pounds at grade, this pressure to be taken with the water flowing. A standard hose stream for general use is one flowing 250 gallons per minute through a 1⅛-inch smooth nozzle. It is important that the number of full-capacity hose streams necessary at any one time be predetermined and their existence or non-existence established by actual test, namely: Flowing water simultaneously through the required number of streams to determine whether under such conditions the pressure requisite can be maintained. Such a supply not being available in a majority of instances, recourse is had to one of the following systems: Gravity supply from elevated reservoir or standpipe of limited capacity, fed by pumping engines, direct pressure service from pumping engines, or a combination of gravity feed and direct pressure. It often occurs that a gravity supply is adequate for domestic purposes, but the pressure therefrom needs to be radically increased in time of fire by pumping directly into the mains, or, it may be that the pressure from gravity supply is adequate for a portion of the town, but that, due to area and height of buildings or elevation of land, high pressure is required for another portion. It is manifest that a gravity supply is more reliable than supply from pumping engines, other conditions as to pressure and quantity being equal. This is due to the occasional necessary interruption of pump service and holds true except where a number of separate pumping units are maintained, each adequate to the service required. An important precaution rarely taken is the location of such pumps in strictly fireproof buildings and where not subject to damage by exposure to fires. The modern city building of excessive height and area has created a demand for fire protection and water supplies not previously contemplated and which existing systems are quite unable to meet. This is being provided for by special high-pressure pipe lines, often of special design to provide against leakage and breakage, fed by pumps capable of discharging their rated capacities at high pressures, generally at about 300 pounds. Such systems are now to be found in Boston, Buffalo, Chicago, Cleveland, Detroit, Milwaukee, Philadelphia and Providence. In most cases the fire boats serve these mains, but in Philadelphia there is a fireproof pumping station in which numerous force pumps, each operated independently by its individual gas engine, are located. This station is used only for supplying the high-pressure fire service, at about 300 pounds pressure. The pipes for this system were submitted to a foundry test of 800 pounds per square inch. The use of gas engines for this purpose is a novelty, and have been resorted to for economy of maintenance as compared with the steam plant. The gas engines can be started to full capacity in a few minutes, and, as this high pressure service will be called upon but a few times per month, it will be seen a material saving is effected in cost of maintenance. Salt water from the sea is desirable for fire extinguishing purposes, and has theoretically a slightly greater fire extinguishing value. Being a never failing and inexpensive source, it should wherever available be made use of for high-pressure fire service systems.

Steam stationary fire pumps for factories and private protection generally, should be duplex, and of the type which is most carefully specified by the underwriters. While these pumps may not be economical for constant service — they are not built with such intention — they will be found staunch and fully efficient for an emergency run at time of fire. They are generally made in four sizes and are rated according to the number of gallons to be discharged per minute under average conditions, namely: 500 gallons, 750, 1,000, and 1,500. Where larger capacities are desired, they should be secured by the use of two or more such pumps. Special care is taken in their design to have the areas and passages of ample size and to make the pump proof against such rust as could cripple its operation and of substantial design. Automatic governors can be inserted in the steam supply of such pumps, causing the pump to maintain automatically a predetermined water pressure in its discharge pipe. A more modern arrangement for this purpose is a small pump auxiliary to a larger fire pump, each fitted with an automatic regulator, but the smaller one set at a higher point so that it takes up all of the slip and wear and tear of operation except in event of fire, when, unable to maintain the pressure in view of the increased demands, the larger pump comes into play for such purpose. Portable steam fire engines are commonly used to provide pressure and quantity of water desired for fire streams when both these factors are not found existing in the public water service. They are called "steamers," being designed to very rapidly "get up steam" sufficient to operate the engines driving the water pumps. Their capacity per minute is commonly rated as follows: 1st class, 900 gallons; 2d class, 700 gallons; 3d class, 600 gallons; 4th class, 500 gallons; 5th class, 400 gallons. They are generally drawn by horses, although a number of steam driven machines have been in satisfactory use for many years. In such machines, by a change of gearing, the engines used for propulsion are, upon reaching a fire, disconnected from the running gear and used to operate the water pumps. They are built to discharge as high as 1,400 gallons per minute.

To bring the water to the seat of fire from the source of supply with as little friction loss as possible, much care is required, not only in having the pipes of sufficient size, but also that they shall be fed at proper points and connected in a general net-work or "gridiron" to prevent dead-ends. It should be clearly borne in mind that the very frequent location of hydrants is, in the long run, very much less expensive than the reverse policy, as the latter would involve the purchase and maintenance of much larger supply of hose, the latter being perishable and costly. The greatest amount of expert supervision is necessary in the laying of such pipe systems that they shall be correctly installed so as to give a minimum percentage of leakage, to prevent foreign matter entering the pipes while being laid, and constant care is required thereafter that buried gate valves may be kept wide open and all portions of the system free from obstructions.

Fire Alarms.— During 1852, in Boston, the first fire alarm was transmitted electrically from a central office to the nineteen tower bells of the city. Two years previous the Morse telegraph had been used in New York for sending notice of fire from police stations and engine houses to watchmen stationed in bell towers. The modern system consists of numerous street boxes which can be instantly operated by any citizen who desires to announce a fire in the vicinity. This alarm is electrically transmitted to a central station, and from that point to such of the fire department houses as should respond to a fire in the district indicated. Thermostat or automatic fire alarm systems are now extensively introduced and extend this principle of electric fire alarm transmission into and throughout a building. The thermostats, which are small devices for opening or closing an electric circuit as the case may be, are distributed about on the ceiling and wired up to a certain point where they are connected with gongs for the local announcement of fire or direct connection is made with the central station through which the public department is summoned. These thermostats are commonly set to operate at some 150° F. It will, therefore, be seen that they can be affected by the heat rising from a very small fire, and thereby summon the department, perhaps a mile distant, who often arrive upon the scene while the fire is still small enough to be extinguished by a few pails of water.



AUTOMOBILE CHEMICAL ENGINE AND HOSE CARRIAGE.

Open Sprinklers.— Where it is desired to wet down the exterior surface of a roof or side wall of a building to guard against heat from exposing fires, an arrangement of open sprinklers may be provided, consisting of piping to which open valve sprinklers are attached, the piping being fed by the water supply normally kept out of service by a closed gate-valve, which, in event of need, is opened by hand, and the water allowed to issue from all of the open heads. This is found to be an efficacious arrangement where ample water supply is available and exposure is not excessively severe.

Chemical Extinguishers.— The use of chemicals for extinguishing fires has received a considerable amount of attention from ancient times to the present day, yet it is only recently that a successful and reliable type of chemical extinguisher has been upon the market. Numerous so-called fire extinguishing solutions or compounds, claimed to be of mysterious and wonderful power, have been placed before the public, and frequently it is claimed that such a revolutionary extinguisher has but just been "invented." The chemical salts and gases which tend to extinguish fire are well known, and are not likely to be invented at the present day. They consist of the following: Alum, soda, borax, hyposulphite of soda, silicate of soda (water glass), chloride of lime, tungstate of soda, chloride of tin, sulphate of ammonia, chloride of ammonia, sulphate of soda, nitrate of soda, chloride of sodium (common salt), potash, bicarbonate of soda, and ammonia.

To-day the only generally recognized chemical fire extinguisher is the so-called carbonic acid gas machine. It consists of a cylinder, usually of copper, containing bicarbonate of soda dissolved in water, also a bottle containing sulphuric acid. Arrangement is made whereby the contents of the bottle may be emptied into the soda solution thereby instantly generating carbonic acid gas which serves as a propelling agent to eject the soda solution at the cylinder outlet at which point hose is attached. The proportions of acid and soda are arranged so as to allow an excess of the latter. The effectiveness of the stream is, therefore, due to the water discharged on the fire under high pressure, averaging at the start 100 pounds or more; to the carbonic acid gas which, to a considerable extent is carried along with the jet of water, and also to the sulphate of soda deposited by the water jet and which tends to form a crust over a burning surface, this in part excluding the air. The 3- and 5-gallon machines of this type are designed for individual use, 40-gallon machines on wheels are employed for the protection of private property, while the larger 80-gallon machines are the most efficient weapon of the public fire brigade.

Automatic Sprinklers.—Automatic sprinklers afford the most efficient known means of fire protection. They are operated almost immediately by heat from the fire which they are destined to extinguish. This prompt action checks the fire at its incipiency and confines the water to that portion only where it is required. Such effectiveness is in theory and practice all that can be desired. An automatic sprinkler is a small device for distributing water having a valve arranged to be released by action of heat, as from a fire which it is intended to extinguish. The sprinklers are screwed into the outlets of piping, the latter suspended on the ceilings of rooms and filled with water under pressure. It is essential that the sprinklers shall be so located that distribution of water therefrom will cover all portions of the premises; that the piping shall be of sufficient size; that the water supply be of sufficient quantity and pressure and automatic at all times; and finally, that such systems be kept under regular and intelligent inspection. The first device of this nature was patented in England in 1723. Sir William Congreve, in 1812, invented a sprinkler which he described as follows: "An apparatus for extinguishing fires which shall be called into action by the fire itself at its first breaking out, and which shall be brought to bear on the precise spot where the flames exist." Major Harrison, an Englishman, in 1864, invented an improved sprinkler and drew up details for sprinkler installation. In 1874 Henry Parmelee, of New Haven, Conn., patented and installed an automatic sprinkler which was the first practical device of the kind. It was, however, not sensitive, inasmuch as the release joint was in contact with the water which filled the sprinkler and the pipe system. Another step in the art, and one of great importance, was the invention of Frederick Grinnell, of Providence, R. I., in the making of a thoroughly sensitive sprinkler which he did by isolating the location of the release device so that it quickly felt the heat of a fire and operated most promptly. Mr. Grinnell's patents also included a diaphragm valve seat which was self-tightening under increasing water pressure, and also the Grinnell differential dry pipe valve, which devices have since been generally used throughout the civilized world. Realizing the importance, underwriters have made specially exhaustive rules governing the installations of automatic sprinklers, and most carefully test and examine all devices used in such equipments. The installation of a sprinkler equipment in full conformity with the detailed underwriters' rules is a trade in itself. As a basis for the rules, it is required that each automatic sprinkler have an unobstructed outlet of such size and form that, with five pounds pressure maintained at the sprinkler, it will discharge approximately 12 gallons per minute. This is very nearly the discharge through a ½-inch circular orifice in a thin plate. The size of the piping to which the sprinklers are attached is graduated with this discharge per sprinkler as a basis, and also on the assumption that a limited number of sprinklers will come into operation at any one time. This assumption is warranted in view of statistics which show that out of 3,645 fires of record in sprinklered risks, but 5 sprinklers or less were operated in 66.8 per cent of the whole number of fires; 8 sprinklers or less in 76.1 per cent; 20 sprinklers or less in 88 per cent; 50 sprinklers or less in 93.3 per cent. These statistics also show that automatic sprinklers have been introduced in nearly all classes of manufacturing and mercantile buildings, and also in numerous other places, such as hotels, theatres, schools, cold storage depots, etc. Also, that sprinklers have failed to control but 6 per cent of the fires of record, and that these failures summarize according to cause of failure as follows:

	Per cent.
Defective or partial equipment	27
Failure due to water being shut off	24

	Per cent.
Faulty building construction and obstruction	13
Hazard too severe for control	12
Exposures or conflagration	9
Inadequate water supply	7
Water supplies crippled by explosion	2
No watchman	2
Town water out of service	1
Unaccounted for	3

The release principle responsible for the operation of all of the existing approved sprinklers and also a majority of the successful thermostats is that of the fusible alloy, discovered by Sir Isaac Newton in 1799. The sprinkler solder of to-day for ordinary temperatures is marked 160° F., this being the temperature at which the solder granulates or loses its strength. It is composed of: Bismuth, 50 per cent; cadmium, 13 per cent; tin, 12 per cent; lead, 25 per cent. It requires care in making and particularly so in its application to the adjoining metal parts of the sprinkler head. Solders of higher fusing points are made for locations which so require. Sprinklers in use over 20 years under ordinary conditions as to freedom from corrosive influences show on test no change in the fusing point. The stability of the sprinkler solder in this respect is of the utmost value. Once the solder has fused by the heat from a fire, that which holds the sprinkler valve to its seat is removed and the valve opens, either from the spring of the metal parts themselves, or under pressure of water in the pipes. Water then discharges through the sprinkler orifice and is deflected by a splash-plate and distributed in drops over the ceiling and on the floor within the prescribed limitations allotted to one sprinkler. The heads are placed near together on the pipe, generally from 8 to 10 feet apart, and as a rule, covering a floor area of about 80 square feet, the distance varying according to the construction and occupancy of the building and the water supplies, all as precisely stipulated in the requirements. Usually supplies for sprinklers are obtained from the public water service, provided quantity and pressure are ample. Other supplies are elevated gravity tanks, steam and rotary fire pumps, and pressure tanks, the latter consisting of a riveted iron shell resembling that of a boiler, which is filled two thirds with water, and in the remainder an air pressure is created of 75 pounds or more; the discharge pipe to the sprinklers takes out at bottom of tank and the expansion of the air under pressure is sufficient to force all the water out of the tank, the last being discharged under pressure of 15 pounds or more. For best results, it is important that the primary supply to sprinklers be of heavy pressure, 25 pounds or more on highest line of sprinklers, and of sufficient volume to be capable of maintaining approximately this pressure for an ample period with a considerable number of the sprinklers in operation. At least one of the supplies must be automatic on the sprinklers at all times. In addition to the above noted double water supply, a hose inlet pipe is attached to sprinkler systems for connection from hose or steamer of the public fire department, thus allowing the department to make use of the sprinkler piping and heads, the most effective medium through which water can be discharged. Gate valves of prescribed pattern are so located as to control the water supply that it may be shut off for repairs if found necessary. An important adjunct to such a system is a valve which when inserted in the main piping gives an alarm, either electrical or mechanical, in event of a flow of water in the piping. This acts not only to give an alarm of fire, but to notify those interested of any leakage. In places where water within the sprinkler piping would freeze during cold weather, a special "dry valve" is provided which holds the water out of the exposed interior sprinkler piping. By the means of a small pump, air pressure is created within the sprinkler piping which holds the dry valve closed, but is released in event of a sprinkler opening, thus allowing the water to flow in through the dry valve and out through the opened sprinkler. See FIRE UNDERWRITERS. EVERETT U. CROSBY,

Secretary National Fire Protection Association.

Fire-ships are generally old vessels filled with combustibles, fitted with grappling-irons, to hook enemies' ships, and set them on fire. If they are used on a river they are allowed to be carried down by the current, if they are used at sea advantage is taken of a favorable wind to bear them into the midst of the enemy and set their ships on fire. In ancient times the Tyrians employed them against Alexander, and the Carthaginians against the Romans; and during the Christian era the Crusaders made use of them at Ptolemais (Acre). In the time of Philip II. the Spaniards suffered severely by them on two well-known occasions. The first was at the siege of Antwerp in 1585, when by means of fire-ships Gianibelli utterly destroyed a bridge that the Duke of Parma was attempting to throw over the Scheldt, with the aid of some other vessels which he had prepared so as to explode when they reached the bridge. The second case was when Lord Howard of Effingham used them with such effect against the Armada in 1588. In this case also their use is said to have been suggested by Gianibelli. The Greeks in their struggle with Turkey also employed them with great success. In 1857, during the war with the Chinese, whole fleets of such vessels were sent against the British warships, without inflicting the slightest damage.

Fire-toad, or **Fire-bellied Frog**, one of the commoner and more aquatic of the European toads or frogs (*Bombinator igneus*), so called because of the flame-colored patetus upon the bluish-black abdomen. They have many peculiar and interesting habits, and make good use of the colors. "When these toads," says Gadow, "are surprised on land, or roughly touched, they curl themselves into an extraordinary attitude displaying the red of their bellies and throats, and remain so until the danger is past, expecting that the enemy will let them alone after having been shown with what a terrible creature it had to deal." In fact the secretions of the skin are very poisonous, and not even turtles will eat them knowingly. This toad inhabits north-central Europe, and two other species of the genus are known, one in China. It is called "unke" in Germany. Detailed accounts of the animal may be found in Gadow's 'Amphibia and Reptiles' (1901).

Fire Worshippers, the Zoroastrians, called also Guebres. Herodotus, about 450 B.C., said "The Persians think fire to be a god." Strabo, about 50 A.D., said, "They peculiarly sacrifice to fire and water, placing dry wood on the fire stripped of its bark, with fat thrown on it." Rev. Dr. Wilson, of Bombay, alleges that "they actually address it in supplication, as if it were sentient, intelligent, divine, and omnipresent, and ready to hear, bless, assist, and deliver; as is clearly proved by many passages of the Vandidad and by several of the Yasts and Has of the Yacna and Niashes, to be found in the works esteemed sacred and used by the Parsis (Parsees) in their daily prayers." No prominent race now in India has become more rapidly modified by intercourse with Europeans. See GUEBERS.

Fireproofing and Fireproof Construction. The supply of incombustible materials for construction purposes, rather than the rendering of combustible materials fireproof and incombustible by treatment with various chemical substances, has been an important factor in the development of modern building methods.

The subject of fireproofing embraces the manifold plans that have been adopted to erect buildings and repositories for valuable articles capable of resisting the action of fire, and to render wood and textile fabrics incombustible. Among the principal incombustible or fire-retardent materials are asbestos (q. v.), silicate and tungstate of soda, phosphate of ammonia, and borax. A solution of silicate of soda has been found one of the best of the various chemical substances which have been used with the view of rendering wood fireproof. Wood carefully painted and impregnated with this solution requires long exposure to a fierce flame before it becomes charred.

Injections of phosphate of ammonia have been used for fireproof wood in ships with the same fire-retardent effect, but it has been found impossible to render wood absolutely incombustible. After being chemically treated, much greater heat is necessary to kindle it, and its nature is so altered that it burns more slowly, but dampness destroys the effect of the solution, and a beautiful piece of woodwork is in most cases ruined by being saturated with a chemical injurious to its fiber, to the nails and screws holding it together, and to the varnishes upon which depend the beauty of the finished job, and, wherever possible, its use is discontinued.

Among flexible fibrous substances capable of being spun and woven into tissues, asbestos pre-eminently possesses the property of slowly conducting heat, and is largely used for theatre curtains, the padding of fireproof safes, etc. Wool, cotton, and other fibrous matters in common use for the purposes of clothing may be rendered very imperfect conductors by immersion in certain saline solutions, of which sulphate of ammonia and tungstate of soda are most commonly used. The former is cheap, but has the disadvantage of becoming decomposed when the article so treated is ironed. Borax also is very well adapted for rendering articles of dress fireproof, but it weakens the tissue of the material and renders it more liable to tear.

In modern times, a great deal of ingenuity has been applied to the construction of fireproof safes. These are now generally constructed with double walls of stout iron, having a space of three to four inches thick between the walls, filled with some substance which is a bad conductor of heat. See SAFE INDUSTRY IN AMERICA.

In building, the attention of the allied professions of architect and builder has long been devoted to providing materials that will not burn at all. Among early literature on the subject is a small work written in French by Monsieur le Compte d'Espie, Knight of the Military Order of St. Lewis, translated into English by L. Dutens, and published in London 1775, entitled "The Manner of Securing all sorts of Buildings from Fire, or A Treatise upon the Construction of Arches made with Bricks and Plaister, called Flat-Arches, and of a Roof without Timber, called a Bricked-Roof." The author writes: "The Invention is this; to erect a roof of such Construction (which three years ago I myself built on my House at Thoulouse) as to be absolutely composed of no other materials than Bricks, Mortar, and Plaister, there being no Wood or Iron in the whole Formation of it; and therefore I give it the Name of a *Bricked Roof*. . . . . It is much to be wished that they were universally introduced throughout the Kingdom, what a number of Lives as well as Houses would be preserved from Fire? Accidents that are now so frequent and so numerous would in a great measure be avoided, and besides this great Security, there are other advantages peculiar to these solid flat arches and ought to be well-weighed: for instance they make Apartments in Winter warm and in Summer cool, Rats and Mice can find no shelter there, neither is Noise anyways communicated from an upper to a lower Floor, which as the former now is, is very troublesome, notwithstanding the Care taken to fill up Vacancies and make our floors double, a Method very expensive and what is more takes up a great deal of Room; neither does it absolutely prevent the inconvenience, for an hollow disagreeable Sound is always perceptible, and besides the inclosed Timber of the Floor (as it lies out of Sight) in time grows rotten, no Repair therefore can be done, at last it falls and the whole must be rebuilt."

Another work also published in London in 1775 had for its title page "Various Methods to prevent Fires in Houses and Shipping, and for preserving the Lives of People at Fires with an Account of Remarkable Accidents by Fire, in different Parts of the World, selected historically, for the space of One Hundred and Eight Years, to this present Period: wherein The Negligence of Architects and Builders, in constructing Buildings in Town and Country is pointed out; and showing That the Encouragement of Arts and Sciences is a public Benefit to these Commercial Islands. With Abstracts from the last Act of Parliament, to regulate Buildings, and prevent Fires in London. Necessary to be known in all Families from the lowest Peasant to the highest Peer in the Realm. Approved by the Society of Arts, Manufactures and Commerce."

Compte d'Espie had taken his idea from the barrel vaults of the Romans, but his suggested elimination of iron in building has a comparative value in the light of subsequent experiments in fireproof construction in the United States from 1854 to 1870. During this period the substitution of iron for wood for all constructive purposes was thought an advance in the right direction, until it was discovered that iron of all kinds was unreliable if exposed to temperatures of 900° Fahr. and over. The danger to so-called fireproof buildings, in which only this incumbustible material had been extensively introduced, was much greater than to those which had been previously erected without any regard to protection from the effects of fire, in many instances, with structures in which cast-iron fronts had been exclusively used, the effect being a complete collapse. These failures helped to call attention to the danger of using *unprotected iron* for all purposes, and after 1870 the plan diminished in favor, there being an almost universal demand for the abandonment of constructive iron and a return to wood. Thoughtful investigators, however, had directed their attention to the necessity for protecting rather than discarding the use of iron for constructive purposes, and the advantages of *protected iron construction* began to be recognized. As soon as fire protection in connection with constructive steel became an accomplished fact, the improvement of both of these arts advanced rapidly, and the development of the capacity of steel for building purposes became no less remarkable than that of the fireproofing systems used in connection with the metal. The steel skeleton construction now in general use is the principal result, and newly introduced materials and processes are everywhere employed throughout the United States for all improved building purposes, their use also being extended to foreign countries.

The first valuable improvements in fireproofing cast-iron columns were made from 1875 to 1879 by Peter B. Wight, architect, who used porous terracotta in hand-made blocks. Soon after this, rolled iron I-beam girders were fireproofed with porous terracotta in many buildings. The first iron roof trusses of which the individual parts were covered with porous terracotta about 1878 are in the Board of Trade Building at Milwaukee. These were the beginnings of the protection of structural iron. Improvements in floor construction with a view to relieving the floors of weight were made before this time. The first use of hollow burned tiles for this purpose in the United States was made by the late George H. Johnson of Chicago. They were built in one of the corridors of the New York post office in 1873. About the same time Mr. Johnson — whose son, E. V. Johnson, was one of the founders of the Pioneer Fireproof Construction Company — used a similar floor construction in the Kendall building at Chicago, the Singer building at St. Louis, and several others. The contract for the fireproof work of the Chicago City Hall, awarded in 1879, was one of the first in which the fireproof protection of the columns and girders was combined with a floor construction of I-beams and flat hollow-tile arches. Almost all the improvements in the manufacture and use for fireproofing purposes of burned fireclay, between 1879 and 1885, were made by the experts of the Pioneer Fireproof Construction Company and the Wight Fireproofing Company. The Montauk, built in 1881–82, was the first high building erected exclusively for office purposes in Chicago, and is just within the limit of 130 feet now fixed by law, beyond which a building shall not go in Chicago. In it were combined all the plans and materials for fireproof construction then in greatest favor, and since the erection of that building all the improvements in the construction and fireproofing of high buildings have been made step by step. In 1884 the Mutual Life Building on Nassau street, New York City, was fireproofed throughout with porous terracotta and hollow fire-clays. This was the first building in which the under sides of the beams were ever covered by fireclay tiles for the protection of the same from fire, and leaving a flush ceiling.

The different materials now used in fireproof construction are few in number, and the peculiar application or use in certain places sometimes makes one more desirable than another. The following constitute the principal incombustible materials now in use, singly or in combination; dense and porous clay or terracotta; solid concrete as a lintel in floor construction; cinder concrete supported by light iron work; plaster block of plaster-of-paris and fire-clays as foundation material; expanded metal or wire lath supported on light iron work, leaving an air space. The different uses to which fireproofing material is put in a building are: for floors,— the filling in of the spans between iron beams; for partitions,— the 2-inch to 6-inch walls dividing the interior of a building into rooms; for furring — or covering the inside of exterior exposed walls, leaving an air space; for column covering — all interior columns, and those left exposed by brick work; for girder covering — all girders projecting below the floor arches; for ceilings — the placing of false or hanging ceilings; and for roofs — the flat or sloping base for slate, etc.

The standard regulations for fireproof buildings suggested by the National Board of Fire Underwriters, and incorporated in the building laws, provide that every building hereafter erected or altered to be used as a theatre, lodging house, school, jail, public station, hospital, asylum, institution for the use, care or treatment of persons, the height of which exceeds three stories, and not more than 40 feet in height, and every building hereafter erected or altered to be used as a hotel, which exceeds four stories, and not more than 50 feet in height, excepting all buildings for which specifications and plans have been heretofore approved by the proper authorities, and every other building, the height of which exceeds 55 feet or more than four stories in height, shall be built fireproof, that is to say — they shall be constructed with walls of brick, stone, Portland cement, concrete, iron or steel, in which wood beams or lintels shall not be placed, and in which the floors and roofs shall be constructed with rolled wrought iron or steel floor beams, so arranged as to spacing and length of beams that the load to be supported by them, together with the weights of the materials used in the construction of the said floors, shall not cause a greater deflection of the said beams than one-thirtieth of an inch per foot of span under the total load, and they shall be tied together at intervals of not more than eight times the depth of the beam with suitable tie-rods.

Between the floor beams shall be placed brick arches springing from the lower flanges of the steel beams, or the spaces between the beams may be filled with hollow tile arches of hard-burnt clay or porous terracotta, or arches of Portland cement reinforced with metal, or such other fireproof composition may be used, provided that in each and all cases the strength and method of construction shall be acceptable to the Inspector of Buildings. The stairs and staircase landings shall be entirely of brick, stone, Portland cement, concrete, iron or steel.

No woodwork or other inflammable material shall be used in any of the partitions, furrings or ceilings in any such fireproof buildings, excepting, however, that when the height of the building does not exceed eight stories, nor more than 100 feet, the doors and windows, and their frames and trims, the casings, the interior finish when filled solidly at the back with fireproofing material, and the floor boards and sleepers directly thereunder, may be of wood, but the space between the sleepers shall be solidly filled with fireproofing materials and extend up to the floor boards. When the height of a fireproof building exceeds eight stories or more than 100 feet, the floor surfaces shall be of stone, cement, rock asphalt, tiling or similar incombustible material, or the sleepers and floor boards may be of wood treated by some process approved by the Inspector of Buildings to render the same fire-retarding. All hall partitions or permanent partitions between rooms in fireproof buildings shall be built of fireproof material, and shall not be started on wood sills, nor on wood boards, but be built upon the fireproof construction of the floor and extend to the fireproof beam filling above. The tops of all doors and window openings in such partitions shall be 12 inches below. The provisions for inclosing structural iron and steel work, for elevator inclosures, stairs, openings in floors and roofs for light, ducts for pipes and ventilation, fireproof shutters and doors, the installation of electrical work and fire appliances are also outlined on a careful and elaborate scale, with which, however, great simplicity and perfection of construction are combined.

It has been pointed out that modern so-called fireproof appliances tend toward a protection of property rather than a protection for life, and the delusion of the "absolutely fireproof" building has provided a fertile theme for discussion, but it undoubtedly stands to reason that with the advances made in the fireproof construction of buildings, the danger to life has been, if not proportionately, at least considerably diminished.

The unsatisfactory nature of so-called "fireproof wood" has already been pointed out, and a movement for relief from compulsion in its use has long been agitated by architects and builders. Described as "an obnoxious imposition," a repeal of the fireproof wood clause in the Building Code is sought, and is now supported by the National Board of Underwriters. The influence of this clause has been much more detrimental than would appear to the casual observer. The permanence of any process or measure adopted for use in the great building industry, which architects, owners, and builders are all constantly studying to improve depends on merit alone. As such merit is established, no laws are required to secure prompt adoption.

Fireproofed wood is not a material of standard and recognized merit like hollow brick or wire glass. It is a material which has been for the most part manufactured in order to enable builders to meet the provisions of the law, and builders themselves have no confidence in the value of such fireproofing. Experts are agreed that the amount of wood used in the finish of buildings, the walls, floors, and windows of which are thoroughly fireproofed, is not a source of danger, and in building a skyscraper there is no ordinary business inducement to have the roof fireproofed. Fire Chief Croker of New York says "the only way to make a building fireproof is to build it of non-inflammable materials from the foundation up to the skylight, and permit only fireproof furniture to go in. And the less oil and paint used in a building which is desired to be fireproof, the better."

Among the leading systems of fireproof construction are the Roebling system, described as "a system of fireproof construction that is fireproof;" the Rapp system of fireproof construction; the Hennebique iron-concrete system of construction; the De Mann system of fireproof construction, the systems employed by the G. A. Fuller Construction Company and other building companies.

Of the many high buildings of steel skeleton construction erected in the large cities of the United States by the G. A. Fuller Company, in which the various problems of fireproofing were elaborately carried out, several passed through such disastrous ordeals as the Baltimore fire in 1904, and the earthquakes and fires of San Francisco in 1906. In no case was there any but trifling damage done to their structural portion. They were all repaired by renewing the woodwork and decorative portions of the buildings and the damaged part of the exteriors. The percentage of salvage in these buildings ranged from 60 to 85 per cent.

PAUL STARRETT,
President, Fuller Construction Company.

Fires, Notable. Among the more important and disastrous conflagrations of history were the following:

64. Rome burned for eight days; most of city destroyed.
1086. London; great part of the city destroyed.
1212. London; great part of the city destroyed.
1666. London; Great Fire, 2–6 September; 436 acres; loss, $50,000,000.
1794. London; 650 houses burnt; loss, $5,000,000.
1812. Moscow fired, 14–20 September; loss, $150,000,000.
1835. New York, 16 December; loss, $15,000,000.
1842. Hamburg, 5–7 May; loss, $35,000,000.
1845. New York, 20 July; loss, $7,500,000.
1861. London, Tooley Street, 22 June–22 July; loss $10,000,000.
1871. Paris, Communist outrages in May; loss $150,000,000.
1871. Chicago, 8–10 October; 2,124 acres; loss, $200,000,000.
1872. Boston, 9–10 November; loss, $75,000,000.
1903. Chicago, 30 December, Iroquois Theatre; 531 lives lost.
1904. Baltimore, Md., 7 February; loss, $70,000,000.
1904. New York, steamer General Slocum, June, nearly 1,000 lives lost.
1906. San Francisco, Cal., 18–21 April; earthquake and fire; loss about $300,000,000.

Firing Machines, blasting batteries, electric blasting machines or exploders are electric generators which are used in firing charges of explosives, in blasting, and in military and naval operations. Broadly speaking, there are three types: (1) in which the current is induced in coils of wire surrounding the poles of a permanent magnet, by suddenly detaching a soft-iron armature therefrom; (2) in which a coil-wound armature is rotated between the poles of a permanent magnet; (3) in which a coil-wound armature is rotated between the poles of an electro-magnet as in an ordinary dynamo. It has been found advantageous in practice to construct the dynamo-electric machines on the series method of winding, that is, the field-magnet coils, armature, and external circuit (which in this case is the firing-line) are joined together in series. These machines are operated by cranks or by means of racks and pinions, many mechanical arrangements having been devised by which to secure the continuously accelerated motion and automatic switch-off which is desired. The general principle upon which the dynamo-electric machines work is that an armature, rotated between the poles of an electromagnet, has set up in its coils a feeble electric current, due to the magnetization produced by the residual magnetism in the iron. By continuing rotation (with the firing-line short-circuited) the weak current thus started passes round the field-magnet coils, increases the intensity of the field, and, consequently, the volume of current in the armature. This gradual increase or building up of the current goes on, until the maximum capacity of the machine is reached. At the limit of magnetic saturation, the short circuit previously existing is automatically broken and the whole available energy is switched on to the firing-line, through the binding posts or terminals on the side or top of the machine, to which the leading wires are attached. Machines are rated in the market at the full number of detonators which a machine of that pattern will fire, but, to ensure freedom from "miss-fires," a machine should never be worked up to its rated maximum capacity. The diameters of the leading wires should vary with their lengths, thus for distance up to 600 feet No. 16 B. W. G. (0.065 inch) wire should be used, for 800 feet No. 14 (0.083 inch) and for 1,000 feet No. 13 (0.095 inch). To prevent accidental explosions, it should be the invariable rule, that the leading wires are not attached to the binding posts of a firing machine, until all other preparations for firing are completed and everyone has got to a safe distance from the blast or mine; and it should be also the invariable rule that the leading wires are detached from the machine as soon as the blast has been fired.

Firishtah, fē-rēsh'tä, more properly **Mohammed Kasim,** Persian historian: b. Astrabad about 1550; d. about 1612. He went to India, and was for some time the tutor of a native prince. He wrote a 'History of the Mohammedan Power in India till the Year 1612,' which is the best yet written on the period which it embraces.

Firmament, in ancient astronomy, the eighth heaven or sphere, with respect to the seven spheres of the planets which it surrounds. It is supposed to have two motions, a diurnal motion, given to it by the *primum mobile* from east to west, about the poles of the equator; and another opposite motion, from west to east, which last it finishes, according to Tycho, in 25,412 years; according to Ptolemy, in 36,000; and according to Copernicus, in 25,800; in which time the fixed stars return to the same points in which they were at the beginning.

Firman, fėr'man or fėr-män', in Turkey, any decree issued by the Porte and authenticated by the sultan's own cipher or signet. Each of the ministers and members of the divan has right of signing firmans relative to the business of his own department, but only the grand vizier is authorized to place at their head the cipher containing the interlaced letters of the sultan's name, which alone gives them force. A decree signed by the sultan's own hand is called hatti-sherif. The name firman is also applied to a passport issued either by the Porte or a pasha, enjoining the subordinate authorities to grant protection and assistance to the traveler in whose favor it is granted. (See TURKEY.) In India, a written permission to trade is called a firman.

Firozpur, fē-rōz-poor', India, town, Punjab, on the Sutlej River, three and a half miles from Sutlej, capital of a district of the same name. It has the largest arsenal in the Punjab. It has a trade in grain and manufactures of cotton. Pop., including the military cantonments two miles south of the city, 50,437. Firozpur is also the name of a town in Gurgaon district, Punjab. Pop. 6,848.

First Aid, the term applied to a plan for popularizing certain measures for the relief of the injured and distressed. Instant application is necessary in many cases, if remedial measures are to succeed. Thus a slight knowledge of the course of arteries and of means for compressing them will enable one to stay a fatal flow of blood. Antidotes for poison rapidly lose value as time elapses. The resuscitation of the drowning is largely a matter of persistence in artificial respiration. General knowledge of the cleansing of wounds is all-important. This knowledge is now widely used in armies and among people most liable to witness accidents, as trainmen, etc., circulars of instruction and packets containing the most necessary articles for dressing wounds being often furnished by those in authority.

First-born (Heb. *bekor,* Gr. *prōtotokos,* Lat. *primogenitus*), in scriptural use, signifies the first male offspring, whether of man or of other animals, due to the Creator by the Mosaic law as a recognition of his supreme dominion. The first-born male, whether of men or of animals, was devoted from the time of birth to God, and the first-born male child had to be redeemed one month after birth by an offering not exceeding in value five shekels of silver (Exod. xiii. 13), provided the child lived longer than that period. The first-born male of animals also, whether clean or unclean, was equally regarded as devoted to God. By the Mosaic law primogeniture had certain privileges attached to it, the chief of which were the headship of the family and a double portion of the inheritance. Among other nations considerable variety existed as to the succession of children to the inheritance of their parent. See INHERITANCE; PRIMOGENITURE.

First-footing, a Scottish practice still existing in Edinburgh, and elsewhere. Late in the evening of 31 December in each year, 2,000 or 3,000 of the common people assemble in the vicinity of the Edinburgh Tron Church, to ascertain on good evidence when the new year commences. When the clock is about to strike 12 they cheer so loudly that the strokes are not heard. Instantly that it has finished, they depart for the purpose of first-footing; that is, each one tries to be the first person that year to cross the threshold of his friend's house and wish him the compliments of the season. On such occasions also not a few are accustomed to drink their friends' health at the manifest risk of their own.

First-fruits and **Firstlings** are terms of the Mosaic and Jewish law, denoting respectively those portions of the fruits of the earth and of the increase of live stock which were to be offered to the Lord (for First-fruits, see Exod. xxii. 29; Num. xviii. 12, etc.; for Firstlings, see Exod. xiii. 12; Num. xviii. 15, etc.). A custom which had its rise in the Roman Catholic Church as early as the 6th century was that men ordained to ecclesiastical offices made to the bishop who ordained them an offering of some portion of the first year's revenue of the office. In course of time the claim of the See of Rome to the whole of the first year's income of a bishopric or an abbey or other office or benefice was recognized and enforced. When in 1531 King Henry VIII. forbade the payment of this tax to the papal see by his subjects, the amount of the first-fruits annually forwarded from England to Rome was about £3,000. When Henry was made supreme head on earth of the Anglican Church, the tax of the first-fruits was still exacted, but the proceeds were turned into the royal treasury. Such was the disposition made of the first-fruits in England till in 1704 Queen Anne, for herself and successors, relinquished the income from first-fruits and other imposts on the profits of spiritual preferments and, under an act of the Parliament, formed this income into a fund for the relief of clergymen holding poor livings: this is "Queen Anne's Bounty." The official name of first-fruits is *Annates*, or *Annalia*, from *annus*, year: they are also called *primitiæ*, the Latin equivalent of first-fruits.

Firth, Charles Harding, English historian: b. Sheffield, England, 16 March 1857. He was educated at Clifton and Oxford and since 1883 has devoted his attention to literary work and teaching at Oxford, having been lecturer at Pembroke College there 1887–93. He has published: 'The Clarke Papers' (1891–1901); 'Scotland and the Commonwealth' (1895); 'Scotland and the Protectorate' (1899); 'Oliver Cromwell' (1900); 'Cromwell's Army' (1901); etc.

Firth, Mark, English steel manufacturer: b. Sheffield 1819; d. 28 Nov. 1880. In 1849 with his father and brother he established in Sheffield the great Norfolk steel works, whose specialty soon became the manufacture of steel ordnance. He was a munificent benefactor to his native town, his gifts including almshouses (1869), a public park (1875), and the Firth College (1879) in connection with university extension.

Fis'cal, from *fiscus*, the state treasury. (1) In most German states an officer who has charge of the state treasury. (2) In the German states, and in Scotland, the fiscal is also the public prosecutor in the criminal courts. This use of the name seems to arise from the ancient practice of punishing most violations of the criminal law by a fine.

Fiscal Lands, lands, among the Franks, set apart for the use of the sovereign, to support his dignity, and to give him the means of rewarding merit or valor.

Fischart, Johann, yō'hän fish'ärt, German satirist: b. Mainz between 1545 and 1550; d. Forbach about 1590. As a satirist he is the most unrestrained of his age, inexhaustible in droll, humorous, and witty thoughts, not seldom guilty of equivoque and obscenity, intimately acquainted with the follies of his age, and never at a loss whether to ridicule or lash them. He treats the German language with the greatest freedom, coining new words and turns of expression without any regard to analogy, and displaying in his most arbitrary formations, erudition and wit. In the broad comic and burlesque he is not to be surpassed, and even in his most satirical effusions there is an honesty and good nature always observable. His most celebrated works are a rifaccimento of the Gargantua of Rabelais, first printed in 1575; 'Das gluckhaft Schiff von Zürich' (The Lucky Ship of Zurich) (1576); 'Aller Praklik Grossmutter' (1572); 'Eulenspiegel Reimensweiss' (1572), and several others. We find in Fischart the first attempt at German hexameters.

Fischer, Emil, ā'mēl fish'er, German chemist: b. Euskirchen 1852. He was appointed professor extraordinary at the University of Munich 1852 and became professor of chemistry at Erlangen 1882, filling a similar chair at Würzburg 1885. He was appointed professor of organic chemistry at the University of Berlin 1892, receiving in that year the Nobel prize for chemical research. He has paid much attention to the chemical constitution of sugars, his principal work being 'Anleitung zur Darstellung organischer Präparate.'

Fischer, Johann Georg, yō'hän gā-ōrg' fish'er, German poet: b. Gross Süssen, Würtemberg, 25 Oct. 1816; d. 1897. His lyric poems are in eight volumes (1854–91). He excelled in popular songs and ballads; and in his love songs nobly idealized nature and passion. He wrote four dramas: 'Saul' (1862); 'Frederick II. of Hohenstaufen' (1863); 'Florian Geyer' (1866); 'Emperor Maximilian of Mexico' (1868). In 'From Bird Life' (1863) he notes the characteristic phenomena of the psychic life of animals with the acuteness of a naturalist and the sympathy of a poet.

Fischer, Kuno, koo'nō, German historian of philosophy: b. Sandewalde, Silesia, 23 July 1824; d. Heidelberg, 4 July 1907. He was interdicted from teaching philosophy at Heidelberg in 1853; but after filling professorships in Berlin and Jena, had the satisfaction of being called to the chair of philosophy at Heidelberg in 1872. His principal writings are: 'Diotima; The Idea of the Beautiful' (1849); 'Logic and Metaphysic, or the Doctrine of Science' (1852); 'History of Modern Philosophy' (1852–93, new ed. in 9 vols. 1897 et seq.), his greatest work, written in the form of brilliant monographs on Descartes, Kant, Fichte, Schelling, and other great philosophers down to Schopenhauer; 'Francis Bacon and His Successors' (1856); 'Lessing's Nathan the Wise' (1864); 'Spinoza's Life and Character' (1865); 'Origin and Evolution-Forms of Wit' (1871); 'Goethe Schriften' (1895–1900).

Fischer, Ludwig Hans, lood'vig hänts, Austrian painter: b. Salzburg 2 March 1848. After a course of art study he traveled extensively, settling finally in Vienna. Among his works are nine landscapes for the Museum of Natural History, Vienna, and etchings and engravings forming historical landscapes from Austria-Hungary. He is the author of ‹Die Technik der Aquarellmalerei.›

Fiscus. See FISCAL.

Fish, Hamilton, American diplomatist: b. New York 3 Aug. 1808; d. Garrison, N. Y., 7 Sept. 1893. He was graduated at Columbia College, and admitted to the bar in 1830. A Whig in politics, he was elected a congressman in 1842, and governor in 1848. In 1851 he was returned to the United States Senate, where he opposed the repeal of the Missouri Compromise and joined the Republican party on its formation. He was secretary of state under Grant 1869–77, signing, as one of the commissioners, the Washington Treaty of 1871, and carrying through the settlement of the «Alabama» question.

Fish, Nicholas, American military officer: b. New York 28 Aug. 1758; d. there 20 June 1833. He joined the Continental army, participated in the battles at Saratoga in 1777; led a corps of light infantry in the battle of Monmouth; and otherwise distinguished himself during the Revolutionary War. He was made adjutant-general of New York in 1786; supervisor of United States revenue in 1794, and president of the New York State Cincinnati Society in 1797.

Fish, Nicholas, American diplomatist: b. New York 19 Feb. 1848; d. there 16 Sept. 1902. He was educated at Columbia and the Harvard Law School, practised law in New York, became second secretary of legation in Berlin 1871, secretary in 1874, and in 1877–81 was *charge d'affaires* in Switzerland. From 1882 to 1886 he was United States minister to Belgium, and in 1887 entered the firm of Harriman & Company, bankers of New York. He was a son of Hamilton Fish (q.v.), the well-known secretary of state, and president of the New York chapter of the Society of the Cincinnati.

Fish. In the popular sense a fish is a cold-blooded, chordate or vertebrate animal, adapted for life in the water, breathing by means of gill-slits all its life, having its limbs, if present, developed as fins, never as fingers or toes. This definition excludes invertebrates as having no notochord and no backbone. It excludes the tunicates and enteropneustans as not fish-like in form when adult, and as being at all times without fins. It excludes the amphibians, because these develop, in the adult state, jointed limbs with toes, and most of them cease to breathe with gills or gill-slits. The fishes, as thus defined include all members of the groups known as the lancelets (*Leptocardii*), the lampreys (*Cyclostomi*), the sharks (*Elasmobranchii*), and the true fishes (*Teleostomi*), as also all of the varied series of extinct fish-like form. In technical writings the lancelets and the lampreys are usually excluded from the class *Pisces* or fishes, and many writers would still further limit the name of *Pisces* by the exclusion of sharks and skates, and also the chimæras (*Holocephali*). Still others exclude the *Dipneusta*, and the extinct *Placodermi* or *Ostracophori*, and *Arthrodira*. It is perhaps not necessary to regard *Pisces* or fishes as a technical term at all. In this case there is no violence in using the word fish as coextensive with the popular definition as given above. Taking this significance, we may recognize two classes of chordates (*Tunicata* and *Enteropneusta*) as lying below and to one side of the series of fishes, while this series is itself composed of nine classes or sub-classes unequal in size and in taxonomic value, *Leptocardii*, *Cyclostomi*, *Cyclia*, *Elasmobranchii*, *Ostracophori*, *Arthrodira*, *Crossopterygii*, *Dipneusta*, and *Actinopteri*. The first two groups differ widely from the others, and must in any scheme of classification be regarded as forming distinct classes. The last-named class or sub-class includes the great majority of recent fishes. The *Cycliæ*, *Ostracophori*, and *Arthrodira* are wholly extinct; the *Crossopterygii* and *Dipneusta* nearly so.

Taking the true fishes, or *Actinopteri*, as typical of the group, we see at once that these have the general structure of the higher vertebrates, but with less complexity of structure, with various adaptations that fit these animals for life in the water.

Form of the Body.— The body is in general boat-shaped, the head in the same axis, without neck in most cases, the shoulder-girdle being attached to the skull at the nape, and in the more specialized forms the pelvic girdle joined to the shoulder-girdle below. In this case the vertebral column might be held to consist of skull and tail only. The form is fitted for swift progress through the water. The body is longer than deep, and the greatest width is in front of the middle, leaving in most cases the compressed paddle-like tail to serve as the organ of locomotion. To all of these statements there are numerous exceptions. Most fishes depend on speed to secure their food or to escape from their enemies, but there are some which preserve themselves by lying prone on the bottom, by hiding in crevices of one sort or another, or which are defended from all attacks by pungent spines or by a bony coat of mail.

Exoskeleton of the Fish.— The surface of the fish is typically covered by an exoskeleton of overlapping scales. To this there are many exceptions. Some are naked, some covered with prickles, spines, or bony plates. The scales may be ganoid (enameled, like teeth), placoid (reduced to shagreen-like roughness), ctenoid (with a comb-edge), or cycloid (smooth, with concentric striæ), or they may be variously coalescent, forming bony plates. Historically the placoid scale precedes the ganoid scale. This is followed by the cycloid, and finally by the ctenoid type. Bony plates may be formed by the coalescence of scales of any type.

Fins of the Fish.— In most cases the motion of a fish is mainly produced by the lateral movement of the caudal or tail fin, the other fins exerting chiefly the function of direction. In the more primitive of existing fishes the different fins are composed of soft rays connected by membrane. The soft rays are finely jointed and usually branched, as distinguished from the spines, which are without branches or joints, and which are usually stiff and pungent. In the more specialized fishes spines are usually present, these occupying the front of the dorsal and

SPINY-FINNED FISHES (Chætodontidæ).

1. The Banner Fish (Chætodon setifer).
2. The Coral Fish (Chætodon fasciatus).
3. The Clipp Fish (Chætodon vittatus).
4. The Lash Fish (Heniochus macrolepidotus).
5. The Prince Fish (Chætodon diacanthus dux).
6. The Emperor Fish Chætodon imperator).

anal fins, the first ray of the ventral fin being also spinous.

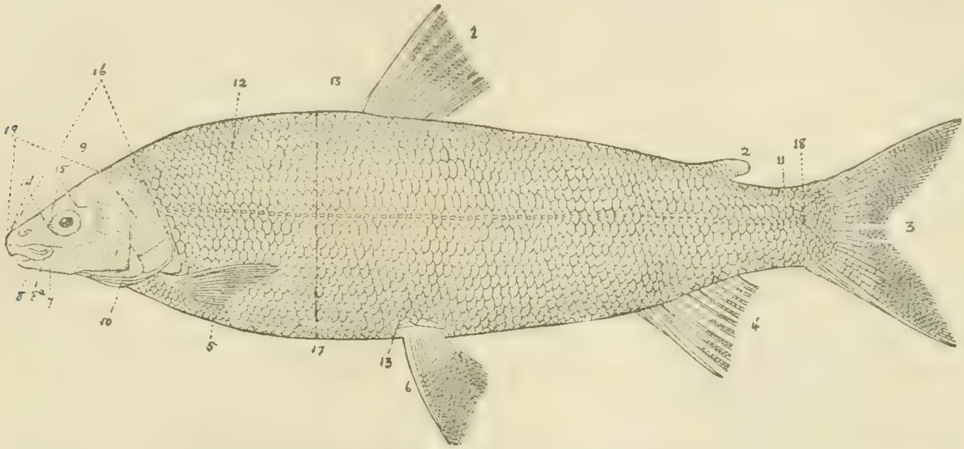
The fins usually present are of two kinds — the paired fins and the vertical fins. The paired fins are represented on either side of the body, the anterior or uppermost pair, the pectoral fins, representing in the fish the arms or forelegs of the higher vertebrates, the lower or posterior pair (ventral or pelvic fins) representing the hinder legs. The vertical fins are on the median line of the body, the dorsal on the back, the caudal on the tail, and the anal on the lower side behind the body cavity. Each of these fins is subject to great variation.

The vertical fins, with their appendages, arise from the modification and specialization of a dorsal median fold of skin. This is found in embryos and in the lancelet and other forms of low organization. It is generally believed that the paired fins, with the bones which support them, have been derived from a lateral fold of skin, similarly modified, and still more specialized. As to this, the evidence is much less complete than in the case of the vertical fins.

At the base of each ray or group of rays in the vertical fins, supporting bones are developed. These bones, called interspinal bones, stand in some definite relation to the bones of the vertebral column, to which, however, they are not directly joined.

The pectoral fin is attached, by means of certain intermediate bones, to the shoulder-girdle. The ventral fin is similarly joined to a pelvis. The pelvis in all the lower fishes is detached from the rest of the skeleton and placed beneath the body cavity. In the more specialized modern forms the pelvis is moved forward, usually connected with the shoulder-girdle, but sometimes attached at the throat well in front of the latter. In accordance with the insertion of the pelvis, the ventral fins are said to be *abdominal* (free from the shoulder-girdle), *thoracic* (connected with the shoulder-girdle), or *jugular* (in front of the shoulder-girdle).

Muscular System of the Fish.— The movement of the fins is accomplished through the agency of muscles. These organs lie band-like along the sides of the body, forming the flesh of the fish. They are little specialized, and not as clearly differentiated as in the higher vertebrates. In the typical fishes there are several distinct systems of muscles, controlling the jaws, the gills, the eyes, and the different fins. The largest of these is the great lateral muscle, composed of flake-like segments, these corresponding in general in number to the numbers of vertebræ. In general, the muscles are white in color and tender in substance. In a few fishes muscular tissues are modified into electric organs.



Great Lake Whitefish (*Coregonus clupeiformis*).
Showing the location of fins and mouth parts (after Jordan and Evermann).

1. Dorsal fin.
2. Adipose dorsal.
3. Caudal fin.
4. Anal fin.
5. Pectoral fin.
6. Ventral fin.
7. Lower jaw or mandible.
8. Upper jaw or maxillary.
8a. Supplementary maxillary.
9. Opercle.
10. Branchiostegals.
11. Caudal peduncle.
12. Lateral line.
13. Series of crosswise scales usually counted.
14. Snout.
15. Eye.
16. Head.
17. Depth of body.
18. Base of caudal.
19. Distance from snout to nape or occiput.

The skeleton of the fish is cartilaginous in the more primitive forms, bony in the more specialized types. In all cases the bones contain less of mineral matter than do the bones of the higher vertebrates.

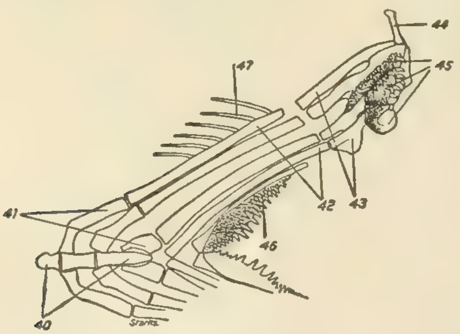
Skeleton of the Fish.— In the process of development the vertebral column is built up on a soft, cartilaginous cord extending lengthwise of the body, called the notochord. This exists in all young fishes, and is more or less completely persistent through life in the more primitive types, as the lamprey or the sturgeon. This notochord is not the backbone, but it indicates where the backbone is to be. In the higher forms the vertebræ are developed around it, strung spool-fashion, as it were, until finally in most recent fishes the original chord is entirely obliterated.

Explanation of plate of the skeleton of the striped bass (*Roccus lineatus*) after Edwin Chapin Starks.

1. Vomer.
2. Ethmoid.
3. Prefrontal.
4. Frontal.
5. Sphenotic.
6. Parietal.
7. Epiotic.
8. Supraoccipital.
9. Pterotic.
10. Opisthotic.

11. Exoccipital.
12. Basioccipital.
13. Parasphenoid.
14. Basisphenoid.
15. Prootic.
16. Alisphenoid.
17. Hyomandibular.
18. Symplectic.
19. Quadrate.
20. Pterygoid.
21. Palatine.
22. Mesopterygoid.
23. Metapterygoid.
24. Preopercle.
25. Opercle.
26. Subopercle.
27. Interopercle.
28. Articular.
29. Angular.
30. Dentary.
31. Maxillary.
32. Premaxillary.
33. Interhyal.
34. Epihyal.
35. Ceratohyal.
36. Basihyal.
37. Glossohyal.
38. Urohyal.
39. Branchiostegal.
40. Basibranchials.
41. Hypobranchials.
42. Ceratobranchials.
43. Epibranchials.
44. Suspensory pharyngeal.
45. Upper or Superior pharyngeals.
46. Lower or Inferior pharyngeals.
47. Gill-rakers.
48. Supraorbital.
49. Preorbital.
50. Suborbitals.
51. Nasal.
52. Supra-temporal.
53. Post-temporal.
54. Supraclavicle.
55. Clavicle.
56. Postclavicle.
57. Hypercoracoid.
58. Hypocoracoid.
59. Mesocoracoid.
60. Actnosts.
61. Pectoral Rays.
62. Pelvic Girdle.
63. Ventral Spine.
64. Abdominal vertebræ.
65. Caudal vertebræ.
66. Centrum.
67. Neuropophyses.
68. Neural spine.
69. Hæmapophyses.
70. Hæmal spine.
71. Zygapophyses.
72. Parapophyses.
73. Rib.
74. Epipleural spines or Epipleurals.
75. Interneural spines or Interneurals.
76. Dorsal rays and spines.
77. Interhæmal spines or Interhæmals.
78. Anal rays and spines.
79. Hypural.
80. Caudal rays.

The skull of the fish consists of a great variety of bones, the names of which are given on the accompanying plate. In the naming of the bones of the head and shoulder-girdle of fishes great confusion has arisen. This is due mainly to ineffective attempts to trace the homologies of these bones with bones occupying similar positions in the skeleton of man; while, no doubt, the skeleton of the higher vertebrates is derived by descent from that of primitive fishes, homologies can be traced only in a general way. The skull of the one corresponds to the skull of the other, but the specialized fishes have developed many more bones than were found in ancestral types, and many more than exist in man. In like fashion the shoulder-girdle in the one represents that of the other, but the fish has more bones than can be covered by the names scapula, coracoid, and clavicle.

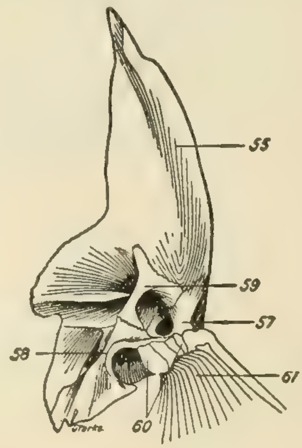


STRIPED BASS (*Roccus lineatus*). Branchial arches (after Starks).

40. Basibranchials.
41. Hypobranchials.
42. Ceratobranchials.
43. Epibranchials.
44. Suspensory pharyngeal.
45. Upper pharyngeal.

In the accompanying plate of the bones of the striped bass (after Edwin Chapin Starks) we use the terminology now adopted by Gill, Starks, and most American osteologists. The bones of the head may be roughly divided into those of the cranium, the jaws, the suspensory (of the lower jaw), the gill-structures, and the membrane-bones. The latter, on the outside of the head, are formed by ossification of the skin, and have no homologies among the higher vertebrates. They are also wanting in the sharks and lampreys.

The shoulder-girdle in the lower forms consists of an arch of cartilage. In the progress of specialization this is divided into several pieces as indicated in the plate. It is separate from the skulls in sharks and skates, as in the higher vertebrates. In the typical fishes its uppermost bone (post-temporal) is joined to the temporal bone of the cranium. In some groups it is immovably consolidated with the latter. In the eels, by a process of degeneration, it loses its connection with the skull. The pelvis in fishes usually consists of a single bone on either side, more or less fully coalesced with its fellow.



BUFFALO-FISH (*Ictiobus bubalus*). Inner view of shoulder-girdle, showing mesocoracoid arch.

55. Clavicle.
57. Hypercoracoid.
58. Hypocoracoid.
59. Mesocoracoid.
60. Actinosts.
61. Pectoral rays.

The vertebral column may be divided into abdominal and caudal vertebræ. The former have their lower processes divergent, to include the body cavity. In the caudal vertebræ, the hæmal processes unite, leaving opening only for the hæmal canal or place of the large artery. The neural processes of each vertebræ unite above the centrum or body of the vertebra, leaving space for the spinal cord. The pointed upper continuation of each is called the neural spine, as the downward projection is called the hæmal spine. In the primitive fishes generally the tail is extended to a point, the last vertebra being progressively reduced, and the caudal fin lying below the axis. This forms the heterocercal tail, characteristic of the shark, sturgeon, and of various extinct types of fish. In the modern types, the vertebræ cease more or less abruptly at the base of the caudal fin, the tail being homocercal.

The number of vertebræ is least in the more specialized, spiny-rayed fishes. In several families of these there are 24 vertebræ, 10 abdominal and 14 caudal. This number is much greater in all the soft-rayed and all the primitive forms. It is also materially increased by a process of degeneration in most arctic or subarctic derivatives from these families, and in general in fresh-water, pelagic, and deep-sea forms derived from forms having 24 vertebræ. In cold waters, fresh waters, and the oceanic abysses, the processes of competition called natural selection are apparently less active, and we have the phenomenon of reduction of parts with the increase in number of similar structures.

The cause for the vegetative increase in the numbers of vertebræ as we leave the tropical shores may perhaps be found in the reduction of the stress of natural selection. For such "cessation of selection" the name *panmixia* has been suggested by Dr. August Weismann. It should be noticed that the increase in the number of vertebræ is accompanied, necessarily, by the loss of importance and the reduction of specialization in each individual one. In this change the fin-rays usually share, there being a greater number, as a rule, in forms outside the tropics as compared with similar forms on warm shores.

Organs of Nutrition.— The organs of nutrition in the fish are generally homologous with those of higher vertebrates. Some fish feed exclusively on vegetable food. These have generally incisor-like teeth loosely planted in the gums, and a greatly elongate alimentary canal.

Most fishes feed on animal food, other fishes, crustaceans, mollusks, worms, insects, and whatever else may be found in the sea. The mouth and teeth are adapted to the kind of food, and the varieties in form and armature are even more varied than the forms of the body among fishes.

The mouth is usually capacious. It may have no teeth; it may have teeth on the jaws only, or any bone in its circumference may be armed with them. In most fishes additional teeth of one sort or another may be found on the pharyngeals, in the gullet behind the gills.

The stomach may be U-shaped — an opening at either end — or it may have the form of a blind sac, the two openings close together. Often glands, called pyloric cæca, secreting a digestive fluid, occur at the end of the stomach. The intestine may be a single tube, or it may be variously complicated, wound in spiral, or as in the sharks, having its surface increased by means of a spiral valve within. The liver, gall-bladder, and spleen are usually developed in fishes much as in the higher forms.

Fishes lack salivary glands. The tongue is cartilaginous or bony, with few nerves of taste, although taste buds may exist in the barbels, as in the cat-fish. Kidneys lie along the inner edge of the backbone, less specialized than in the higher vertebrates, their ducts leading into a common cloaca. In the lower fish-like forms (lancelets) the structures which serve the purpose of kidneys bear a close resemblance to similar glands (nephridia) in worms.

Organs of Respiration and Circulation.— In the lowest fish-like forms (lancelets), the heart is reduced to a simple pulsating tube. In the typical fishes it consists mainly of three parts, the auricle, the ventricle, and a thickened part of the large artery, known as the *bulbus arteriosus.* These parts correspond in a general way to right auricle and right ventricle in the higher vertebrates. The blood reaches the heart from the vein-system of the body. It is passed from auricle to ventricle, then sent through a large artery to the gills to be purified. From the gills it is distributed through the main artery or aorta to the different parts of the body, to be again gathered up from the capillaries into the veins.

It is not returned to the heart after purification, as in the higher vertebrates. Its flow is therefore relatively sluggish, and, as in reptiles and amphibians, its temperature is little above that of the environment. In some of the more primitive fishes the heart is more complex than in the typical forms, the arterial bulb being provided with a large number of valves.

All the chordate animals, including the tunicates and the *Enteropneusta,* have the purification of the blood effected through some form of gill-slit. In the lower forms these are merely slits, admitting water to the pharynx, where it comes in contact with thin membranes covering capillaries filled with blood.

In the typical fishes a much more elaborate apparatus is developed. There are usually five long bony arches attached to the cranium above and to the base of the tongue below. Each of these has two rows of slender filaments, the gills. The blood flows in and out of these filaments, where it comes in contact with the water. This water is swallowed through the mouth, and is forced out through the gill-opening. Behind the true gill-arches is a fifth arch, more or less similar, usually without gills, being modified to form a pair of gullet-jaws, the pharyngeals. On the anterior edge of the first gill-arch is a series of projections, sometimes forming a straining apparatus. These are the pharyngeals. A small accessory gill, the pseudobranchia, is usually developed on the inner side of the opercle or gill-cover.

In sharks and skates, the gills are fastened by their longer side, like the leaves of a book. In other groups there are many minor modifications.

In the sharks and skates there is no trace of lung or air-bladder. In the more primitive forms ancestral to the true fishes, there is a well-developed lung, which assists in the purification of the blood in exactly the same way as the lung of the higher vertebrates. Most of the forms known or supposed to possess lungs (*Dipneusta, Crossopterygii, Ganoideii*) are now extinct. In the few living forms with this character (*Neoceratodus, Lepidosiren, Protopterus, Polypterus, Lepisosteus,* and *Amia*) this lung is either of one or two lobes. It is connected by a trachea with the pharynx. In the earliest forms this windpipe opens below the œsophagus, as in the higher vertebrates, but in the other forms, the opening is transferred to the dorsal side. These early fishes were therefore literally amphibious, being capable both of breathing atmospheric air with the lungs, and the air dissolved in water, with the gills. There is little doubt that from some of these forms, probably crossopterygians, the whole series of land vertebrates is descended, while from the same stock has arisen the great body of the typical or bony fishes. In the former case we have the gradual obliteration of the gills, which are developed only in embryonic or larval stages. Among the typical fishes we have the gradual degeneration of the lung and the loss of its function as a breathing-organ.

In this case we have first the reduction of the lung to a single sac, the loss of its cellular structure. It assumes in the soft-rayed fishes the form of an empty sac, sometimes divided by a cross-constriction, the anterior part connected with the œsophagus by a very slender membranous tube. This tube is gradually lost in the spiny-rayed fishes, no trace of it usually existing except in the embryo. The airbladder is then a hollow sac, filled with air containing an excess of nitrogen, this air being secreted from the blood of the fish. The air-bladder has some value in enabling the fish to hold itself in place in the water. In pelagic fishes, and in fishes which habitually lie on the bottom, the air-bladder is often greatly reduced, or entirely obliterated, when the fish is fully developed. The different stages of the air-bladder must be looked on as steps toward the gradual loss of the lung, an organ which becomes progressively less important in the more complete adjustment of the fish to continuous life in the water.

The Organs of Sense.— The sense-organs of the fish correspond in general to those of the higher vertebrates. The sense of taste is, however, feeble, and that of hearing is muffled and without much power of acute discrimination. The sense of smell resides in the nostrils, which have no relation to the work of breathing. No fish breathes through its nostrils, and only in a few of the more generalized types does the nostril pierce through the roof of the mouth. In the bony fishes the nostrils are cavities, one on either side, lined with delicate or fringed membrane, well provided with blood-vessels, as with nerves from the olfactory lobe. In most cases each nasal cavity has two external openings, either simple or, with the rim of the nostril, forming a papilla or barbel. The openings may be round, slit-like, pore-like, or may have various other forms. In certain families of bony fishes there is but one opening to each nostril. In the sharks, rays, and chimæras there is also but one opening on either side, and the nostril is larger and highly specialized, with valvular flaps controlled by muscles which enable them "to scent actively as well as to smell passively."

In the lancelet there is a single median nostril, a small depression at the front of the body covered by ciliated membrane. In the hagfish the single median nostril pierces the roof of the mouth, and is strengthened by cartilaginous rings, like those of the windpipe. In the lamprey the single median nostril leads to a blind sac. In all other fishes there is a nasal sac on either side of the head. There is no doubt that the sense of smell in fishes is relatively acute, and that the odor of their prey attracts them to it. It is known that flesh, blood, or a decaying carcass will attract sharks, and other predatory fish are drawn in a similar manner. At the same time, the strength of this function is yet to be tested by experiments.

The Organs of Sight.— The eyes of fishes differ from those of the higher vertebrates mainly in the spherical form of the crystalline lens. This extreme convexity is necessary because the lens itself is not very much denser than the fluid in which the fishes live. The eyes vary much in size, and somewhat in form and position. They are larger in fishes living at a moderate depth than in shore-fishes or river-fishes. At great depths, as a mile or more, where all light is lost, they become aborted or rudimentary, and may be covered by the skin. Often species with very large eyes, making the most of a little light, or of light from their own luminous spots, will inhabit the same depths with fishes having very small eyes, or eyes useless for seeing, retained as vestigial structures through heredity. Fishes which live in caves become also blind, the structures showing every possible phase of degradation. The details of this gradual loss of eyes, either through reversed selection or hypothetically through inheritance of atrophy produced by disuse, have been given in a number of memoirs on the blind fishes of the caves of Kentucky, Missouri, and Cuba by Dr. Carl H. Eigenmann.

Many of the sharks possess a distinct nictitating membrane or special eyelid, moved by a set of muscles. The iris in most fishes surrounds a round pupil, without much power of contraction. It is frequently brightly colored, red, orange, black, blue, or green.

In the lowest of the fish-like forms, the lancelet, the eye is simply a minute speck coated by black pigment, connected with the spinal cord by a short nerve. In the development of such a pigment-spot the vertebrate eye doubtless has its origin. In the hagfishes, which stand next highest in the series, the eye, still incomplete, is very small and hidden by the skin and muscles. This condition is very different from that of the blind fishes of the higher groups, in which the eye is lost through atrophy, because in life in caves, or under rocks, the organ is no longer necessary.

The Ear of the Fish.— The ear of the typical fish consists of the labyrinth only, including the vestibule and three semi-circular canals, these dilating into one or more sacs which contain large, loose bones, the ear-stones or otoliths. There is no external ear, no tympanum, and no Eustachian tube. The ear-sac on each side is lodged in the skull or at the base of the cranial cavity. It is commonly surrounded by bone, but sometimes it lies near a fontanel or opening in the skull above.

The otoliths, two in each labyrinth, are usually large firm bones with enameled surface and peculiar grooves and markings. Each species has its peculiar type, but they vary much in different groups of fishes. The sense of hearing in fishes cannot be very acute, and is probably confined chiefly to the perception of disturbances in the water. Most movements of the fish are governed by sight rather than by sound.

Voices of Fishes.— Some fishes make distinct noises, variously described as quivering, grunting, grating, or singing. The name grunt is applied to species of *Hæmulon* and related genera, and fairly describes the sound these fishes make. The Spanish name *ronco* or *roncador* (grunter or snorer) is applied to several fishes, both sciænoid and hæmuloid. The noise made by these fishes may be produced by forcing air from part to part of the complex air-bladder, or it may be due to grating one on another of the large pharyngeals. The grating sounds arise, no doubt, from the pharyngeals, while the quivering or singing sounds arise in the air-bladder. The midshipman, *Porichthys notatus*, is often called singing-fish, from a peculiar sound it emits. These sounds may possibly be useful to the species, but they are not well differentiated, nor have they been so investigated as to be well understood.

Sense of Taste.— It is probably certain that fishes possess a sense of taste, though it is little differentiated, and is in some species located in the barbels about the mouth. The tongue is without delicate membranes or power of motion. In some fishes certain parts of the palate or pharyngeal region are well supplied with nerves, but no direct evidence exists that these have a function of discrimination among foods. Fishes swallow their food very rapidly, often whole; and mastication, when it takes place, is a crushing or cutting process, not one likely to be affected by the taste of the food.

Sense of Touch.— The sense of touch is better developed among fishes. Most of them flee from contact with actively moving objects. Many fishes use sensitive structures as a means of exploring the bottom, or of feeling their way to their food. The barbel or fleshy filament, wherever developed, is an organ of touch. In some fishes, as the moray, barbels are outgrowths from the nostrils. In the catfish the principal barbel grows from the rudimentary maxillary bone. In the horned dace and gudgeon the little barbel is attached to the maxillary. In other fishes barbels grow from the skin of the chin or snout. In the goat-fish and surmullet the two chin-barbels are highly specialized. In the cod-fish the single beard is little developed. In the gurnards and related forms, the lower rays of the pectoral are separate and barbel-like. Detached rays of this sort are found in the thread-fins, and in various other fishes. Barbels or fleshy flaps are often developed over the eyes, and sometimes on the scales or the fins.

The sense of pain is very feeble among fishes. A trout has been known to bite at its own eye, placed on a hook, and similar insensibility has been noted in the pike and other fishes. «The Greenland shark, when feeding on the carcass of a whale, allows itself to be repeatedly stabbed in the head when abandoning its prey.»

The Nervous System.— The nervous system in the fish, as in the higher vertebrates, consists of brain and spinal cord, with sensory or afferent and motor or efferent nerves. As in other vertebrates, the nerve-substance is divided into gray matter and white matter, or nerve-cells and nerve-fibres. In the fish, however, the whole nervous system is relatively small, its structures feeble, and the gray matter less developed than in the higher forms. According to Günther, the brain in the pike (*Esox*) forms but 1-1305th part of the weight of the body; in the burbot (*Lota*) about 1-720th part.

The cranium in fishes is relatively small, but the brain does not nearly fill its cavity, the space between the dura mater, which lines the skull cavity, and the arachnoid membrane, which envelops the brain, being filled with a soft fluid containing a quantity of fat.

It is most convenient to examine the fish-brain in its higher stages of development, as seen in the sun-fish, striped bass or perch. As seen from above, the brain of a typical fish seems to consist of five lobes or ganglia, four of them in pairs, the fifth posterior to these on the median line. The posterior lobe is the cerebellum or metencephalon, and it rests on the broadened termination of the spinal cord, called the medulla oblongata.

In front of the cerebellum lies the largest pair of lobes, each of them hollow, the optic nerves being attached to the lower surface. These are known as the optic lobes or mesencephalon. In front of these lie the two lobes of the cerebrum, also called the hemispheres, the prosencephalon. These lobes are usually smaller than the optic lobes and solid. In some fishes they are covered by a fold, but are never corrugated, as is the brain of the higher animals. In front of the cerebrum lie the two small olfactory lobes, which receive the large olfactory nerves from the nostrils.

In the hollow of the optic lobe are small protuberances, supposed to represent the corpora quadrigemina of the higher vertebrates. From its lower surface is suspended the hypophysis or pituitary gland.

In most of the bony fishes the structure of the brain does not differ materially from that seen in the perch. In the sturgeon, however, the parts are more widely separated, so that the connecting nerve-substance is more clearly seen between the several parts. In the dipnoans the cerebral hemispheres are united, while the optic lobe and cerebellum are very small. In the sharks and rays the large cerebral hemispheres are usually coalescent into one, and the olfactory nerves dilate into large ganglia below the nostrils. The optic lobes are smaller than the hemispheres and also coalescent. The cerebellum is very large, and the surface of the medulla oblongata is more or less modified or specialized.

Besides the structures noted in other fishes, the epiphysis or pineal organ is largely developed in sharks, and traces of it are found in most or all of the higher vertebrates. In some of the lizards this epiphysis is largely developed, bearin at its tip a rudimentary eye. This leaves no doubt that in these forms it has an optic function. For this reason the structure, wherever found, has been regarded as a rudimentary eye, and the «pineal eye» has been called the «unpaired median eye of chordate» animals.

It has been supposed that this eye, once possessed by all vetrebrate forms, has been gradually lost with the better development of the paired eyes, being best preservd in reptiles as «an outcome of the life-habit which concealed the animal in sand or mud and allowed the forehead surface alone to protrude, the median eye thus preserving its ancestral value in enabling the animal to look directly upward and backward.» In none of the fishes is the epiphysis more than a nervous enlargement, and neither in fishes nor in amphibia is there the slightest suggestion of its connection with vision. It seems probable, as suggested by Dr. Hertwig, that the original function of the pineal body was a nervous one, and that its connection with, or development into, a median eye in lizards was a modification of a secondary character.

The brain of the cyclostomes (hagfishes and lampreys) differs widely from that of the higher fishes, and the homologies of the different parts are still uncertain. The different ganglia are all solid and are placed in pairs. It is thought that the cerebellum is wanting in these fishes, or represented by a narrow commissure (*corpus restiforme*) across the front of the medulla. In the lancelet there is no trace of brain, the band-like spinal cord tapering toward either end.

The spinal cord extends from the brain to the tail, passing through the neural arches of the different vertebræ when these are developed. In the higher fishes it is cylindrical and inelastic. In a few fishes (head-fish, trunk-fish) in which the posterior part of the body is shortened or degenerate, the spinal cord is much shortened, and replaced behind by a structure called cauda equina. In the head-fish it has shrunk into "a short and conical appendage to the brain." In the cyclostomes and chimæras the spinal cord is elastic, and more or less flattened or band-like, at least posteriorly.

The nerves of the fish correspond in place and function with those of the higher animals. They are, however, fewer in number, both large nerve-trunks and smaller nerves being less developed than in higher forms. The olfactory nerves and optic nerves may be regarded as outgrowths of the brain. The olfactory nerves, or first pair, extend through the ethmoid bone to the nasal cavity, which is typically a blind sac, with two roundish openings, but is subject to many variations. The optic nerves, or second pair, extend from the eye to the base of the optic lobes. In cyclostomes these nerves run from each eye to the lobe of its own side. In the bony fishes or *Teleostei* each runs from the eye to the lobe of the opposite side. In the sharks, rays, chimæras, and ganoids the two optic nerves are joined in a chiasma as in the higher vertebrates. The other nerves arising in the brain need not be mentioned in detail.

A sympathetic system coresponding to that found in the higher vertebrates is found in all the *Teleostei* or bony fishes, and in the body of sharks and rays when it is not extended to the head.

The operations of the nervous system in fishes are essentially those of the higher vertebrates, the instincts being relatively weak and the intellect or power of choice among competing responses to external stimulus being apparently wanting. All acts of the fish may be regarded as reflex, the results of external stimulus or of stimulus arising within the body of the fish. These actions in each species tend to run in grooves or to be repeated in a special way for each species. These ways constitute the habits of the fish.

Organs of Reproduction.— In most fishes the germ-cells are produced in large sacs (ovaries, testes) arranged symmetrically one on either side of the posterior part of the abdominal cavity. The sexes are generally but not always similar externally, and may be distinguished on dissection by the difference between the sperm-cells and the ova. The ovary with its eggs is more yellow in color and the contained cells appear granular. The testes are whitish or pinkish, their secretion milk-like and, to the naked eye, not granular.

In a very few cases both organs have been found in the same fish as in Serranus, but all fishes seem to be normally diœcious, the two sexes in different individuals. There are no external genital organs, but in some species a papilla or tube is developed at the end of the urogenital sinus. This may exist in the breeding season only, as in fresh-water lampreys, or it may persist through life, as in some gobies.

The great majority of fishes are oviparous, the egg-cells being fertilized after deposition. The eggs are laid in gravel or sand or other places suitable for the species, and the milt or sperm-cells of the male is discharged over or among them in the water. A very small quantity of the sperm-fluid may impregnate a large number of eggs. In a number of families the species are ovoviviparous, the eggs being hatched in the ovary or in a dilated part of the oviduct. In no case is a real uterus developed. In the case of viviparous fishes actual copulation takes place, and there is usually a modification of some organ to effect transfer of the sperm-cells. This may be the sword-shaped form of the anal fin in many top-minnows, the fin itself being placed in advance of its usual position.

It may be an alteration of the structure of part of the anal fin as in the surf-fishes (*Embiotocidæ*); or, as in the *Elasmobranchi,* large bony organs (claspers) may be developed from the ventral fins.

In some viviparous fishes, as the rock-fishes and rose-fishes, the young fishes are very minute at birth. In others, as the surf-fishes, they are relatively large and few in number. In the viviparous sharks, which constitute the majority of the species, the young are large at birth and prepared to take care of themselves.

The eggs of fishes vary much in size and form. In those sharks and rays which lay eggs the ova are deposited in a horny egg-case, in color and texture suggesting the kelp in which they are laid. The eggs of the bull-head sharks (*Heterodontus*) are spirally twisted, those of the cat-sharks (*Scyliorhinidæ*) quadrate, with long filaments at the angles. Those of rays are wheelbarrow-shaped, with four handles. One egg-case may sometimes contain several eggs, and develop several young. The eggs of lancelets are small, but those of hagfishes and lampreys are large, ovate, with fibres at each end, each with a triple hook at tip. The chimæras have also large egg-cases, oblong in form.

In the higher fishes the eggs are spherical, large or small according to the species, and varying in the firmness of their outer walls. All contain food-yolk from which the embryo in its earlier stages is fed. The eggs of the eel (*Anguilla*) are microscopic. According to Günther, 25,000 eggs have been counted in the herring, 155,000 in the lumpfish, 3,500,000 in the halibut, 7,635,200 in the sturgeon, and 9,344,000 in the cod. Smaller numbers are found in species with large ova. Where an oviduct is present, the eggs are often poured out in glutinous masses, as in the bass. When, as in the salmon, there is no oviduct, the eggs lie separate and do not cohere together. It is only with the latter class of fishes, those in which the eggs remain distinct, that artificial impregnation and hatching are practicable. In this regard, the value of the salmon and trout is pre-eminent. In some fishes the ovary of but one side is developed.

In most fishes the parents take no care of their eggs or young. In a catfish (*Bunocephalus*) the eggs adhere to the under surface of the females. In a kind of pipefish (*Solenostomus*) a large pouch for retention of the eggs is formed on the belly of the female. In the sea-horses and pipefishes a pouch is formed in the skin, usually underneath the tail of the males. Into this the eggs are thrust, and here the young fishes hatch out, remaining until large enough to take care of themselves.

In certain sea catfishes the male carries the eggs in his mouth, thus protecting them from the attacks of the female. In numerous cases the male constructs a rough nest, which he defends against all intruders, against the female as well as against outside enemies. The nest-building habit is especially developed in the sticklebacks (*Gasterosteidæ*), a group in which the male fish, though a pigmy in size, is very fierce in disposition. In a minnow of Europe (*Rhodeus amarus*) the female is said to deposit her eggs within the shells of river mussels.

In the relatively few cases in which the sexes are unlike, the male is usually the brighter in color and with more highly developed fins. Blue, red, black, and silvery white pigment are especially characteristic of the male, the olivaceous and mottled coloration of the female. Sometimes the male has a larger mouth, or better developed crests, barbels, or other appendages. In some species the pattern of coloration in the two sexes is essentially different.

In various species the male develops peculiar structures not found in the female, and often without any visible purpose. In the male chimæra, a peculiar cartilaginous hook, armed with teeth at the tip, is developed in the male only. In the skates or true rays (*Raja*) the pectoral fin has near its edge two rows of stout incurved spines. These the female lacks.

In the breeding season the male sometimes becomes much brighter by the accumulation of bright red or blue pigment, black or white pigment-cells. This is especially true in the minnows, darters, and other fresh-water species which spawn in the brooks of northern regions in the spring. In the minnows and suckers horny excrescences are also developed on head, body, or fins, to be lost after the deposition of the spawn.

In the salmon, especially those of the Pacific, the adult male becomes greatly distorted in the spawning season, the jaws and teeth being greatly elongated, and hooked or twisted so that the fish cannot shut its mouth. After the act of spawning, all the individuals of these species die, both male and female. The Atlantic salmon and the trout show also some elongation of the jaws, but not to the same extent, and in these species the individuals mostly survive the act of spawning.

In fishes generally the eggs are laid in the spring, to be hatched in warming water. Among the salmon, trout, and cod-fishes, a reverse condition obtains. The eggs are laid in fall or winter, being deposited in water which is growing colder, hatching when the temperature of 54° F. is passed. In those fishes which pair, the relation seems not to be permanent, nor is anything to be called affection recorded among them.

Embryology and Growth of Fishes.— The egg of the fish develops only after fertilization, the union of its nuclear substance with that of a sperm-cell from the male. When this process, known as amphimixis, takes place, the egg is ready to begin its segmentation. The eggs of all fishes contain more or less of food-yolk attached to the structures of the germ-cell proper and included with it in the same spherical mass. The presence of this food-yolk affects the manner of segmentation.

The process of cell-division or segmentation common among fishes need not be described in detail, as it is essentially that of the higher vertebrates. When the food-substance or yolk is consumed, and the little fish is able to shift for itself, it leaves the egg-envelopes and is said to be hatched.

The young fish usually differs from the adult chiefly in size and proportions. The eye is larger, the head larger, the fins are lower, the appendages less developed, and the body more slender in the young than in the adult. But to most of these distinctions there are numerous exceptions, and in some fishes there is a change so marked as to be fairly called a metamorphosis. In such case the young fish in its first condition is properly called a larva. The larva of the lamprey (*Petromyzon*) is nearly blind and toothless, with slender head, and was long supposed to belong to a different genus from the adult. The larva of sharks and rays and of some dipnoans are provided with bushy external gills, which disappear in the process of development. In most soft-rayed fishes the embryonic fringe, which precedes the development of the vertical fins, persists for a considerable time.

Hybridism is very rare among fishes in a state of nature. Two or three peculiar forms among the snappers (*Lutianus*) in Cuba seem fairly attributable to hybridism, the single specimen of each showing a remarkable mixture of characters belonging to two common species. Hybrids may be readily made in artificial impregnation among those fishes with which this process is practicable. Hybrids of the different salmon or trout usually share nearly equally the traits of the parent species.

The age of fishes is seldom measured by a definite period of years. Most of them grow as long as they live, and apparently live until they fall victims to some stronger species. It is reputed that carp and pike have lived for a century, but the evidence needs verification. Some fishes, as the salmon of the Pacific (*Oncorhynchus*) have a definite period of growth (usually four years) before spawning. After this act all the individuals die — so far as known — without exception.

Fishes differ greatly in tenacity of life. In general, fishes of the deep seas die at once if brought near the surface. This is due to the reduction of pressure. This forces the stomach out through the mouth and may burst the air-bladder and the large blood-vessels. Marine fishes usually die very soon after being drawn out from the sea. Some fresh-water fishes are very fragile, dying soon in the air, often with injured air-bladder or blood-vessels. They will die even sooner in foul water. Other fishes are extremely tenacious of life. The mud-minnow (*Umbra*) is sometimes plowed up in the half-dried mud of Wisconsin prairies. The related Alaska black-fish (*Dallia*) has been fed frozen to dogs, and has escaped alive from their stomachs after being thawed out. Many of the catfishes (*Ameiurus*) will live after lying half-dried in the dust for hours. The dipnoan (*Lepidosiren*) lives in a ball of half-dried mud during the dry season, and the fishes, mostly Asiatic, with accessory breathing organ, can long maintain themselves out of water.

Some fishes can readily resist starvation, while others succumb as readily as a bird or mammal. The limits of distribution of many fishes are marked by changes in temperature. Few marine fishes can endure any sudden or great change in this regard, although fresh-water fishes adapt themselves to the seasons. Those fishes which are tenacious of life and little sensitive to changes in climate and food are most successfully acclimatized or domesticated. The Chinese carp (*Cyprinus carpio*) and the Japanese goldfish (*Carassius auratus*) have been naturalized in almost all temperate and tropical river-basins. Within the limits of clear, cold waters, most of the salmon and trout are readily transplanted. But some of these, as the grayling, are very sensitive to the least change in conditions. Most of the catfish (*Siluridæ*) will thrive in almost any fresh waters except those which are very cold.

The eggs of many salmon placed on ice to retard their development have been successfully transported to great distances. The king salmon has been thus transferred from California to Australia. It has been found possible to stock rivers and lakes with desirable species, or to restock those in which the fish-supply has been partly destroyed, through the means of artificially impregnated eggs.

Fishes have little power to reproduce lost parts. Only the tips of fin-rays or filaments are thus restored after injury. Sometimes a fish in which the tail has been bitten off will survive the injury. The wound will heal, leaving the animal with a truncate body, fin-rays sometimes arising from the wounds.

Fishes as Food for Man.— Among all races of men fishes are freely eaten as food, either raw, as preferred by the Japanese and Hawaiians, or else as cooked, salted, dried, or otherwise preferred.

The flesh of most fishes is white, flaky, readily digestible, and with an agreeable flavor. Some, as the salmon, are charged with oil, which tends to give an orange hue known as salmon-color. Others have colorless oil which may be of various consistencies. Some have dark red flesh, which usually contains a heavy oil that becomes acrid when stale. Some fishes, as the sharks, have tough, coarse flesh. Some have flesh which is watery and coarse; some are watery and tasteless. Some, otherwise excellent, have the muscular area, which constitutes the chief edible part of the fish, filled with small bones.

The writer has tasted most of the noted food fishes of the northern hemisphere. First in the ranks as a food-fish (when properly cooked, for he is no judge of raw fish) he would place the eulachon or candlefish (*Thaleichthys pacificus*). This little smelt, about a foot long, ascends the Columbia River, Frazer River, and streams of Southern Alaska in the spring, in great numbers, for the purpose of spawning. Its flesh is white, very delicate, charged with a white and very agreeable oil, readily digested, and with a sort of fragrance peculiar to the species.

Next to this he is inclined to place the ayu (*Plecoglossus altivelis*), a sort of dwarf salmon, which runs in similar fashion in the rivers of Japan and Formosa. The ayu is about as large as the eulachon, and has similar flesh, but with little oil and no fragrance.

Very near the first among sea-fishes must come the pompano (*Trachinotus carolinus*) of the Gulf of Mexico, with firm, white, finely flavored flesh.

The red surmullet of Europe (*Mullus barbatus*) has been long famed for its delicate flesh, and may perhaps be placed next. Two related species in Polynesia, the *Pseudupeneus bifasciatus* and *Pseudupeneus porphyreus*, are scarcely inferior to it.

Side by side with these belongs the whitefish (*Coregonus clupeiformis*) of the Great Lakes. Its flesh, delicate, slightly gelatinous, moderately oily, is extremely agreeable. It has long been known among hunters that one can eat the flesh of this fish longer than any other without the feeling of cloying. The salmon cannot be placed in the front rank because, however, excellent, the stomach soon becomes tired of it.

The Spanish mackerel (*Scomberomorus maculatus*), with flesh at once rich and delicate; the great opah (*Lampris luna*), still richer and more delicate; the bluefish (*Pomatomus saltatrix*), similar, but a little coarser; and the kingfish (*Scomberomorus cavalla*) firm and well-flavored, represent the best of the fishes allied to the mackerel.

The shad (*Alosa sapidissima*), with its sweet, tender, finely oily flesh, stands also near the front among food-fishes, but it runs above all others in the matter of small bones. The weakfish (*Cynoscion regalis*) and numerous relatives rank first among those with tender, white, savorous flesh. Among the bass and perch-like fishes, common consent places near the first the striped bass (*Roccus lineatus*), the bass of Europe (*Dicentrarchus labrax*), the susuki of Japan (*Lateolabrax japonicus*), the red tai of Japan (*Pagrus major*), the sheepshead (*Archosargus probatocephalus*), the muttonfish or pargo criollo of Cuba (*Lutianus analis*), the European porgy (*Pagrus pagrus*), the uku (*Aprion virescens*) of Hawaii, the spadefish (*Chætodipterus faber*), and the black bass (*Micropterus dolomieu*).

The various kinds of trout have been made famous the world over. All are attractive in form and color; all are gamy; all have the most charming of scenic surroundings; and finally, all are excellent as food-fishes — not in the first rank, perhaps, but well above the second. Notable among these are the European charr (*Salvelinus alpinus*), the American speckled trout (*Salvelinus fontinalis*), the dolly varden (*Salvelinus malma*), and the oquassa trout (*Salvelinus oquassa*). Less attractive are the true trout, the brown trout or Forelle in Europe (*Salmo fario*); the rainbow trout (*Salmo irideus*), the steelhead trout (*Salmo gairdneri*), the tahoe trout (*Salmo henshawi*), and the cutthroat trout (*Salmo clarkii*) in America; and the yamabe (*Salmo perryi*) of Japan. Not least of all these is the grayling (*Thymallus*), of different species in the streams of northern regions.

All these are the choicest prizes of the angler, and they have few rivals in any part of the world. Other most excellent food-fishes are the eel (*Anguilla* species), the sole of Europe (*Solea solea*), the pike (*Esox lucius*), the muskallonge (*Esox masquinongy*), the sardine (*Sardinia pilchardus*), the atka-fish (*Pleurogrammus monopterygius*) of Bering Sea, the pescado blanco (*Chirostoma estor* and other species) of Lake Chapala in Mexico, the Hawaiian mullet (*Mugil cephalus*), the California pesce rey (*Atherinopsis californiensis*), the Channel catfish (*Ictalurus furcatus*), the turbot (*Psetta maxima*), the barracuda (*Sphyræna*), and the young of various sardines and herring known as whitebait. Of large fishes, probably the swordfish (*Xiphias gladius*), the halibut (*Hippoglos-*

sus hippoglossus), and the king-salmon or quinnat (*Oncorhynchus tschawytscha*) may be placed first. Those who feed on raw fish prefer, in general, the large parrot-fishes (as *Pseudoscarus jordani*) in Hawaii, or else the young of mullet and similar species.

In general, the economical value of any species depends not on its toothsomeness, but on its abundance and the ease with which it may be caught and preserved.

It is said that more individuals of the herring (*Clupea harengus* in the Atlantic; *Clupea pallasii* in the Pacific) exist than of any other species. The herring is a good food-fish, and wherever it runs it is freely caught. According to Björnson, wherever the schools of herring touch the coast of Norway, there a village springs up, and this is true in Scotland, Newfoundland, and from Killisnoo in Alaska to Otaru in Japan and to Strielok in Siberia. Goode estimates the herring product of the North Atlantic at 1,500,000,000 pounds annually. In 1881, Prof. Huxley used these words:

> It is said that 2,500,000,000, or thereabouts, of herrings are every year taken out of the North Sea and the Atlantic. Suppose we assume the number to be 3,000,000,000 so as to be quite safe. It is a large number, undoubtedly, but what does it come to? Not more than that of the herrings which may be contained in one shoal, if it covers half a dozen square miles, and shoals of much larger size are on record. It is safe to say that scattered through the North Sea and the Atlantic, at one and the same time, there must be scores of shoals, any one of which would go a long way toward supplying the whole of man's consumption of herrings.

The codfish (*Gadus callarias* in the Atlantic; *Gadus macrocephalus* in the Pacific) likewise swarms in all the northern seas, takes the hook readily, and is better food when salted and dried than it is when fresh.

Next in economic importance probably stands the mackerel of the Atlantic (*Scomber scombrus*), a rich oily fish which bears salting better than most.

Scarcely less important is the great king-salmon or quinnat (*Oncorhynchus tschawytscha*) and the blueback salmon or red salmon (*Oncorhynchus nerka*). The canned product of the latter in Alaska alone amounts to nearly $5,000,000 annually.

The salmon of the Atlantic (*Salmo salar*), the various species of sturgeon (*Acipenser*), the sardines (*Sardinia*), the halibut (*Hippoglossus*), are also food-fishes of great importance.

In the tropics no one species is represented by enormous numbers of individuals, as is the case in colder regions. On the other hand, the number of species regarded as food-fishes is much greater in any given part. In Havana about 350 different species are sold as food in the markets, and an equal number are found in Honolulu. Upward of 600 different species appear in the markets of Japan. In England, on the contrary, about 50 species make up the list of fishes commonly used as food. Yet the number of individual fishes is probably not greater about Japan or Hawaii than on a similar stretch of British coast.

Catching Fishes.— In general, fishes are caught in four ways, by baited hooks, by spears, by traps and by nets. Special local methods, such as the use of the tamed cormorant, in the catching of the ayu, by the Japanese fishers at Gifu, may be set aside for the moment, and all general methods of fishing come under one of these four classes.

Of these methods, the hook, the spear, the seine, the beam-trawl, the gill-net, the purse-net, the sweep-net, the trap, and the weir are most important. The use of the hook is again extremely varied. Sometimes for codfish long sunken lines, each baited with many hooks, are used. For pelagic fish a baited hook is drawn swiftly over the surface, with a "spoon" attached which looks like a living fish. In the rivers the line is attached to a pole, and when fish are caught for pleasure or for the joy of being in the woods, recreation rises to the dignity of angling. Angling may be accomplished with a hook baited with an earthworm, a grasshopper, or the larva of some insect. The angler of to-day, however, prefers the artificial fly, as being more workman-like and also more effective than bait-fishing.

With the multiplicity of apparatus for fishing, there is the greatest variety in the boats which may be used. The fishing fleet of any part of the world is a most interesting object, as are also the fishermen with their quaint garb, plain speech, and their strange songs and calls with the hauling-in of the net.

Evolution of Fishes.— When a fish dies its body is at once attacked by hundreds of creatures ranging from the one-celled protozoa and bacteria to individuals of its own species. Its flesh is devoured, the bones are scattered, the gelatinous substance in them decays, and the phosphate of lime is in time dissolved in the water. For this reason few fishes of the millions that die each year leave any trace for future preservation. At the most, a few teeth, a fin-spine, or a bone buried in the clay might remain intact or in such condition as to be recognized.

But now and then it happens that a dead fish may fall in more fortunate conditions. On a sea-bottom of fine clay the bones, or even the whole body, might be buried in such a way as to be sealed up and protected from total decomposition. The flesh would in any case disappear and leave no mark, or at the most a mere cast of its surface. But the hard parts might persist, and now and then they do persist, the lime unchanged or else silicified or subjected to some other form of chemical substitution. Only the scales, the teeth, the bones, the spines and the fin-rays can be preserved in the rocks of sea or lake bottom. In a few localities, as Fossil Station, near Green River, Wyo., Monte Bolca in Tuscany, and Mount Lebanon in Syria, and in lithographic slates in Germany, many skeletons of fishes have been found pressed flat in layers of very fine rock, their structures traced as delicately as if actually engraved on the smooth stone. Fragments preserved in ruder fashion abound in the clays and even the sandstones of the earliest geological ages. In most cases, however, fossil fishes are known from detached and scattered fragments, many of them, especially of the sharks, by the teeth alone. Fishes have occurred in all ages from the Lower Silurian or Ordovician to the present time, and no doubt the very first lived before the Silurian.

No one can say what the earliest fishes were like, nor do we know their real relation to the worms, their presumable ancestors, nor to the tunicates and other chordate forms, not fish-like, but still degenerate relatives of the primitive fish.

From analogy we may suppose that the first fishes which ever were, bore some resemblance to the lancelet, for that is a fish-like creature with every structure reduced to its lowest terms. But as the lancelet has no hard parts, no bones, nor teeth, nor scales, nor fins, no traces of its kind are found among the fossils. If the primitive fish was like it in important respects, all record of it has necessarily vanished from the earth.

The next group of living fishes, the cyclostomes, including the hagfishes and lampreys, fishes with skull and brain but without limbs or jaws, stands at a great distance above the lancelet in complexity of structure, and equally far from the true fishes in its primitive simplicity. In fact, the lamprey is farther from the true fish in structure than a perch is from an eagle. Yet for all that, it may be an offshoot from the primitive line of fish-descent. There is not much in the structure of the lamprey which may be preserved in the rocks and no trace of fossil lamprey is actually known to exist.

The oldest unquestioned fragments of fishes have been very lately made known by Charles D. Walcott, from rocks of the Trenton Period in the Ordovician or Lower Silurian. These are from Cañon City, Col. Among these is certainly a small ostracophore (*Asterapis desiderata*). With it are fragments of a vertebral column, thought doubtfully to belong to an extinct type of chimæras (*Dictyorhabdus*) and other fragments of bony plates, referred with some doubt to the crossopterygian genus *Eriptychius*. This renders certain the existence of ostracophores at this early period, and their association with chimæras and primitive sharks is also probable. These early remains were from shallow, muddy water, more favorable perhaps for ostracophores than for sharks.

The fish-remains next in age in America are from the Bloomfield sandstone in Pennsylvania, of the Onondaga Period in the Silurian; the earliest in Europe are found in the Ludlow shales, both of these being in or near the horizon of the Niagara rocks, in the Upper Silurian Age.

It is, however, certain that these Ordovician remains do not represent the beginning of fish-life. Doubtless sharks, ostracophores and arthrodires, with perhaps chimæras, crossopterygians, and dipnoans existed at a far earlier period, preceded by unarmed, limbless forms, without jaws, of which no trace whatever has been left.

Next appear more or less simultaneously, in the early or middle Silurian, fin-spines, thought to belong to primitive sharks, remains of acanthodean and other sharks, and with these numerous bony shields of the mailed ostracophores, and somewhat later those of the more highly specialized arthrodires. Later appear cestraciont sharks, chimæras, dipnoans, and crossopterygians.

In the Devonian Age the ostracophores increase in size and abundance, disappearing with the beginning of the Carboniferous. The arthrodires also increase greatly in variety and in size, reaching their culmination in the Devonian, but not disappearing entirely until well in the Carboniferous.

These two groups (often united by geologists under the older name placoderms, given by McCoy), together with sharks and chimæras, made up almost exclusively the rich fish-fauna of Devonian times. The sharks were chiefly acanthodian and cladoselachean (*Pleuropterygii*), so far as our records show. The supposedly most primitive known type, that of *Cladoselache*, appeared in the middle Devonian. The *Ichthyotomi* (*Pleuracanthus*), sometimes regarded as still more primitive, are not known before the Carboniferous. In any case it is clear that the records of early shark-life are still incomplete. Chimæroids abound in the Devonian, and with them a considerable variety of crossopterygians and dipnoans. The true fishes appear also in the Devonian, in the guise of ganoid ancestors and relatives of *Palæoniscum*, all these with diamond-shaped enameled scales. In the Devonian, too, we find the minute, lamprey-like forms, our ignorance of which is concealed under the name *Cycliæ*.

In the Carboniferous Age the sharks increase in number and variety, the ostracophores disappear, and the arthrodires follow them soon after, in the Permian. Other forms of dipnoans, crossopterygians, and some ganoids follow, giving the fauna a somewhat more modern aspect. The *Acanthodei* and *Ichthyotomi* pass away with the Permian, which follows the period of coal.

In the Triassic the earlier types of ganoids give place to forms approaching the gar-pike and sturgeon. The crossopterygians rapidly decline. The dipnoans are less varied and fewer in number, and notidanoid sharks make their first appearance. All the ancient types of shark meanwhile have passed away, the *Cestraciontes* being the only group continued from the Permian to the Triassic. Here are found the first true bony fishes, derived from ganoid stock, the allies and predecessors of the great group of herrings. These become more numerous in the Jura, and in this age appear other forms which give the fish-fauna of this period something of a modern appearance. In this age the sharks become divided into several groups, *Notidani*, cat-sharks, lamnoid sharks, angel-fishes, skates, and finally typical sharks, being well differentiated from each other. Chimæras are still numerous. The *Acanthodei* have passed away, as well as the mailed ostracophores and arthrodires. The dipnoans and crossopterygians are few. The early ganoids have given place to more modern types, still in great abundance and variety.

This condition continues into the Cretaceous Period. Here the rays and modern sharks increase in number. The ganoids hold their own, and other groups of soft-rayed fishes, as the smelts, the lantern-fishes, the pike, and the flying-fishes, join the group of herring-like forms which represent the modern bony fishes. In the Cretaceous appear the first spiny-rayed fishes, derived perhaps from pike-like forms, the ancestors of the living genus *Beryx*. From the berycoids spring the perch-like and mackerel-like forms so numerous in recent times.

In the Eocene great changes have taken place. The early families of bony fishes nearly all disappear. The herring, pike, smelt, salmon, flying-fish and berycoids remain, and a multitude of others seem to spring up to join them. Among these are the bowfins, the globe-fishes, the trigger-fishes, the catfishes, the eels, the butterfly-fishes, the porgies, the perch, the bass, the pipe-fishes, trumpet-fishes, the mackerels, and the John-dory, with the sculpins, the anglers, the flounders, the blennies, and the cods. That all these groups, generalized and specialized, arose at once is impossible, although all seem to date from Eocene times. Doubtless all of them had their origin in earlier times, and the simultaneous appearance is related to the fact of the thorough study of Eocene shales which have in numerous localities (Green River, London, Monte Bolca, Licata, Mount Lebanon) been especially favorable for the preservation of their forms. Practically fossil fishes have been studied only in a very few parts of the earth. Scotland, England, Germany, Italy, Switzerland, Syria, Ohio, and Wyoming have furnished the great bulk of all the fish-remains in existence. In some regions perhaps collections may be made which will give us a more just conception of the origin of the different groups of bony fishes. We can now only say with certainty that the modern families were largely existent in the Eocene, that they sprang from ganoid stock, found in the Trias and Jura, that several of them occurred in the Cretaceous also, that the berycoids were earliest of the spiny-rayed fishes, and forms allied to herring the earliest of soft-rayed forms. Few of the modern genera go back to the Eocene; many of them arose in the Miocene; and few species have come down to us from rocks older than the end of the Pliocene. The general modern type of the fish-faunas being determined in the later Cretaceous and the Miocene, the changes which bring us to recent times have largely concerned the abundance and variety of the individual species. From geological distribution we have arising the varied problems of geographical distribution, and the still more complex conditions on which depends the extinction of species and of types.

For much information on the fishing apparatus in use in America, the reader is referred to the reports of the Fisheries in the 10th census (1880), under the editorship of Dr. G. Brown Goode. In these reports Goode, Stearns, Earll, Gilbert, Bean, and the present writer have treated very fully of all economic relations of the American fishes. In an admirable work entitled 'American Fishes' Dr. Goode has fully discoursed of the food and game fishes of America, with especial reference to the habits and methods of capture of each. To these sources, and to many others of similar purport in other lands, the reader is referred for an account of the economic and the human side of fish and fisheries. See FISHES, GEOGRAPHICAL DISTRIBUTION OF; ICHTHYOLOGY.

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Fish Commission, in the United States, a bureau of the Department of Commerce and Labor, created by Congress in 1870, headed by the commissioner of fish and fisheries, with an assistant commissioner. It collects statistics of fisheries in the country, investigates the life histories and food of fish, and conducts experiments.

Fish-crow, a small species of crow (*Corvus ossifragus*), with a violet-green head, of the Atlantic coast, where it limits its wanderings to the sea-coast and tidal rivers, finding its food mainly along the beaches. It is perhaps the most destructive robber of birds' nests in the country. A similar species inhabits Cuba.

Fish Culture, or **Pisciculture**, the artificial propagation, fertilization, breeding, rearing, training and protecting of fishes, particularly food-fish. The art or industry was known in the early ages in China, and later in Germany and Sweden. In 1350, a monk, Dom Pinchon, hatched fish eggs by an artificial process, but the honor of introducing the modern plan of propagation is generally conceded to Stephen L. Jacobi, a Prussian soldier of Westphalia, who, in 1763, devised the process now in use in Europe and the United States, of stripping the ova from the female fish and mixing them with milt taken from the male. Fifty years after Jacobi's discovery, Joseph Remy, a fisherman of the Vosges Mountains, made the further discoveries upon which the culture depends — that the impregnation of fish eggs differs from that of all other oviparous animals in taking place after the eggs have left the body of the creature, and can therefore be performed as well artificially as by the animals themselves.

The first government fish culture station was established in 1850 at Hüningen, Alsace, and the following year a similar institution was established on the Tay in Great Britain. The process was introduced in the United States in 1865, when Dr. Garlick of Cold Springs, N. H., imported salmon eggs from Canada to hatch in the waters of his trout ponds. The process was also introduced in other sections of the country. The United States Commission of Fish and Fisheries, established by Congress 9 Feb. 1871, embraced in the scope of its work "the propagation of useful food-fishes, including lobsters, oysters, and other shellfish, and their distribution to suitable waters."

Technically, the process now in use consists in taking the ripe eggs from the female fishes and the milt from the male, mixing them artificially, and leaving them until impregnation has been effected, after which the eggs separate of themselves, and are placed in water, washed and treated in different ways according to the species or variety of the fish. Those of the salmon are placed in a filter-box or trough, through which passes a stream of pure water, and left to hatch into "fry," which process takes from 35 to 70 days. The advantage of pisciculture consists in the saving of multitudes of eggs which would otherwise be lost, the protection of the young fish from the dangers incident to their exposed condition, and the transplantation of species and varieties to other localities, where they soon become naturalized.

The operation for obtaining the ova and milt consists simply in pressing the body of the fish from the head toward the tail, and in collecting the excluded particles in a common vessel; the contents are occasionally put in motion in order to prevent the growth of parasites upon the eggs, which are very sure to destroy them. A low temperature and even desiccation is not necessarily fatal, so that many kinds in a nearly mature state may be transported for considerable distances. It has been estimated that 1,000,000 trout may be raised in this way at a cost of less than $200. Fish readily adapt themselves to new localities. Pickerel were easily introduced into ponds in Berkshire County, Mass., and the great pike of the northern lakes have been transplanted to the Connecticut River. The salt water smelt lives contentedly in ponds at Jamaica, Mass., and the tantog has found a new home in Massachusetts Bay. The expense of fish culture is small and the labor slight. There have been numerous inventions to aid the fish culturist, among them McDonald's fish-hatching jar which keeps the eggs in motion and automatically separates the dead fish from the living.

The United States government has established large salmon-breeding establishments in California and in Maine. It operates 28 hatcheries in various localities, owns 4 railroad cars for transporting eggs and young fish, and a steamer, the Fishhawk, is under its supervision. The vessel is in reality a floating hatchery. Western waters have been stocked with eastern fish and exhausted streams have been restored with a new supply. In 1901 the government planted 1,164,336,754 eggs and fishes in United States waters. Of this number nearly one fifth were shad and one fourth whitefish.

Aquatic birds are known to be of more or less assistance to the government in the dissemination of fish spawn. Naturalists tell us that these birds frequently carry the eggs from river to river and from lake to lake, by having their feet covered with the eggs. In the course of their flight the birds come to an inland sheet of water, or small creek, where they dive in or wade into the water, and the eggs are washed from their feet. In this way the waters become populated with new species and propagation progresses.

Fish culture has been found exceedingly profitable, too, as a private business or industry. There are over 400 fish hatcheries in Europe, and more than one half of these are owned by individuals. The Trout Pond Association, at Cold Springs, N. H., which began business in 1866, added a black bass branch in 1868, and erected salmon-breeding works in 1879, which in the first year yielded 450,000 eggs.

Several of the States have organized independent State Fish Commissions for the express purpose of disseminating the «fry» of food-fish in public waters. This is true of New York, whose commission of five members is appointed by the governor. Its principal office is at 83 Fulton Street, New York. The commission has established five hatcheries for the propagation of the «fry» from the eggs of the female fish, as follows: The Adirondack, Saranac; Cold Springs, Long Island; in Franklin County; Old Forge in the Fulton chain; at Newton Corners, and in Chautauqua County.

Fish Davit, in ship-building, a spar or small crane projecting from the bow of a ship for the suspension of the tackle, called the fish fall, used in hauling up the arms of the anchor in getting it aboard. The fish davit is such a distance abaft the cat-head as the length of the anchor may require, and is used to lift the fluke of the anchor to the bill-board; a roller keeps the fluke from bruising the vessel's side.

Fish Duck, a merganser (q.v.).

Fish-fly, one of the aquatic neuropterous insects of the family *Sialidæ*, and especially of the genus *Chauliodes,* represented by the hellgrammite and other species whose crawling larvæ are useful as fish-bait. See CORYDALIS.

Fish as Food in America. The question of the importance of fish as an article of food is no longer an open question. Recent food investigations have proved that it not only forms an economical source of variety to the diet, but that, like many other food materials, it also supplies the elements necessary for the building and repairing of the body as well as for maintaining the bodily heat required for energy and muscular work. With its protein, fat, and carbohydrates, the importance of its position has long been established, although the value of these properties differ in the dietary scale with the various fish, ranging in fuel value per pound from 40 calories represented by oysters in shells; 45 calories, shell crawfish and salted herring; and 65 calories for clams in shell, to 1,005 calories for canned salmon; 1,155 calories, canned salt mackerel; and 1,530 calories, caviare, as compared with 2,455 calories, the average value of beef, veal, and mutton; 1,670 calories, corn meal, and 1,655 calories, wheat flour.

Although the study of fish as a food is a wide subject, the most important difference that one detects in comparing the present with the past is represented in the method of preservation. Thus, for example, the method of salting and drying fish as practiced in Scandinavia is of the most remote antiquity, and as the aboriginal races in the Far North found it unnecessary, because of climatic conditions, to do anything more than dry their fish, this may be regarded as one of the earliest methods of preserving food for future use. The method of smoking fish to prepare them for eating unquestionably came later. In either instance, however, it was necessary that the work of curing should be performed as near the fishing ground as possible so it was to meet this requirement that the early Norse or Basque fishermen of the 12th and 13th centuries, as well as the English, French, and Spanish fishing fleets of the 16th and 17th centuries established so many colonies in the vicinity of the waters on which they sailed to fish.

From the earliest days of the history of this industry there has always been a great demand for cured fish, not only because it can be kept for a long time but also for its high nutrient qualities. As we have progressed in our knowledge of food compositions, therefore, we have applied our newly attained scientific knowledge to the improvement of the old methods of conservation, and yet, viewing our present achievements in the light of what we know about the past, we are compelled to admit that our present achievements are nothing more than a refinement of the methods that were pursued by the more ignorant fishermen several centuries ago.

The first attempt at refrigerating fish was made by Enoch Piper of Maine, but all his experiments were made in the British provinces. They were finally so successful that his methods were adopted by all large dealers in fish along the American seaboard with the result that fish, when the catch is in excess of the demand, is never lost but is stored in refrigerators until it can be disposed of at a fair price.

The invention of canning fish was perfected in Scotland, and was imported to this country in 1843, when a cannery for lobsters and mackerel was established at Eastport, Me. Owing to unfavorable legislation the lobster canning branch of the industry was not financially successful, but mackerel and other fish were preserved in this manner with profit to the canners. The canning of salmon, now one of the most important industries along the Pacific coast, dates from the year 1864. The product of this branch of the fishery industry was so successful from the date of its inception that it continued to increase its output until 1890 and 1891, when overproduction compelled the various companies to form a combine to regulate the product. Next to salmon, the sardine and its substitutes hold a position in the front rank of American canned fish. This branch of the industry was inaugurated in 1875, and, since that time, has presented a strong competition to the imported sardine. The centre of the sardine industry is in Maine.

As the canning industry is of comparatively recent origin some idea of its remarkable growth may be obtained by a glance at the Twelfth Census, in which it may be seen that, in the year 1900, the total value of the fish canned in the United States was $14,639,127, of which salmon was valued at $9,287,162, and the value of the sardine product at $4,212,351; the total value of the smoked fish was placed at $986,000, while that of the salted product was fixed at $5,260,927, of which sum cod alone represented about 60 per cent. Thus it may be seen that the total value of the American preserved fish industry was reported to be nearly $21,000,000 per annum.

Great as the demand for preserved fish has become the demand for the more natural fresh fish has also shown a constant increase. To have met such requirements a comparatively few years ago would have been impossible, whereas the more expeditious methods of transportation now enjoyed make the solution of this problem a simple one. In the old days of slow transportation fish was not shipped long distances, owing to the fact that it spoiled so easily, while this article of food is now transported from every part of the United States and Canada, to meet in the main centres of the commerce, where it is redistributed and shipped away again upon the largest scale possible.

The ever-increasing demand for all kinds of fish is partly explained by the increase in the population, but as the quantity of fish consumed per capita is also growing larger every day the question of the ability of the supply to withstand the demand has become an important one. To this there can be but one answer: So far as the deep-sea fish are concerned their number is practically inexhaustible, while, in the case of lake or river fish, as well as the various kinds of shell-fish, conditions are different.

Take, for example, the fishing grounds of Newfoundland. Discovered by the Cabots, they gave such an abundance of fish during the 16th century that no less than 5,000 men were steadily employed there. For nearly 400 years these same fishing banks have been the source of supply for a vast army of fishermen, and, although every kind of invention has been resorted to to increase the catch there has been no appreciable diminution of the staple fish in these waters.

So far as the rivers and lakes are concerned, however, this is not the case. There are some fish, called "anadromous," which, like the salmon and the shad, return periodically to the fresh from the salt water. Born at the source of a river, they go down to the salt water for certain periods of their existence, but they always return to the place of their origin when under the influence of the instinct of reproduction. As fish are in their best edible condition at about the time when they are laying their eggs, men have conspired to catch them at this period, and as there is no time when they can be caught more easily, it would require nothing more than a series of nets cross-barring a river to catch practically every anadromous fish that ventured into the stream. A practical illustration of this may be found in the Columbia River. Once the finest salmon river in the world, it has now, from over-fishing, been almost depleted of its stock. So, too, the building of dams for manufacturing purposes in so many New England rivers has driven the anadromous fish to seek other spots to lay their eggs. To a certain extent the same thing is true, even in regard to the great American lakes. Vast as their extent may be they are still restricted areas of fresh water. As the result the range of fish is necessarily limited and if no effort were made to protect them, indiscriminate capture would inevitably lead to their complete destruction. It is wise and proper, therefore, that State Legislatures should pass laws restricting lake and river fishing to certain seasons and regulating the character of the nets to be used, the size of the meshes, etc.

The same principle not only holds good in regard to all kinds of shell-fish, but, especially so far as the oyster is concerned, the problem which is presented is a most serious one. The oyster-beds of Maryland and Virginia were at one time considered almost inexhaustible, but, as the demand for this bivalve has constantly increased, the almost ceaseless dredging for the oyster has shown that even such beds as those of Chesapeake Bay are unable to stand the demands made upon them. Fearful of the total extinction of the species, science has adopted every precaution to prevent such a possibility. Titles have been granted to oyster-beds, or privileges of dredging have been rented; the planting of oysters has been encouraged, and laws have been passed regulating the work of dredging. In spite of all these efforts, it is feared that the prolific day of the oyster has passed.

Clams, lobsters, and terrapin are among the other shell-fish that have shown the most serious effect of over-fishing. Clams are by no means as plentiful as they were a few years ago, and in some waters they have practically disappeared altogether, and while terrapin in the far South are still moderately abundant their over-capture has made them very scarce in more northern waters. For years lobsters have been steadily decreasing in number, a fact that is due not only to over-fishing but also in the indifference shown by their captors in regard to the age of the catch, and while legal restrictions were long ago placed upon the indiscriminate catching of this fish the difficulties found in enforcing the laws have prevented their successful operation.

It is not by legal enactment alone, however, that efforts have been made to increase the fish production of the country, for it is in this emergency that the new science of fish culture has exercised an important influence for good. While fish culture alone is unable to create fish the scientists have devoted themselves so closely to the spawning habits of the fish that they are now able to secure the fecundated eggs, to hatch them artificially, to rear the young fish, caring for them until they are old enough to supply their own wants, and then to introduce the young fry in large quantities in such rivers or lakes where, from over-fishing, or from some other known cause, such fish are scarce. It was many years ago that the attention of the Government was first called to this matter, and, in 1871, the demand for protective legislation became so great that the United States Fish Commission was established, with the late Spencer F. Baird at its head. It is only just, however, to state that the first practical efforts in the direction of sensible fish culture were made through the enterprise of a private body, the American Fish Culture Association, and it was largely due to the influence which they exerted that the Government consented to establish its bureau of fish culture. To-day, if never before, the wisdom of the introduction of scientific methods in the care and protection of fish is absolutely beyond question, for it is to the fish-culturist that we must look for our future supply of fresh water fish. It is that power that is engaged in planting the fingerling in our lakes and streams, that, in years to come, when the fish has had time to grow to full size, the American people may have the wholesome food that is in such great demand. Moreover, the question of the depletion of the shell-fish supply is also receiving attention from the scientists who are employed in this work, and while their efforts have not yet met with the success for which they may have hoped it is by no means impossible that they may yet devise some means of relieving the oyster and lobster situation.

According to the list of the fish sold in the New York market in 1804, it may be seen that, about a century ago, only 57 varieties were known, whereas, to-day, more than 75 different kinds of sea-products are offered for sale in the markets of any of the American seaboard cities, the number varying a little, of course, according to the season. It is chiefly during the past few years that the number of varieties has shown such marked increase, a circumstance which may be traced to the fact that improved railway facilities have made the transportation of this product from long distances thoroughly practicable. According to the census report for 1900 the total catch of the United States fishing industry was valued at $46,453,000, while the annual value of the oil and fertilizer derived from the menhaden fisheries was in excess of $2,500,000. See CANNING INDUSTRY.

Fish-hawk, or **Osprey.** This almost cosmopolitan bird is known throughout North America as the "fish-hawk," never in popular speech as "osprey." The species (*Pandion haliaëtus*) occurs on all continents, gathering in the neighborhood of the sea and other large bodies of water, where it dexterously procures the living fish that constitute its food, by plunging from a great height and seizing them in its talons. These gains it is frequently obliged to relinquish to the fish-loving sea-eagles, especially our own bald eagle, which pounces upon the osprey and forces it to drop its property to be caught and swallowed by the robber. Fish-hawks have increased rather than diminished in most of their American haunts where they are protected by law and good-nature, and for the picturesqueness they lend to the landscape. Their nests are huge masses of sticks, placed on a ledge of rocks, or along low shores, in trees, and reoccupied for a long series of years. On the New England coast fish-hawks often make nests in belfries or on platforms set up on stout poles for their accommodation. The eggs are dirty white, marked with irregular purplish and red-brown blotches. This fine hawk (*Pandion haliaëtus*) is about 25 inches long, and has long pointed wings giving it great power and grace in flight. The general color of the upper parts is brown, but the head, neck and all under parts are white, except a band of brown spots across the breast. It stands alone among falconiform birds in a family (*Pandionidæ*) equivalent in rank to the *Falconidæ*, from which it essentially differs in the reversibility of the outer toe; the toes are nearly equal, and have no connecting membrane, but with spicules on their under surfaces and much curved claws enabling the birds to take a firm hold of their slippery prey. A general guide to further information as to the osprey in the Old World may be found in Newton's 'Dictionary of Ornithology'; and as to the American fish-hawk in Dr. Fisher's 'Hawks and Owls of the United States.'

Fish-killer, one of the huge heteropterous bugs (q.v.) of the aquatic family *Belostomidæ*, some of which reach a length of four inches, and are able to overcome small fishes. They are oval in outline, dull brown in color, and possess powerful mouth-parts by which they first stab their prey, then seize it and suck its blood. Their legs are flattened, and form powerful paddles, but are also useful for walking; and, supplied by the bubbles of air they take down with them, these big bugs lurk on the muddy bottoms of sluggish waters, ready to rush at and capture their living food. They are highly destructive among the fry in piscicultural ponds, and should be carefully eradicated. They come out of the water in early summer and fly in swarms at night, gathering about lights: and in some places so throng the street-lamps that they have become known as "electric-light bugs." Consult Howard's 'Insect Book' (1901); and see FRESH-WATER INSECTS.

Fish-lice, any of many copepod crustaceans, mainly of the group *Siphonostoma*, parasitic on marine animals. All are of small size, often very unlike ordinary *Copepoda* (q.v.) in appearance, and usually transparent. They are born of eggs attached to stones, plants, and the like, and begin life as normal larvæ, but some become parasitic and retrograde: yet some species are able as adults to swim about and change their hosts. These copepods attach themselves to the host by the suckers at the mouth, or by a sucking proboscis, and in some cases, by hooks on the forward swimming-appendages. While generally they confine their attacks to the exterior of the host, some live in the gills of fishes, and others embed themselves in the muscles. *Argulus* is a temporary epizoön. With four pairs of swimming-feet, it moves freely, and is not confined to a single host, entering the gills of a fish, there living for a time, and then enjoying a free life until it is hungry, when it enters another host. *Caligus* is sessile, and attaches itself to the gills of a fish, on whose blood it lives permanently. *Lernea*, and related forms, are wormlike, and anchor in the gills or in the skin of all kinds of fishes, and are sometimes so numerous as finally to cause the death of the host. Not only fishes, but all sorts of marine animals, including whales, are infested by these parasites, which have been extensively studied and reported upon by the United States Fish Commission, whose publication should be consulted.

Fish of Paradise. See PARADISE FISH.

Fish Trap, a box or basket set in a river, and containing bait to attract fish. A basket, net, or staked area with a divergent-sided or funnel-shaped opening through which fish pass, and in which they find a difficulty in retracing their course, owing to obstacles or blind sacs.

Fish'er, Charles, American comedian: b. Suffolk, England, 1816; d. New York 1891. He made his first appearance at the Princess Theatre, London, in 1844, but from 1852 was identified with the American stage, on which he made his début as Ferment in 'The School of Reform.' From 1872 to 1890, when he retired, he was a member of Augustin Daly's company. Best known as Triplet in 'Masks and Faces,' he was also seen as Jacques in 'As You Like It,' and Sir Peter Teazle in 'The School for Scandal.'

Fisher, Clara, American actress: b. London, England, 14 July 1811; d. Metuchen, N. J., 12 Nov. 1898. She made her first appearance on the stage in London when six years old, as Lord Flimnap in 'Gulliver in Lilliput.' Her success at this early age was phenomenal. Later under the direction of her parents she made tours of the United Kingdom, and besides other parts played Norval and Sir Peter Teazle for five years with great financial success. She made her first appearance in the United States as Albina Mandeville in 'The Will' at the Old Park Theatre in New York in 1827. Her success was immediate. Later she visited all of the larger cities of the eastern, southern, and western States. In 1834 she married James Gaspard Maeder, a well-known musician, and settled in Albany, N. Y. She, however, continued on the stage till 1889, when she retired.

Fisher, Frederic Henry, English journalist: b. London, England, 13 April 1849. He has been editor of the 'Literary World' from 1883 and has published: 'Cyprus, Our New Colony, and What We Know About It' (1878); 'Afghanistan and the Central Asian Question.'

Fisher, George Jackson, American physician: b. Westchester County, N. Y., 27 Nov. 1825. He was graduated from the medical department of New York University in 1849; was physician and surgeon at Sing Sing State Prison 1853–4; surgeon to the 7th Brigade, National Guard, State of New York, in 1853–73; and president of the New York Medical Society in 1874. He published 'On Animal Substances Employed as Medicines by the Ancients' (1862); and many other professional monographs.

Fisher, George Park, American educator: b. Wrentham, Mass., 10 Aug. 1847; was graduated at Brown University in 1847; studied theology at the Yale Divinity School, at Andover, and in Germany, was professor of divinity 1854–61, and subsequently of ecclesiastical history at Yale. He is the author of: 'Essays on the Supernatural Origin of Christianity' (1865); 'History of the Reformation' (1873); 'The Beginnings of Christianity' (1877); 'Faith and Rationalism' (1879); 'The Christian Religion' (1882); 'The Grounds of Historic and Christian Belief' (1883); 'Manual of Christian Evidences' (1890); 'Colonial History of the United States' (1892), etc.

Fisher, Irving, American educator: b. Saugerties, N. Y., 27 Feb. 1867. He was graduated at Yale 1888 and took a post-graduate course in Berlin and Paris. He was made instructor in mathematics at Yale 1890, becoming assistant professor of mathematics 1893. He has been professor of political science there from 1895. He has published: 'Mathematical Investigations in the Theory of Value and Prices' (1892); 'Bibliographies of the Present Officers of Yale University' (1893); 'Elements of Geometry,' with A. W. Phillips (1896); 'A Brief Introduction to Infinitesimal Calculus' (1897).

Fisher, John, English prelate: b. Beverley, Yorkshire, 1459; d. London 22 June 1535. In 1501 he was made chancellor of the University of Cambridge, and in 1502 became the first Margaret professor of divinity at Cambridge. In 1504 he was promoted to the see of Rochester. Deeply prepossessed in favor of the ancient faith of the nation, he opposed with zeal and perseverance the principles of Luther and his followers. But the same conscientious motives which induced Fisher to become the champion of Henry VIII., impelled him to oppose the king's measures for procuring a divorce from his wife, and declaring himself head of the Church. In 1527 he was the only prelate who had the courage to refuse to sign a declaration that the marriage of the king was unlawful. He was subsequently sent to the Tower for refusing to submit to the provisions of an act of Parliament which annulled the king's marriage with Catharine of Aragon, and confirmed his subsequent union with Anne Boleyn. Pope Paul III. thought proper to reward his zealous adherent by giving him a cardinal's hat (May 1535). The king exclaimed in a passion, "Mother of God! he shall wear it on his shoulders, for I will leave him never a head to set it on." As no evidence against him existed sufficiently strong to affect his life, Henry employed crafty emissaries to entrap Fisher into a positive denial of the king's supremacy. The plot succeeded, and the bishop was beheaded on Tower Hill. Bishop Fisher was an able theologian, and the author of a commentary on the Seven Penitential Psalms, of sermons, controversial and devotional treatises, etc.; his writings being partly in Latin, partly in English.

Fisher, Joshua Francis, American author b. Philadelphia, Pa., 1807; d. 1873. He was graduated from Harvard in 1825, was admitted to the bar in 1829, practised in Philadelphia, and was there one of the incorporators of the Pennsylvania Institution for the Instruction of the Blind. His historical studies include: 'The Private Life and Domestic Habits of William Penn' (1836); and 'The Degradation of Our Representative System' (1863).

Fisher, Mary, American educator: b. Marshall County, Ill., 12 April 1858. She is a teacher of French and German in the Kansas City Manual Training High School, and has published: 'Twenty-five Letters on English Authors' (1895); 'A Group of French Critics' (1897); 'A General Survey of American Literature' (1899).

Fisher, Sydney George, American lawyer and historical writer: b. Philadelphia, Pa., 11 Sept. 1856. He was graduated at Trinity College 1879, studying law at Harvard, and being admitted to the bar 1883. His works include: 'The Evolution of the Constitution' (1887); 'The Making of Pennsylvania' (1896); 'Pennsylvania: Colony and Commonwealth' (1897); 'Men, Women, and Manners in Colonial Times' (1898); 'The True Benjamin Franklin' (1899); 'The True William Penn' (1900); 'The True Story of the Revolutionary War' (1902).

Fisher, William Arms, American musician and composer: b. San Francisco, Cal., 27 April 1861. He was a pupil in counterpoint, canon, and fugue of H. W. Parker, in composition of Dvorák, and in singing of William Shakespeare. In 1897 he became an editor for Oliver Ditson & Company, the Boston music-publishers. His compositions number an 'Elegie' for violin and piano, some 40 solo songs, and many part-songs and anthems.

Fisher. Pennant's marten. See MARTEN.

Fisheries, a term which includes the taking of all kinds of water products as a business, and thus applies to the pursuit of whales, seals, otters, and other mammals; to the hunting of frogs, turtles, and alligators; to the taking of oysters, clams, lobsters, crabs, shrimp, and other shellfish; and to the gathering of corals, sponges, and seaweeds, as well as to the capture of fish proper. Closely related to the fisheries are fish culture, by which the supply of water animals is maintained and increased; and the various shore industries having for their object the utilization or preservation of the products as brought in by the fishermen.

The countries whose fisheries are of greatest commercial importance, being worth upward of $5,000,000 yearly, are the United States, Great Britain, Japan, Russia, France, Canada, Norway, and Newfoundland, in about the order given. Countries which may be regarded as of second-rate importance in this respect, whose fisheries are worth between $1,000,000 and $5,000,000 annually, are Portugal, Spain, Holland, Sweden, Germany and Italy. No data are available for China and India, whose fisheries must be very extensive, and perhaps entitled to rank with those of the leading countries. An estimate based on official data and all other available information gives $300,000,000 as the approximate annual value of the commercial fisheries of the world. Water animals which are of great economic importance in both hemispheres are whales, seals, sea-herring, mackerel, tunny, cod, halibut, lobsters, shrimp, oysters, and sponges. The most valuable of all fishery products are oysters; the most valuable of all fishes are sea-herring, salmon, and cod.

United States.— This is the leading country as regards the aggregate value of its fisheries and the amount of capital invested in the fishing in-

Rank	States	Persons employed	States	Capital invested	States	Value of products
1	Maryland	36,260	Massachusetts	$13,372,902	Alaska	$7,412,456
2	Virginia	29,325	New York	9,865,759	New Jersey	4,755,522
3	Maine	16,954	Washington	6,601,243	Virginia	4,613,384
4	Massachusetts	14,363	Maryland	6,506,066	Massachusetts	4,463,727
5	New York	13,474	Alaska	6,137,737	New York	4,196,272
6	North Carolina	12,045	Maine	4,013,053	Maryland	3,767,461
7	New Jersey	12,030	Virginia	3,633,104	Washington	2,871,438
8	Washington	9,911	Oregon	3,497,643	Maine	2,654,919
9	Alaska	8,680	California	2,780,186	California	2,559,993
10	Florida	6,143	New Jersey	2,729,571	Connecticut	1,559,599
11	Oregon	5,643	Pennsylvania	2,567,364	North Carolina	1,316,017
12	Louisiana	4,933	Illinois	2,096,665	Florida	1,080,870
13	California	4,042	Ohio	1,889,971	Rhode Island	955,058
14	Michigan	3,427	Florida	1,300,417	Michigan	894,060
15	Mississippi	3,105	Michigan	1,287,448	Oregon	855,750
16	Illinois	3,074	Connecticut	1,241,291	Louisiana	784,144
17	Pennsylvania	2,948	North Carolina	1,218,459	Ohio	743,043
18	Iowa	2,637	Rhode Island	957,142	Illinois	616,452
19	Ohio	2,563	Delaware	657,197	Wisconsin	542,304
20	Connecticut	2,473	Wisconsin	657,164	Pennsylvania	527,378
21	South Carolina	2,139	Missouri	645,671	Texas	302,763
22	Delaware	1,998	Mississippi	561,672	Mississippi	290,009
23	Wisconsin	1,919	Louisiana	537,532	Alabama	237,931
24	Georgia	1,869	Iowa	341,669	Missouri	211,301
25	Rhode Island	1,687	Georgia	284,864	South Carolina	210,456
26	Missouri	1,531	Texas	240,112	Iowa	207,801
27	Texas	1,372	Minnesota	222,633	Delaware	203,372
28	Alabama	1,197	Alabama	179,520	Georgia	170,605
29	Minnesota	783	South Carolina	174,354	Arkansas	168,071
30	Indiana	610	Nebraska	122,884	Tennessee	87,537
31	Kentucky	589	Tennessee	92,883	Minnesota	87,405
32	Utah	505	Kentucky	87,286	Indiana	86,129
33	Tennessee	476	Indiana	55,175	Kentucky	78,899
34	Arkansas	463	Utah	52,985	New Hampshire	48,987
35	Nebraska	196	New Hampshire	52,648	Utah	47,458
36	Vermont	169	Arkansas	39,105	Nebraska	15,937
37	New Hampshire	154	Vermont	4,794	South Dakota	14,850
38	Nevada	120	Kansas	3,836	Kansas	13,546
39	Kansas	118	West Virginia	3,591	Nevada	12,834
40	South Dakota	115	South Dakota	2,974	West Virginia	12,112
41	West Virginia	86	Idaho	2,375	Idaho	11,929
42	Idaho	57	Nevada	1,905	Vermont	7,160
	Total	212,183	Total	$76,720,850	Total	$49,696,939

dustry, and it also takes first rank in the yield of a number of special products common to many countries. The importance attained by the United States fisheries has been due to the abundance, variety, excellence, and wide distribution of the products, augmented by cultivation and acclimatization. The abundance of food fishes had a marked influence on the original colonization of the country, and was also an important factor in the subsequent development of various regions. At the outbreak of the Revolutionary War, some of the vessel fisheries had already become very extensive, and sailor-fishermen, mostly from New England, manned our naval vessels and privateers and rendered valiant service.

The number of persons who are regularly engaged in the fishing industry (1903) is about 212,000, of whom 154,000 are sea fishermen and 58,000 shoresmen, preparators, factory hands, etc. The aggregate number of people dependent on the fisheries is upward of 1,000,000, or about one eightieth of the entire population. The capital invested in the fisheries is about $76,720,850, of which $13,456,050 represents vessels, $4,530,600 boats, $8,215,330 apparatus and appliances, and $50,518,835 shore property and cash capital. The number of fishing vessels is 6,337, tonnage 172,377, and the number of open boats and vessels under five tons' burden is 79,216. The yield of the United States fisheries fluctuates considerably, but of late has averaged about $45,000,000. The statistics herewith presented, which embody the latest returns for the different regions, give a total catch of $49,696,900, a sum representing the value of the fish as first put on the market. The approximate aggregate weight of the output is 1,916,427,600 pounds, including only the soft parts of products like oysters, clams, scallops, etc.

Following is a summary showing the rank of the different States as regards persons employed, capital invested, and value of products. The years to which the figures in this and the following tables relate are, for the New England States, 1898; for the Middle Atlantic States, 1901; for the South Atlantic and Gulf States, 1897; for the Pacific States, Great Lakes, and interior waters, 1899; for Alaska, 1900. The statistics have been supplied by the Bureau of Fisheries, Department of Commerce and Labor.

A characteristic feature of the New England fisheries is the employment of a large fleet of fine schooner-rigged vessels in the offshore fisheries for cod, haddock, hake, halibut, and mackerel. Cod is the principal fish so taken, part of the catch being made on the Grand Banks and other banks lying off Newfoundland and Nova Scotia, and part on the very extensive and prolific banks adjacent to the New England shore, the most noted of which is Georges Bank. The most important of the New England boat and shore fisheries are those for sea-herring (caught chiefly in brush weirs), lobsters (caught in pots made of laths), soft-shell clams, and oysters. In the catch of herring, soft-shell clams, and lobsters, Maine surpasses all other States.

The oyster industry of the Middle Atlantic States gives to that region the importance which its fisheries have attained. The principal oyster grounds are in Long Island Sound, Delaware Bay, and Chesapeake Bay, a large part of the output now being taken from planted beds. An immense fleet of sailing vessels and boats is engaged in dredging and tonging oysters and running them to market. Other important salt-water products of this section are blue-fish, menhaden, sea bass, squeteague, hard clams, and crabs. The anadromous fishes, the shad, the alewives, and the striped bass, support valuable fisheries. The South Atlantic region has no noteworthy vessel fisheries, but its pound-net, gill-net, and seine fisheries for alewives, shad, sea mullet, and squeteague are important, shad being the leading product. The most prominent products of the Gulf States are mullet, red snappers, squeteague, oysters, shrimp, and sponges.

The Pacific States have very important vessel fisheries addressed to cod, halibut, and whales, and very extensive shore fisheries for salmon, herring, and oysters. The salmon fishery is the most valuable in the world, immense quantities of quinnat, blue-back, silver, and other salmon being caught in the Sacramento and Columbia rivers, in Puget Sound, and in Alaska. Much of the yield is canned. The salmon output of 1902 exceeded 248 million pounds.

The fisheries of the Great Lakes are the most important lake fisheries in the world, those in the United States waters producing over 100,000,000 pounds of excellent food fish annually. Lake Erie has the largest catch, closely followed by Lake Michigan. The principal fishes are whitefish, lake herring or cisco, lake trout, pike perch, and yellow perch. The numerous interior waters of the country are well supplied with economic animals and support valuable fisheries. The most productive waters are the Mississippi River and tributaries. The species figuring most conspicuously in the catch are black bass, buffalo-fish, carp, crappies, suckers, frogs, and mussels, the shells of the last named being extensively used in making pearl buttons.

The table on the following page shows the extent of the fisheries in each of the foregoing geographical divisions:

The products of the United States fisheries may be classified as follows.

Products	Value
Food-fishes in general	$27,889,588
Menhaden (for oil and guano)	973,200
Whales, seals, and other mammals	1,321,247
Turtles, terrapin, alligators, frogs	254,922
Oysters and other mollusks	16,700,524
Lobsters and other crustaceans	2,251,869
Sponges	305,589
Total	$49,696,939

United States Insular Possessions.— In 1900 the fisheries of Hawaii gave employment to 2,345 people, of whom 1,571 were natives, 485 Japanese, and 238 Chinese. The value of fishing property was $272,591. The catch comprised 6,222,455 pounds of fish and other products, mostly eaten fresh, and was valued at $1,083,646. The Philippine Islands have valuable fishing resources which are but little developed. The leading fishery is that for pearls and pearl shells in the Sulu archipelago; from time immemorial the pearls from this region have been famous. No statistics are available. The fisheries of Porto Rico are comparatively unimportant, although capable of development; at present the catch is only for local consumption and is eaten fresh.

Canada.— The fisheries of the Dominion of Canada are very extensive and closely resemble those of the United States. The aggregate yield

FISHERIES OF THE UNITED STATES ACCORDING TO GEOGRAPHICAL SECTIONS.

Sections	Persons employed			Vessels				Boats		Apparatus of capture	Shore property	Cash capital	Total investment	Products	
	Fishermen	Shoresmen	Total	No.	Net tonnage	Value	Outfit	No.	Value					Lbs.	Value
New England States	22,367	13,264	35,631	1,427	43,821	$2,920,825	$1,303,514	10,557	$ 621,670	$1,218,898	$7,115,030	$6,457,099	$19,637,036	393,457,906	$ 9,682,290
Middle Atlantic States	70,923	22,738	93,661	3,721	54,761	3,657,103	1,088,706	36,237	2,024,980	1,713,454	9,561,356	7,035,872	25,081,471	819,046,576	17,485,500
South Atlantic States	14,449	2,736	17,185	243	2,791	158,350	41,830	6,691	276,866	492,696	531,290	327,800	1,828,832	80,390,465	1,833,155
Gulf States	11,180	2,787	13,967	425	5,053	464,343	252,733	6,025	436,041	137,216	579,578	714,150	2,584,061	65,660,623	2,271,726
Pacific States	16,065	12,143	28,208	309	62,297	1,942,440	803,361	7,059	744,850	2,870,031	4,695,690	7,954,744	19,011,116	340,515,386	13,691,095
Great Lakes	7,905	1,765	9,670	208	3,541	659,650	142,971	3,281	227,766	1,428,226	2,225,503	1,933,600	6,617,716	113,727,240	2,611,439
Interior Waters	11,180	2,681	13,861	4	113	18,000	2,225	9,366	198,462	354,808	788,923	598,200	1,960,618	103,629,404	2,121,734
Total	154,069	58,114	212,183	6,337	172,377	$9,820,711	$3,635,340	79,216	$4,530,635	$8,215,329	$25,497,370	$25,021,465	$76,72[illegible],850	1,916,427,600	$49,696,939

in 1901, according to official statements, was $25,737,153, which includes the value of canned products and hence exceeds by several million dollars the actual value of the fisheries proper. The number of persons engaged in 1901 was about 93,000, and the capital invested was $11,491,000. The fisheries of Nova Scotia are more extensive than those of the other provinces; here cod, haddock, herring, mackerel, and lobsters are taken in large quantities. New Brunswick and Quebec have fisheries similar to those of Nova Scotia, while Ontario and Manitoba have important fresh-water fisheries for whitefish, trout, and other lake species. The fisheries of British Columbia, which rank next to those of Nova Scotia, are addressed chiefly to salmon. The principal catch is in the Fraser River. See CANADA — FISHERIES.

Newfoundland.— In proportion to population, the fisheries of this island are more valuable than those of any other country. The value of fishery products exported in 1902 was $7,777,305, and the value of products consumed locally was estimated at $1,000,000. The leading fish are cod and herring, the cod fishery being more valuable than in any other country. The hair-seal fishery is another branch in which Newfoundland leads.

Great Britain and Ireland.— The fisheries of the British Isles surpass those of any other country of Europe, and are about equal to those of the United States. Besides extensive coast fisheries, there are very important offshore vessel fisheries for cod, haddock, herring, and flatfishes, gill-nets being set for herring and beam trawls used for the other species. In 1901, 106,477 persons found employment in fishing, of which 39,566 were in England and Wales, 37,394 in Scotland, and 27,947 in Ireland. The registered fishing vessels and boats numbered 25,797. In 1901, the fisheries of England and Wales were valued at $33,212,800; Scotland, $11,252,000; Ireland, $1,813,900 — a total of $46,278,700.

Russia.— This country has vast fishery resources, and the annual catch exceeds in value that of any other country of Europe except Great Britain. The ocean fisheries are insignificant, but those of the Caspian Sea and the fresh waters, especially the Ural and Volga rivers are very highly developed. The herring fisheries of the Caspian Sea are famous, and millions of pounds are caught annually. The sturgeon and the pike perch fisheries are the most valuable in the world. The roach is so abundant and cheap that it may be considered the national fish; between 200,000,000 and 300,000,000 pounds are taken annually in the Caspian Sea. Other important products are carp, catfish, bream, whitefish, yellow perch, and lampreys. Accurate statistics are lacking, but a Russian official estimate gives an annual catch of 1,500,000,000 pounds, valued at $25,000,000.

France.— Fisheries of great magnitude are prosecuted in the coast waters of France and by French fishermen in Newfoundland, Iceland, and the North Sea. In 1900 the number of vessel and boat fishermen was 96,413 and of shore fishermen 61,979; and the value of the products taken was $21,240,000. In the cod fisheries of Newfoundland, Iceland, and the North Sea, 44,565,234 kilograms of fish, valued at $3,793,550 were caught; and in the high-sea fisheries 56,227,289 kilograms of herring, mackerel, and other fish, valued at $5,509,997, were taken. The principal coast fishery is that for sardines, large quantities of which are canned and sent to all parts of the world; the quantity taken (1900) was 40,192,817 kilograms, worth $2,361,182. Other valuable products are tunny, lobsters, spiny lobsters, crayfish, oysters, mussels and seaweeds. The cultivation of oysters has reached great perfection and upward of 1,000,000,000 oysters, grown in artificial enclosures, are marketed annually.

Norway.— More than 120,000 people are employed in the Norwegian fisheries. The principal products are cod, valued at $3,660,000 in 1900; herring, valued at $2,440,000; and salmon and trout, valued at $280,000. The cod fishery is carried on chiefly at the Lofoten Islands, where 35,000 fishermen are engaged. Other important fisheries are the lobster, whale, seal, and shark. The total value of the fisheries in 1900 was $7,900,000. A large part of the catch is exported to other European countries and the United States.

Other European Countries.— Germany has cod and herring fisheries, in the Baltic and North seas, and minor fresh-water fisheries. Upward of 32,000 persons are reported to be employed, and the annual catch is worth several million dollars, but definite statistics are not available. The Netherlands have valuable herring fisheries, which in 1901 yielded $1,478,000. Other valuable products are cod, anchovy, and oysters. The yearly production is valued at about $2,000,000. The fisheries of Denmark were valued at $1,995,000 in 1900. The fishermen of Belgium catch chiefly herring and cod, the output being about $1,250,000 annually. Portugal has 4,000 vessels and boats, mostly engaged in the sardine and tunny fisheries; the products taken in 1898 had a value of $4,182,000. The fisheries of Spain are estimated to be worth $2,500,000, but no definite information regarding them is obtainable. Italy has nearly 100,000 fishermen engaged in the tunny, coral, sponge, and general food-fish fisheries. The aggregate value of water products is estimated at $3,500,000 yearly. The Swedish fisheries were valued at $2,056,000 in 1896. The principal species sought is the herring; the herring fishery of Bohuslän is famous, employing 7,500 men. Other important products are cod, mackerel, eels, salmon, and lobsters. The sea fisheries of Austria-Hungary in 1901 gave employment to 15,300 persons, and yielded $1,405,000 worth of fish, etc. Greece and Turkey have valuable sponge fisheries.

Japan.— The fisheries of Japan are in some respects the most important in the world, and in value rank next to those of the United States and Great Britain. While complete statistics are lacking, it is known that about 400,000 vessels and boats are employed and that in 1901 2,508,000 persons were engaged in fishing. All the coast waters abound in excellent food fishes, mollusks, crustaceans, and other products, together with many objects used for ornamental, artistic, and other purposes beside for food. The leading products are sardines (of which 500,000,000 pounds are annually caught), herring, tai, bonito, mackerel, tunny, salmon, cod, squid, coral, and algæ. The herring, salmon, cod, and other fisheries of Hokkaido, the most northern of the main islands, are very extensive, yielding nearly 1,000,000,000 pounds. The aggregate output of the Japanese fisheries is probably not less than 2,000,000,000 pounds a year, with an estimated value of $30,000,000. GEORGE M. BOWERS,

Bureau of Fisheries, Washington.

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Fisheries Question. The provinces of British North America in 1760–76 enjoyed mutual fishing rights on the entire North Atlantic coast, but when the Revolution severed Canada from the rest of the seaboard, Great Britain proposed to deny the United States the right to fish there, on the ground of Canadian opposition. As this meant ruin to a great New England industry, the Canadian waters being the cream of the fishing grounds, John Adams refused to sign the Treaty of Paris (7 Sept. 1783) until the right was granted, though his fellow commissioners would have sacrificed them; and his stubbornness secured their retention. Fishing could still go on; but we could not dry or cure fish on the coast of Newfoundland, or the settled coasts or river-banks of Nova Scotia, the Magdalen Islands, or Labrador, except by agreement with the inhabitants. Under these provisions, the energetic American fishermen occupied many excellent fishing stations along the Canada shore; to the envy and dissatisfaction of the British; and when the War of 1812 broke out, the latter seized the opportunity to declare the Treaty of Paris abrogated, and order the Canadian officials to refuse American fishermen access to the grounds. The Americans declared the fishery provisions of the Treaty unvoidable. The Treaty of Ghent, of 1814, ignored this question, as it did so much else of vital import, and the old rights were tacitly allowed to stand. But in 1818 a joint convention at London revised the fishing provisions: the United States were to have the right only of fishing in the deep sea at least three miles from shore, except on the western and northern coast of Newfoundland and the Magdalens; but could dry and cure on the coasts as before, and enter bays and harbors for wood or water or for refuge. But the three-mile provision was the bone of contention it has always been, as to headlands, etc., and here as to the Gut of Canso — in effect, the American right to fish in the Gulf of St. Lawrence, Chaleurs Bay, or the Bay of Fundy; as to the latter, an American vessel was seized for fishing in it, and on arbitration the American claim was held valid. Finally, the Reciprocity Treaty of 1854 abolished all mutual restrictions on deep-sea fishing except for shellfish. The United States abrogated this treaty in 1866, and conditions reverted to those of 1818, but the Treaty of Washington in 1871, to take effect in 1873, revived it again in full down to lat. 39° N. The Canadians, however, asserted that their waters were much the more valuable, and on arbitration provided for in the treaty, they were awarded $5,500,000 in 1877, on a claim of $14,280,000. In 1885 the United States again abrogated reciprocity, under pressure from fishing interests, and returned to the 1818 status with its disputed meanings. Our fishing vessels were seized as before; and in 1887 Congress authorized the President at his discretion to lay an embargo on all Canadian commerce to American ports, which, however, has not been done. In 1888 the Chamberlain-Bayard Treaty arranged these difficulties, but the Senate rejected it; in 1890, however, the Canadian government embodied it in its laws. A joint high commission to settle the question met in Washington in 1899, but adjourned without coming to a decision. In all cases, however, the provisions of the Convention of London, 1818, is held by both governments as binding in absence of special treaties overriding them. The crucial point has always been and is likely to be the "headland doctrine." The Americans claim that it should not be recognized, but the curves of the coast followed instead of drawing the line from headland to headland; the Canadians say it is vital to the protection of their own fishermen.

Fisher's Hill, about 20 miles south of Winchester, Va., between the Massanutten and North Mountains, and with its base washed by a branch of the Shenandoah. This place was the scene of an action, 22 Sept. 1864, between a National force under Gen. Sheridan, and one of Confederates commanded by Gen. Early.

Fisher's Hill, Battle of. Gen. Early was defeated at the battle of the Opequon, Va., 19 Sept. 1864, and retreated during the night, 20 miles up the Shenandoah Valley to Fisher's Hill, two miles south of Strasburg, Va. Gen. Sheridan followed at daylight of the 20th up the Valley pike, Gen. Wilson's cavalry division covering his left and Gen. Averell's division on his right. During the afternoon of the 20th Wright's Sixth corps and Emory's Nineteenth corps arrived at Cedar Creek, crossed and took position on the heights fronting Strasburg. Crook's Eighth corps halted on the left bank of the creek. On 21 Sept. Sheridan pushed through the town, drove Early's skirmishers to the entrenchments and reconnoitered the position, which, naturally strong, Early had strengthened with works of earth and stone, behind which was Wharton's division on the right, then Gordon's, Pegram's, and Ramseur's, with Lomax's division of dismounted cavalry on the extreme left. Fitz Hugh Lee's cavalry was at Millford, 12 miles above Front Royal, guarding Luray Valley and Early's right. Sheridan ordered Gen. Torbert, with Merritt's and Wilson's cavalry divisions, to the Luray Valley to drive out any force of the enemy in that quarter, and cross over from the valley to New Market, and intercept Early's retreat. During the afternoon the Sixth corps, after a serious repulse, succeeded in gaining a commanding position near the Confederate works, which was immediately entrenched and artillery put in position. Early's right was too strongly posted to attack in front, so Sheridan concluded to turn and attack his left. During the night of the 21st Crook crossed Cedar Creek and, hidden in a clump of timber, remained until daylight, when, under cover of woods and ravines, he marched in rear of and beyond the right of the Sixth corps, and was again concealed, while Rickett's division of the Sixth corps was pushed out and confronted the left of Early's infantry, ready to join Crook's left when he should attack. While Rickett's was threatening in front Crook marched unobserved into the dense timber on the eastern face of Little North Mountain, until he gained the rear of Early's works when, facing to the left, he marched down the mountain side, at sunset. He was seen by Lomax, artillery was turned upon him, but too late; he struck Lomax's dismounted men in flank and rear, driving them back on Ramseur, who endeavored to change front, but Rickett's division advancing struck Ramseur in the act, joined Crook's left, and the two commands moved along in rear of Early's entrenchments, his men giving way all along the line, abandoning many guns. The swinging movement of Rickett's division on the right was taken up from right to left, and between sunset and darkness Early's entire army was defeated and in disorderly retreat. Early reported next morning to Gen. Lee that the enemy "succeeded in driving back the left of my line which was defended by the cavalry, and throwing a force in the rear of the left of my infantry, when the whole of the troops gave way in a panic and could not be rallied." Early retreated four miles beyond Woodstock and Sheridan pursued him all night, to Woodstock, 12 miles, which was reached at daybreak next morning. The Union loss was 509 killed and wounded. Early reported a loss in infantry and artillery of 240 killed and wounded and 995 missing. The loss in Lomax's cavalry would swell the entire Confederate loss to about 1,400.

Consult: 'Battles and Leaders of the Civil War,' Vol. IV.; 'Official Records,' Vol. XLII.; Pond, 'The Shenandoah Valley in 1864'; Sheridan, 'Personal Memoirs.'

E. A. Carman.

Fisher's Island, at the entrance of Long Island Sound, near Connecticut. The island is in the State of New York; it is a part of the Southold township, in Suffolk County, N. Y. Area 4,000 acres.

Fishes, Geographical Distribution of. The laws governing the distribution of animals are reducible to three very simple propositions. Each species of animal is found in every part of the earth having conditions suitable for its maintenance, unless:

(*a*) Its individuals have been unable to reach this region through barriers of some sort; or,

(*b*) Having reached it, the species is unable to maintain itself, through lack of capacity for adaptation, through severity of competition with other forms, or through destructive conditions of environment; or else,

(*c*) Having entered and maintained itself, it has become so altered in the process of adaptation as to become a species distinct from the original type.

Under the first head, numerous illustrations may be given. The absence of loaches in America and of mooneyes in Europe may serve as examples.

Of species under (*b*), those who have crossed the seas and not found lodgment, there is, in the nature of things, no record. Of the existence of multitudes of estrays there is abundant evidence. Now and then one among thousands finds permanent lodgment, and by such means a species from another region will be added to the fauna. The rest disappear and leave no trace. A knowledge of the currents of the sea and their influence is essential to any detailed study of the dispersion of fishes.

In the third class, that of species changed in the process of adaptation, most insular forms belong. As a matter of fact, at some time or another almost every species must be in this category, for isolation is a source of the most potent elements in the initiation and intensification of the minor differences which separate related species. It is not the preservation of the most useful features, but of those which actually existed in the ancestral individuals, which distinguished such species. In many cases the persistence of characters rests not on any special usefulness or fitness, but on the fact that individuals possessing these characters have, at one time or another, invaded a certain area and populated it.

Barriers Checking Movement of Fishes.—The limits of the distribution of individual species or genera must be found in some sort of barrier, past or present. The chief barriers which limit marine fishes are the presence of land, the presence of great oceans, the differences of temperature arising from differences in latitude, the nature of the sea-bottom, and the direction of oceanic currents. That which is a barrier to one species may be an agent in distribution to another. The common shore-fishes would perish in deep waters almost as surely as on land, while the open Pacific is a broad highway to the albacore or the swordfish.

Again, that which is a barrier to rapid distribution may become an agent in the slow extension of the range of a species. The vast continent of Asia is undoubtedly one of the greatest of barriers to the wide movement of species of fish, yet its long shore-line enables species to creep, as it were, from bay to bay, or from rock to rock; till, in many cases, the same species is found in the Red Sea and in the tide-pools or sand-reaches of Japan, or even in the brooks or coral pools of Tahiti or Samoa. In the North Pacific the presence of a range of half-submerged volcanoes, known as the Aleutian and the Kurile Islands, has greatly aided the slow movement of the fishes of the tide-pools and the kelp. To a school of mackerel or of flying-fishes these rough islands might form an insuperable barrier.

Temperature the Central Fact.—It has long been recognized that the matter of temperature is the central fact in all problems of geographical distribution. Few species in any group freely cross the frost-line, and except as borne by oceanic currents, few species extend their range far into waters colder than those in which the species is distinctively at home. Knowing the average temperature of the water in a given region, we know in general the types of fishes which must inhabit it. It is the similarity in temperature and physical conditions, not the former absence of barriers, which chiefly explains the analogy of the Japanese fauna to that of the Mediterranean or the Antilles. This fact alone must explain the resemblance of the Arctic and Antarctic faunæ. Like forms lodge in like place.

Ocean Currents.—We may consider again for a moment the movements of the great currents in the Pacific as agencies in the distribution of species.

A great current sets to the eastward, crossing the ocean just south of the tropic of Cancer. It extends between the Gilbert and the Marshall islands and passes on nearly to the coast of Mexico, touching the Galapagos Islands, Clipperton Island, and especially the Revillagigedos. This may account for the number of Polynesian species found on these islands, about which they are freely mixed with immigrants from the mainland of Mexico.

From the Revillagigedos the current moves northward, passing the Hawaiian Islands and thence onward to the Ladrones. The absence in Hawaii of many of the characteristic fishes of the Samoan Islands and the Gilbert Islands is perhaps due to the long detour made by these currents, as the conditions of life in these groups of islands are not very different. Northeast of Hawaii is a great spiral current, moving with the hands of the watch, forming what is called Fleurieu's Whirlpool. This does not reach the coast of California. This fact may account for the almost complete distinction in the shore-fishes of Hawaii and California.

It is, of course, not necessary that the movements of a species in an oceanic current should coincide with the direction of the current. Young fishes, or fresh-water fishes, would be borne along with the water. Those that dwell within floating bodies of seaweed would go whither the waters carry the drifting mass. But free-swimming fishes, as the mackerel or flying-fishes, might as readily choose the reverse direction. To a free-swimming fish, the temperature of the water would be the only consideration. It is thus evident that a current which to certain forms would prove a barrier to distribution, to others would be a mere convenience in movement.

Centres of Distribution.—We may assume, in regard to any species, that it has had its origin in or near that region in which it is most abundant and characteristic. Such an assumption must involve a certain percentage of error or of doubt, but in considering the mass of species, it would represent essential truth. In the same fashion, we may regard a genus as being autochthonous or first developed in the region where it shows the greatest range or variety of species. Those regions where the greatest number of genera are thus autochthonous may be regarded as centres of distribution. So far as the marine fishes are concerned, the most important of these centres are found in the Pacific Ocean. First of these in importance is the East Indian Archipelago, with the neighboring shores of India. Next would come the Arctic Pacific and its bounding islands, from Japan to British Columbia. Third in importance in this regard is Australia. Important centres are also found in temperate Japan, in California, the Panama region, and in New Zealand, Chile, and Patagonia. The fauna of Polynesia is almost entirely derived from the East Indies; and the shore fauna of the Red Sea, the Bay of Bengal and Madagascar, so far as genera are concerned, seems to be not really separable from the Indian fauna generally.

In the Atlantic the chief centre of distribution is the West Indies; the second is the Mediterranean. On the shores to the northward or southward of these regions occasional genera have found their origin. This is true especially of the New England region, the North Sea, the Gulf of Guinea, and the coast of Argentina. The fish-fauna of the North Atlantic is derived mainly from the North Pacific, the differences lying mainly in the lower richness of the North Atlantic. But, in certain groups common to the two regions, the migration must have been in the opposite direction; exceptions that prove the rule.

Realms of Fresh-Water Distribution.—If we consider the fresh-water fishes alone we may divide the land areas of the earth into districts and zones, fairly agreeing with those marked out for mammals and birds. The river-basin, bounded by its water-sheds and the sea at its mouth, shows many resemblances, from the point of view of a fish, to an island considered as the home of an animal. It is evident that with fishes the differences in latitude outweigh those of continental areas, and a primary division into Old World and New World would not be tenable.

The chief areas of dispersion of fresh-water fishes may be indicated as below, following essentially the grouping proposed by Dr. Günther.

Northern Zone (Arctic and Temperate): With Dr. Günther, we may recognize, first the Northern Zone characterized familiarly by the presence of sturgeon, salmon, trout, whitefish, pike, lamprey, stickleback, and other species of which the genera and often the species are identical in Europe, Siberia, Canada, Alaska, and most of the United States, Japan, and China.

Equatorial Zone: The Equatorial Zone is roughly indicated by the tropics of Cancer and Capricorn. Its essential feature is that of the temperature, and the peculiarities of its divisions are caused by barriers of sea or mountains.

Dr. Günther finds the best line of separation into two divisions to lie in the presence or absence of the great group of dace or minnows, (*Cyprinidæ*), to which nearly half of the species of fresh-water fishes the world over belong. The entire group, now spread everywhere except in the Arctic, South America, Australia, and the islands of the Pacific, had its origin in India, from which its genera have radiated in every direction.

The Cyprinoid division of the Equatorial Zone forms two districts, the Indian and the African. The Acyprinoid division includes South America, south of Mexico, and all the islands of the tropical Pacific lying to the east of Wallace's line. This line, separating Borneo from Celebes and Bali from Lompoe, marks in the Pacific the western limit of cyprinoid fishes, as well as that of monkeys and other important groups of land animals. This line, recognized as very important in the distribution of land animals, coincides in general with the ocean current between Celebes and Papua, which is one of the sources of the Kuroshiwo.

Southern Zone: The third great region, the Southern Zone, is scantily supplied with fresh-water fishes, and the few it possesses are chiefly derived from modifications of the marine fauna or from the Equatorial Zone to the north. Three districts are recognized, Tasmanian, the New Zealand and the Patagonian.

Faunal Resemblances.— There are two main sources of faunal resemblances; first, the absence of barriers permitting the actual mingling of the species; second, the likeness of temperature and shore configuration favoring the lodgment or development of the same or analogous types. If the fish-faunas of different regions have mingled in recent times the fact would be shown by the presence of the same species in each region. If the union were of remote date the species would be changed, but the genera might remain identical.

In case of close physical resemblances in different regions, as in the East Indies and West Indies, like conditions would favor the lodgment of like types, but the resemblance would be general, the genera and species being unlike. Without doubt part of the resemblance between Japan and the Mediterranean is due to similarity of temperature and shores.

Direction of Shore-Line.— We may first note that a continuous shore-line produces a mingling of fish-faunas only when not interrupted by barriers due to climate. A north and south coast-line, like that of the East Pacific, however unbroken, permits great faunal differences. It is crossed by the different zones of temperature. An east and a west shore-line lie in the same temperature. In all cases of the kind which now exist on the earth (the Mediterranean, the Gulf of Mexico, the Caribbean Sea, the shores of India), most species will extend their range as far as the shore-line goes. The obvious reason is because such a shore-line rarely offers any important barrier to distribution, checking dispersion of species.

Genera in Different Faunas.— For our purposes, the genera must be rigidly defined, a separate name being used in case of each definable difference in structure. The wide-ranging genera of the earlier systematists were practically cosmopolitan, and their distribution teaches us little. Using the modern definition of genus, we find in Japan 483 genera of marine shore-fishes; in the Red Sea, 225; in the Mediterranean, 231. In New Zealand 150 are recorded; in Hawaii, 171; 357 from the West Indies, 187 from the Pacific coast of tropical America, 300 from India, 450 from the East-Indian islands and 427 from Australia.

Of the 483 genera ascribed to Japan 156 are common to the Mediterranean also, 188 to the West Indies and Japan, 169 to the Pacific coast of the United States and Mexico. With Hawaii Japan shares 90 genera, with New Zealand 62; 204 are common to Japan and India, 148 to Japan and the Red Sea, most of these being found in India also; while 200 genera are common to Japan and Australia.

From this, it is evident that Japan and the Mediterranean have much in common, but apparently not more than Japan shares with other tropical regions. Japan naturally shows most likeness to India, and next to this to the Red Sea. Proportionately less is the resemblance to Australia, and the likeness to the Mediterranean seems much the same as that to the West Indies, or to the Pacific coast of America. But, to make these comparisons just and effective, we should consider not the fish-fauna as a whole; we should limit our discussions solely to the forms of equatorial origin. We should eliminate all pelagic and all deep-sea forms, for the laws which govern the distribution of these are very different from those controlling the shore-fishes, and most of the genera have reached a kind of equilibrium over the world. We may note also, as a source of confusion in our investigation, that numerous forms found in Japan and elsewhere are very rarely taken, and their real distribution is unknown. Some of these will be found to have, in some unexpected quarter, their real centre of dispersion. Such

AMERICAN FOOD FISHES

1. Alewife.
2. Red Snapper.
3. Black Sea-bass.
4. Steel-head.
5. Spanish Mackerel.
6. Rainbow Trout.
7. Whitefish.
8. Striped Bass.
9. Sunfish.
10. Bluefish.
11. Sauger.
12. Fall-fish.

species may inhabit oceanic plateaus, and find many halting places in their circuit of the tropical oceans.

Extension of Indian Fauna.—From statistical tables representing the distribution of genera it is evident that the warm-water fauna of Japan, as well as that of Hawaii, is derived from the great body of the fauna of the East Indies and Hindustan; that the fauna of the Red Sea is derived in the same way; that the fauna of the Mediterranean bears no especial resemblance to that of Japan, rather than to other elements of the East Asiatic fauna in similar conditions of temperature, and no greater than is borne by either to the West Indies; that the faunas of the sides of the Isthmus of Suez have relatively little in common, while those of the two sides of the Isthmus of Panama show large identity of genera, although few species are common to the two sides. Of the 255 genera recorded from the Panama region 179, or over 70 per cent, are also in the West Indies; while 68, or more than 30 per cent of the number, are limited to the two regions in question.

The Isthmus of Suez as a Barrier.— With free connection across the Isthmus of Suez, the fauna of the Red Sea must have been once practically the same as that of the Mediterranean. The present differences must be due to later immigrations to one or the other region, or to the extinction of species in one locality or the other, through some kind of unfitness. In neither region is there evidence of extensive immigration from the outside. The present conditions of water and temperature differ a little, but not enough to explain the difference in faunas. The Red Sea is frankly tropical and its fauna is essentially Indian, much the same, so far as genera are concerned, as that of southern Japan. The Mediterranean is at most not more than semi-tropical, and its fishes are characteristically European. Its tropical forms belong rather to Guinea than to the East Indies. With the Red Sea the Mediterranean has very little in common, not so much, for example, as has Hawaii, much less than has Samoa. Forty genera of shore-fishes (and only 50 of all fishes) are identical in the two regions, the Mediterranean and the Red Sea. Of those, every one is a genus of wide distribution, found in nearly all warm seas. Of shore-fishes, only one genus in seven is common to the two regions. Apparently, therefore, we cannot assume a passage across the Isthmus of Suez within the lifetime of the present genera. Not one of the types alleged to be peculiar to Japan and the Mediterranean is thus far known in the Red Sea. Scarcely any of the characteristically abundant Mediterranean types crosses the Isthmus of Suez, and the distinctive Red Sea and Indian types are equally wanting in the Mediterranean. The only genera which could have crossed the Isthmus are certain shallow-water or brackish-water forms, sting-rays, torpedoes, sardines, eels, and mullets, widely diffused through the East Indies and found also in the Mediterranean. The former channel, if one ever existed, had therefore much the same value in distribution of species as the present Suez Canal.

Submersion of the Isthmus of Suez.— Yet, from geological data, there is strong evidence that the Isthmus of Suez was submerged in relatively recent times. The recognized geological maps of the isthmus show that a broad area of post-Pliocene or Pliocene deposits constitutes the isthmus and separates the nummulitic hills of Suez from their fellows about 30 miles to the eastward. The northern part of the isthmus is alluvium from the Nile, and its western part is covered with drifting sands. The Red Sea once extended farther north than now, and the Mediterranean farther to the southeast. Assuming the maps to be correct, the isthmus must have been open water in the late Pliocene or post-Pliocene times.

Admitting this as a fact, the difference in the fish-fauna shows that the waters over the submerged area must have been so shallow that rock-loving forms did not and could not cross it. Moreover, the region must have been overspread with silt-bearing fresh waters from the Nile. To the reef-loving fishes of the Red Sea, or of the Mediterranean, such waters would form a barrier as effective as the sand-dunes of to-day.

In earlier times the Mediterranean must have been directly connected with the Indian Ocean. This is shown from the abundance of Indian types now extinct in Europe, in the Eocene deposits of Italy.

We are therefore led to these conclusions:

1. There is no evidence, derivable from the fishes, of the submergence of the Isthmus of Suez since Miocene times.
2. If the isthmus was submerged in Pliocene or post-Pliocene times the resultant channel was shallow and muddy, so that ordinary marine fishes or fishes of rock-bottoms, or of deep waters, did not cross it.
3. It formed an open water-way to brackish-water fishes only.
4. The types common to Japan and the Mediterranean did not enter either region from the other, by way of the Red Sea, at least not in recent times.
5. As most of these are found also in India or Australia or both, their dispersion was probably around the south coast of Africa or by the Cape of Good Hope.
6. In Eocene times the Mediterranean and the Indian Ocean were fully connected.

We may then conclude that the resemblance of the Mediterranean fish-fauna to that of Japan or India is no more than might be expected, the present contour of the continents being permanent for the period of duration of the present genera and species. The imagined removal of barriers on any large scale would necessitate much closer resemblances than those which actually exist.

Isthmus of Panama as a Barrier.— Conditions in some regards parallel with those of the Isthmus of Suez exist in but one other region — the Isthmus of Panama. Here the first observers were very strongly impressed by the resemblance of forms. Nearly half the genera found on the two sides of this isthmus are common to both sides. Taking those of the Pacific shore for first consideration, we find that three fourths of the genera of the Panama fauna occur in the West Indies as well. This identity is many times greater than that existing at the Isthmus of Suez. Moreover, while the Cape of Good Hope offers no impassable barrier to distribution, the same is not true of the southern part of South America. The subarctic climate of Cape Horn has doubtless formed a complete check to the movements of tropical fishes for a vast period of geologic time.

But curiously enough, this marked resemblance is confined chiefly to the genera, and does not extend to the species on the two shores. Of 1,400 species of fishes recorded from tropical America north of the equator, only about 70 are common to the two coasts. The number of shore-fishes common is still less. In the 70 are included a certain number of cosmopolitan types which might have reached either shore from the Old World. A few others invade brackish or fresh waters and may possibly have passed, in one way or another, across the Isthmus of Nicaragua. Of fishes strictly marine, strictly littoral, and not known from Asia or Polynesia, scarcely any species are left as common to the two sides. This seems to show that no waterway has existed across the isthmus within the lifetime, whatever that may be, of the existing species. The close resemblance of genera shows apparently with almost equal certainty that such a waterway has existed, and within the period of existence of the groups called genera. How long a species of fish may endure unchanged no one knows, but we know that in this regard great differences must exist in different groups. Assuming that different species crossed the Isthmus of Panama in Miocene times, we should not be surprised to find that a few remain to all appearances unchanged; that a much larger number have become "representative" species, closely related forms retaining relations to the environment of those of the parent form, and, finally, that a few species have been radically altered.

This is exactly what has taken place at the Isthmus of Panama with the marine shore-fishes, although, curiously enough, the movement of genera seems to have been chiefly from the Atlantic to the Pacific.

As to the localities inhabited by fishes, we may roughly divide the species into marine species and fresh-water species. The marine species may be again divided into three main categories according to differences in vertical distribution, the pelagic, bassalian and littoral fishes.

Pelagic Fishes.— Pelagic fishes are those inhabiting the open sea and ranging widely within given limits of temperature. In this series some species are practically cosmopolitan. In other cases the genera are so. Each school or group of individuals has its breeding-place, and from the isolation of breeding-districts new species may be conceived to arise. The pelagic types have reached a species of equilibrium in distribution. Each type may be found where suitable conditions exist, and the distribution of species throws little light on questions of distribution of shore-fishes. Yet among these species are all degree of localization. The pelagic fishes shade into the shore-fishes on the one hand and into the deep-sea fishes on the other.

Bassalian Fishes.— The vast group of bassalian or deep-sea fishes includes those form which live below the line of adequate light. These, too, are localized in their distribution, and to a much greater extent than was formerly supposed. Yet, as they dwell below the influence of the sun's rays, zones and surface temperatures are nearly alike to them, and the same forms may be found in the arctic or under the equator. Their differences in distribution are largely vertical, some living at greater depths than others, and they shade off by degrees from bathybial into semi-bathybial, and finally into ordinary pelagic and ordinary shore-types. See Deep-sea Life.

Littoral Fishes.— The shore-fishes are in general the most highly specialized in their respective groups, because exposed to the greatest variety of selecting conditions and of competition. Their distribution in space is more definite than that of the pelagic and bassalian types, and they may be more definitely assigned to geographical areas.

Distribution by Coast-lines.— The distribution of littoral fishes is best indicated not by realms or areas, but as forming four parallel series, corresponding to the four great north and south continental outlines. Each of these series may be represented as beginning at the north in the Arctic fauna, practically identical in each of the four series, actually identical in the two Pacific series. Passing southward, forms are arranged according to temperature. One by one in each series, the Arctic types disappear; subarctic, temperate, and semi-tropical types take their places, giving way in turn to south-temperate and Antarctic forms. The distribution of these is modified by barriers and by currents, yet though genera and species may be different, each isotherm is represented in each series by certain general types of fishes.

Distribution of Fresh-water Fishes.—As to their distribution in the streams, the fresh-water fishes may be subdivided as follows:

1. Lowland fishes; as the bowfin, pirate-perch, large-mouthed black bass, sun-fishes, and some catfishes.

2. Channel fishes: as the channel catfish, the mooneye, garpike, buffalo-fishes, and drum.

3. Upland fishes; as many of the darters, shiners and suckers, and the small-mouthed black bass.

4. Mountain fishes; as the brook-trout, and many of the darters and minnows.

To these we may add, (5) the more or less distinct classes of lake fishes, inhabiting only the waters which are deep, clear, and cold, as the various species of whitefish and the Great-Lake trout; (6) anadromous fishes, or those which run up from the sea to spawn in fresh waters, as the salmon, sturgeon, shad, and striped bass; (7) catadromous fishes, like the eel, which pass down to spawn in the sea; and (8) brackish-water fishes, which thrive best in the debatable waters of the river-mouths, as most of the sticklebacks and the killifishes.

As regards the range of species, we have every possible gradation from those which seem to be confined to a single river, and are rare even in their restricted habitat, to those which are in a measure cosmopolitan, ranging everywhere in suitable waters.

Still again, we have all degrees of constancy and inconstancy in what we regard as the characters of a species. Those found only in a single river-basin are usually uniform enough; but the species having a wide range usually vary much in different localities. Such variations have at different times been taken to be the indications of as many different species.

Where species can readily migrate their uniformity is preserved; but whenever a form becomes localized its representatives assume some characters not shared by the species as a whole. When we can trace, as we often can, the disappearance by degrees of these characters, such forms no longer represent to us distinct species. In cases where the connecting forms are extinct, or at least not represented in collections, each form which is apparently different must be regarded as a distinct species.

Barriers to River Fishes.— The existence of boundaries to the range of species therefore implies the existence of barriers to their diffusion. We may now consider these barriers and, in the same connection, the degree to which they may be overcome.

Least important of these are the barriers which may exist within the limits of any single basin, and which tend to prevent a free diffusion through its waters of species inhabiting any portion of it. In streams flowing southward, or across different parallels of latitude, the difference in climate becomes a matter of importance. The distribution of species is governed very largely by the temperature of the water. Each species has its range in this respect — the free-swimming fishes, notably the trout, being most affected by it; the mud-loving or bottom fishes, like the catfishes, least. The latter can reach the cool bottoms in hot weather, or the warm bottoms in cold weather, thus keeping their own temperature more even than that of the surface of the water. Although water communciation is perfectly free for most of the length of the Mississippi, there is a material difference between the faunas of the streams in Minnesota and in Louisiana. This difference is caused chiefly by the different temperature occupying the difference in latitude. That a similar difference in longitude, with free water communication, has no appreciable importance, is shown by the almost absolute identity of the fish-faunas of Lake Winnebago and Lake Champlain. While many large fishes range freely up and down the Mississippi, a majority of the species do not do so, and the fauna of the upper Mississippi has more in common with that of the tributaries of Lake Michigan than it has with that of the Red River or the Arkansas. The influence of climate is again shown in the paucity of the fauna of the cold waters of Lake Superior, as compared with that of Lake Michigan. The majority of our species cannot endure the cold. In general, therefore, cold or northern waters contain fewer species than southern waters do, though the number of individuals of any one kind may be greater. This is shown in all waters, fresh or salt. The fisheries of the northern seas are more extensive than those of the tropics. There are more fishes there, but they are far less varied in kind.

But in most streams the difference in latitude is insignificant, and the chief differences in temperature come from differences in elevation, or from the distance of the waters from the colder source. Often the lowland waters are so different in character as to produce a marked change in the quality of their faunas. These lowland waters may form a barrier to the free movements of upland fishes; but that this barrier is not impassable is shown by the identity of the fishes in the streams on the uplands of middle Tennessee with those of the Holston and French Broad. Again, streams of the Ozark Mountains, similar in character to the rivers of east Tennessee, have an essentially similar fish-fauna, although between the Ozarks and the Cumberland Range lies an area of lowland bayous, into which such fishes are never known to penetrate. We can, however, imagine that these upland fishes may be sometimes swept down from one side or the other into the Mississippi, from which they might ascend on the other side. But such transfers certainly do not often happen. This is apparent from the fact that the two faunas are not quite identical, and in some cases the same species are represented by perceptibly different varieties on one side and the other. The time of commingling of these faunas is perhaps now past, and it may have occurred only when the climate of the intervening regions was colder than at present.

The effects of waterfalls and cascades as barriers to the diffusion of most species is self-evident; but the importance of such obstacles is less, in the course of time, than might be expected. In one way or another very many species have passed these barriers. The falls of the Cumberland limit the range of most of the larger fishes of the river, but the streams above it have their quota of darters and minnows. It is evident that the past history of the stream must enter as a factor into this discussion, but this past history it is not always possible to trace. Dams and artificial waterfalls now check the free movement of many species, especially those of migratory habits; while, conversely, numerous other species have extended their range through the agency of canals.

Every year fishes are swept down the rivers by the winter floods; and in the spring, as the spawning season approaches, almost every species is found working its way up the stream. In some cases, notably that of the quinnat-salmon and the red salmon, the length of these migrations is surprisingly great. To some species rapids and shallows have proved a sufficient barrier, and other kinds have been kept back by unfavorable conditions of various sorts. Streams whose waters are charged with silt or sediment, as the Mississippi, Arkansas, or Brazos, do not invite fishes; and even the occasional floods of red mud, such as disfigure otherwise clear streams, like the Red River or the Colorado (of Texas), are unfavorable. Extremely unfavorable also is the condition which obtains in many rivers of the southwest; as for example, the Red River, the Sabine, and the Trinity, which are full from bank to bank in winter and spring, and which dwindle to mere rivulets in the autumn droughts.

In general, those streams which have conditions most favorable to fish-life will be found to contain the greatest number of species.

There can be no doubt that the general tendency is for each species to extend its range more and more widely until all localities suitable for its growth are included. The various agencies of dispersal which have existed in the past are still in operation. There is apparently no limit to their action. It is probable that new «colonies» of one species or another may be planted each year in waters not heretofore inhabited by such species. But such colonies become permanent only where the conditions are so favorable that the species can hold its own in the struggle for food and subsistence. That various modifications in the habitat of certain species have been caused by human agencies is of course too well known to need discussion here.

Of watersheds in the United States the most important and most effective is unquestionably that of the main chain of the Rocky Mountains. This is due in part to its great height, still more to its great breadth, and most of all, perhaps, to the fact that (Two Ocean Pass excepted) it is nowhere broken by the passage of a river. In the few cases when species have crossed this barrier a break in the chain (as the Two Ocean Pass in Wyoming connecting the Snake River with the Yellowstone) has now been recorded.

Habitat of Species.— Each species finds its habitat fitted to its life, and then in turn is forced to adapt itself to this habitat. Any other kind of habitat then appears as a barrier to its distribution. Thus to a fish of the ripples a stretch of still water becomes a barrier. A species adapted to sandy bottoms will seldom force its way through swift waters or among weeds or rocks.

The stream that has the greatest variety of animals in it would be one (1) connected with a large river; (2) in a warm climate; (3) with clear water, and (4) little fluctuation from winter to summer; (5) with little change in the clearness of the water; (6) a gravelly bottom; (7) preferably of limestone, and (8) covered in its quiet reaches and its ripples with water-weeds. These conditions are best realized in the tributaries of the Ohio, Cumberland, Tennessee, and Ozark rivers among American streams, and it is in them that the greatest number of species of fresh-water animals (fishes, crayfishes, mussels, etc.) has been recorded. These streams approach most nearly to the ideal homes for animals of the fresh waters. The streams of Wisconsin, Michigan, and the Columbia region have many advantages, but are too cold. Those of Illinois, Iowa, northern Missouri, and Kansas are too sluggish, and sometimes run muddy. Those of Texas and California shrink too much in the summer, and are too isolated. The streams of the Atlantic coast are less isolated, but none connect with a great basin, and those of New England run too cold for the great mass of the species. For similar reasons the fresh-water animal life of Europe is relatively scanty, that of the Danube and Volga being richest. The animal life of the fresh water of South America centres in the Amazon, and that of Africa in the Nile, the Niger, and the Kongo. The great rivers of Siberia, like the Yukon in Alaska and the Mackenzie River in British America, have but few forms of fresh-water animals, though those kinds fitted for life in cold, clear water exist in great abundance. See FISH; ICHTHYOLOGY.

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Fishing Cat, a wild cat (*Felis viverrina*), native to eastern India and eastward. It is nearly three feet long, and has a tapering tail about a foot in length. It is dark-gray or brown, striped and spotted with darker color; the tail is barred, and the throat and breast are quite white. Though it is a fierce animal, and has been known to carry off infants, it lives, generally, by catching fish and shellfish.

Fishing Frog, a fish. See GOOSEFISH.

Fishing Laws. See GAME LAWS.

Fishkill Landing, or **Fishkill-on-Hudson,** N. Y., in Dutchess County; on the Hudson River, the New York C., and a branch of the New York, N. H. & H. R.R.'s. It is connected with the West Shore R.R., at Newburg, by ferry, and with many of the towns and cities along the Hudson River by electric railways. It is about 55 miles north of New York. It was used as a "landing" as early as the times of exploration along the Hudson, and the first settlement was made about the last of the 17th century. During the Revolution the New York Provincial Convention met here, and it shares with Newburg and Mattewan the distinction of being the military depot for supplies for the American troops and frequently the headquarters of Washington. When peace was restored, its advantages as a trading post for the settlements on the east side of the Hudson gave it opportunities that caused it to become quite a good-sized village in the early part of the 18th century. Its chief manufactures are the Corliss engines and rubber goods. Coal and food products are shipped here in large quantities from New York. In 1783 the Society of Cincinnati was organized here. Consult: 'New England Magazine,' No. 5, Vol. XIV., 'The Birthplace of the Order of Cincinnati'; Smith, 'History of Dutchess County.' Pop. (1900) 3,673.

Fishway, a device to enable fish, especially salmon, to ascend a fall. It may consist of a series of steps over which the water descends, turning a fall into a cascade, and sometimes known as a fish ladder; or it may consist of a chute for diminishing the velocity, and assisting the fish to the level above the dam.

Fisk, Clinton Bowen, American politician: b. Griggsville, N. Y., 8 Dec. 1828; d. New York 9 July 1890. In the Civil War he rose from private to brevet brigadier-general of volunteers 1865. He was assistant commissioner in the Freedmen's Bureau and founder of Fisk University, Nashville, Tenn., 1865, an institution for the education of colored persons of both sexes. He became a member of the Indian Commission 1873, joining the Prohibition party 1884, and running as its candidate for the governorship of New Jersey 1886, and for the presidency 1888.

Fisk, Franklin W., American educator: b. Hopkinton, Vt., 1820; d. Chicago 4 July 1901. He was graduated at Yale University in 1849; became professor of rhetoric in the Seminary of Beloit, Wis., and was called to the Chicago Theological Seminary when that school was founded in 1859. Subsequently he was president of the seminary till 1900, when he resigned.

Fisk, James, American stock speculator: b. Bennington, Vt., 1834; d. New York 1872. He became a member of the Boston mercantile firm of Jordan & Marsh, drove shrewd bargains with the government during the Civil War; later opened a broker's office in New York, and was employed with one Belden by Daniel Drew (q.v.) as agent in Drew's struggle with Cornelius Vanderbilt for control of the Erie Railway. The Drew-Fisk and Gould-Eldridge interests in concert succeeded in forcing out Vanderbilt and in placing Gould and Fisk in power, the former as president, the latter vice-president and comptroller of the road. The activity of the two in bribery and corruption involved State and Federal officials, and at its climax brought about the gold conspiracy of 1869 and the well-known "Black Friday" (24 Sept. 1869), when the efforts of the combination to corner the gold market resulted in financial panic. Fisk was shot after a quarrel by E. S. Stokes, a business associate.

Fisk, Wilbur, American Methodist clergyman and educator: b. Brattleboro, Vt., 31 Aug. 1792; d. 22 Feb. 1839. He was graduated from Brown University 1815, and a few years later entered the Methodist ministry. In 1825 he became the principal of the Wesleyan Academy at Wilbraham, an institution which had already under his auspices risen to considerable eminence, and continued in this position until 1830, when he was elected president of the Wesleyan University at Middletown, Conn., which under his charge became exceedingly popular. He was twice elected to the office of bishop, but declined both honors. He published 'Travels in Europe' (1838), and other works.

Fisk University, a coeducational institution in Nashville, Tenn.; founded in 1866 under the auspices of the Congregational Church; reported at the close of 1901: Professors and instructors, 30; students, 618; volumes in the library, 6,778.

Fiske, Amos Kidder, American editor and author: b. Whitefield, N. H., 12 May 1842. He was graduated at Harvard 1866, and admitted to the bar 1868. He collaborated with George Ticknor Curtis in the 'Life of Daniel Webster' and was a large contributor to the revised edition of the 'American Encyclopædia' (1873–6). He served for 20 years on the editorial staff of the New York *Times*, joining the staff of the *Mail and Express* 1900. His published works are: 'Midnight Talks at the Club' (1890); 'Beyond the Bourn' (1891); 'The Jewish Scriptures' (1896); 'The Myths of Israel' (1897); 'The Story of the Philippines' (1898); 'The West Indies' (1899).

Fiske, Bradley Allen, American naval officer: b. Lyons, N. Y., 13 June 1854. He was appointed a cadet midshipman in the United States navy in 1870; and became lieutenant-commander 30 March 1900. He invented a boat detaching and attaching apparatus for warships in 1877; the first electric ammunition used in the navy in 1888; electric gun-training apparatus and electric steering gear the same year; range- and position-finders in 1889; improvements of the range-finder and electric steering gear in 1895; and an electrical apparatus for transmitting the orders of a ship's commander from the deck bridge to the engine room in 1896; and has been attached to the Naval Bureau of Ordnance since 1895. Author: 'Electricity and Electrical Engineering'; 'Electricity in Theory and Practice.'

Fiske, Daniel Willard, American educator: b. Ellisburg, N. Y., 11 Nov. 1831; d. Frankfort-on-the-Main, Germany, 17 Sept. 1904. He studied at Hamilton College and in Europe, was an instructor in English and lecturer on American literature in the University of Upsala, Sweden, in 1849–52; member of the Astor Library (New York) staff 1852–9; and general secretary of the American Geographical Society in 1859–60. After having held a post in the Vienna legation (1861–2), he was editor of the Syracuse (N. Y.) *Journal* (1864–6), of the Hartford (Conn.) *Courant* (1867), and librarian-in-chief and professor of the languages of northern Europe in Cornell University. He removed to Florence, Italy, in 1881.

Fiske, John (originally **Edmund Fiske Green**), American historian and philosopher: b. Hartford, Conn., 30 March 1842; d. Gloucester, Mass., 4 July 1901. In 1855 he assumed the name of his maternal great-grandfather, John Fiske, of Middletown, Conn. In 1863 he was graduated from Harvard, in 1865 from the Harvard Law School, in 1864 was admitted to the Suffolk bar, but never entered legal practice. In 1861 he published in the 'National Quarterly Review' a notable critical article ('Mr. Buckle's Fallacies') on Buckle's 'History of Civilization in England.' From 1869 to 1879 he was at Harvard, first as a brilliant university lecturer in philosophy, and from 1872 as assistant librarian. In 1884 he received appointment to the chair of American history in Washington University (St. Louis, Mo.), where for some years he held annual lecture courses. His reputation as a lecturer was considerable, also, in Great Britain, where he delivered addresses on American history in 1879 at University College, London, and in 1880 at the Royal Institution. His earlier recognition, however, was chiefly as a thinker and writer in evolutionary philosophy, in particular as the foremost expounder to English-speaking students of Herbert Spencer's philosophic system. In this popularization of Spencer, best represented by his 'Outlines of Cosmic Philosophy' (1874), his lucidity won strong approbation from Darwin. From 1879 his attention was turned toward American history, largely through researches made by him in American aboriginal life in connection with a projected work on the Aryans. Thenceforth his philosophic studies took subordinate place, though he wrote in this field occasional volumes of much interest, and in his 'Idea of God' (1885) and 'Origin of Evil' gave ultimate presentation of his confirmed views on questions of philosophy and religion. In his series of historical writings, forming broadly a continuous account of events from the earliest discoveries to the beginnings of Federal government, he displayed a marked ability for clear and interesting narrative, and infused a particular interest into the adventurous characters and daring deeds of the period of exploration. He fails at times in points of minor accuracy, but in arrangement, judgment, proportion, and dramatic interest he exercised a strong influence on the progress of American historical studies in this country. His style here is not inferior to that of his philosophical treatises. He worked with tremendous energy, and, though dying prematurely, had accomplished an impressive amount of literary labor. Among the titles of his further volumes are: 'Myths and Mythmakers' (1872); 'The Unseen World' (1876); 'Darwinism and Other Essays' (1879; rev. ed. 1885); 'Excursions of an Evolutionist' (1883); 'The Destiny of Man' (1884); 'American Political Ideas' (1885); 'The Critical Period of American History' (1888); 'The War of Independence' (1889); 'The Beginnings of New England' (1889-98); 'Civil Government in the United States' (1890); 'The American Revolution' (1891); 'The Discovery of America' (1892); 'History of the United States for Schools' (1894); 'Edward Livingston Youmans' (1894); 'Old Virginia and Her Neighbors' (1897); 'The Dutch and Quaker Colonies in America' (1899); 'Through Nature to God' (1899); 'New France and New England' (1902); and 'Essays, Literary and Historical' (1902).

Fiske, Lewis Ransom, American Methodist minister and educator: b. Penfield, N. Y., 24 Dec. 1825. He was graduated at the University of Michigan 1850, entered the Methodist ministry, and held pastorates in Jackson, Ann Arbor, and Detroit. He taught in the State Normal School and the State Agricultural College of Michigan; was president of Albion College 1877–98; and has been professor emeritus of philosophy there from 1898. He was editor of the Michigan 'Christian Advocate' (1875–9). He has published: 'To-day and To-morrow' (1898); 'Chosing a Life-Work' (1900); 'Human Life and Its Forces' (1901).

Fiske, Stephen, American editor and author: b. New Brunswick, N. J., 22 Nov. 1840. He was graduated at Rutgers College and early became an editorial writer on the staff of the New York *Herald,* for which newspaper he acted as special correspondent in the suite of the Prince of Wales, now king of England, while the Prince was traveling in the United States and Canada, and later as war correspondent. For many years he was dramatic critic of the *Herald*; afterward managing the St. James Theatre and the Royal English Opera Company in London, and the Fifth Avenue Theatre, New York, presenting Modjeska and Mary Anderson. Among his works are: 'English Photographs'; 'Off-hand Portraits of Prominent New Yorkers'; and several plays including: 'Corporal Cartouche'; 'Martin Chuzzlewit'; 'My Noble Son-in-Law'; 'Robert Rabagas.'

Fission, fish'ŏn, a term in biology applied to various separation processes, as cell-division of the bacteria and related algæ, and the dividing of chromosonus (see EMBRYOLOGY). When used in reference to hydroids and related animals it means the process of reproduction by germination or budding, in which the offspring arises as a bud from the parent and is then constricted off. See BUDDING.

Fissirostres, fis-ĭ-ros'trēz, one of the four or five tribes or sub-orders into which the insessorial birds were divided by early ornithologists. The term is no longer used, as the group it represented was not a natural one. It contained the nightjars, swifts, trogons, and various other more or less related families.

Fissure, fish'ūr. Any rock fracture or crack is a fissure, but generally the term is applied to fractures of some size. If accompanied by dislocation of the rocks the fissure is termed a fault. The term true fissure vein so frequently used by miners should be applied to a vein formed along a fault. Such a vein is apt to have considerable length and sometimes great depth. As the term is commonly used by mine promoters it really means nothing except that the promoter wants to give the impression that the mine he is trying to sell is on a vein that will go down indefinitely. See FAULT; JOINT; ORE DEPOSITS.

Fissure. See BRAIN; RECTUM.

Fissure Needle, a spiral needle for drawing together the gaping lips of wounds. By revolution, the point is made to pierce the lips alternately, carrying its thread or silver wire with it. See SURGERY.

Fis'tula, a burrow or tract through the tissues. Usually the term is applied to tracts between cavities lined by mucous membrane or from a cavity to the body surface. The lining of the tract is infected with granulation tissues, which make it difficult to heal. They are formed by suppuration, or by a low grade of infection along the course of a false passage made by foreign bodies or surgical instruments. The most frequent sites are the anus, the rectum, the intestines, the bladder, the vagina, and the salivary ducts. Fistula in ano is always secondary to an abscess in the rectum or perirectal tissue. Abscesses here are difficult to heal, owing to constant inflection from the fæces and the construction of the parts. Chronic alcoholics, consumptives, and otherwise debilitated subjects are particularly liable to these abscesses, and consequently to fistulæ. When the passage is from the bowel to the skin, with openings at both points, it is said to be complete. Blind internal and blind external are two other common varieties. The tissues about the anus may be riddled with these tracts. The conversion of the tract into an open wound must be made before a positive cure will result.

Fistulina. See FUNGI.

Fitch, Ebenezer, D.D., American clergyman: b. Norwich, Conn., 26 Sept. 1756; d. West Bloomfield, N. Y., 21 March 1833. He was graduated at Yale College in 1777, where in 1780 he was appointed tutor, and continued to act as such for several years. In 1790 he was chosen preceptor of the academy in Williamstown, Mass., and when in 1793 it grew into and was incorporated as Williams College, he was elected its first president, which office he filled with ability and success till 1815, when, resigning, he was chosen pastor of the Presbyterian Church in West Bloomfield, N. Y. This charge he held till 1827.

Fitch, John, American inventor: b. East Windsor, Conn., 21 Jan. 1743; d. Bardstown, Ky., 2 July 1798. At the outbreak of the Revolution he became a gunsmith for the American troops, with whom he wintered at Valley Forge. He next made surveying and trading tours in the West, and after escaping from captivity among the Indians returned to Pennsylvania, where in 1785 he completed his first model of a steamboat: this had wheels at the sides, which were replaced in the following year with paddles or oars. In the face of discouragement and neglect he succeeded in constructing a vessel, 45 feet long and 12 feet beam, with an engine of 12-inch cylinder, which made a successful trial trip on the Delaware, at Philadelphia, 22 Aug. 1787. Larger vessels were built in 1788 and 1790, the latter being run as a passenger boat, at 8 miles an hour, to Burlington (20 miles) throughout the summer. Misfortune, however, dogged "poor John Fitch's" steps: his supporters fell away; and in 1793 he went to France to construct a steamboat, only to find his project frustrated by the Revolution there. It is said that his plans and specifications were deposited with the American consul at L'Orient, who for several months entrusted them to Robert Fulton (q.v.); and the latter's steamboat certainly was in 1817 declared by a committee of the New

York legislature to be "in substance the invention patented by John Fitch in 1791." Penniless and dejected, Fitch worked his passage back to America, where in the summer of 1798 he is said to have committed suicide at Bardstown, Ky. Consult Westcott, 'Life of John Fitch, Inventor of the Steamboat' (1857); Thurston, 'Growth of the Steam Engine' (1878).

Fitch, Sir **Joshua Girling,** English educationist: b. 1824; d. London August 1903. He was educated at the University of London. In 1852 he was appointed principal of the Normal College of the British and Foreign School Society and in 1877 government school inspector for the eastern counties. He was also examiner in English and member of the senate in the University of London. In 1888 he visited the United States with a view of studying transatlantic educational methods. The result of his observations he embodied in his 'Notes on American Schools and Colleges' (1890). Among his other works may be mentioned: 'Lectures on Teaching at Cambridge' (1881); 'The Arnolds and their Influence on English Education.'

Fitch, Ralph, English merchant and voyager of the 16th century. He dealt in eastern goods, and, excited by the narratives of Drake and other voyagers, persuaded John Newbery and others to join him in an expedition to the East by way of the Mediterranean. The adventurers set sail in January 1583, landed in Syria, went to Aleppo, and traversing Mesopotamia reached Bagdad. From that city they sailed down the Tigris and through the Persian Gulf to Ormus, where they began a profitable traffic. But their success roused the jealousy of other European merchants in those parts, one of whom denounced them as heretics to the Portuguese inquisition. The Englishmen were thrown into prison at Goa, but finally released, and seeing reason to apprehend further injustice, they secretly escaped. After passing through Golconda, they traveled north through the Deccan, and visited successively Burhampoor, Mandoo, Agra, Allahabad, Benares, Patna, Tanda in Bengal, and a country called by Fitch Couche, which appears to be at the foot of the mountains of Bootan. They traveled south to Hoogly and through Orissa, passing by a port called Angeli, which they described as the seat of a great trade. It cannot now be identified. Returning to the Ganges, they saw Serampore and other towns on its lower branches, made an excursion into Tipperah, and took passage in a vessel to Negrais, in Pegu. They visited Malacca, went back to Bengal, shipped for Ceylon, and thence doubling Cape Comorin sailed to Cochin and Goa, and returned to England in 1591, by the same route they had come, after having performed the most extensive journey that had yet been made by any Europeans in India. Fitch's narrative of his travels, which may be found in Hakluyt and in Purchas' 'Pilgrims,' is exceedingly interesting not less for its quaint style than for the mass of information which it contains.

Fitch, William Clyde, American playwright and author: b. New York 2 May 1865. He was graduated at Amherst College 1886. He has written many successful plays, among them: 'Beau Brummell'; 'The Climbers'; 'The Way of the World'; 'The Girl and the Judge'; 'Barbara Frietchie'; 'The Moth and the Flame'; 'The Stubbornness of Geraldine'; etc. He is also the author of: 'The Knighting of the Twins, and Ten Other Tales' (1891); 'Some Correspondence and Six Conversations' (1896); 'A Wave of Life,' a novel.

Fitch'burg, Mass., city, one of the county-seats of Worcester County, on the New York, N. H. & H., and the Fitchburg R.R.'s; 50 miles northwest of Boston. It comprises the villages of Traskville, Rockville, South Fitchburg, West Fitchburg, and Fitchburg Centre. It contains a public library, high school, electric street railroad, electric lights, several national and savings banks, and a number of daily and weekly newspapers. The various industries employ about 5,000 people. There are manufactories of pianofortes, tools, machinery, paper, saws, electrical apparatus, steam-engines, bicycles, firearms, cotton and woolen goods etc. Pop. (1900) 31,531.

Fitché, or **Fitchée,** fi-chā, in heraldry, pointed, like a dagger; sharpened at the lower part. Fitché is usually applied to crosses to indicate that they taper from the centre downward, or fitché at the foot, when the tapering commences only at the bottom of the cross. See Heraldry.

Fitchett, William Henry, Australian journalist and Methodist clergyman. He was educated at Melbourne University, entered the Methodist ministry and for a time edited the Melbourne *Daily Telegraph.* He is the editor of the 'Review of Reviews' of Australia, and principal of the Methodist Ladies' College at Melbourne. He has published: 'Deeds that Won the Empire' (1897); 'Fights for the Flag' (1898); 'Stories of the Indian Mutiny'; 'How England Saved Europe' (1899); 'Wellington's Men' (1901); 'Nelson and His Captives' (1902).

Fitchew. See Polecat.

Fitger, Arthur Heinrich Wilhelm, hīn'rīн vil'helm fit'gėr, German poet and painter: b. Delmenhorst, Oldenburg, 4 Oct. 1840. He has written several successful dramas: 'Adalbert of Bremen' (1873), with the afterpiece 'Here Empire! Here Rome!' (1875); 'The Witch' (1878); 'The Roses of Tyburn' (1888). Besides these he is the author of a short epic, 'Roland and the Rose' (1871); and two volumes of collected poems, 'Traveling Folks' (1875), and 'Winter Nights' (1881). He has painted several important friezes and other decorations at Bremen and Hamburg.

Fitts, James Franklin, American journalist and novelist: b. Lockport, N. Y., 1840; d. there 11 Jan. 1890. During the Civil War he distinguished himself on several occasions, and was rewarded with promotions. After the war he devoted himself to writing for newspapers, magazines, and syndicates. Of his novels the most popular were: 'The Parted Veil'; 'A Version'; 'A Modern Miracle'; 'Captain Kidd's Gold.'

Fitz (old French for *fils*, son), a syllable frequently forming a prefix in English surnames (Fitz-Herbert, Fitz-Clarence, Fitz-James), like the Scottish Mac, and the Irish O'. Latterly *Fitz* usually denotes illegitimate descent. There are several noble families of such origin, who include their royal progenitors in their genealogical tables.

Fitzball′, Edward, English dramatist: b. Burwell, Cambridgeshire, 1792; d. 1873. His name was orginally Ball, but he substituted the present form in 1819. He made his first dramatic success with 'The Innkeeper of Abbeville' (1820). This was succeeded by a dramatization of 'The Fortunes of Nigel' (1822); and 'Joan of Arc,' and he soon became a prolific dramatist, turning out plays to order in great number, and some of them having enormous success. Among his works are: adaptations of Scott's 'Peveril of the Peak' and 'Waverley' (1823); 'The Pilot' (200 nights); 'The Flying Dutchman' (1828); 'Jonathan Bradford' (1838) (400 nights); 'Walter Tyrrell' (1835); 'Zazezizozu' (1836); 'The Momentous Question'; 'The Miller of Derwentwater'; and libretti for several of Balfe's, Donizetti's, Bishop's and Wallace's operas. He was the author of 'Thirty-five years of a Dramatic Author's Life.'

Fitzgerald, fits-jĕr′ald, **Edward,** Lord, Irish patriot: b. near Dublin, Ireland, 15 Oct. 1763; d. 4 June 1798. He was a son of the first Duke of Leinster. He distinguished himself for intrepidity as aide-de-camp to Lord Rawdon in the American Revolution, and was severely wounded in the battle of Eutaw Springs. When the French Revolution broke out, he supported its principles, and in 1793 hastened to Paris. Here he married Pamela, the reputed daughter, it is said, of Louis Philippe Joseph, the Duke of Orleans, and Madame de Genlis. On his return to Ireland, Fitzgerald was desirous of effecting a separation of that country from England, and induced the French Directory to furnish him with a fleet and troops. A landing was attempted on several occasions, but without success, and Fitzgerald was seized, tried, and condemned to death. He died of his wounds before the time fixed for his execution, 1798. His wife married a second time, Mr. Pitcairn, the American consul at Hamburg, from whom, however, she separated soon afterward. See Moore, 'Life and Death of Edward Fitzgerald' (2d ed. 1875).

Fitzgerald, Edward, English poet: b. near Woodbridge, Suffolk, 31 March 1809; d. Merton, Norfolk, 14 June 1883. At 17 he entered Trinity College, Cambridge, where he graduated in 1830. At school and college he formed several lifelong friendships with men who afterward became celebrated in different spheres, among them being Spedding and Thackeray. At a later period he gained the friendship of Tennyson and Carlyle. His life was passed quietly — almost in retirement — in various parts of Suffolk, first at Bredfield, his birthplace, then near Ipswich, where he contracted friendships with George Crabbe, the son of his favorite English poet, and Bernard Barton, the Quaker poet; and lastly at Boulge Hall and Woodbridge. Books were his chief indoor recreation; out of doors he occupied himself at first chiefly with boating, and afterward with his garden. Fitzgerald's works are not numerous, by far the most important being his celebrated translation of the 'Rubaiyát' (or quatrains) of the Persian semi-pessimistic astronomer-poet, Omar Khayyám. Having for some time studied Persian, in 1856 he published a translation of Jámi's 'Salámán and Absál.' Three years later his *magnum opus* appeared without causing any stir, but before he died four editions had been issued. The beauty of Fitzgerald's poem is universally admitted, but some have doubted whether it does not contain more of the Englishman than of the Persian. The general consensus of opinion now seems to be that though undoubtedly embellished, altered in some ways and adapted, we have in Fitzgerald's work a real translation of Khayyám's. Other works by him are: 'Euphranor: a Dialogue on Youth' (1851); 'Polonius: a Collection of Wise Saws and Modern Instances' (1852), both of which appeared anonymously; 'Six Dramas of Calderon, freely translated by Edward Fitzgerald' (1853); and translations of Æschylus' 'Agamemnon' and the 'Œdipus' plays of Sophocles. Tennyson's poem, 'Tiresias,' was dedicated to Fitzgerald. See 'Letters and Literary Remains of Edward Fitzgerald,' edited by W. Aldis Wright (1889; new edition 1894); 'Variorum Edition of the Poetical and Prose Writings of Fitzgerald,' edited by Bentham (1902–3).

Fitzgerald, James Newbury, American Methodist bishop: b. Newark, N. J., 27 July 1837; d. Hong Kong, China, 3 April 1907. He studied law and was admitted to the New Jersey bar in 1858, but in 1862 entered the Methodist ministry. He was recording secretary of the missionary society of his denomination 1880–8, and was appointed bishop in 1888.

Fitzgerald, Oscar Penn, American Methodist bishop: b. Caswell County, N. C., 24 Aug. 1829. He was ordained a Methodist minister in Georgia 1853, went to California 1855 and became editor of the 'Pacific Methodist and Christian Spectator,' serving as State superintendent of public instruction in California 1867–71, and being appointed editor of the Nashville 'Christian Advocate' 1878. He was made a bishop of the Methodist Episcopal Church, South, 1878. His works include: 'California Sketches'; 'Christian Growth'; 'Glimpses of Truth'; 'A Life Study'; 'Centenary Cameos'; 'Bible Nights'; 'Eminent Methodists'; 'The Whetstone'; 'The Epworth Book'; 'The Menagerie'; 'Judge Longstreet'; 'Sunset Views' (1900); 'The Day and the Word' (1898); etc.

Fitzgerald, Percy Hetherington, Irish novelist and miscellaneous writer: b. Fane Valley, south Ireland, 1834. Educated at Trinity College, Dublin, he was called to the Irish bar in 1855, and was afterward a crown prosecutor on the northeastern circuit. Beside novels he has written many biographical and other works, of which the most important are: 'Life of Laurence Sterne' (1864); 'Charles Lamb: His Friends, His Haunts, and His Books' (1865); 'Charles Townshend, Wit and Statesman' (1866); 'Life of David Garrick' (1868); 'Principles of Comedy and Dramatic Effect' (1870); 'The Kembles: an Account of the Kemble Family' (1871); 'Book of Theatrical Anecdotes' (1873); 'The Romance of the English Stage' (1874); 'Life, Letters, and Writings of Charles Lamb' (1875–6); 'History of the Suez Canal' (1876); 'Croker's Boswell, and Boswell: Studies in the Life of Johnson' (1880); 'A New History of the English Stage' (1882); 'The Royal Dukes and Princesses of the Family of George III.' (1882); 'Kings and Queens of an Hour: Records of Love, Romance, Oddity, and Adventure' (1883); 'Life and Times of

William IV.' (1884); 'The Lives of the Sheridans' (1887); 'Life and Times of John Wilkes, M.P.' (1888); 'Picturesque London' (1890); 'Henry Irving: a Record of Twenty Years at the Lyceum' (1893); 'Fifty Years of Catholic Life and Social Progress' (1901).

Fitz-Gerald, Shafto Justin Adair, English novelist and dramatist: b. 9 Nov. 1859. He has published: 'Sketches from Bohemia' (1890); 'The Wonders of the Secret Cavern' (1892); 'Ballads of a Bohemian' (1893); 'A Book of Words' (1895); 'The Mighty Toltec' (1897); 'Stories of Famous Songs' (1897); 'The Grand Panjandrum' (1898); 'The Black Tulip' (1899); 'Rip Van Winkle' (1900); 'How to Make Up' (1901); and a dozen or more plays.

Fitzgib'bon, Mary Irene, American philanthropist: b. London, England, 12 May 1823; d. New York 14 Aug. 1896. She removed to New York early in life; entered the community of the Sisters of Charity at Mount St. Vincent in January 1850, and became sister superior in 1856. In 1869 Archbishop (later Cardinal) McCloskey requested her to organize a work for the care of the waifs of the diocese. On 11 Oct. 1870 the New York Foundling Asylum was opened and within a month was caring for 45 children. During the same year the legislature authorized the city to grant the asylum a site and to appropriate $100,000 toward a building, providing an equal amount should be provided by subscriptions. This amount was soon raised. At the time of Sister Irene's death, the buildings of the asylum covered an entire block and were valued at over $1,000,000. Aside from having full charge of this institution from its inception, Sister Irene raised $350,000 with which she founded the Seton Hospital for Incurables.

Fitzher'bert, Maria Anne (Smythe), morganatic wife of King George IV. of England: b. Brambridge, England, 26 July 1756; d. Brighton, England, 27 March 1837. Her first husband was Edward Weld, to whom she was married in 1775. He died within a year and she was married to Thomas Fitzherbert 1778. He died in 1781 and she was married to the Prince of Wales 21 Dec. 1785. Under the Marriage Act of 1772 the marriage might have been declared invalid if publicly acknowledged, and it would, if avowed, have changed the succession under the Act of Settlement, Mrs. Fitzherbert being a Catholic. She, however, lived with the prince as his wife, the relationship ending in 1803.

Fitzhugh', George, American lawyer: b. Prince William County, Va., 2 July 1802; d. Huntsville, Texas, 30 July 1881. He held very extreme views in reference to slavery. He published: 'Sociology for the South, or the Failure of Free Society' (1854); 'Cannibals All, or Slaves Without Masters' (1856).

Fitz-John Porter Case, The. See PORTER, FITZ-JOHN.

Fitzmaurice, fits-mor'ris, LORD **Edmond George,** English politician: b. 19 June 1846. He sat in the House of Commons for Calne 1869–85, and was under-secretary for foreign affairs 1882–5. He has published: 'Life of William, Earl of Shelburne' (1875–7); 'Sir William Petty, the Political Economist' (1895).

Fitzmaurice-Kelly, James, English scholar: b. 20 June 1858. He was examiner in Spanish at Oxford University 1900–2, and has published: 'The Life of Miguel de Cervantes Saavedra' (1892); 'History of Spanish Literature' (1898); and edited the complete works of Cervantes.

Fitzpat'rick, Benjamin, American politician: b. Green County, Ga., 20 June 1802; d. 1869. He settled in Alabama in early life, studied law, and in 1821 obtained license to practise. He was soon afterward elected State's attorney, and held that office until 1829. In 1841 he was elected governor, and in 1843 was re-elected without opposition. In 1848 he was appointed United States senator to fill a vacancy, and continued in the Senate until 1861.

Fitzpatrick, Charles, Canadian lawyer and politician: b. Quebec 19 Dec. 1853. He was graduated at Laval University in 1873 and being admitted to the bar in 1876, was appointed crown prosecutor for the city and district of Quebec 1879 and 1887. He was a member of the Quebec Assembly 1890–6, and was elected to the Dominion Parliament 1896, becoming solicitor-general in the same year.

Fitzralph', Richard, English prelate: b. Dundalk, Ireland, about 1300; d. Avignon 16 Nov. 1360. He took orders, becoming Fellow of Balliol College, Oxford, and being made chancellor 1333. He was archbishop of Armagh 1347. He was a popular preacher and in favor with the Pope at Avignon, interesting himself greatly in the Armenian question, and also in the case of the secular clergy against the mendicant friars in England. In connection with the former he wrote an argument, 'Summa in Questionibus Armeniorum,' and in reference to the latter a treatise 'De Pauperie Salvatoris.' When summoned by the friars before Pope Innocent VI. he defended himself in a notable sermon, 'Defensio Curatorum,' dying before the case was decided. His bones were taken to Dundalk 1370, where his tomb became an object of veneration.

Fitzroy' River, the name of two Australian rivers, one in western Australia and one in Queensland. The former rises in the King Leopold Mountains and empties in King Sound; length 300 miles. The Queensland River is formed by the junction of the Mackenzie and the Dawson and empties into Keppel Bay.

Fiume, fē-oo'mĕ, Austria-Hungary, seaport town on the small river Fiumara; 40 miles southeast of Trieste. Some of the manufactures include tobacco, paper, leather, chemicals, soap, torpedoes, and rosoglio, and it carries on shipbuilding. Since 1872 the Hungarian government has spent large sums in providing moles, quays, docks, and other accommodations, with the result of immensely increasing the trade. The principal exports are corn, sugar, tobacco, wood, fruit, refined petroleum, etc.; the principal imports — wine, coal, jute, rice, cotton, salt, etc. Pop. 29,494.

Five or Nine, a game, analogous to dominoes, played with a pack of 52 cards. The name is derived from the fact that the player leading off to the table must play a five or a nine; then the cards are played in sequence, as dominoes are placed. The rules of the game are similar to those governing dominoes. The game is also called domino whist. See DOMINOES.

Five-cent Piece, Half-dime, or **"Nickel."** Silver half-dimes were the first coins struck under the Coinage Act of 1792. None were coined in 1798, 1799, 1804, or 1806 to 1828. See COINS; NUMISMATICS.

Five-fingers. A starfish (q.v.).

Five Forks, Battle of. At the close of the battle of Dinwiddie Court House, 31 March 1865, Gen. Sheridan was holding position in front of the place, Gen. Pickett, with infantry and cavalry, confronting him. At 12 P.M. Pickett, threatened by Warren's Fifth corps on his left, ordered a retreat to Five Forks to protect his communications with the South Side Railroad. Sheridan followed him at daylight with Devin's and Custer's divisions, Crook's division being thrown on roads to the left. Pickett was found entrenched at Five Forks. By 1 P.M. Sheridan's cavalry had worked close up to Pickett's lines, and Sheridan ordered up the Fifth corps. MacKenzie's cavalry division, advancing on the extreme right, drove back Robert's cavalry and gained the White Oak road.

At 4 P.M. Warren had formed his lines, Ayres' and Crawford's divisions in double lines, with one brigade in reserve, on the left and right respectively of the Gravelly Run Church road. A few moments brought Warren to the White Oak road, and Ayres, whose right had crossed it, received a severe fire upon his left, and at once changed front and attacked the return of the entrenchments. Crawford kept straight on through the woods and, receiving fire from Munford's cavalry, swerved to the right, thus isolating his division from Ayres, and Griffin followed Crawford. But Griffin and his brigade commanders taking in the situation, soon marched by the left flank and protected Ayres' flank, which had been thrown into some confusion. Ayres meanwhile, connecting with the cavalry on his left, had made a gallant charge, carried the left of the Confederate works and, with support on the left and right, swept down inside them to and beyond Five Forks, capturing many prisoners. The only stand the Confederates tried to make was on the road leading to the railroad, and at this point they were pressed so closely by Griffin and Crawford that they soon gave way. On the right Warren took Crawford's division in hand, changed its direction to the left and, advancing in rear of the Confederate infantry line, with MacKenzie's cavalry on the right, drove Munford's cavalry, continually turning the left of the Confederates opposing Ayres and Griffin, gained the road leading to the South Side Railroad, forced Munford north of Hatcher's Run, and took four guns and many prisoners. On the extreme left Custer had a severe fight with cavalry and infantry, and gained but little ground until Devin and Ayres, advancing behind the works, drove the infantry out. The Confederate cavalry made no further stand, save to cover the retreat, and just before dark Custer, in connection with an attack by a small body of the Fifth corps, led by Warren in person, drove the last of the Confederates westward on the White Oak road, and followed them until long after dark. The battle was one of the most decisive of the War. The Confederates were totally routed, losing over 5,000 men captured, 6 guns, and 11 colors. The Union loss was 830 killed and wounded, of which the Fifth corps lost 634. The Confederate loss in killed and wounded is not definitely known. Consult: 'Official Records,' Vol. XLVI.; Humphreys, 'The Virginia Campaign of 1864–5'; Powell, 'The Fifth Army Corps'; Sheridan, 'Personal Memoirs,' Vol. II; The Century Company's 'Battles and Leaders of the Civil War,' Vol. IV.

E. A. CARMAN.

Five Members, The, whom Charles I. attempted to arrest early in 1642, were John Pym, John Hampden, Denzil Holles, Sir Arthur Haselrig, and William Strode, representing in the Commons Tavistock, Buckinghamshire, Dorchester, Leicestershire, and Dorchester respectively. The king, expecting an impeachment of the queen, determined to prevent it by impeaching these commoners along with Lord Kimbolton. The impeachment was subsequently abandoned when the Commons had declared against the illegality of his procedure. See ENGLAND.

Five-mile Act, an old English law, passed in 1665, which forbade non-conformist pastors who refused to take an oath of non-resistance to come within five miles of any corporation in which they had preached since the passing of the Act of Oblivion in 1660. The law was repealed in 1688.

Five Nations, a confederacy consisting of five tribes of Indians who lived in the western and central part of what is now the State of New York. The five tribes were: the Cayugas, Mohawks, Oneidas, Onondagas, and Senecas. In 1712 the Tuscaroras were taken into the confederacy, and they were then known as the Iroquois, or the Six Nations. See IROQUOIS, OR THE SIX NATIONS.

Five Points, New York, a locality between Centre and Reade streets and Park Row. At one time it was noted as a resort for criminals and "hard cases." The Ladies' Home Missionary Society of the Methodist Episcopal Church began a reform work at Five Points in 1850, and they have been most successful. The Church of the Ascension contributed funds to establish an industrial school which, in 1854, was incorporated. The mission secured by purchase and by building an excellent home, which they still occupy; and thousands of children have been reclaimed and educated through the efforts of the mission workers. The character of the place has changed greatly for the better.

Five Points of Doctrine, the principal subjects of doctrine which are disputed topics between Arminians and Calvinists. They are: (1) extent of the atonement; (2) predestination; (3) free will; (4) grace; (5) final perseverance. Various efforts have been made to settle the differences; they were fully discussed at the Synod of Dort, in Holland, in 1618–19; at Cambridge, in England, in 1594, and at two other conferences held in England in 1626.

Five-twenties (that is, redeemable after 5 years and payable in 20), 6 per cent gold bonds issued in 1862, 1864, and 1865. See DEBT, UNITED STATES.

Fives, an English game, originally called hand-tennis, in which the ball is struck against a wall. It is played either in close or in open courts, of various shapes and proportions. The game is known as hand-fives or bat-fives, according as the ball is struck by the open hand or a small wooden bat. The origin of the name is disputed. Also a disease in horses, resembling the staggers, and consisting of an inflammation of the parotid glands; written also vives.

Fixed Oils, in medicine, oils used as demulcents, laxatives, and in external application as emollients. Some, notably linseed oil, while still in the seed, are very useful in poultices because of the high specific heat of the oils. By means of this specific heat the poultice stays warm much longer. Others of the fixed oils are useful as foods — cod-liver oil, peanut oil, etc.

Fixing. (1) In machinery, a piece of cast iron adapted to carry pillow blocks and the like. When it is built into a wall it is called a wall fixing, or wall box; when attached to a wall by bolts it is a plate fixing. There are also beam fixings, as when wheels intended to work at the position where the fixing is situated; and when the fixing is adapted to them, it is then commonly called a wheel fixing. (2) In metallurgy, the material used in preparing the hearth of a puddling or boiling furnace for receiving its charge. It is called fettling in some parts of England. (3) In photography, of a negative; the removal, by a solution of hyposulphite of soda or cyanide of potassium, of the unaffected deposit of iodide and bromide of silver in the collodion film after exposure and development of the picture. Of a positive; the removal of the unaltered chloride of silver from the surface of the photographic paper after exposure under the negative.

Fjord. See Fiord.

Flabellum. See Fans.

Flaccus, Caius Valerius, kā'yus va-lē'rĭ-us flak'us, Roman poet of the latter half of the 1st century. He lived in Padua, and died young. He sung the expedition of the Argonauts in an epic poem, ‘Argonautica,’ of which seven books and part of the eighth have remained to us.

Flacius, flā'shĭ-us, or **Vlacich, Matthias,** mät-tē'äs flä'siH, German Lutheran theologian: b. Albona, Illyria, 1520; d. Frankfort-on-Main 1575. He became professor of the Hebrew Scriptures at Wittenberg University in 1544. From this time he took an active part in all the theological discussions of the time; and for his attacks on Melanchthon's compromise, known as the Leipsic Interim, he was, four years later, deprived of his professorship. Nor did he procure another appointment until 1557, when he became professor of theology at Jena. This post he again lost, after five years, on account of his doctrine that original sin was essentially inherent in man's nature. Of his numerous works three deserve mention: ‘Clavis Scripturæ Sacræ’ (1567); ‘Catalogus Testium Veritatis’ (1556); ‘Ecclesiastica Historia’ (1559–74).

Flag, a strip of cloth of a light fabric, varying in form and color, frequently bearing some emblematic design, and ordinarily fixed by one end to a staff, pole, rope, etc., while the other is allowed to fly free. The length of a flag from the part near the staff to the free end is called the fly, and the measurement at right angles to this is known as the hoist, height, or depth.

The uses of flags are numerous. They serve in a variety of ways as signals. They convey definite information of various kinds, and are used as general symbols of rejoicing, congratulation, sympathy, mourning, etc. In a classification of the uses of flags, that which stands first, as the most general, is their use as national emblems. Next in order comes their use as distinguishing emblems of the naval and military forces of particular nations. In the army each regiment is distinguished by its particular flag or colors. This usage is general, and the colors of regiments come to be distinctive of their services and of their *esprit de corps,* as well as of their position in the army. Flags are sometimes presented by persons of rank or official station, or by other individuals or groups of people, and often bear names and emblems commemorative of past achievements. In Catholic countries their consecration is a religious ceremony. This use of flags is of great antiquity. In the Bible the standards of the different tribes are referred to in the arrangement of the camp of the Israelites in the desert. The Greek and Roman armies had their distinctive flags. In the French army distinctive flags were introduced during the wars in Italy in the 16th century. The word *drapeau* in French (which, in its most extended signification is equivalent to our "flag") is used specifically for the colors of an infantry regiment; *étendard* for those of a cavalry regiment; *pavillon* for the colors used in the naval service.

The union of St. Andrew and St. Patrick marks, first the union of England and Scotland into the kingdom of Great Britain and then this kingdom with Ireland. This is the union flag of Great Britain, and was brought by the colonists to America. (See Flag, The American.) Every battalion of infantry in the British army, except the Rifles, has two colors; namely, the king's color and the regimental color. The former consists, for all regiments, of the union device, with the name of the regiment in the centre and the number of the battalion on the upper part near the staff. The regimental color is of the same color as the collars and facings of the regiment; but if these are white, it bears a St. George's cross in red. On it are emblazoned the name of the regiment, the names of the battles in which it has served, and its various badges, crests, mottoes, etc. Among cavalry regiments, only the guards, dragoon guards, and dragoons have standards, as cavalry flags are termed. These are made of crimson silk, and are emblazoned like those of infantry regiments. The standards of the guards and dragoon guards are rectangular, like those of the infantry, but the dragoons carry standards with the end farthest from the staff rounded and scalloped. The lancers have red and white pennants on their lances.

The standard is the war-flag, and bears the royal or other arms of the nation. Ensigns are flags carried by ships to indicate their nationality. The place for the ensign in a steamer or large ship is on a pole over the taffrail; in schooners and similar ships, at the peak of the main gaff; in cutters and sloops, at the peak; in yawls, at the mizzen-peak; and in rowing-boats, over the stern.

Jacks are national flags used for signaling and various other purposes. Pennants or pendants are small pointed or swallow-tailed flags generally used in connection with signals. The best-known is the answering pennant used in the international signal-code. A burgee is a swallow-tailed flag used by yachts and merchant vessels, usually with the ship's name on it. Shipping companies generally have square flags with distinctive colors and devices; these are known as house-flags. A plain white flag indicates a clean bill of health, and is also used in war as the flag of truce (q.v.). The quarantine flag is yellow. Vessels carrying explosives display a red flag. A flag hoisted upside down is a signal of distress, and one borne half-mast high is a sign of mourning. Flags are often dipped in token of respect. See SIGNAL SERVICE.

Flag, The American. The colonies used the English flag, bearing first the red cross of St. George; after the union with Scotland in 1707, the "union" of St. George and St. Andrew; the present union jack, with St. Patrick's added, dates only from 1801. It was the former which Endicott cut from the flag as a popish symbol; Massachusetts petitioned for red and white roses in their place, but the military commissioners simply left out the cross and substituted the king's arms. Militia companies had sometimes their own flags. In 1686 Andros had a special one made for the New England Union. From 1700 to 1750 the New England flags were "a red or blue ensign cantoned white, with a red St. George's cross, and having a tree or globe in upper corner of the canton" (Preble); the tree is usually assumed as a pine, like that on the coins, but in neither case with any evidence. The colonial merchant ships, to distinguish them from the mother country's, had a white escutcheon in the middle of the jack. The first outbreak of special flags was at the time of the Stamp Act, when each gathering usually improvised a flag. But the "union flags" of the early Revolution times and just before seem to have been the English union jack with patriotic mottoes: the colonies kept up the theory that they were loyal subjects of England. What flag or flags, if any, were used at Bunker Hill is uncertain, as the British captured none, and the reminiscences are inconsistent. Most probably each detachment had its own and carried it off.

In the early part of the Revolutionary War there was no attempt at a national flag, each colony or even troop or privateer pleasing itself. Some of the famous ones — as Col. William Washington's at Eutaw Springs, a piece of crimson damask cut by his fiancée from her upholstered chair — were private. The public ones were mainly of two sorts. The New England type had a tree (officially made a pine) in green on a white ground, and "An Appeal to Heaven" or the Connecticut "Qui Transtulit Sustinet" as a legend; in one case, a pine and a field of Indian corn, with two wounded officers and several children, and the motto, "For posterity we bleed." One of greater national significance was the rattlesnake type: at first cut into 13 pieces, with the initial of a colony on each, and the legend "Join, or Die"; then coiled to strike, with the legend "Don't Tread on Me"; later, 13 stripes with the snake across them. In either case, there were generally 13 rattles. Another flag was white, with a mailed hand grasping 13 arrows; still another, a female figure with a staff from which streamed 13 pennants. The first in the South was said to be devised by Col. Moultrie, in the fall of 1775 — a large blue flag with a crescent in the right upper corner, and "Liberty" in the centre; this was the one used in the defense of Fort Moultrie, and which Sergt. Jasper picked up under the British fire.

The national flag had no single or definite origin. After a few months of war it was seen to be needful, but the reluctance to break with the English pattern confirms the sincerity of the protestations of continued loyalty; and in December 1775 a committee consisting of Franklin, Thomas Lynch, and Benjamin Harrison recommended, and Congress adopted, the British union plus 13 stripes, which was hoisted over the headquarters at Cambridge, 1 or 2 Jan. 1776. The origin of the stripes is so utterly unagreed that it is probable any one of several things may have suggested it: their use on the Dutch East India Company's flags; those on the escutcheon of the Washington family; or simply the stripe which was the one distinguishing feature of the army uniform. Paul Jones claims to have been the first to raise the national flag, late in December 1775, but it seems to have been one of the rattlesnake type; that, however, was the kind selected by the Congressional naval committee on 8 Feb. 1776. In June 1776 it was unofficially decided by Congress and Washington, in view of the impending Declaration, to replace the union by a five-pointed star; but the first official adoption of a flag was on 14 June 1777, displacing the union by 13 stars, "a new constellation," and using just 13 stripes. The first use of the new flag is disputed; it seems to have been improvised and run up over captured British standards at Fort Stanwix, 8 Aug. 1777, after the battle of Oriskany, but a regular flag was made and carried at the battle of Brandywine, 11 September. Historical paintings are full of anachronisms as to flags. The stars were generally in a circle. The first change was the addition of two new stripes and two new stars for Vermont and Kentucky, in 1794; and though Ohio and Louisiana came in, no further alteration was made for nearly a quarter of a century. The stars were generally in three lines of fives. Finally, on 4 April 1818 it was ordered that the 15 stripes be reduced permanently to 13, in memory of the original colonies, and the stars keep pace with the total number of States, on the 4th of July after each admission. The arrangement of the stars was not specified, and has been at the taste of the makers. The revenue flag has 13 blue stars on a white ground, as a union, with 16 perpendicular red and white stripes; it indicates the authority of the Treasury Department. The secretary of war, the secretary of the navy, and the President have each their flags; the latter carried at the main of naval vessels and on boats he is in. Each of the flag-officers has his own flag. The union jack, white stars on a blue ground, is used by pilots, and at the bow of ambassadors' and ministers' boats.

The Confederate States had their own flags. But at the outset of the War their Congress adopted the "Stars and Bars"— having a white stripe between two red ones, and a blue union with seven white stars in a circle, for the number of seceding States. Later the stars were increased to 13. The usual battle-flag was red, with a blue cross and white stars diagonally. Late in the War the "bars" were exchanged for a white ground next the staff and red outside; and it was sometimes made black. Consult: Preble, 'History of the Flag' (1872).

Flag Association, The American, an organization formed in the council chamber of the city hall, New York, 12 Feb. 1898, with the object of honoring the national flag and of protecting it from desecration by securing the enforcement of present laws and the enactment of others for that purpose. The association was an outcome of the Congress of National Patriotic Societies held at the same place in November 1897, and besides individual members it is composed of the members of these societies, many of which are actively represented in the association by their flag committees. In order to promote respect and love for the flag, the association encourages its proper display on private buildings, schoolhouses, churches, etc., and uses its influence to make the observance of Flag Day (June 14) a national custom.

Flag, Sweet, an aquatic, flag-like plant (*Acorus calamus*) of the natural order *Acoraceæ,* which grows in wet places throughout the northern hemisphere, and is well known for its sweetly odorous leaves and root. The leaves are sword-shaped, 3 to 6 feet long, and the spadix is lateral with bisexual flowers. The creeping, woody rhizome has long been employed in medicine as an aromatic stimulant, considered useful in ague in Great Britain, and in India as a remedy for intestinal ills among children. It is also employed in flavoring beer, and by makers of snuff and vinegar; and is chewed by singers to clear the voice.

Flag of Truce, a white flag displayed in time of war as an indication of a desire to communicate with the enemy. The flag of truce is regarded as of so sacred a character that to shoot the bearer intentionally and without warning is to place the stigma of disgrace upon the side perpetrating the act. The display of a flag of truce during active hostilities does not necessitate the cessation of firing, and accidental shooting of the bearer may be unavoidable. If he advances during an engagement, he may be denied permission to enter the enemy's lines, or he may be held. To take advantage of the protection of a flag of truce in an illegitimate way, as for instance in order to obtain information of the enemy's resources, is held to be peculiarly dishonorable. A flag of truce is not regular unless sent and received by order of the senior officers of the respective forces. During naval hostilities, a flag of truce is met by a boat in charge of a commissioned officer from the senior officer's ship.

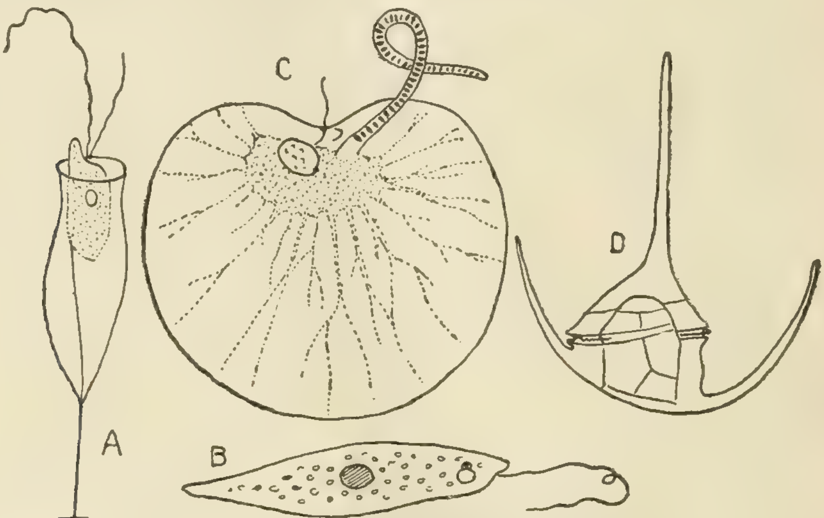
Flagellants, flaj'e-lants (Lat. *flagellare,* to lash or scourge), a sect which arose in 1260 at Perugia, called by the French *Perouse,* and spread throughout and beyond Italy. Its adherents, said to have numbered 10,000, attempted to expiate their sins and obtain mercy by self-inflicted suffering. They ran through the cities scourging their bare shoulders and exhorting bystanders to repentance. Led by priests bearing banners and crosses, they moved in procession through the streets. They could be seen going about by night as well as by day, even in the cold of winter. They went in thousands from country to country begging alms. In 1261 they crossed the Alps in Alsatia, Bavaria, Bohemia, and Poland, and found there many imitators. In 1296 a small band of Flagellants appeared in Strasburg, who, with covered faces, whipped themselves through the city, and at every church. At first the Flagellants were noted for sanctity, and made many converts even from the most abandoned classes, but doubtful characters beginning to join their ranks, they fell into disrepute, and were restrained from their processions by the civil and ecclesiastical authorities, then the sect gradually died away. The terror produced by the dreadful disease called the black death, which destroyed many millions of people in Europe in the middle of the 14th century, produced a revival of the flagellation mania, which spread over most of Europe and was attended by greater extravagances than before. In the reign of Edward III., a band of 120 Flagellants, male and female, made their appearance in London on a missionary enterprise, but had to leave the country without having made one proselyte. In 1349 Clement VII. declared the Flagellants heretics and took steps to repress them. In 1414 an effort was made in Thuringia to revive them, under a form marked by wild fanaticism and by strange doctrines which were condemned by the Council of Constance. The burning alive of their leader, Conrad Schmidt, and 90 of his followers, partially checked the project, though the extirpation of the sect was found a work of extreme difficulty. One form of fanaticism which marked some of the Flagellants was violent hatred and persecution of Jews.

Flagellata, a group of *Protozoa,* sometimes regarded as a division of the class Infusoria, sometimes as a distinct class by itself. The group is characterized by having a body-form usually fixed and definite for the species, and by having as organs for locomotion and taking of food one or more long vibratile whiplash-like processes, the "flagella." Like all Protozoa (q.v.) the body is composed of a single cell. The group is divided into three orders: *Autoflagellata, Dinoflagellata* and *Cystoflagellata.* In the Autoflagellata the body is usually oval and has both nucleus and contractile vacuole. Sometimes the body is naked and capable of amœboid motions, but usually it has a cuticle and enveloping cases are not uncommon. In one sub-order (*Choanoflagellata*) a peculiar collar-like structure is developed around the flagellum. Some of the group closely approximate plants, some forms like Euglena and Volvox being claimed by the botanist. A few are human parasites. The Dinoflagellata have a firm external armor of hard cellulose plates, divided by a groove around the body, and with a second longitudinal groove. At the junction of the two grooves are the two flagella, one lying in the circular groove, the other projecting freely. These forms occur in salt and fresh water. In the Cystoflagellata the large gelatinous body is enclosed in a stout membrane. The best-known form is Noctiluca (q.v.), noted for its phosphorescent powers.

Flagella'tion, scourging or whipping, either self-inflicted or administered by another person, especially as a religious practice. Its application as a means of religious penance is an old Oriental custom, admitted into Christianity partly because self-torment was considered salutary as mortifying the flesh, and partly because both Christ and the apostles underwent scourging. From the 1st century of Christianity religious persons sought to atone for their sins by voluntary bodily torture. Like the Abbot

Regino, at Prum, in the 10th century, many tried to imitate the sufferings of Christ, in order to make themselves the more certain of forgiveness through him. It became general in the 11th century, when Peter Damiani of Ravenna, abbot of the Benedictine monastery of Santa Croce d'Avellano, near Gubbio, in Italy, afterward cardinal bishop of Ostia, zealously recommended scourging as an atonement for sin, to Christians generally, and, in particular, to the monks. His own example and the fame of his sanctity rendered his exhortations effective. Clergy and laity, men and women, began to torture themselves with rods, and thongs, and chains. They fixed certain times for the infliction of this discipline upon themselves. Princes caused themselves to be scourged naked by their father confessors. Louis IX. constantly carried with him for this purpose an ivory box, containing five small iron chains, and exhorted his father confessor to scourge him with severity. He likewise gave similar boxes to the princes and tomb of Thomas à Becket (q.v.). In its theological aspect flagellation has no especial merit in itself and is classed merely as a form of penance or self-mortification. It is meritorious only as a means of expiation of sins repented for and absolved, or as a method of mortification of the flesh for the suppression and control of the passions. Any excess in it is prohibited. See FLOGGING; PENANCE; WHIPPING POST.

Flageolet, flaj'ō-let, a small wind-instrument, the notes of which are exceedingly clear and shrill. It is a sort of whistle with a mouthpiece that is usually inserted in a bulb. It is generally made of box or other hard wood, though sometimes of ivory, and has six holes for the regulation of its sounds, besides those at the bottom and mouthpiece, and that behind the neck. Its compass is two octaves, and a set of five different sizes is needed to take all the semitones in this range. It was formerly used in the orchestra.



" Flagellata." (See page preceding)

Various Flagellata. A, Bicoseca; B, Englina vividis (Autoflagellatis); C, Noctiluca miliaris (Cystoflagellate); D, Ceratium tripos (Dinoflagellate).

princesses of his house, and to other pious friends, as marks of his peculiar favor.

The expectation of being purified from sin by flagellation prevailed throughout Europe in the last half of the 13th century. "About this time," says the monk of Padua in his chonicles of the year 1260, "when all Italy was filled with vice, the Perugians suddenly entered upon a course never before thought of; after them the Romans, and at length all Italy. Men of noble and ignoble birth, old and young, traversed the streets of the city naked, yet without shame. Each carried a scourge in his hand, with which he drew forth blood from his tortured body, amidst sighs and tears, singing at the same time penitential psalms." The penitents united into fraternities called the Flagellants (q.v.). After the Council of Constance (1414–18) both clergy and laity gradually abandoned flagellation. The Franciscan monks in France (Cordeliers) observed the practice longest.

Flagellation was sometimes voluntary and sometimes imposed as a penance. Henry II. of England allowed himself to be scourged at the

Flaget, flä-zhā, **Benedict Joseph**, American Roman Catholic bishop: b. Contournat Angergne, France, 7 Nov. 1763; d. Nazareth, Ky., 11 Feb. 1850. He was educated in France, came to America, and was made bishop of Bardstown in 1810. The name of his diocese was subsequently changed and he became bishop of Louisville in 1841.

Flagg, George Whiting, American artist: b. New Haven, Conn., 26 June 1816; d. Nantucket, Mass., 5 Jan. 1897. He studied art for six years in London, England, and on his return to the United States opened a studio in New York. He was elected a member of the National Academy of Design in 1843, and an academician in 1851. Among his best-known paintings are: 'Landing of the Pilgrims'; 'Washington Receiving His Mother's Blessing'; 'The Good Samaritan'; 'The Scarlet Letter'; and 'The Execution of Lady Jane Grey.'

Flagg, Isaac, American Greek scholar: **b.** Beverly, Mass., 7 Sept. 1843. He is a son of Wilson Flagg (q.v.) and was graduated **from**

Harvard 1864. He was professor of Greek at Cornell University 1871–88, and at the University of California since 1899, holding at the latter institution the chair of classical philology 1890–9. He is the author of 'Versicles'; 'Outlines of the Temporal and Model Principles of Attic Prose'; and has edited: 'The Hellenic Orations of Demosthenes'; 'The Seven Against Thebes, of Æschylus'; etc.

Flagg, Jared Bradley, American Episcopal clergyman and artist: b. New Haven, Conn., 1820; d. 1899. He studied art with his brother G. W. Flagg (q.v.), entered the Episcopal ministry in 1854 and was for several years rector of Grace Church, Brooklyn Heights, N. Y. He was especially noted for the excellence of his portraits. He published 'Life and Letters of Washington Allston' (1892).

Flagg, Wilson, American naturalist: b. Beverly, Mass., 5 Nov. 1805; d. Cambridge, Mass., 6 May 1884. He published: 'Studies in the Field and Forest' (1857); 'Halcyon Days'; 'A Year Among the Trees' (1881); and 'A Year Among the Birds.'

Flag'ler, Henry M., American capitalist: b. Canandaigua, N. Y., 1830. He began life as a clerk in a country store, then going to Saginaw, Mich., he became a salt manufacturer. He afterward removed to Cleveland, Ohio, and formed one of the firm of Rockefeller, Andrews and Flagler, now known as the Standard Oil Company, and with which he is still connected. He is the proprietor of some 600 miles of railroad in Florida and of the Ponce de Leon and Alcazar hotels at Saint Augustine.

Flagler, Isaac Van Vleck, American organist: b. Albany, N. Y., 15 May 1842. He studied at Paris under Batiste, and has since become famous as a church organist in the United States, being at present organist of the First Presbyterian Church, Auburn, N. Y. He has composed, among many organ pieces, 'Variations on an American Air.'

Flag'staff, Arizona, an important railroad town in Coconino County, on the Atchison, T. & S. F. R.R. It has an altitude of 6,935 feet. The town has extensive live-stock and lumber interests. Tourists going to the Grand Cañon of the Colorado make Flagstaff their base of supplies. Pop. (1901) 1,285.

Flambard, flam'bärd, **Ranulph** or **Ralph,** Norman prelate and statesman, d. 5 Sept. 1128. He was early connected with the Conqueror's court, and being handsome, clever, and unscrupulous, gained great influence with the king, and rose to still greater favor with Rufus, whom he encouraged in his tyrannical and rapacious courses. His flagrant extortions earned the hatred of the people, and his character is painted in the blackest characters by the chroniclers. In 1099 he was made Bishop of Durham; but on the death of Rufus he was committed to the Tower by Henry I. He managed to escape, however, by means of a rope conveyed to him in a vessel of wine, and instigated Robert, Duke of Normandy, to invade England. He was subsequently forgiven by Henry and restored to Durham, where he engaged in architectural works connected with the city and the cathedral. See Freeman, 'The Norman Conquest,' Vols. IV. and V.; Freeman, 'William Rufus.'

Flamborough (flam'bur-ō) **Head,** a bold promontory of England, on the Yorkshire coast, projecting a considerable distance into the sea; lat. 54° 7′ N.; lon. 0° 5′ W. This is at once the most striking and most celebrated headland on the east coast of Great Britain, rising 450 feet sheer above the sea, having on its summit a lighthouse, 214 feet high, showing a revolving light which is visible 21 miles. Vast caverns, haunted by myriads of sea-fowl, penetrate deeply through this headland. For the battle of Flamborough Head, see JONES, PAUL.

Flamboy'ant, a term applied to the decorated and very ornamental style of architecture of French origin, and employed in France contemporaneously with the Perpendicular style in England. One of the most striking and common features is the waving and somewhat flame-like arrangements of the tracery of the windows, panels, etc. The Church of St. Maclou, Rouen, erected 1432–1500, is said to be one of the finest specimens of this style.

Flame, any gas or gaseous mixture that is actively undergoing combustion. Solid bodies (such as coke) which do not contain volatile constituents become incandescent when they burn, but their combustion is not attended by the development of actual flame. The flames that appear to issue from such solid combustibles as wood and coal are in reality due to the combustion of gases that are distilled from the fuel by the intense heat, as may be very easily proved by subjecting these bodies to the same temperature in closed vessels which prevent the access of air. Abundant quantities of combustible gases are then given off, and these may be led away in pipes, or stored in tanks, to be burned at more convenient times or places. The gas that is obtained from coal in this way has been used for many years for purposes of illumination. The mixed gases that are evolved when wood is subjected to destructive distillation contain methyl alcohol, acetic acid, and many other organic substances; and in fact they constitute the chief commercial source of the two substances just named. (See ALCOHOL.) Flames are usually very hot and luminous, though in some cases there is but little light developed. The flame of a spirit lamp, for example, is barely visible, although it is intensely hot; and the flame of burning hydrogen is an even more striking case of the same sort. The luminosity of flames is due chiefly to the incandescence of tiny particles of solid carbonaceous matter that they hold in suspension, as has been proved by many ingenious experiments. When a piece of wire gauze is brought down over the flame of a candle, the gauze permits the gases that arise from the wick to pass through it, but it chills them so that they are no longer capable of combining with one another, and hence the flame does not extend above the gauze. This simple and instructive experiment enables the observer to examine the structure of the candle flame without the least difficulty, and shows it to be a hollow cone, burning only on the outside, where the oxygen of the air can mingle with the gases in sufficient quantities to support combustion. That the gases developed at the wick really do rise up through the gauze is easily proved by igniting them with a burning match. Flames may be colored, and often very brilliantly, by the presence within them of certain metallic salts. Thus sodium compounds produce a strong orange-yellow color, potassium a violet, and strontium a crimson. Advantage is taken of this fact for the production of gorgeous color effects in pyrotechny. In chemical analysis, too, the color that a given substance yields when placed in a hot but normally non-luminous flame often gives valuable information concerning its composition. See BLOW-PIPE ANALYSIS; SPECTROSCOPE.

Flame-flower. See TRITOMA.

Flameless Explosives, explosives containing ammonium nitrate, with or without ammonium oxalate, which are to be used in blasting in mines containing fire damp or combustible dust. As examples of such explosives we have «ammonite,» consisting of ammonium nitrate 87 to 89 per cent, and dinitronaphthalene 13 to 11 per cent; «amvis,» ammonium nitrate 88 to 91 per cent, dinitrobenzene and chloronaphthalene 4 to 6 per cent, and wood pulp 4 to 6 per cent; «bellite,» ammonium nitrate 82 to 85 per cent, and metadinitrobenzene 18 to 15 per cent; «benedite,» ammonium nitrate 93 to 95 per cent, and rosin 7 to 5 per cent; «Casteaux's explosive,» ammonium nitrate 90 per cent, nitrodextrine 10 per cent; «grisoutine,» ammonium nitrate 67 per cent, nitroglycerin 30 per cent, and nitrocotton 3 per cent; «nitroferrite,» ammonium nitrate 93 to 94 per cent, potassium forrocyanide 2 per cent, crystallized sugar 3 to 2 per cent, and «trinitronaphthalene» 2 per cent; «progressite,» ammonium nitrate 94 to 95 per cent, and aniline chlorhydrate 6 to 5 per cent, and «roburite,» ammonium nitrate 90 per cent, chlorodinitrobenzene 10 per cent.

Flamen, flā'men, a priest of ancient Rome consecrated to the service of a particular divinity. They were established by Numa and were at first three in number: *flamen Dialis*, the priest of Jupeter; *flamen Martialis*, the priest of Mars, and *flamen Quirinalis*, the priest of Romulus. These three constituted the *flamen majores*, and were always of the patrician class. Later twelve *flamen minores* were created, chosen from the plebeians. The *flamines* held office for life, but were removable for neglect of duty or contamination, and were required to resign and remain single upon the death of their wives, the *flaminica*, who assisted them in their duties and were governed by the same rules as their husbands. The *flamen* was distinguished by the *apex*, a conical cap in the top of which was fastened a pointed twig of olive wood bound at its base with a lock of wool. He was not required to take an oath, was an ex-officio member of the Senate, was entitled to the use of the *toga prætexta* and the curule chair. He was entitled to the assistance of a lictor, and for himself and for his house held the right of sanctuary and of pardon. He could not leave the city for a single night or sleep out of his own bed for three consecutive nights, mount or touch a horse, touch a dead body, or engage in a long list of occupations that were considered to contaminate him. The flamens were selected by the Pontifex Maximus from three candidates nominated by the pontifices. When the emperors were deified they had flamens, as the *flamen Augusti*. There were also *flamines curiales*, and a *flamen arvalium*. Consult Marquart, 'Romishe Staatsverwaltung' (1885).

Flameng, Francois, frän-swä flä-män, French painter: b. Paris 1859. He began his art studies under his father, Leopold Flameng (q.v.), the engraver, and studied subsequently under Cabanel, Hedouin and Jean Paul Laurens. He is an artist of distinguished ability as a figure painter, and among the most striking works of his are: 'The Girondins Summoned' (1879); 'The Bowlers' 1886); and 'Grolier and Alus,' which last hangs in the Grolier Club of New York.

Flamingo, flā-ming'gō, a peculiar web-footed bird of the group *Phœnicopteri*, which may be regarded as intermediate between the storks and the ducks, the long legs and necks giving it a resemblance to the former, while the webbed feet connect it with the latter. There are six species of true flamingoes, widely spread over the warmer regions of both hemispheres. Our North American species (*Phœnicopterus ruber*), once common all along the southern shores of the United States, but now almost exterminated even from Florida, and ranging southward to the Argentine Republic, is light vermilion with brighter wing coverts. The other forms are rosy white (scarlet on the wing coverts) with black wing-quills. All have small goose-like bodies, but the long legs and neck give them a height of four or five feet. Their most extraordinary part is the bill, which is large, swollen and bent upon itself so that the upper half is turned downward when the bird feeds, with its head twisted and crown downward. The edges of both upper and lower jaw are furnished with small transverse plates, which serve, as in ducks, for a sieve, allowing the escape of the mud, but retaining the small worms, crustaceans, mollusks, fishes, etc., on which the birds feed. The upper surface of the tongue is beset on the sides and base with flexible, recurved, horny spines. Flamingoes live and migrate in large flocks, warning one another of danger by a loud trumpeting note, which is the signal for the flock to take wing. When flying, they form a triangle.

They breed in companies in mud-flats or inundated marshes, where they spend most of their time wading about, raising up the mud into a small hillock, which is concave at the top so as to form a nest. In this hollow the female lays her one egg, and hatches it by sitting with her legs doubled up under her. The young, usually two in number, do not fly till they have nearly attained their full growth, though they can run very swiftly and swim with ease almost immediately after their exclusion from the shell. This bird was held in high repute among the luxurious Romans; and Apicius, so famous in the annals of gastronomy, is recorded by Pliny to have discovered the exquisite relish of the flamingo's tongue, and a superior mode of dressing it. When taken young they soon grow familiar, but they are not generally found to thrive in the domesticated state. The European flamingo (*P. roseus*) is abundant in marshy regions of Spain and southern France, and is found as far south as Cape Colony, and as far east as Lake Baikal. In northwestern India it may be seen in flocks numbering tens of thousands. Another very similar species (*P. minor*), but of less size and with the chin feathered, is found from Madagascar around the whole circuit of the shores of the Indian Ocean. Three

FLAMINGO (*Phœnicopterus antiquorum*).

From a Photograph provided by the American Museum of Natural History.

other species are known in South America, *P. andinus* of the central Andes, the largest of the family; *P. jamesi*, of southern Peru and Chile, and *P. chilensis* of the region south of Brazil, which has greenish shanks. In addition to the various ornithologies, the reader may consult an article by H. A. Blake, 'Nineteenth Century' (December 1887); Chapman and Buck, 'Wild Spain' (1893); and F. M. Chapman, 'Bird Lore' (1902).

Flaminian (flā-min'i-an) **Way,** the northern road which led from ancient Rome. It was constructed by Gaius Flaminius the elder in 202 B.C. during his censorship, and led from Rome to Ariminum (Rimini) on the Adriatic, 222 miles. Remains of it are yet extant in various places.

Flamininus, Titus Quintius, tī'tus kwin'shi-us flam-ĭ-nī'nus, Roman general: b. about 230 B.C.; d. about 175. Elected consul in 198, he undertook the conduct of the war against Philip II. of Macedon. By pretending that his object was to remove from Greece the Macedonian yoke, he detached many of the Greek states from Philip, and defeated him at Cynoscephalæ (197) in Thessaly. By the treaty soon after concluded Philip surrendered all the Greek towns which he possessed in Europe and Asia, and paid a heavy contribution to the Romans. At the Isthmian games in 196 Flamininus proclaimed, to the great joy of the assembled Greeks, the freedom of those states which had been subdued by Macedon. In 195 he diminished the power of the tyrant Nabis of Sparta, after which he occupied himself in restoring internal peace and prosperity to Greece.

Flaminius, Gaius, ka'yus flā-min'i-us, Roman general: d. 23 June 217 B.C. He was tribune of the people in 232, consul in 223 and 217, and censor in 220. As tribune he carried against the opposition of the senate an agrarian law. In his first consulship he with his colleague attacked the Gauls beyond the Po, and was defeated. The senate then recalled the consuls, but Flaminius resisted the order by refusing to open the letter, and obtained a victory over the Insubrians. A triumph was refused him on his return, but he was rewarded with demonstrations of popular favor. The circus Flaminius and via Flaminia were the monuments of his censorship. In his second consulship he marched against Hannibal, and rashly giving battle, was slain near Lake Thrasymenas.

Flammarion, Camille, kä-mēl flä-mä-rē-ôṅ, French writer on astronomy: b. Montigny-le-Roi (Haute-Marne), 26 Feb. 1842. In 1858 he entered the Paris observatory as pupil, being transferred in 1862 to the Bureau des Longitudes, where he remained till 1866. Although still a youth, he had already published the first of his many works, namely: 'La Pluralité des Mondes habités' (1862; 36th ed. 1892); 'Les Mondes imaginaires et les Mondes réels' (1865; 21st ed. 1892); and 'Les Merveilles Célestes' (1866; 7th ed. 1881). For five years from about 1868 he made a study of the upper regions of the atmosphere during several balloon ascents. In 1882 he founded the monthly magazine 'L'Astronomie,' and in 1887 started the French Astronomical Society. M. Flammarion has gained considerable fame for original researches in astronomy, especially in connection with double and multiple stars, colors of stars, sun-spots, and the proper motion of the stars; but is much better known for his excellent, well-written and accurate popular hand-books. Among his other works are: 'Etudes et Lectures sur l'Astronomie' (1867–80); 'Dieu dans la Nature' (1867; 22d ed. 1892); 'Lumen' (1872; 40th ed. 1890); 'Voyages en Ballon' (1870; 20th ed. 1889); 'Vie de Copernic' (1872); 'L'Atmosphère' (1872); 'Histoire du Ciel' (1873); 'Petite Astronomie' (1877); 'Les Terres du Ciel' (1877); 'François Arago' (1879); 'Astronomie Populaire' (1880); 'Les Etoiles et les Curiosités du Ciel' (1881); 'Le Monde avant la Création de l'Homme' (1886); 'Les Tremblements de Terre' (1886); 'Uranie' (1889); 'Qu'est-ce que le Ciel' (1891); 'La Planète Mars et ses Conditions d'Habitabilité' (1893). Several books have been translated into English.

Flam'steed, John, English astronomer: b. Denby, near Derby, 19 Aug. 1646; d. Greenwich 31 Dec. 1719. He began his mathematical and astronomical studies at an early age, and in 1675 took orders in the Established Church. He still continued his astronomical observations, and was in constant correspondence with scientific men. He found the astronomical tables of the day to contain large errors, and was anxious to make more detailed and accurate observations. This having come to the knowledge of Charles II., he was appointed astronomical observer to the king, and carried on his observations at the Queen's House at Greenwich, until the observatory was built for him in 1676. Here he passed the remainder of his life amidst his astronomical labors, which are considered as the foundation of modern practical astronomy. He was so ill supported that he had to teach for his own support, and erect instruments at his own expense. In 1684 he was presented with a small living, and his father dying in the same year, he was enabled to provide some needful apparatus at his own expense, which, on his death, was claimed by the government as public property.

Flan'ders, Henry, American lawyer: b. Sullivan County, N. H., 13 Feb. 1826. He studied law and since 1850 has practised his profession in Philadelphia. He has published: 'Maritime Law' (1852); 'The Law of Shipping' (1853); 'Lives of the United States Chief Justices' (1855–8); 'An Exposition of the Constitution of the United States' (1869); 'Law of Fire Insurance'; 'Adventures of a Virginian.'

Flanders (French, *Flandre;* German and Flemish, *Flandern;* Dutch, *Vlaanderen*), a former country or district of Europe, now included in Holland, Belgium, and France. It stretched from the Schelde, below Fort Lillo, west along the Hond, or West Schelde, and west-southwest along the German Ocean to the entrance of the Straits of Dover, near Gravelines, and was bounded east by the duchy of Brabant, south by Hainaut, and west by the French provinces of Artois and Picardy. The origin of the name is unknown. It occurs for the first time, but in a very restricted sense, in the 7th century. The erection of the territory into a county took place in the 9th century, and was made by Philip the Bold, king of France, in favor of his son-in-law, Baldwin, of the Iron Arm. It afterward passed to the united houses of Spain and Austria, and ultimately to the latter, but underwent considerable curtailment by the conquests of the French in the west, when part of it became French Flanders, and is now included in departments Nord and Ardennes; and by the conquests of the Dutch in the north, who succeeded in including the most northerly portion of it in the province of Zeeland. The remainder still retains its ancient name, and forms the modern provinces of East and West Flanders, in Belgium (q.v.).

Flanders, East (Fr. *Flandre Orientale*), a province of Belgium, bounded north by Holland, east by the provinces of Antwerp and Brabant, south by Hainaut, and west by West Flanders; length, north to south, 34 miles; central breadth, east to west, 32 miles; area, 1,158 square miles. The surface forms an extensive plain, sloping gently eastward. It wholly belongs to the basin of the Schelde, which by itself, its tributaries, and canals connected with them, furnishes ample water communication. Its soil, partly of a sandy and partly of a clayey nature, is so industriously and skilfully cultivated that it has the appearance of a vast garden, and presents one of the richest rural landscapes which anywhere exists. The principal crops are wheat and flax, but almost all the plants which can be grown under the same latitude are cultivated with success. There are no forests properly so called, but owing to the general practice of planting hedge-row trees, there is no want of wood. In general, however, it consists of poplar and other soft-wood trees, and makes only indifferent timber. There are no minerals of any value, but manufactures have made great progress, and all the ordinary, as well as the fine tissues of wool, cotton, and flax, are well and largely made. There are also numerous tanneries, breweries, distilleries, soap-works, roperies, sugar and salt refineries, etc. The trade includes, in addition to these articles, flax, hops, and oil. For administrative purposes the province is divided into six arrondissements — Gand, or Ghent, the capital; Alost, Audenarde, Termonde, St. Nicolas, and Eecloo. Pop. (1901) 1,029,971.

Flanders, West (Fr. *Flandre Occidentale*), a province of Belgium, bounded north and northwest by the German Ocean, west-southwest and south by France, southeast by the province of Hainaut, east by East Flanders, and northeast by Holland; greatest length, north-northeast to south-southwest, 54 miles; greatest breadth, 48 miles; area, 1,249 square miles. The surface is generally flat, but a few low hills occur in the south and east, and a range of sand hills or downs lines the greater part of the coast. The most important crops are flax, both abundant in quantity and excellent in quality; oats, barley, hops, oil-seeds, tobacco, madder, and chicory. The cattle, of all sorts, are of excellent breeds; and fish, poultry, and game abound. The most important branch of industry is linen, ordinary and damask. Great quantities of lace also are made, and there are numerous breweries, distilleries, tanneries, dye-works, oil-works, soap-works, salt and sugar refineries, etc. The province is divided into eight arrondissements — Bruges (the capital), Courtrai, Ypres, Furnes, Thielt, Roulers, Ostend, and Dixnude. Pop. (1901) 805,236.

Flandin, Eugène Napoléon, nä-pō-lā-ôṅ ė-jen flăṅ-dăṅ, Italian painter and archæologist: b. Naples, Italy, 15 Aug. 1809; d. Tours, France, 1876. He published: 'Etudes sur la Sculpture Perse' (1842); 'Etudes sur la Perse moderne' (1842); 'Relation du voyage in Perse' (1843). In 1843–5 he traveled with Botta through the country of the Tigris, and illustrated his fellow traveler's 'Monuments de Ninive,' with drawings of the sculptures of Khorsabad. He finally made a full artistic exposition of Oriental life in his elaborately illustrated work, 'L'Orient' (1856); and also wrote 'Histoire de chevaliers de Rhodes' (1854).

Flan'drau, Charles Macomb, American writer of fiction: b. Minnesota 1870. He is the author of 'Harvard Episodes'; 'The Diary of a Freshman.'

Flan'drians, or **Flemings**, a subdivision of the Mennonite Anabaptist sect. They arose in the 16th century, and were rigid in their procedure. In 1630 A.D. the majority of them entered into a union, confirmed in 1649, with their more moderate brethren, who were often called Waterlanders.

Flandrin, Jean Hippolyte, zhoṅ ē-pō-lēt flăṅ-drăṅ, French historical and portrait painter: b. Lyons 23 May 1809; d. Rome, Italy, 21 March 1864. He worked under Ingres, and from him he imbibed that love of severe and definite form and that classical feeling which he used for his own ends in his religious painting. In 1832 he won the Prix de Rome by his 'Recognition of Theseus'; and before his five years' residence in Italy was completed he had produced his 'St. Clair Healing the Blind,' now in the cathedral of Nantes. Henceforward he was mainly occupied with decorative monumental work, though he also executed many admirable portraits. In 1842 he began his great frescoes of 'Christ Entering Jerusalem,' and 'Christ Going up to Calvary,' in the sanctuary of the Church of St. Germain-des-Près, Paris, deeply impressive works, which already entitled their painter to rank as the greatest religious painter of the century. The choir of the same church he adorned (1846–8) with figures of the Saints and the Virtues. He also decorated the Church of St. Paul at Nimes (1847–9), the Church of St. Martin d'Ainay at Lyons (1855), and painted the frieze of St. Vincent de Paul, in Paris, with a noble series of saints and martyrs. In 1855 he began his last great work in the nave of St. Germain-des-Près, consisting of subjects from the Old and New Testaments, of which some were left uncompleted at his death, at Rome, 21 March 1864. His 'Lettres et Pensées,' with a memoir and a catalogue of his works, were issued 1865. See 'Lives,' by Poncet (1864); 'Montrard' (1876).

Flandrin, Jean Paul, zhoṅ pōl, French painter: b. Lyons 8 May 1811; brother of the portrait and historical painter Hippolyte Flandrin (q.v.), and a landscape painter whose compositions are of an ideal character and represent a survival of the classical school of Poussin and Claude.

Flan'nan or **Flan'nen Islands**, or **The Seven Hunters**, a group of small rocky islands in Scotland, in the Outer Hebrides, included in the county of Ross and Cromarty, about 15 miles west-northwest of Gallon Head. They are frequented by large numbers of sea-birds, and sheep used to be pastured on some of them. There is a lighthouse of recent erection, standing at a height of over 200 feet, the structure itself being 75 feet high, with a light visible 24 miles.

Flannel, a woolen fabric of more or less loose texture and various degrees of fineness, much used as an article of clothing both in hot and cold countries, and for outer as well as inner garments, being very commonly worn next the skin. Flannel made in Wales from the wool of the native mountain sheep has the highest reputation.

Flannel-mouth, a local name for the great Mississippi catfish (*Ameiurus lacustris*). (See CATFISH.) Another fish, one of the suckers (*Catostomus latipinnis*) is so called in the neighborhood of the Rio Colorado.

Flannen Islands. See FLANNAN ISLANDS.

Flash, Henry Lynden, American author: b. Cincinnati, Ohio, 20 Jan. 1835. He served during the Civil War as volunteer aide on the staffs of the Confederate Gens. Hardee and Wheeler; and later edited the ‹Telegraph› and ‹Confederate› in Macon, Ga. He was the author of ‹Poems,› and of many popular ballads which appeared during the Civil War.

Flashlight, Electric. See FOG SIGNALS.

Flat Foot, or **Pes Planus**, a very common deformity of the foot due to a loss of the natural arch. A strong ligament holds the os-calcis and astragalus in such a position that an arch is formed by the bones of the foot and the weight of the body is transmitted through that arch. There is a congenital variety that is said to be due to lack of the normal fatty pad in the hollow of the new born infant's foot. During the first five years of life this fatty pad takes the place of the bony arch and if the pad be lacking the arch does not develop. The acquired variety affects those suddenly called upon to stand for long hours upon the feet. A very large number of nurses and soldiers and policemen suffer more or less with this deformity in their early months of training. Rickets, knock-knees, sprains and badly set fractures of the leg may give rise to flattening of the arch.

The bones are not changed from their normal shape except in the very young, but their relation to each other is altered. There is also a stretching of the extensor tendons of the foot and the muscles and fascia of the sole. Besides the flattening of the foot there is a more or less marked turning out of the toes and a tendency to walk on the inner side of the foot. This gait becomes quite characteristic.

In the acute cases particularly there is apt to be severe pain in the spring ligament, the inner malleolus or the ball of the great toe. Because of this, the affection is very commonly thought to be rheumatism, gout, or disease of the bone.

The normal marking of the sole of the foot is an impression of the heel, a narrow margin of the outside of the foot and a broad line made by the ball of the foot. When the arch becomes weakened there is a gradual increase of the outer margin until almost the whole foot makes its impression. This simple test is of great value.

Congenital flat foot may be greatly improved if discovered in time by manipulative massage, bandaging and the use of supports until the bony arch is formed. Acute cases of flat foot in adults sometimes require rest for a time. Properly made shoes without braces frequently suffice to prevent a return of the trouble. Others require the constant use of felt or well-adjusted steel springs in the shoes. Exercises of the extensors of the foot, massage and electricity are of value.

The bad cases of deformity that cannot be corrected require operation under an anæsthetic, the joints being forcibly freed and kept in normal position by plaster cast for a period and then kept up by a support.

Flat'bush, New York, formerly a town in Kings County, Long Island, but since 1900, a part of the borough of Brooklyn, New York. Before being incorporated in the city Flatbush had a population of 15,620. The locality is of considerable historic interest, having been the scene of a part of the battle of Long Island, 27 Aug. 1776.

Flatfish, a fish of the *Heteromomata*, including the families *Pleuronectidæ* and *Soleidæ*, which are characterized by their greatly compressed form, distorted skulls and the habit of lying and moving on the side. They are somewhat related to the cod family, and inhabit the seas of all parts of the world, more than 500 species, classified in some 55 genera, being known to ichthyologists. All are oval or elliptical in outline, very thin and flexible, and habitually rest, half covered, or move sidewise along sandy sea-bottoms, some species near shore, or even ascending rivers, others only in deep water. They are carnivorous, taking as food mainly mollusks, worms, sand-dollars and the like, found in such places, for the crushing of whose shells they are provided with strong teeth, chiefly developed on the inferior side of the mouth. The flatness of these fishes is not a broadening laterally but a compression of the body whereby they become high and thin in a dorso-ventral direction, lie over on one side (usually the left), and have the head permanently twisted to the side uppermost in their customary position. This, however, comes about only with age. The very young flatfish are born in the normal shape of fishes, and swim in the ordinary vertical position, but soon begin to assume the adult peculiarities. This tendency causes profound changes in structure. The skull gradually becomes so distorted that its facial part is twisted at right angles to the plane of the cranial part, and both eyes, set close together, look upward, so that the fish has a seeing and a blind side. In order to get into this position the eye of the under side is rotated around, or in some species right through the young skull, when the fry is only an inch or so in length and the bones not yet ossified. The curious condition of the dorsal fin in the flatfish is nevertheless a greater mark of distinction. The external ethmoid bone belonging to the blind side is much enlarged, and sends back a process outside the eye belonging to that side to meet another process from the cranial region of the skull. Thus, says Cunningham, the eye which has migrated is enclosed in a complete bony orbit, while the other (lower) eye is merely bounded on its outer side by the jaw muscles. It is on this bony bridge entirely foreign to the anatomy of an ordinary fish that the dorsal fin is supported, and is able to extend from the tail clear to the snout, not passing between the eyes, but separating the hidden from the exposed side. Similarly the ventral and anal fins form a continuous growth along the ventral keel, defining there the upper side from the lower. The lesser forward fins, like the mouth, are usually asymmetrical. They are able to swim well when they please, and sometimes appear at the surface, progressing with a curious sideways undulatory movement very graceful. This is a dangerous excursion, however, and flatfish as a rule cling to the bottom, trusting to be overlooked because of their close resemblance to the sand or mud.

The young flounder or other species is brown on both sides alike; but when it turns on one side and lies flat, the under side becomes nearly white while the upper assumes the color of the bottom upon which the fish habitually rests. This is an excellent example of protective resemblance. (See COLORATION, PROTECTIVE); and that it arises from the habits of the fish and is the effect of persistently keeping the under side in shadow, is plain from the fact, demonstrated by experiment, that when flatfish are confined in aquaria with glass bottoms, through which light is reflected upon the under side, color will develop there. Some flatfish are spotted, increasing their likeness to a pebbly bottom. All these circumstances make it evident that flatfishes originated from symmetrical ancestors related to those of the cod, but what were the inducing causes of the extraordinary changes that have characterized their evolution are not plain. Little help is derivable from palæontology for fossil flatfishes are extremely rare, the oldest known being a sole-like form from the Upper Eocene of southern Europe.

The group includes two families, the flounders (*Pleuronectidæ*) and the soles (*Soleidæ*). Jordan subdivides the former into three sections, namely *Hippoglossinæ*, halibut tribe; *Pleuronectinæ*, flounder tribe; and *Psettinæ*, turbot tribe. The soles are a small family distinguished by the hidden, adnate character of the gill-cover, the small, much twisted eyes and mouth, and the absence of teeth. The whole group yields excellent flesh, and furnishes some of the most important food-fishes of commerce as well as several regarded as especial delicacies. They are treated of at length in Goode's 'Fishery Industries,' Sec. 1 (1884); and in Jordan and Evermann's 'Fishes of North and Middle America' (1898). See FLOUNDER; FLUKE; HALIBUT; PLAICE; SOLE; TONGUE-FISH; TURBOT; WINDOWPANE.

Flathe, Heinrich Theodor, hīn'riH tā'ō-dōr flä'tĕ, German historian: b. Tanneberg, near Nossen, Germany, 1 June 1827. He attended the Fürstenschule in Meissen, studied philology and history in Leipsic and in 1867 was appointed teacher in the Fürstenschule at Meissen. His main achievement was the revision and rearrangement of F. W. Bottiger's 'Geschichte des Kurstaats und Königreichs Sachsen' (1867), which he transformed into a new work, for he not merely added new details, but rewrote much of the main argument. He has also among other works written 'Allegemeine Weltgeschichte' (1883).

Flathead, or (properly) **Salish Indians**, a tribe of Indians with uncompressed skulls, as distinguished from the «peaked-heads» who did compress their skulls, and who gave the others the name of Flatheads. These Flatheads are a superior tribe, originally dwelling around the Flathead Lake and River in northwestern Montana; much respected by the traders and explorers as at once very brave against their enemies (chiefly the Blackfeet) and honorably requiting friendly treatment. The famous Flathead mission, the most successful in the Northwest, was established among them in 1841 by the Jesuit missionary P. J. De Smet. They are now located on the Jocko reservation in their old territory, confederated with the Pend d'Oreilles and joined with the Kootenais, the whole numbering 1,280.

Flather, John Joseph, American mechanical engineer: b. Philadelphia, Pa., 9 June 1862. He was graduated from the Sheffield Scientific School of Yale, and after several years' experience in American and foreign machine shops was instructor in mechanical engineering at Lehigh University 1888–91; professor of the same at Purdue University 1891–8; and he has filled a similar post at the University of Minnesota from 1898. He has published: 'Treatise on Steam Boilers' (1889); 'Rope Driving' (1892); 'Dynamometers and the Measurement of Power' (1900).

Flat'tery, Cape. See CAPE FLATTERY.

Flat'ulence. See INDIGESTION.

Flatworms, worm-like animals of the phylum *Platyhelminthes*; especially those of the order *Turbellaria*, characterized by oval outline and decided flatness of body. See *Classification* in article ANATOMY; also PLANARIAN WORMS.

Flaubert, Gustave, güs-täv flō-bār, French novelist: b. Rouen, France, 12 Dec. 1821; d. Rouen 8 May 1880. His greatest novel was his first, 'Madame Bovary' (1857). He next wrote a historical novel, 'Salammbô,' the scene laid in the most flourishing period of Carthage — a splendid description of ancient Punic life, but having lively interest as a story; 'The History of a Young Man' (1869), like 'Madame Bovary,' a pessimistic picture of social life; 'The Temptation of St. Anthony' (1874), a piece of imaginative writing dealing with philosophical problems; and 'Three Stories' (1877), which had a favorable reception. The posthumous novel, 'Bouvard and Pécuchet' (1881) is a satire on humanity in general. His comedy, 'The Candidate' (1874), failed on the stage. See Tarver, 'Gustave Flaubert' (1895); Faquet, 'Flaubert' (1899).

Flav'el, John, English Nonconformist: b. Bromsgrove, Worcestershire, about 1630; d. Exeter 29 June 1691. He was graduated at Oxford University, inducted into the rectory of Dartmouth, Devonshire, in 1656, but dispossessed and ejected for nonconformity in 1662. During the remainder of an active ministry he preached from house to house and wrote devotional works, which were long popular, and among which are: 'Husbandry Spiritualized' (1669); 'Divine Conduct' (1678); 'The Touchstone of Sincerity' (1697); 'The Soul of Man' (1698); etc.

Flavian Cæsars, flā'vi an sē'zarz, the Roman emperor Vespasian and his sons and successors, Titus and Domitian, who were of the house of Flavius.

Flav'in, a yellow or orange dyestuff. American flavin is got from quercitron bark, and is said to be the same as quercitrin.

Flax (*Linum usitatissimum*). The use of flax has a greater antiquity than any other commercial fibre. It was cultivated and manufactured by the Swiss lake dwellers in the Stone Age in Europe, well preserved specimens of straw, fibre, yarn, and cloth being preserved in the museums. This ancient flax, however, was from another species, *Linum angustifolium*. The Egyptians produced and used flax thousands of years ago, and the Chaldæans and Babylonians carried its use to the highest state of textile development. Three thousand years ago the Phœnicians extended the culture, and the Greeks and Romans made it a household industry, and it became the aristocratic fibre. It is claimed that the ancient Mexicans knew of both flax and hemp, and its culture in this country goes back to the earliest date of our civilization.

A bast fibre, it may be considered, next to cotton, the most valuable and universally employed textile in the whole range of vegetable fibres. While the plant can be grown in nearly every portion of the temperate world, it is produced commercially in Great Britain and Ireland, Denmark, Sweden, Belgium, Holland, France, Germany, Russia, Austria, Spain and Portugal, portions of Africa and Asia, Japan and the Australian colonies. It thrives in Canada, the United States, and Mexico and in some of the South American countries. Good flax has been grown as far north as Alaska, and the flax of Archangel is famous.

Its cultivation was brought to this country by the American colonists, the records showing that considerable quantities were grown in eastern Massachusetts as early as 1630. Its growth was early extended to other States, though for the most part it was a household rather than commercial industry. In the fifties of the last century three quarters of a million pounds of flax were produced in the United States, Vermont, Connecticut, New York, and New Jersey leading in the culture. With the increased use of cotton fine flax culture steadily declined, and while, as late as 1869, 13,000 tons of flax were produced, a very small proportion was fine line, the bulk being mere tow for the bagging factories. A year or two later, when jute was admitted free of duty, the industry collapsed, At the present time we are growing flax to the extent of a million acres annually, but for the seed, for linseed-oil manufacture, and not for the fibre. The straw, which is rough and coarse, is largely thrown away, although in recent years attempts are being made to use the rough product for paper.

Good commercial fibre could be grown in many localities, notably in Michigan, Wisconsin, Minnesota, Oregon, and Washington. In a series of government experiments, conducted by the writer in the Puget Sound region of Washington, flax-straw was produced from which was hackled out a fibre valued by experts at $500 per ton. Very little line flax is produced at the present time, however, our commercial supply coming largely from Russia, Holland, Belgium, and Ireland; a little comes from Italy and Canada. Much of the "Irish flax" is grown in Belgium and sent to Ireland for preparation.

Nearly every country producing commercial flax has established grades and marks save the United States and Canada. In portions of Russia the grades bear the names of the districts where grown. The grades of Archangel flax are known by the terms first, second, or third Crown, etc., and first Zabrack, second Zabrack, while Riga flax is graded from the standard K as HK, PK, HPK, HSPK, etc. Holland flax is graded by roman numerals or by double numerals, as $\frac{\text{II}}{\text{IV}}$ $\frac{\text{I}}{\text{V}}$ VI, VII, etc., Belgian flax also by numerals except Friesland flax, which is lettered, as D, E, Ex, F, Fxx, and so on to Gxxx. French flax is known by the districts where produced and Irish flax by the counties where the flax is grown (see 'Descriptive Catalogue Useful Fibre Plants of the World,' p. 222). Our importations of all kinds of raw and hackled flax last year amounted to 8,466 tons, worth $2,227,141.

The culture of flax requires a deep, well-tilled soil, in high state of fertility, such as moist, deep, strong loams upon upland; a wet soil is disastrous and clays are therefore avoided; and a soil filled with the seeds of weeds is equally fatal to flax culture. The land must be deeply plowed and reduced to fine tilth by harrowing and rolling. In the preparation of the soil, especially in Europe, a systematic rotation of crops is practised, flax occupying the same land not oftener than once in 5 or 10 years. Imported Riga seed gives the best results, although Belgian Riga (Belgian seed produced from one sowing of Riga seed) gives a fine fibre. The common seed of the oil-mills should never be used for fibre culture. When flax is grown for the production of seed alone, to be sold to the oil-mills, the ground is seeded at the rate of two to three pecks to the acre. For fibre culture one and a half to three bushels is the proper quantity per acre.

After the seed has vegetated and is about two inches high the weeding begins, for no fine flax can be produced if the crop is choked with weeds. Flax is harvested by pulling the straw out of the ground roots and all, the straw being laid in handfuls to dry, and afterward made into bundles, which are stacked in the field. Practice varies, however, in different countries as to the handling before the retting period. In Flanders the greatest care is given to drying and storing, in order to keep the flax clean and bright for the final process of retting.

There are three methods of soaking or retting the straw: Dew retting is the simplest and the least careful, the straw being spread over the field like hay, to be retted by the dew, and by the action of the elements. Pool retting is practised by immersing the straw in pools of stagnant water, the softest water giving the best results. The pools are dug in the ground for the purpose, though a great deal of the Irish flax is retted in "bog holes." Retting in running water is the third method, this form of retting being practised in Belgium; the famous Courtrai flax is retted in the sluggish and murky waters of the river Lys, the straw, in bundles, being placed in large crates and weighted with paving stones until the crates sink sufficiently to fully cover the flax. The flax of Courtrai, retted in the Lys, is the finest flax in the world. It is very light in color, clean, and even, and shows a superior tensile strength. The flax is given two immersions, the straw being taken from the crates and carefully dried before the second immersion.

The first operation in cleaning or extracting the fibre is to pass the straw through a breaker, which loosens the woody portions of the stem, and reduces them to fragments, to facilitate the next operation, the scutching, which whips out the «chive» and all waste matters and leaves the pure flax fibre. In former times the scutching was done by hand, though now machinery is generally used. The scutched flax is subsequently hackled or dressed by repeated combings, which removes the short and broken or tangled fibre, these combings producing tow. Each hackling adds to the quality of the fibre, and of course to the cost. Flax is usually imported in the scutched form, the hackled flax known as «dressed line.» The cheaper grades of flax come from Canada and Russia, the medium and finer grades from Holland, Belgium, and Ireland. The product is used in the United States for threads, twine, and crash, as no fine linen is woven in America. Mexico produces some good flax, and there are linen mills in Mexico city which produce fair grades of fabric. For the details of flax culture and manufacture, consult 'Special Reports' (Nos. 1, 4, and 10), office of Fibre Investigations of the Department of Agriculture; 'Spinning the Threads,' by A. R. Turner, Jr., in Jubilee number of 'New York Dry Goods Economist,' and (Etudes sur La Culture le Rouissage et el Teillage du Lin,' by Alfred Renouard. See CORDAGE; CORDAGE INDUSTRIES; FIBRE; LINEN.

CHAS. RICHARDS DODGE,
Commercial Fibre Expert.

Flax'man, John, English sculptor and draughtsman: b. York, England, 6 July 1755; d. London 7 Dec. 1826. From his earliest years he exhibited and cultivated his talent for designing, and was also attracted by the picturesque conceptions of Greek mythology. He began to study at the Royal Academy in 1770, earning for some time a living by making designs for Wedgwood, the potter, and other persons. He went to Italy in 1787, and acquired the highest reputation by three series of designs, the illustrations to Homer, Æschylus, and Dante. He became a member of the Royal Academy 1797, and professor of sculpture there in 1810. The monument to Lord Mansfield in Westminster Abbey, the group of 'Cephalus and Aurora,' 'Psyche,' the group of the 'Archangel Michael and Satan,' are among his best works. He executed many exquisite bassi-relievi, compositions from Scripture subjects, and marked by some special religious sentiment. The monuments to Nelson, Howe, and Reynolds in St. Paul's are by his hand. One of his latest and finest productions is the 'Shield of Achilles.' The sculptures and sketches of Flaxman are now deposited and exhibited in a gallery called the «Flaxman Hall,» at University College, London. His 'Lectures on Sculpture' appeared in 1829, passed through a new edition in 1866.

Flaxseed, the seed of the flax plant (*linum*) largely used for domestic and medicinal purposes, produced in large quantities in the south of Europe, Egypt, parts of Asia and in the United States. (For a detailed description of the plant see FLAX; and for its commercial qualities other than seed, see FIBRE and LINEN.) The seeds of flax are dark brown, glossy, oval oblong, flattened, with acute edges, and pointed at one end. The seed is rich in an oil of such superior drying qualities as render it an indispensable ingredient in paint and varnish, and in the manufacture of linoleum, oilcloth, printer's ink, patent leather and other products and manufactures. The cultivation of the plant for fibre requires harvesting before the seed is fully ripe, which impairs the quality and reduces the quantity of the crop of flaxseed. The cultivation of flax for the seed requires a seeding of 2 or 3 pecks to the acre, and while it yields an increase of seed, the fibre straw is coarser; hence flax must be raised exclusively either for fibre or for seed. European countries cultivate flax for fibre, while the United States, Argentine and British India produce the world's commercial crop of flaxseed.

Introduction in America.— Flax for fibre was introduced in the United States soon after the landing at Plymouth. The seed for which there was obviously a limited domestic demand, gradually developed as an article of commerce. So long ago as 1791 the exports of flaxseed from the United States amounted to 292,460 bushels. In the same year began the manufacture of linseed oil in this country. In 1810 there were 283 linseed oil mills located in 14 States, 171 mills being in the State of Pennsylvania. The total annual output of these mills amounted to 770,583 gallons, representing 300,000 bushels of seed. In 1839 the first cargo of flaxseed ever brought into the United States was imported from Russia, and a few years later ships carrying ice to India brought flaxseed on the return voyages. From 1850 to 1870 India shipped a larger quantity of flaxseed to the United States than was produced in this country. From 1850 to 1860 half the entire crop here was grown in Ohio and Kentucky. The linseed oil mills divided or arranged themselves about 1891 into two groups, eastern and western. The former utilized the India imports of seed, while the western mills used the home product. In 1892 the United States took rank among the surplus flax-producing nations of the world and became an exporter of importance. In 1894 a short crop necessitated the import of 4,000,000 bushels. In 1903 there were 13 mills of large capacity in the Eastern States, 4 in Buffalo, 2 in New York, 3 in Philadelphia and other individual mills at Pittsburg and Allegheny, Pa., and Troy and Amsterdam, N. Y. These combined mills crush annually upward of 12,000,000 bushels of seed.

The Western Crop.— The flaxseed industry has migrated from its original western home in Ohio and Kentucky, State by State, until its present area includes North Dakota, South Dakota, Minnesota, Iowa and Wisconsin (known as the northwestern crop), and in Kansas, Missouri, Nebraska, Oklahoma and Indian Territory (known as the southwestern crop). Up to 1869, Ohio was the leading producing State. In 1879 Illinois produced the largest crop, 1,812,438 bushels. In 1889 North Dakota took the lead with a production of 7,776,610 bushels, and in 1902, out of a total production in the United States of 29,284,880 bushels North Dakota produced 55 per cent or 15,552,000 bushels. There are two varieties of seed produced in the West.

The small-grained seed of the Southwest yields an average of 17 pounds of oil to the bushel, while the larger-grained seed of the Northwest yields 20 pounds of oil to the bushel (56 pounds).

PRODUCTION OF FLAXSEED IN THE UNITED STATES.

District	1849	1879	1902
	Bushels	Bushels	Bushels
Northwestern crop......	315,506	6,010,700	26,966,600
Southwestern crop......	13,696	970,956	1,856,240
All other States........	233,110	189,295	462,040
Total	562,312	7,170,951	29,284,880

FLAXSEED PRODUCTION OF THE WORLD.

Country	1899	1901
	Bushels	Bushels
United States................	19,979,000	24,000,000
Russia	18,022,000	16,194,000
Argentine	8,639,000	15,354,000
British India................	17,116,000	13,041,000
Austria	735,500	1,131,000
France	345,000	611,000
Other countries..............	1,511,100	1,910,000
Total	66,347,600	72,241,000

The manufacture of linseed oil in the West has become largely localized in cities on and near the Great Lakes. There were 5 mills in Minneapolis in 1902, 6 in Chicago, 2 at Toledo, and 1 each at Cleveland, Milwaukee, South Bend, Ind., and Redwing, Minn. In the northwestern States of Iowa, North and South Dakota, there are but 3 mills, the bulk of all the western crop going to Chicago. Flaxseed in its natural state has no domestic uses on the farm, so that internal commerce involves the entire crop.

Flaxseed Products.— The principal product as understood is linseed oil. The residue after the extraction of the oil is the by-product the oilcake, a valuable cattle food, which, when ground, is known to commerce as linseed oil meal. Out of a crop like that for 1902 (29,000,000 bushels), there could be manufactured over 67,000,000 gallons of oil and upward of 1,000,000,000 pounds of oilcake. Of this vast quantity of oil the foreign demand only amounts to 100,000 gallons a year. Linseed oil has many uses and the monopoly of its field is so complete it has no substitutes nor adulterants. Probably 75 per cent of the oil manufactured is compounded with pigments and gums and used as paint and varnish. The remainder is utilized in making linoleum, oilcloth, printer's ink, waterproof fabrics not made of rubber, enamel for buttons, for making soap and for a few medicinal purposes. The oilcake, used only as a cattle food finds an extensive market abroad. It is highly prized by European stockraisers, but little appreciated in America. About 80 per cent of the oilcake product is exported. Belgium alone bought 148,263,752 pounds in 1901. In the fiscal year 1901–2 oilcake to the value of $5,665,392 was shipped to foreign countries, and the average amount exported for five years prior to 1902 was 488,891,125 pounds. In the manufacture of linseed oil from flaxseed two processes are used, one known as the «old» or hydraulic press process, and the other as the «new» or naphtha process. The old process is in use generally throughout the United States, the new process being represented in 1902 by a single mill in Chicago. In December 1902 there were 40 linseed oil mills in operation in the United States. They contained 750 presses with a crushing capacity, if operated 250 days in the year, of 25,000,000 bushels, with an output of 70,000,000 gallons of oil.

AVERAGE PRICE OF FLAXSEED (PER BUSHEL).

Month	1891	1901	1902
January	1.19¼	1.66½	1.65¼
April	1.20¼	1.61	1.72½
July	1.03¼	1.84½	1.55
October	.95½	1.49½	1.19½

ACREAGE, PRODUCTION, AND VALUE OF FLAXSEED IN THE UNITED STATES IN 1902.

States and Territories	Acreage	Yield per acre	Production	Price per bushel Dec. 1	Farm value Dec. 1
	Acres	Bushels	Bushels	Cents	Dollars
Wisconsin	41,000	12.1	496,100	120	595,320
Minnesota	667,500	10.4	6,942,000	107	7,427,940
Iowa	97,500	7.9	770,250	105	808.762
Missouri	65,700	5.0	328,500	104	341.640
Kansas	190,200	6.4	1,217,280	101	1,229,453
Nebraska	14,500	8.0	116,000	113	131,080
South Dakota..........	427,500	7.5	3,206,250	114	3,655,125
North Dakota..........	2,160,000	7.2	15,552,000	103	16,018,560
Montana	12,500	9.0	112,500	68	76,500
Idaho	34,500	9.2	317,400	97	307,878
Oregon	2,300	6.8	15,640	122	19,081
California	1,100	15.0	16,500	105	17,325
Oklahoma	19,800	7.7	152,460	95	144.837
Indian Territory......	5,600	7.5	42,000	98	41,160
United States.........	3,739,700	7.83	29,284,880	105	30,814,661

The value of the flaxseed crop as compared to the value of other crops raised in the United States in 1902, will be of interest:

Value of flaxseed crop...................	$30,814,661
Value of rye crop........................	17,080,793
Value of buckwheat crop..................	8,654,704
Value of barley crop.....................	61,898,034
Value of tobacco crop....................	57,503,510

Flea-beetles, small leaf-beetles of the tribe *Halticini*, of the family *Chrysomelidæ*, differing from other forms of this family by their extraordinary leaping power due to the enormously developed hind femora. Many of them are injurious to vegetation from their habit of eating the starting leaves full of holes, causing the drying up and death of the plant; hence certain species are known, as «tobacco flea,» "potato flea," "cabbage flea," etc. In their larval state some species live on the root system of various weeds, the adults doing the principal damage to useful plants. Some species are also leaf-miners, while a few feed on the upper surface of leaves like the young of common leaf-beetles, but most species feed on both surfaces. One of the best remedies is bordeaux mixture, doubly efficient when mixed with Paris green and administered in the form of a spray. See LEAF-BEETLES.

Flea-hopper, either of two species of injurious minute black bugs of the family *Capsidæ.* The commonest is the garden flea-hopper (*Halticus uhleri*), which feeds and breeds normally on clover, but attacks all garden vegetables, commonly on the under sides of leaves, which it punctures so as to cause the death of the tissue in small irregular white patches. It somewhat resembles a flea-beetle (q.v.), but is remarkable in being dimorphic, a portion of the females having well-developed wings, the remainder being short-winged. The best remedy is kerosene emulsion as an under spray, and the avoidance of planting susceptible crops after the cutting of clover fields. A related species is known as the false flea-hopper (*Agalliastes associatus*).

Flea-louse, one of the jumping plant-lice of the family *Psyllidæ,* familiarly represented by a pest of the pear-tree (q.v.). Some of the species make galls.

Fleabane. See ERIGERON.

Fleas, minute wingless insects with bodies covered by a strong armor of fine scaly plates and mouth-parts formed for sucking. They constitute the order *Siphonaptera* and are related to the *Diptera.* Everyone is familiar with these troublesome parasites of man and domestic animals, but few persons have studied them sufficiently to know the larval and pupal stages, or to recognize the fact that there are many species. Only recently has it been established that the flea most annoying to human beings in America is not the human flea of the Old World (*Pulex irritans*), but the so-called dog-and-cat flea (*Pulex serraticeps*). Both species are of cosmopolitan distribution, but the former is fortunately extremely rare in this country, while the latter is to be found everywhere. Observations conducted by the United States Department of Agriculture have shown that the development of these insects is hastened by a moist or humid atmosphere. The egg stage is very short, th larvæ, which are worm-like, spin cocoons in which the pupal stage is formed in from 7 to 14 days after hatching and the imago appears five days later, showing that in the warmest weather an entire generation may develop in little more than a fortnight. Fleas will develop successfully in any situation where they are not too much disturbed, as in rugs, mats, or in straw or litter on which cats or dogs have slept; and they are also carried from one place to another by rats and mice and other animals. Dr. C. F. Baker ascertained in 1895 that there were 47 valid species of fleas in the United States; and probably this number might be doubled if all of the parasites of our larger animals were known. While many persons are indifferent to the presence of fleas others suffer severely from their attacks. Very many alleged cases of "hives" have been found to be produced by fleas, and epidemics of fleas in restricted areas as, for example, in several neighboring houses, have been traced to the body of an animal which had died near by The fleas desert the dying body of their host, jump on the clothing of any person passing, and are thus carried from house to house. One means of protection against them consists in avoiding carpets, and keeping the floors painted and covered with rugs, which should be frequently moved, swept and aired. Household pets should be kept out of the house during the summer time; in fact, it is better to exclude cats entirely, because they cannot be washed and freed from parasites so readily as dogs. Rats and mice also carry these and other parasites. The best remedy for those who suffer from fleas is to apply ammonia as strong as can be borne and as soon as possible to the bite, which in some persons is followed by an eruption as big as a dime, attended by severe itching. The free use of baking soda would serve nearly the same purpose where ammonia cannot readily be obtained. Consult: Howard & Marlatt, 'Household Insects of the United States,' issued by the Department of Agriculture.

Fleece Golden, in Grecian mythology, the fleece of gold taken from the ram on which Phrixus and Helle escaped from being sacrificed.

Fleece, Order of the Golden, a military order instituted by Philip the Good, Duke of Burgundy, at Bruges, 10 Jan. 1429, on the occasion of his marriage with the Portuguese princess, Isabella. The order now belongs to both Austria and Spain. See GOLDEN FLEECE, ORDER OF.

Fleet, (1) A tidal stream, so called from the swiftness of its current, which flowed by the walls of old London city; the title is also applied to a creek; an inlet or arm of the sea, as North-fleet, etc. (2) Fleet Street, London, derives its name from the Fleet ditch. (3) The Fleet, or Fleet Prison, an historic prison in London, so called from its being situated by the side of the Fleet ditch. In it were confined persons committed by the ecclesiastical courts and the courts of equity, exchequer, and common pleas. It existed from the 12th century until its abolition in 1846. (4) Fleet books, the original records of the marriages celebrated in the Fleet prison, between 1686 and 1754. (5) Fleet marriages, marriages performed clandestinely and without banns or license by the poor chaplains in the Fleet prison, previous to 1754, when they were declared illegal by the Marriage Act.

Fleet'wood, Charles, English soldier: b. Northamptonshire, England; d. Stoke Newington, London, 4 Oct. 1692. He was of good family, studied law, was elected member of Parliament in 1646, and appointed governor of the Isle of Wight in 1649. He was made lieutenant-general of cavalry in Cromwell's army, distinguished himself at the battle of Worcester (1651) and married Bridget, Henry Ireton's widow, the daughter of Cromwell. He was put in command of the troops in Ireland, where he resided as Lord Deputy until 1655. He was appointed general of Richard Cromwell's army 18 Oct. 1659, but on the promotion of Monk in December 1659, he resigned. After the Restoration he retired to obscurity at Stoke Newington.

Fleetwood, George, English parliamentarian: b. in Buckinghamshire, England; d. in America about 1665. He represented his native shire in the Long Parliament (1647). He signed the death warrant of the king, raised a regiment of horse for Cromwell's army and was by the latter raised to the peerage. By the government of Charles II. he was condemned to death as a regicide, but on changing his allegiance, the sentence was mitigated to confiscation of his estates, and he emigrated to America.

Fleetwood, or **Brandy Station, Battle of.** Gen. Hooker, suspecting that Gen. Lee was gathering his forces on the upper Rappahannock for a movement northward, and informed that Gen. Stuart's Confederate cavalry was at Culpeper Court House, ordered Gen. Pleasonton, who was at Catlett's Station, to cross the Rappahannock at Beverly and Kelly's Fords, attack Stuart, and ascertain Lee's intentions. Pleasonton had the cavalry divisions of Buford and Gregg, and Hooker sent him two picked provisional infantry brigades of 3,000 men, under Gens. Ames and Russell, making in all, cavalry and infantry, an effective force of 10,900 men. Stuart had five brigades of 10,200 men. At daybreak 9 June 1863 Buford, with his cavalry and one brigade of infantry, crossed at Beverly Ford and encountered one of Stuart's brigades, under command of Gen. Sam Jones, and a severe contest ensued, in which the 8th New York cavalry, Col. B. F. Davis, was routed and its commander killed. A charge of the 8th Illinois cavalry drove Jones back two miles, where he joined Stuart and the two brigades of Wade Hampton and W. H. F. Lee. Meantime Gregg, with his cavalry division and an infantry brigade, crossed the river at Kelly's Ford, and pushing back Robertson's brigade, approached Fleetwood Hill from the east, as Buford moved on Brandy Station from the northwest. Fleetwood Hill is a few hundred yards north of Brandy Station, and a hard hand-to-hand struggle ensued at both points, with varying success. Buford held his own near Brandy Station, but Gregg, at Fleetwood Hill, was finally compelled to withdraw, leaving three of his guns in the hands of the enemy. Pleasonton, satisfied that a great part of Lee's army was in his front, recrossed the Rappahannock with about 100 prisoners. The Union loss was 484 killed and wounded and 382 missing. The Confederate loss was 485, of whom 301 were killed or wounded. This engagement marks the beginning of the Gettysburg campaign. Consult: 'Official Records,' Vol. XXVII.; The Century Company's 'Battles and Leaders of the Civil War,' Vol. III.

E. A. CARMAN.

Fleischer, Heinrich Leberecht, hīn'riH lā'be-reHt flī'sher, German Orientalist: b. Schandau, Saxony, 21 Feb. 1801; d. Leipsic 10 Feb. 1888. He was professor of Oriental languages at the University of Leipsic 1836–88. Beside editing Ali's 'Hundred Sayings' (1837), and other works, he wrote a 'Critical Dissertation on Habicht's Glossary to the First Four Volumes of the Thousand and One Nights' (1836); 'Grammar of the Modern Persian Languages' (1875); 'Kleinere Schriften' (1885–8).

Fleming, George. See FLETCHER, JULIA CONSTANCE.

Flem'ing, John Ambrose, English electrical engineer: b. Lancaster, England, 1849. He was educated at the Royal College of Chemistry and St. John's College, Cambridge, and has been associated for many years with the progress of electrical science. He has published: 'Short Lectures to Electrical Artisans' (1885); 'Treatise on the Alternate Current Transformer' (1889–92); 'Electric Lamps and Electric Lighting' (1894); 'Magnets and Electric Currents' (1897); 'Waves and Ripples in Water, Air, and Ether' (1902); etc.

Fleming, May Agnes Early (MRS.), Canadian story-writer: b. New Brunswick 1840; d. 1880. She was a prolific author of romances, mostly sensational, among them being: 'Guy Earlscourt's Wife'; 'Lost for a Woman'; 'Pride and Passion.'

Fleming, or **Flemming, Paul,** powl, German lyric poet: b. Hartenstein, Saxony, 5 Oct. 1609; d. Hamburg 2 April 1640. As an attaché of an embassy to Russia and Persia, he had an opportunity (1635–9) of studying many peoples. His 'German Poems,' which appeared in 1642, has been often republished.

Fleming, Richard, English prelate: b. Yorkshire about 1360; d. 1431. At first a supporter of Wiclif's doctrines he subsequently, when bishop of Lincoln, became staunchly orthodox and is remembered as the prelate who dug up and burned the body of Wiclif and cast the ashes into the Swift. He planned a college at Oxford to be a bulwark against heresy, but the present Lincoln College was, however, not founded till after the bishop's death.

Fleming, SIR Sandford, Canadian engineer: b. Kirkcaldy, Fifeshire, Scotland, 7 Jan. 1827. He went to Canada in 1845 where he constructed the Inter-Colonial Railway through Nova Scotia, New Brunswick and Quebec. He was engineer in chief of the Canadian Pacific Railway 1871–80, and has published: 'The Inter-Colonial: a History, 1832–76'; 'England and Canada'; 'Time and its Notation'; etc. He was knighted in 1897.

Fleming, William Hansell, American Shakespearian scholar: b. Philadelphia, Pa., 23 Aug. 1844. He was educated at Princeton University and has published: 'How to Study Shakespeare' (1897–9), and edited the 'Bankside Shakespeare.'

Flem'ingsburg, Ky., a town and county-seat in Fleming County, on the Covington, F. & A. R.R. Pop. (1900) 1,711.

Flem'ington, a town and county-seat of Hunterdon County, N. J., on the Pennsylvania, the Lehigh Valley, and the Central Railroad of New Jersey, 50 miles west of New York. Pop. (1900) 2,145.

Flemish Art. See FLEMISH SCHOOL.

Flemish Bond, in bricklaying, a particular mode of disposing bricks in a wall, so as to tie and break joints. It consists of a header and stretcher alternately.

Flemish Brick, European brick used for paving; 72 will pave a square yard. They are of a yellowish color, and harder than the ordinary bricks.

Flemish Language and Literature. *Vlämisch* or *Duytsch*, the Low German vernacular spoken by the Vlamingen or Flemings inhabiting the Belgian provinces of East and West Flanders, parts of Holland and the French department of Nord, is akin to the Frisian and to the Hollandish or Dutch which is its younger branch. The latter differs from Flemish in having been reformed and simplified, while Flemish retains the greater part of the archaic features of its 16th century spelling, pronunciation, and words and forms of speech of French and Spanish origin. Since Belgium became an independent kingdom in 1830, a strong desire has been manifested to foster Flemish traditions and to cultivate and promote its language and literature; before that date its history is identified with that of Dutch language and literature. (See HOLLAND.) Among early Flemish literature is the 'Spiegel historical' (historic mirror) of Jacob van Maerlant (1235–1300), a translation of 'Boece' or 'Boethius' by Jacob Velt of Bruges in the 15th century, and the 'Hive of the Catholic Church,' by Philip van Marnix (1569). The modern movement to rehabilitate the vernacular was largely due to the efforts of Jan Frans Willem who before the separation of Belgium from Holland had strenuously advocated its use as a literary language. With the able co-operation of such authors as Van Ryswyck, Ledeganck, Rense, Van Duyse, Blieck, Serrure, David Conscience and others, the movement made great progress, received official support, and was crowned with success in 1886 when the Koninklije Vlaamsche Akademie (Royal Flemish Academy) was founded and the use of Flemish, as well as French, was adopted as the legal and official language of the kingdom. Prominent amid modern Flemish literature is the verse of Ledeganck: 'De drie Zustersteden,' 'De Hut in 't Wowd,' etc.; of Ryswyck, 'Antigonus,' 'Eppenstein,' and 'Oorspronkelikje Verhalen'; of Van Beers, 'Begga,' 'Levensbeelden' and 'Gevoel en Leven.' Among works of fiction are Hendrick Conscience's 'Artevelde'; Delcroix's 'Geld of Liefde' and 'Philippine van Vlaanderen'; Sleeckx's 'In 't Schipperskwatier' and 'Dirk Meyer'; and Sneiders' 'De gasthuisnon.' Other well-known novelists are Bergmann, Madame Courtmans, and the two poetesses, Rosalie and Virginie Loveling, poets also including Dantzenberg, De Cort, and Van Droogerbroeck. Representative drama is Sleeckx's 'Meester en Knecht,' and 'Zannekin.' Consult: Willems, 'Sur la langue et la littérature neerlandaises, par rapport aux provinces méridionales des Pays-Bas' (1818); Vercoullie, 'Spraakleer van het Westvlaamsch' (1894); Hamelius, 'Histoire politique et littéraire du mouvement flamand' (1894).

Flemish School, a school of painting which originated in Flanders in the early part of the 15th century, with the invention, or at least the first practice, of painting in oil. It has been generally attributed to Jan Van Eyck, who was accustomed to varnish his distemper pictures with a composition of oils. In course of practice he came to mix his colors with oil instead of water, which rendered them brilliant without the trouble of varnishing. From this and subsequent experiments arose the art of painting in oil. The chief early masters of the school were Jan Van Eyck and his brother and sister, Hubert and Margarete, Matsys, Mabuse, Memling, Weyden, and Moro; to the second period belong Rubens, VanDyck, Snyders, Jordaens and the younger Teniers.

Flensburg, flens'boorg, Prussia, a town in the province of Schleswig-Holstein, 20 miles from the town of Schleswig. It was a place of importance as early as the 12th century, but subsequently suffered much from wars and conflagrations. It is again prosperous, and is now the most important town in Schleswig. The industrial establishments include ship-building yards, sugar-refineries, tobacco-factories, soap-works, foundries, breweries, distilleries, etc. In 1866 it fell to Prussia, along with the duchy of Schleswig-Holstein. Pop. (1901) 48,992.

Flesh (or muscle) is composed of the proteids, myosin, musclin, myoglobulin, and myo-albumin, together with varying amounts of fats, salts, and nitrogenous extractive substances. Of the three classes of foodstuffs needed in the human economy, meat supplies most of the proteid and fat, while the vegetable kingdom supplies the carbohydrates. The proteids are more properly the tissue-building elements, while the fats and carbohydrates are more readily oxidizable, and supply the body with energy. Proteids must be taken as such, since the human economy cannot cause conversion of the other sorts of food into proteids. The minimum of these various substances for the proper preservation of life has not been positively determined, but approximately the average healthy man requires 100 grams of fat, 400 grams of carbohydrate, and 100 grams of proteid per diem. The necessary amount of proteid material can be obtained from the vegetable kingdom, and there is no doubt that some systems are better suited for this diet; but to the large majority of individuals a mixed diet, containing a certain amount of meat, is more readily taken care of. The meat proteids are usually more quickly and completely digested.

The nitrogenous extractive substances, ceratine, the xanthin bases, and the like, are also of value to the system because of their power of exciting gastric secretions and stimulating circulation. The various meat extracts contain a large proportion of these substances, and most of them have little else. An overabundance of meat very frequently causes a nervous, irritable condition. This is less true of the so-called white meats, a difference not to be explained on the ground that the white meats contain less of the extractives, since the opposite is the case. As a general rule the diet of the well-to-do in America is entirely too high in food-value, but particularly in the amount of albuminous foods. These constant errors find their expression in the well-nigh universal complaint of dyspepsia and so-called uric-acid disturbances. Such intoxications are almost sure to follow if more animal food is taken than can be digested and absorbed. Putrefaction of the unabsorbed food takes place, with generation of toxic substances and absorption of them into the general circulation.

Flesh-fly, any of a large group of showy flies (family *Sarcophagidæ*), the more familiar and typical members of which breed in decaying flesh. Some, however, pass their larval stages in dung, or decaying vegetables, or are parasitic in the wounds and sores of animals and man. Most of them look like large house-flies, sometimes bright with metallic blue or green, or gray with black stripes: common names are "blue-bottle" (for *Lucilia cæsar,* which often comes into houses in stormy weather), or "green-bottle," for the "blow-flies" (q.v.) of the genus *Calliphora.* The common flesh-fly of Europe (*Sarcophaga carnaria*) is a pest that does not appear in the United States, but we have a very similar and equally troublesome species in *S. sarraceniæ.* The directness with which these flies find and utilize a piece of decayed meat, for the deposit of their eggs, or their living maggots, avoiding fresh meat equally accessible, is regarded as an evidence that they are under the control of an impulse of a chemical character rather than merely following a sense of smell.

Fleshly School, The. See DECADENTS.

Fletch'er, Alice Cunningham, American ethnologist: b. Boston, Mass., 1845. She is the originator of the scheme by which loans are made to Indians in order that they may buy lands and build houses. She is now employed in the management of the Peabody Museum of American Archæology and Ethnology, and is the author of 'Indian Story and Song from North America' (1900).

Fletcher, Andrew, of Saltoun, Scottish political writer and patriot: b. Saltoun, Haddingtonshire, 1655; d. London, September 1716. Having distinguished himself in opposition to the court he deemed it prudent to retire to Holland; and on his non-appearance to a summons from the lords in council he was outlawed. In 1685 he joined the enterprise of the Duke of Monmouth. He subsequently joined the Scottish refugees in Holland, and when the revolution of 1688 took place returned to England with William of Orange, resumed possession of his estate, and became a member of the convention for settling the new government in Scotland. In 1698 he printed 'A Discourse on Government in Relation to Militias'; and also, 'Two Discourses Concerning the Affairs of Scotland.' His tracts and some of his speeches appeared in one volume, entitled: 'The Political Works of Andrew Fletcher, Esq.' (1737). Consult Omond, 'Fletcher of Saltoun' (1897).

Fletcher, Benjamin, English colonial governor. He was appointed by William and Mary in 1692, after serving during the war in the Low Countries, as well as in Ireland. When William Penn was for a time deprived of his proprietary rights he acted as governor in Pennsylvania (1693–4). He was at last forced to resign from his post in New York, and many charges were made against him. Consult: Wilson, 'Memorial History of the City of New York' (1892).

Fletcher, Giles, English poet: b. Watford, Hertfordshire, about 1549; d. London March 1611. He was ambassador to Russia in 1588, but his description of that country, 'Of the Russe Common Wealth,' appearing in 1591, was suppressed. It was reprinted for the Hakluyt Society 1856. He also wrote: 'Licia: Poems of Love' (1593).

Fletcher, Giles, English poet: b. about 1588; d. 1623. He was a son of Giles Fletcher the elder, and wrote the poem, 'Christ's Victory' (1610). A new edition appeared in 1824.

Fletcher, James Cooley, American clergyman and author: b. Indianapolis, Ind., 1823. Between 1851 and 1865 he traveled widely as a missionary in Brazil, and was at one time secretary to the United States legation at Rio de Janeiro. In 1869–73 he was consul at Oporto, Portugal, later was a missionary in Naples, Italy, and from 1877 was resident at Indianapolis. His 'Brazil and the Brazilians,' early editions of which contain the name of D. P. Kidder as associate author, was long the authoritative English work on the subject.

Fletcher, John. See BEAUMONT, FRANCIS, AND FLETCHER, JOHN.

Fletcher, Joseph Smith, English journalist and novelist: b. Halifax, Yorkshire, 1863. He has written extensively for newspapers under the pseudonym "A SON OF THE SOIL," as well as novels and collections of short stories which have been very popular, and several of which have been widely read in the United States. His published books include: 'Anima Christi' (1884); 'When Charles the First was King' (1892); 'Poems' (1892); 'The Quarry Farm' (1893); 'The Wonderful Wapentake' (1894); 'Where Highways Cross' (1895); 'Mistress Spitfire' (1896); 'Ballads of Revolt' (1896); 'Life in Arcadia' (1896); 'At the Gate of the Fold' (1896); 'God's Failures' (1897); 'The Making of Matthias' (1897); 'The Builders' (1897); 'The Paths of the Prudent' (1899); 'From the Broad Acres' (1899); 'Morrison's Machine' (1900); 'The Harvesters' (1900); 'A Picturesque History of Yorkshire' (1899–1900); 'The Three Days' Terror'; 'The Golden Spur' (1901); 'Bonds of Steel'; 'The Investigators' (1902); 'In the Days of Drake'; 'At the Blue Bell Inn.'

Fletcher, Julia Constance (pseudonym "GEORGE FLEMING"), American novelist; b. Rio Janeiro, Brazil, 1858. She is a daughter of James Cooley Fletcher (q.v.). She has resided for years in Italy and in London. Her novels are: 'Kismet' (1877); 'Mirage' (1878); 'The Head of the Medusa' (1880); 'Andromeda' (1885); 'The Truth about Clement Ker' (1889); 'For Plain Women Only' (1895); and 'Little Stories about Women' (1897). She has also written the plays: 'Mrs. Lessingham' (1894); 'A Man and His Wife' (1897); 'The Canary' (1899); 'The Fantasticks' (1900).

Fletcher, Lazarus, English mineralogist: b. Salford, England, 3 March 1854. He was educated at Balliol College, Oxford, and has been keeper of minerals in the British Museum from 1880. He has published: 'Introduction to the Study of Meteorites' (1881); 'Introduction to the Study of Minerals' (1884); 'The Optical Indicatrix' (1892); 'Introduction to the Study of Rocks' (1895).

Fletcher, Phineas, English poet: b. Cranbrook, Kent, April 1582; d. about 1650. He was a son of Giles Fletcher the elder and a cousin of John Fletcher (q.v.). He was the author of 'Sicilides,' a pastoral drama (1614); 'The Purple Island and Piscatory Eclogues' (1633). 'The Purple Island' is an allegorical description of man, founded upon an allegory in the ninth canto of the second book of the 'Faerie Queene.' It is composed in the Spenserian manner, and is not without passages of strong fancy and beauty of description. In the first five cantos, however, the reader loses the poet in the anatomist — a character but little adapted to the handling of poetry. When, however, he steps from the physical to the intellectual man, he not only attracts, but secures attention by a profusion of images, many of which are distinguished by much boldness of conception and brilliancy of coloring. The ‹Piscatory Eclogues› have considerable sweetness of versification, and much descriptive elegance. Milton was indebted to both Phineas and his brother Giles for different passages of the ‹Paradise Lost› and ‹Paradise Regained.›

Fletcher, Robert, American surgeon: b. Bristol, England, 1823. He was graduated at the Royal College of Surgeons 1841; came to the United States, and was surgeon of an Ohio regiment during the Civil War. He afterward became principal assistant librarian of the surgeon-general's office at Washington, D. C., and professor of medical jurisprudence in the Columbian University. He has published: ‹Paul Broca and the French School of Anthropology› (1882); ‹Human Proportion in Art and Anthropometry› (1883); ‹The New School of Criminal Anthropology› (1891); ‹Scopelism› (1897).

Fletcher, Robert Howe, American soldier and author: b. Cincinnati, Ohio, 21 July 1850. He entered the United States Naval Academy at 17, and at graduation was transferred to the army where he served on the Indian frontier and in California till 1886. Since 1898 he has been curator of the Mark Hopkins Institute of Art at San Francisco. He has published: ‹A Blind Bargain›; ‹The Johnstown Stage›; ‹Marjorie and Her Papa.›

Fletcher, William Isaac, American librarian: b. Burlington, Vt., 28 April 1844. He has been librarian of Amherst College from 1883 and is the author of ‹Public Libraries in America› (1895); and was joint editor of ‹Poole's Index to Periodical Literature.› He has also edited continuations of the latter (1882–1900); the ‹A. L. A. Index to General Literature› (1893); and the ‹Co-operative Index to Periodicals› (1883–91).

Fleur-de-lis, fler-de-lē, an heraldic emblem probably derived from the iris-plant. Some of the great families of France (most of whom are now extinct) bore the emblem on their shields from the very commencement of the practice of blazoning, and a large number of families in Germany, Sweden, Switzerland, and other parts of Europe have borne the fleurs-de-lis on their coats of arms from the 12th century. The great popularity of this emblem in France dates from the 13th century. The royal coat of arms of France consisted of three golden lilies on a blue ground, with the device, ‹*Lilia neque nent neque laborant.*› The shield of France was anciently, in heraldic language, *semé de fleurs-de-lis*, that is, bore this emblem scattered over the shield. It is commonly believed that it was Charles V. (1364–80) who reduced the number to three; but this is disproved by the fact that two seals have been preserved, the one belonging to Philip the Fair (1285–1314), the other belonging to Philip of Valois (1328–50), both of which bear three fleurs-de-lis; and the town library of Rouen contains a collection of charts relating to the celebrated abbey of Savigny, to one of which, bearing the date 1212, a seal is attached, which is still in a state of perfect preservation, representing three fleurs-de-lis exactly similar to those used on the shield of France. Hence it appears that the use of this emblem in a triple form is much more ancient than is usually thought. See HERALDRY.

Fleurus, fle-rüs, a town in Belgium, province of Hainaut, seven miles northeast of Charleroi. It has manufactures of coarse woolens and flax, with some tanneries and salt-works, and a trade in agricultural produce. In the vicinity, in August 1622, the Spaniards under Gonzales defeated the army commanded by Ernst von Mansfield; 1 July 1690, the French under Marshal Luxembourg defeated the Germans under Prince Waldeck; and 26 June 1794, the French republican forces under Marshal Jourdan defeated the Austrian army. The battle of Ligny, also, is sometimes known as the battle of Fleurus, Ligny being only about two miles from Fleurus. Pop. (1901) 6,264.

Fleury, Andre, Hercule de, än-drā ar-cül de fle-rē, a cardinal and prime minister of France under Louis XV.: b. Lodève, Languedoc, France, in 1653; d. 29 Jan. 1743. Coming to court, he won general favor by his pleasing person and fine understanding; became bishop of Fréjus; and, through the interest of Madame Maintenon, was appointed instructor to Louis XV. In 1726 he was made cardinal, placed at the head of the ministry, and from his 73d to his 90th year he administered the affairs of his country with great success.

Fleury, Claude, clōd, French Church historian: b. Paris, France, 6 Dec. 1640; d. there 14 July 1723. His learning and unaffected simplicity made him a notable figure at the court of Louis XIV., and later at that of Louis XV., whose confessor he became. An ‹Ecclesiastical History› (1691–1720) forms his claim to enduring renown; the work coming down to 1414, at which point a later writer has attempted, though not sympathetically, to round out the master's performance. ‹A History of French Law› (1674) and a ‹Historical Catechism› (1679) are less important achievements.

Fleury, Maurice de, mō-rēs de, French physician: b. Bordeaux 1860. He studied under his father at Bordeaux, and practised in the hospitals there and at Paris. His specialties are nervous complaints and the physical and intellectual training of children, so as to produce a sound mind in a sound body. He has published many valuable contributions to the subjects of his special study. Such are: ‹Contribution à l'étude de l'hysterie senile› (1890); ‹Traitement rationnel de la neurasthénie› (1894); ‹Pathogénie de l'épuisement nerveux› (1896); ‹Introduction à la médecine de l'esprit› (1897); ‹L'âme du criminel› (1899); and ‹Le corps et l'âme de l'enfant› (1899).

Fleury-Husson, Jules. See CHAMPFLEURY.

Flexibility, in physics, the property which all bodies possess to a greater or less degree, and which is evinced in their disposition to yield or change their form in a direction at right angles to their length, through their own weight or by means of any pressure or strain applied to them. Pieces of the same material differ from each other in the degree of flexibility they exhibit in proportion to their length and thickness. See PHYSICS.

Flexner, Simon, American pathologist: b. Louisville, Ky., 25 March 1863. He was graduated from its University of Louisville as M. D. in 1889. He then became a post-graduate student at Johns Hopkins University and subsequently pursued his pathological studies at the University of Strasburg. He was professor of pathology, Johns Hopkins University 1891–8; and of pathological anatomy 1898–9, and has been professor of pathology in the University of Pennsylvania since the year last named. He was also director of Ayer Chemical Laboratory, Pennsylvania Hospital, 1901–3; and pathologist of University Hospital and Philadelphia Hospital 1899–1903. His ability was further recognized by his being chosen in 1902 director of the Rockefeller Laboratory of Research in New York, established to promote the study of the origin of disease. Among his publications are: 'The Pathology of Tox-Albumin Intoxication'; 'Micro-organisms'; 'The Bacillus Pyogenes Filiformis'; 'The Aetiology of Dysentery'; 'Terminal Infections'; 'Experimental Pancreatitis'; 'The Nature of Snake Venoms,' and many other papers and monographs relating to bacteriological and pathological subjects.

Flexure, in mechanics, is a species of strain in which a solid body is distorted so that certain of its original planes become converted into cylindrical or conical surfaces. The term is most commonly used in connection with beams, where it signifies the elastic yield of the beam under the influence of its load. When a beam is supported at both ends and loaded in the middle, it sags in such a manner that its originally straight longitudinal fibres become curved into approximately circular arcs. The radius of these arcs is very large, of course, in practical construction, where the beams are composed of steel or wood. In a beam that is supported and loaded as described above, the upper fibres of the beam are in compression, and the lower ones in tension. The compressive strains in the upper parts, and the tensile strains in the lower parts, decrease toward the middle of the beam, and somewhere about the middle there is a surface (called the "neutral surface," or "neutral axis"), on which there is neither tension nor compression. The flexure of such a beam is measured by the depression of its centre under the influence of the load; this depression being directly proportional to the product of the load by the cube of the length of the beam between supports, and inversely proportional to the continued product of the horizontal thickness of the beam, multiplied by the cube of its vertical depth, and again by the value of Young's modulus for the material of which the beam is made. (See ELASTICITY; STRENGTH OF MATERIALS.) Consult also, Rankine, 'Useful Rules and Tables.'

Flick, Lawrence F., American pathologist: b. Carroll Township, Cambria County, Pa., 10 Aug. 1856. He was educated at the Benedictine College near Latrobe, Pa., and was graduated in medicine at Jefferson Medical College, Philadelphia, in 1879. He took up tuberculosis as a specialty and early in his career began a movement for the prevention of this disease. In June 1888, he read a paper upon the contagiousness of phthisis before the Medical Society of the State of Pennsylvania, showing that houses which had been occupied by consumptives gave the disease to subsequent occupants, and that the malady was essentially a contact disease. He subsequently published many monographs upon this topic, and 1890 started a movement for the establishment of consumption hospitals which culminated in the founding of the Rush Hospital for diseases of the chest. In 1892 he founded the Pennsylvania Society for the Prevention of Tuberculosis, of which he was president for some years. In 1895 he helped to found the Free Hospital for Poor Consumptives and was elected its president. In 1903 he was entrusted with the establishment of the Henry Phipps Institute for the Study, Treatment and Prevention of Tuberculosis and was appointed its medical director.

Flick'el, Paul, powl, German artist: b. Berlin 8 April 1852. He studied three years in the Art School at Weimar, and in 1874 went to Düsseldorf and in a year began his career as a landscape painter. He traveled for the sake of studying art in Germany and Austria. In 1877 he continued his wandering in Italy and on the spot painted many pictures, such as 'The View of Naples from Capo di Monte'; 'Garden at Monte Carlo'; 'Fountain of the Villa Borghese,' scenes in which he showed a skilful management of bright sunlight effect, and complete mastery in handling the luxuriant vegetation of the south. His pictures of mountain forest scenery in Austria attracted notice and his 'Beech Forest,' which was based on studies made near Prerau, Moravia, gained for him the "Great Gold Medal" at the Berlin exhibition of 1886.

Flicker, one of the many local names of the North American golden-winged woodpecker (*Colaptes auratus*). This name, derived from one of the bird's characteristic calls, is coming into far more general use than formerly. A description of the bird will be found under WOODPECKER.

Flick'inger, Daniel Kumler, American bishop of the denomination of United Brethren: b. Sevenmile, Ohio, 25 May 1824. In 1857-85 he was corresponding secretary of the United Brethren Missionary Society, in 1885 became foreign missionary bishop, and in that capacity made 12 journeys in Africa. His publications, besides a volume of sermons, include: 'Off-Hand Sketches in Africa'; 'Ethiopia'; 'The Church's Marching Orders'; 'Our Missionary Work.'

Fliedner, Theodor, tā'ō-dōr flēd'nĕr, German Lutheran clergyman: b. Eppstein, Nassau, Germany, 21 Jan. 1800; d. Kaiserswerth 4 Oct. 1864. He became pastor in Kaiserswerth 1822. He gradually amassed in this poor parish an endowment fund for a church, school and poorhouse. In 1833 he founded an asylum for released female convicts, and in 1835 an infant school, at Düsseldorf, the earliest in Germany; a similar institution was organized by him at Kaiserswerth, the year following. In the same year he founded the Deaconesses' association, which was his greatest and most notable work. Among his writings, which are principally devotional and educational, may be mentioned 'Das Buch der Martyrer.'

Flies, two-winged insects of the order *Diptera* (q.v.), whose larvæ are legless, soft, and eruciform, and are termed "maggots." The group is world-wide in its distribution, and probably quite as numerous as either the beetles, or the group of wasps, bees, ants, etc. It is now known to contain about 40,000 species, most of which are incalculably numerous in individuals; so that "swarms" of flies is a proverbial expression. Entomologists believe that 8 or 10 times 40,000 species really exist. This vast abundance is due to the plenitude of their food, and to their fecundity; and it is accompanied by a very high state of organization, so that certain families of flies are held by some students to stand at the head of the insect tribe in specialization of structure. Intellectually, however, they are far behind the *Hymenoptera;* and to this fact, to the small size and unattractive appearance of most specimens (although great brilliance of color is to be found among some families), and to the comparatively uniform and uninteresting nature of their metamorphoses, are to be charged the relatively small amount of study that has been given to the group. The life-history of the ordinary flies is detailed below; but many peculiarities exist in other families of the order. "With some," says Howard, "no eggs are laid, and living larvæ issue from the body of the female. Such flies then become practically viviparous or 'larviparous.' With others, although these are few in number, the development within the body of the female goes even farther, and when the insect emerges from the body of its mother it is already in the pupal condition. Such forms are called 'pupiparous.' . . . Many species — comprising, in fact, whole families — are aquatic or subaquatic in their early stages, and some possess the faculty of living under what appear to be most disadvantageous conditions." Some of the flies of the family *Ephydridæ* (whose eggs or larvæ are eaten by American Indians,— see AHUATLE; KOO-CHAH-BEE) live in the strongly alkaline lakes of the Far West where little else can exist.

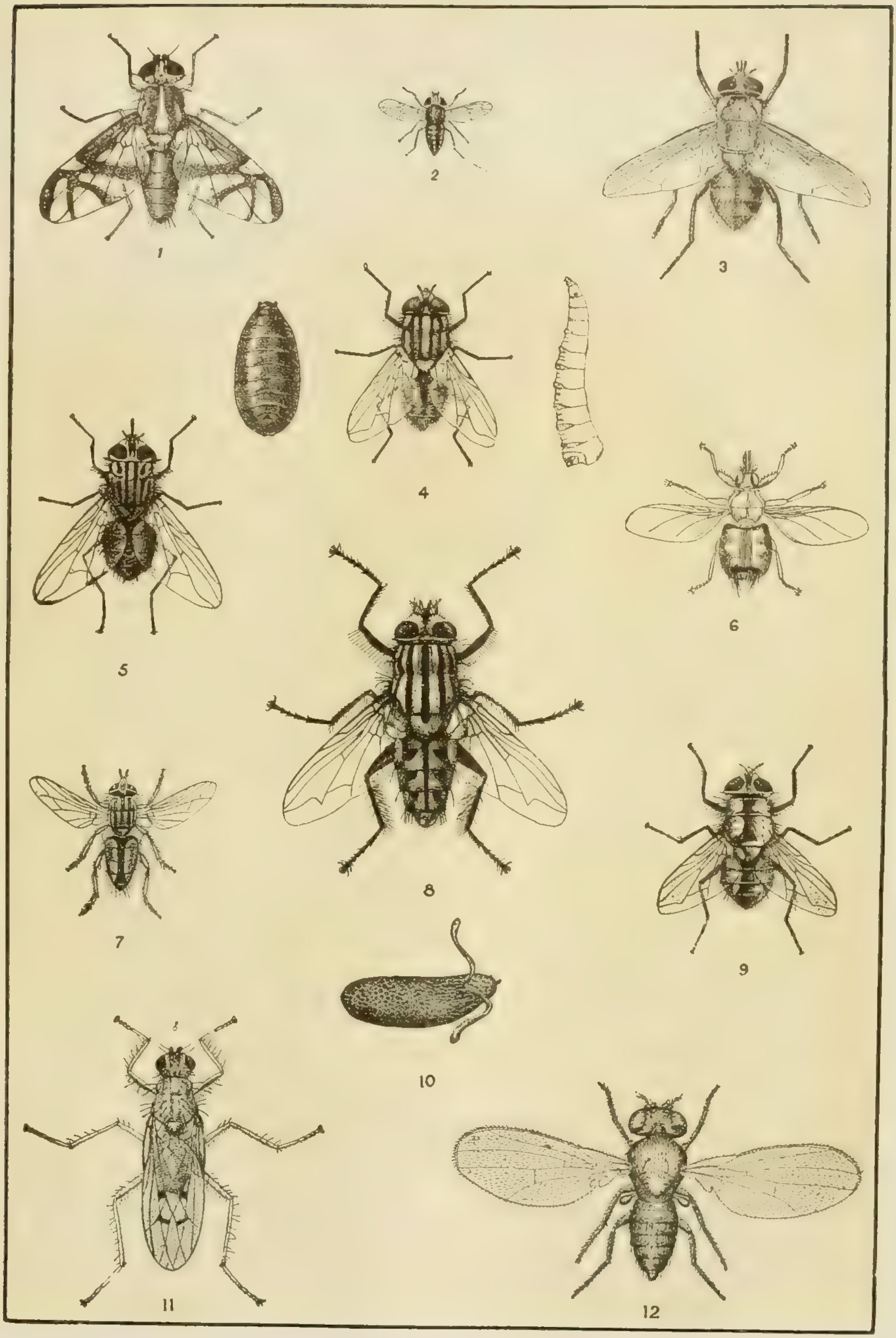
Flies are mainly day-flies, and fond of sunshine, but some appear only at night or in the dusk; a section of the tribe does not fly at all, being wingless and parasitic. They live in the most diverse manner; some attack large animals and suck their blood; some prey on smaller insects; some suck honey, and in search of it take part in the cross-fertilization of flowers (see FLOWERS AND INSECTS); and many find their food in decaying animal and vegetable matter. A large number of dipterous larvæ eat refuse or carrion,— whence arise serious evils to mankind,— others feed inside growing vegetables; and some maggots prey, or are parasitic upon, other animals.

A type of the group is found in the house-fly (*Musca domestica*), which represents the great family *Muscidæ*, in which most of the familiar flies about houses and stables are included, and its life-history represents that of its kind generally. Its eggs are laid preferably on horse-manure, but also on human or other excrement, decaying vegetables, etc., and hatch in six or eight hours, producing white maggots. These mature in four or five days, when their skins harden and turn brown, forming a puparium, or case, within which the true pupa forms, and five days later gives birth to a perfected fly. Thus a total life cycle requires in midsummer only about 10 days, and a dozen generations may thus be born in warm climates within a single season. As each fly deposits on the average 120 eggs, and as the maggots of 1,200 house-flies may be sustained by a pound of manure, the possible rapidity of their multiplication is apparent. Most flies live but a few weeks, and toward the end of the season they die with great rapidity, becoming infested with reddish mites, which suck their juices, or with fatal fungous diseases (see FUNGI). In warm houses a few may survive a winter, but as a rule all adult flies die in the fall, and the species survives and recovers in the spring from the eggs or pupa left over winter in the manure-heap or other feeding-place. It is plain that attempts to mitigate the annoyance and danger resulting from many flies may best be directed toward the destruction of their eggs and young. That such destruction is desirable and the duty of society is plain when one considers the vast amount of injury these insects may do. Many sorts attack vegetables and fruit, for example the hessian-fly, which is perhaps the most destructive insect in the United States, the apple-fly, the gall-flies, fruit-midges, potato-scab gnat, and others. Others harm domestic animals, as the bot-flies, sheep-ticks, horn-flies, tsetse, and all the horse-flies, bee-killing robber-flies and bee-flies, black-flies, mosquitoes, and many more. This catalogue of harmfulness (to which can be opposed only the beneficial work done by the tachina-flies which cause the death, by parasitism, of other kinds of injurious insects) becomes of small importance, however, beside the enormous evil flies do in spreading virulent diseases from man to man and place to place. Were this not so it might be true, as formerly alleged, that their services as scavengers, as parasites, and in the cross-fertilization of plants, balanced the damage caused by some, and left something to their credit.

Flies as Carriers of Disease.— Consideration of the habits of house-flies and their relatives will show how prone they are to feed upon excrementitious matter, and to be attracted to any decaying or purulent substance. When this is the product of wounds, sores or diseased bodies it is likely to contain the germs of disease; and these may be sucked into the blood or cling to the body of the insect. If, then, the fly alights upon a human being or a susceptible animal, and punctures the skin with its sucking proboscis (for ordinary flies do not "bite," properly speaking), it is likely to leave in the puncture some of the germs it has fed upon, and so infect the person with the disease to which they give rise. Wounds may thus be inoculated with "blood-poison"; and certain diseases, grouped as "myiasis" may arise from taking into the stomach, in eating spoiled vegetables, minute flies (*Anthomyia*) breeding in them. Even vegetable diseases may be so transmitted, as is the case with the "scab" of potatoes, which, according to Hopkins, is spread from plant to plant by the visits of a fungus-gnat (*Epidapus scabiei*).

That this theoretical transmission of disease actually occurred has been demonstrated since the latter part of the 19th century by observation and experiment. It was first ascertained of certain mosquitoes, whose responsibility for much if not all of the malaria from which men suffer was shown. This may be found more fully treated under Mosquitoes (q.v.), where the agency of these small ubiquitous flies in spread-

HOUSE, STABLE, AND GARDEN FLIES



1. Apple-worm Fly. 2. Orange-belted Gadfly. 3. Horn-fly. 4. Common House-fly, with maggot and puparium. 5. Stable-fly. 6. Forest-fly or Bird-tick. 7. Meat-fly. 8. American Flesh-fly. 9. Green-bottle Flesh-fly. 10. Egg of Pomace-fly 11. Dung-fly. 12. Pomace-fly.

REPRESENTATIVE FLIES.

ing other diseases is also shown. Dr. Joseph Leidy attributed the spread of gangrene in the hospitals at Washington during the Civil War to the flies; a few years later it was shown that gad-flies which had settled upon the dung of cattle afflicted with anthrax would communicate the disease to healthy kine. In 1888 an Italian investigator showed that flies fed upon a bacillus culture would drop virulent bacilli in their ordure, capable of infecting new cultures; further experiments in India showed that flies fed with a culture of the bacilli of bubonic plague and of Asiatic cholera survived and conveyed the plague to man. An English physician asserted that typhoid fever was spread by insects; and this was abundantly proved during the prevalence of that disease in the military camps during the Spanish-American war of 1898. Flies which have access to the excreta of patients and afterward alight upon food, so infect the food that whoever eats it is in danger of falling ill with the fever. Howard demonstrated that the common house-fly was the principal agent in this transmission. Subsequent investigations showed that the danger of the propagation by flies (and other household insects) was equally great in diphtheria and yellow fever. In another series of cases, as among mosquitoes, the fly acts as intermediary host for disease germs which develop in its blood to the point where they are virulent when introduced into the circulation of man or beast. Such is the case with the African tsetse fly (q.v.), which transmits a greatly dreaded cattle-disease. The purulent ophthalmia, known as «pink-eye,» and particularly prevalent in the South, is facilitated by minute gnats of the genus *Hippelates*.

Dr. L. O. Howard, of the United States Department of Agriculture, has given special attention to this matter, and has found that no less than 77 species of flies frequent human excrement and are therefore liable to obtain and carry disease germs. As the innumerable insects themselves are beyond reach, the measures for protection must be preventive. Dr. Howard says that in order to avoid epidemics of typhoid fever it is necessary to abolish the box privy, prevalent in rural and village districts, and substitute earth-closets, where water-closets cannot be installed; to place stable manure in receptacles and treat it with chloride of lime to destroy the maggots, throwing a shovelful over each day's addition. Pantries, dining-rooms and kitchens should be carefully screened to keep out flies; and especial pains taken in summer to keep flies out of sick-rooms. Detailed instructions and the reasons for them are given by Howard in his pamphlet, ‘How Insects Affect Health in Rural Districts,’ issued as Farmers' Bulletin 155, by the United States Department of Agriculture.

Classification.— The classification of the *Diptera* has proved difficult. An early division was based on the structure of the antennæ: *Nemocera* — those having the antenna thread-like and with 6 to 36 joints; and *Brachycera,* those with the antenna three-jointed and bristle-like. A later and more widely accepted subdivision was based upon the way the pupa-case splits on emergence of the fly; in the *Orthorapha,* the pupæ escape from the larval skin through a T-shaped orifice; in the *Cyclorapha* the pupæ escape through a circular opening at the anterior end. American entomologists, following the special investigations of D. W. Coquillet, now usually divide the order into two sub-orders based upon the character of the mouth-parts, and characterized as follows:

Sub-order Proboscidea.— Antennæ conspicuous, inserted at upper end of the face, sometimes many-jointed, proboscis usually furnished with terminal lips, body rather soft and brittle, legs approximated, wings usually present and frequently furnished with a discal cell; adults oviparous or larviparous, never in all their stages living externally on mammals, birds, or honey-bees.

In this group are placed, in order, the following important families: *Tipulidæ* (crane-flies), *Culicidæ* (mosquitoes), *Cecidomyiidæ* (gall-gnats), *Mycetophilidæ* (fungus-gnats), *Simuliidæ* (black-flies), *Leptidæ* (snipe-flies), *Stratiomyiidæ* (soldier-flies), *Tabanidæ* (horse-flies), *Bombyliidæ* (bee-flies), *Asilidæ* (robber-flies), *Syrphidæ* (syrphus-flies), *Œstridæ* (bot-flies), *Tachinidæ* (tachina-flies), *Sarcophagidæ* (flesh-flies), *Muscidæ* (house-flies), *Anthomyiidæ* (fruit-flies), *Trypetidæ* (fruit-flies), *Ephydridæ* (edible salt-water flies), and *Oscinidæ* (grass-stem flies); besides various less important ones. Each is more particularly described elsewhere in this work.

Sub-order Eproboscidea.— Antennæ usually inconspicuous, commonly inserted near the middle of the sides of the face, and composed of from one to three joints, the apex furnished with a style or bearing several long bristly hairs, proboscis never furnished with terminal lips, body integument tough and leathery, legs on one side of the body usually widely separated from those on the other side, wings, when present, never furnished with a discal cell; adults pupiparous, living externally upon mammals, birds or honey-bees.

This second sub-order comprises only two families, the parasitic bird-ticks (*Hippoboscidæ*) and the bat-ticks (*Nycteribidiidæ*), which owe their vernacular names to their resemblance to true ticks in appearance and habits.

Bibliography.— L. O. Howard's ‘Insect Book’ (New York 1901) contains the latest and most fully illustrated general account of the flies, and also a large list of books on the subject, especially those relating to systematic description. S. W. Williston has an excellent illustrated account in ‘The Standard Natural History,’ Vol. II. His ‘Manual of American Diptera’ (New Haven 1896); Comstock's ‘Manual for the Study of Insects’ (Ithaca, N. Y., 1895); Packard's ‘Half Hours with Insects,’ and ‘Text-Book of Entomology’; and Miall's ‘Natural History of Aquatic Insects’ (1895), may be consulted with profit.

Flight. Flight, strictly speaking, is progress through the air in any desired direction by an agent or object heavier than the air, as opposed to the floating of an object lighter than the air, such as a balloon. Animals accomplish flight mainly by means of wings, which may be special organs as in the insects, or modified fore legs, as in the case of bats and birds. The wings of insects are always thin membranes supported by a stiffer framework. In bats they consist of extensible membranes stretched over the immensely elongated fingers and joined also to the sides of the body and the hind legs. The wings of birds are composed of long stiffened feathers attached to the rudimentary fingers and to the bones of the forearm; the individual feathers overlapping one another so as to form a continuous more or less arched surface. The tail feathers constitute another sail area which plays an important part in flight, while in many bats a continuation of the flight-membrane between the hind legs has much the same function.

Besides these special organs the structure of aërial creatures is modified in many other respects with a view to facilitating flight. Thus the hollow bones of birds are lighter than the solid bones of terrestrial animals and relieve birds of much unnecessary weight; while the general shape of the bird's body and the smooth rounded contour of its feather covering are calculated to give the least possible resistance to the air during flight. Birds are also provided with large distensible air sacs under the skin, the function of which has been a matter of much dispute, but which, as suggested by von Leudenfeld, may aid in shifting the centre of gravity of the body, a matter of the utmost importance to the bird in holding to its course or in turning in flight. The centre of gravity, we may note, is also kept well below the plane of the wings by the distribution of the heavy parts of the body on the pectoral side. So that as the bird flies the heavy breast muscles, which constitute the bulk of its weight, are well down while the wings are attached to the back of the thorax. Thus the body becomes essentially a weight hung directly below an outstretched sail area.

So much for the general structure of flying creatures. Turning now to the principles of flight we have as the main agencies (1) the muscular propulsion on the part of the bird; (2) the support offered to the "sail area" by the air; (3) the force of the wind both in raising and in propelling the bird. Mechanical and physical problems are involved in the study of flight which it will be impossible to consider here, but one or two principles may be mentioned which are of fundamental importance, and the application of which may be seen in all forms of flight. We know that the resistance (that is, support) of the air to a flat surface is greatly increased when the surface is traveling rapidly through the air in its own plane, and it follows that when a bird is once on the wing the buoyancy of the air relative to it is greatly heightened; and having gained a certain momentum it will be possible for the bird to sail some distance without loss of altitude. Again when a flat surface is sailing diagonally through the air the maximum pressure (that is, support) of the air is not under the centre of the surface, but under the forward edge. It is on this principle that we find a tendency to force up the anterior edge of the wings of a sailing bird and in order to counteract it the bird is compelled to shift the centre of gravity of its body farther forward. To do this it may draw the wings back, spread the tail or perhaps extend the head and neck. On the same principle to turn the direction of flight it is merely necessary to flex or raise one wing or one side of the tail. Flight proper may be of two sorts, (1) by flapping the wings, and (2) by soaring. The former is the most familiar and is practised by all birds, while the latter is possible only for birds of large expanse of wing, such as vultures, eagles, gulls, etc.

In taking flight it is very important for the bird to "get a start," as we say; that is, to acquire some relative velocity, and to accomplish this we often see birds which are about to fly run along the ground for a few steps or flap along the surface of the water, while starting head toward the wind with wings properly spread accomplishes the same result. Rising into still air by flapping is very laborious work and some heavy-bodied birds, as the loons, for instance, are utterly unable to take flight when confined within a small area.

When once in the air and fairly started in flight the wing action is far less laborious than at the start, and the upward stroke is often relative to the body only and not necessarily a muscular effort. When this stroke is active, the individual feathers, as instantaneous photographs show us, are more or less separated to reduce the resistance of the air on the recovery. Most birds mingle flapping and straight sailing in various ways, and when once on the wing flight is mainly a matter of presenting their sail area to the air currents in such a way as to gain the greatest benefit from them.

Soaring is flight in circles with set wings and without any visible muscular action on the part of the bird. In spite of this the bird is able to mount higher and higher in the air, gaining impetus enough on the flight with the wind to carry it above its initial altitude when returning on the other half of the circle against the wind. Many theories have been advanced to explain the "soaring bird," some of them purely fantastic, but the true solution of the problem seems still to be lacking. Suffice it to say that this method of flight is possible only in the presence of currents of air, and that the unequal velocity of air at different altitudes doubtless has much to do with it.

Aëronauts naturally look to birds for suggestions in artificial flight, and the great superiority which they exhibit over the best flying machine so far constructed may be seen in Prof. Langly's comparison of his aërodrome which has repeatedly flown from a half to three quarters of a mile, with a condor. The machine with a weight of 30 pounds and a supporting area of 54 square feet is driven by an engine of one and a half horsepower, while the bird weighing 17 pounds has a sail area of only 9.85 square feet and a propelling power of but .043 horsepower. Birds vary very much in wing power according to their method of flight; the humming-bird and pigeon being abundantly supplied with wing muscles to maintain their rapid strokes, while the frigate-bird, a notorious "sailer," is remarkably weak in muscular development. The speed of flying birds also varies greatly. The best flyers of which we have definite record are the carrier pigeons, which travel from 30 to 50 miles an hour, while an albatross, caught and tagged by sailors, was recaptured, according to Lucas, 12 days later, 3,150 miles distant.

Our familiar small birds do not travel at anything like such a rate, but their endurance is very great, as we can realize in view of their migrations, which often reach from the northern United States to equatorial South America, while the small waders travel from one end of the hemisphere to the other. See MIGRATION.

Flying creatures occur among mammals, reptiles, and fishes. The extinct pterodactyls were evidently experts on the wing, and some of them constituted the largest flying animals of which we have any record. Of mammals the bats are the only true flyers, the flying squirrels and lemurs having merely parachute-like expansions of skin on the sides of the body which when the legs are stretched out enable them to sail obliquely downward from the tree tops to the lower branches.

In the flying-fish (q.v.) there is an enormous development of the pectoral fins which simulate wings. Their flight, however, consists only of a short sail through the air on an impetus gained as they leap from the waves with the fins rigidly extended.

Consult: E. J. Marcy, 'Vol des Oiseaux' (Paris 1890); Prof. Chas. S. Roy, article 'Flight,' in 'Newton's Dictionary of Birds' (1896); Prof. S. P. Langley, 'The Greatest Flying Creature,' Smithsonian Report 1901.

Flightless Birds. Certain birds are quite unable to fly, or fly very poorly, or use their wings only as paddles or balancers, or in extreme cases have lost not only the use of wings, but the wings themselves have disappeared. Examples of this degeneration will be found treated of in the articles upon APTERYX; DODO; GAREFOWLS; MOA; OSTRICH; PENGUIN; RATITÆ; SOLITAIRE.

Flinch, a card game said to have had its origin in Kalamazoo, Mich., and to have been invented by a man named Flinch. The game is played with a pack of 150 cards, numbered consecutively from 1 to 15, there being 10 cards of each numeral. All are of the same color; there are no hearts, diamonds, clubs or spades, and the court cards, are, of course, also missing. The cards are shuffled, and 10 cards are dealt to each player for his flinch pile, then 5 more to each to play with. Each player must place his flinch stack face up, with only the top card exposed. The other five cards are kept in hand, spread out like a fan to see the numbers, for flinch has not as yet the dignity of indexed-edged cards. The object of the game is to get rid of the flinch pile, and whoever first succeeds wins the game. To this end the flinch pile must be played from whenever possible. When this is not done, the opponent will call «flinch,» and the player will have to draw a card from the opponent's flinch pile and place it on the bottom of his own. In case two or more of the opponents call «flinch» at the same time, the negligent player must draw a card from the pack. The game may be played by any number from two to eight. After shuffling, the entire pack is usually stacked up criss-cross into hands of five, to facilitate drawing new hands.

Flinck, Govaert, Dutch painter: b. Cleves 25 Jan. 1615; d. Amsterdam 2 Feb. 1660. At Amsterdam, where he took up his permanent residence, he became a pupil of Rembrandt, whose manner and technique he so closely imitated that he comes nearer to the master than any other of his pupils, with the exception of Eeckhout. He was much sought after as a portrait painter, and has also left many religious pictures and a few genres, such as 'Die Wachstube,' which is equally Rembrandtesque in subject, conception and treatment.

Flind'ers, Matthew, English navigator: b. Donington, Lincolnshire, England, 10 March 1774; d. London 19 July 1814. He did much toward mapping out the coastline of Australia. In his first voyage of discovery he started in 1795 from Port Jackson, and skirting the southeast coast reached Van Diemen's Land. In a subsequent voyage of discovery, on which he was despatched by the British government with but poor equipment, he sailed along the south coast to Cape Leeuwin, and the bay which now bears his name. He next explored the east coast of Australia, from Port Stephens to Cape Palmentone; threaded the formidable Barrier Reefs, and coasted the Gulf of Carpentaria. Then turning back he made for Europe, by way of Sydney. He was shipwrecked on this voyage and detained by the French in Isle de France for seven years. From the effects of this imprisonment he never recovered. On his arrival home he published 'A History of Terra Australis.' The coast of South Australia was long called after him Flinders Land. His name is still attached to the southernmost county in Eyre Peninsula, and to Flinders Island, off that coast; to the Flinders Range in South Australia, rising near the head of Spencer Gulf, and running north (highest peaks, 3,100 feet); also to a town in Victoria, 61 miles southeast of Melbourne. See Life by Thynne (1896).

Flinders-Petrie, William M. See PETRIE, WILLIAM MATTHEW FLINDERS.

Flindersia (named after Captain Matthew Flinders), a genus of trees of the order *Meliaceæ,* allied to the mahogany, to which, however, it is generally inferior. The trees of this genus are tall, with a correspondingly great diameter, and furnish large quantities of valuable timber. *F. australis,* the Queensland ash, is used in Australia for staves, etc.; *F. oxleyana* is a hardwood tree yielding excellent material for cabinet-work, and also furnishing a yellow dye. The wood of *F. greavesii* is used in housebuilding, for which it is well adapted by its durability.

Flint, Austin, American physician: b. Petersham, Mass., 30 Oct. 1812; d. New York 13 March 1886. He was graduated at the medical department of Harvard College in 1833. After practising in Northampton, Mass., Boston, and Buffalo, where he established the Buffalo 'Medical Journal' in 1846, he was one of the founders, and for six years a professor, of the Buffalo Medical College. He was a professor in Louisville University 1852-6; professor of pathology in the Long Island College Hospital in 1861-8; president of the New York Academy of Medicine in 1872-5, and of the American Medical Association in 1884. He was the author of numerous text-books, clinical reports and medical papers.

Flint, Austin, American physician, son of the preceding: b. Northampton, Mass., 28 March 1836. He was graduated from the Jefferson Medical College, Philadelphia, 1857, and removing to New York in 1861 became professor of physiology in Bellevue Hospital Medical College, and surgeon-general in 1874. He has published 'Text-book of Human Physiology'; 'Physiology of Man; 'The Source of Muscular

Power'; 'Chemical Examinations of Urine in Disease'; etc.

Flint, Grover (originally **Flint Grover**), American writer: b. New York 27 June 1867. He was graduated at Harvard in 1888 and from 1892-4 served in the United States army as cavalryman. In 1896 he went to Cuba and served with a Cuban insurgent army, and returning to the United States, some months later, married a daughter of John Fiske (q.v.). He served in Cuba in the Spanish-American war and subsequently went to the Philippines as a lieutenant of volunteers. He has published 'Marching With Gomez, With Historical Introduction by John Fiske' (1898).

Flint, Timothy, American author: b. North Reading, Mass., 11 July 1780; d. Salem, Mass., 16 Aug. 1840. He was a Congregational minister during 1812-4; subsequently he devoted himself to editorial work, descriptive writing, and fiction. In these departments his most important work is included in: 'The Geography and History of the Mississippi Valley'; 'Indian Wars in the West'; and 'Francis Berrian'; 'George Mason;' and 'The Shoshone Valley.'

Flint, Weston, American librarian: b. Pike, N. Y., 4 July 1835; d. Washington, D. C., 6 April 1906. He was graduated at Union College in 1860, and at the law department of Columbia University in 1877. He was United States consul to China 1871-4; librarian of the Scientific Library, United States Patent Office, in 1877-87; and was appointed librarian and secretary of the board of trustees of the Public Library in Washington in 1898. His publications include: 'Catalogue of the Library of the United States Patent Office' (1878); 'Catalogue of Additions to the Library of the United States Patent Office, 1878-82'; and 'Statistics of Libraries in the United States, Canada, and Washington' (1893).

Flint, Mich., a city and county-seat of Genesee County, on the Flint River and on the Chicago and Grand T. and the Flint and P. M. R.R.'s; 64 miles northwest of Detroit. Flint has a court-house, the State Institution for the Deaf and Dumb, a private retreat for the insane, a high school, waterworks, gas and electric lights, public library, a national bank, and several daily, weekly, and monthly periodicals. It has a large number of saw-mills, carriage and wagon factories, flour- and woolen-mills, bicycle-works, brewery, etc., and an assessed property valuation of about $13,000,000. Pop. (1901) 13,103.

Flint, or **Flintshire,** North Wales, a maritime county having on the north the Irish Sea and on the east the river Dee and Cheshire, with the county of Denbigh on the west. Its area is 256 square miles, and it is the smallest county in Wales. The low and sandy coast becomes fertile along the estuary of the Dee. A range of hills running parallel to the Dee rises in the highest part to 825 feet. The Carboniferous rocks underlie Flintshire, and the chief minerals are coal, iron, copper, lead, zinc, and limestone. Mining is the principal industry, and there are some manufactures of cotton, pottery, chemicals, etc. The chief towns are Flint, St. Asaph, Mold, Holywell, and Hawarden. Pop. (1901) 81,490.

Flint, Wales, a market town and seaport, in Flintshire, 13 miles southwest of Liverpool. It has a handsome parish church in the Gothic style, erected in 1848. Near the town, on the shore of the estuary, stands the ancient castle of Flint, an object of some historical interest. It was completed by Edward I., and was the prison of Richard II. It has remained in ruins since 1667. Flint is on the Chester and H. R.R. Pop. (1901) 4,624.

Flint, a massive variety of quartz, somewhat resembling chalcedony, but more opaque, and commonly of a gray or smoky-brown color, darker in the interior than on the surface. It occurs abundantly in the United States and in various other parts of the world. In England and France it occurs chiefly in the chalk formations, and a microscopic examination of it often shows the remains of diatoms and other minute organisms, from whose silicious skeletons the silica of the flint was doubtless largely derived. In other cases the flint was probably formed by the replacement of lime by silica held in solution by the ground water. The coloring matter of flint is chiefly carbonaceous matter, with some iron sesquioxide. Flint was used for many ages in the manufacture of stone implements, a use for which it is well adapted by its hardness, and also from the fact that it breaks with a conchoidal fracture, leaving sharp cutting edges. Previous to the invention of matches, flints were greatly used for the production of fire, the flint being struck repeatedly against a piece of steel, from which it detached small particles that were rendered red-hot by the friction. These were caused to fall into a mass of very dry and highly inflammable matter, known as "tinder," which took fire from them as dry grass beside a railroad takes fire from the sparks of passing locomotives. Before the invention of the percussion cap, flints were also used on musket locks, for igniting the powder.

Flint Glass. See GLASS.

Flint Implements, tools, weapons, etc., made of silicious or flinty stones; a term particularly denoting implements used by man before the use of metals. See STONE AGE.

Flint Mill, (1) In pottery, a mill in which burnt flints, having been previously stamped to reduce them below a certain size, are ground to powder for mixing with clay to form slip for porcelain. The flint-mill is a strong circular pan 10 or 12 feet in diameter, having a bottom of quartz or feldspar blocks, and a runner or runners of hard silicious stone, called chert, lime in any form being inadmissible, as it forms a flux for the other material which would vitrify in the seggars or become blistered by the escape of carbonic acid. (2) In mining, a mode formerly adopted for lighting mines, in which flints studded on the surface of a wheel were made to strike against a steel, the blows producing a quick succession of sparks, which lighted the miner at his work.

Flint River, one of the largest rivers in Georgia, rising near Atlanta and flowing 300 miles to the Gulf. It drains an area of 8,000 square miles.

Flintlock, the old-fashioned lock for firearms, in which the cock held a piece of flint, and came glancing down upon the steel cap of the pan which contained the priming. See FIREARMS; MUSKET.

Floating Battery, a vessel strengthened so as to be shot-proof, or as nearly so as possible, and intended for operating in comparatively smooth water, for defending harbors or attacking fortifications. The most notable attempt to make use of floating batteries against maritime fortresses, till the time of the Crimean war, was during the siege of Gibraltar in 1782, when batteries of this description, invented by the Chevalier d'Arçon, were employed at first with considerable effect. On this occasion, however, they turned out in the end a complete failure, being destroyed by the red-hot shot directed against them from the fort. After this failure no more attention was paid to them until Napoleon III. suggested the use of floating batteries, protected by iron plates, in attacking the Russian fortresses in the Black Sea and the Baltic. The suggestion was actually carried out, and the floating batteries then constructed proved very effective in 1855, during the operations against Sveaborg and Kinburn, as well as on subsequent occasions.

Floating Bridge. See Bridge.

Floating Docks. See Docks.

Floating Fern. See *Filicales* (4), under Ferns and Fern Allies.

Floating Gardens. See Floating Islands.

Floating Houses, abodes so constructed as to be movable at will upon the surface of a river or other water. Floating houses form whole streets in Bangkok, being anchored in rows and capable of being moved from one position to another. From the depth of water, large vessels of from 200 to 300 tons burden can sail up to this picturesque town and pass alongside the houses of the inhabitants. These floating houses are made of bamboo stems, wicker-work, and palms, with a veranda in front; and they are built on large rafts. See Bangkok.

Floating Islands, islands formed either by the aggregation of driftwood in rivers and the deposition thereon of soil and vegetable matter, or by the detachment of portions of a river-bank or lake-shore. Tall trees are sometimes seen standing erect on such islands as they are carried down by the river current. Floating islands are sometimes seen 50 or 100 miles distant from the mouth of the large rivers of America, Asia and Africa. Portions of the alluvial soil from river-deltas, held together by the roots of mangroves and other trees, are sometimes detached by hurricanes or typhoons and then swept out to sea; such islands have been met with in the Philippines, in the seas of the East Indies, and in the Pacific. A floating island is mentioned by Herodotus as existing in Egypt. Others were known to Roman writers. Those on Lake Vadimona were, according to the younger Pliny, capable of supporting sheep. Loch Lomond in Scotland long possessed a floating island, which has now, however, disappeared or become attached to one of the stationary islands of the loch. In Ireland large masses of peat float about some of the bogs. In England, in Lake Derwentwater, there is an instance of an island which appears and disappears from time to time in the same spot. Perhaps the most satisfactory of the many theories which have been proposed to account for this phenomenon is that which attributes its rising from the bottom of the lake, where it ordinarily rests, to the permeation of its mass by marsh-gas during hot weather, the upward motion being assisted by the growth of buoyant water-plants on its surface. Between 1696 and 1829, similar islands were observed at irregular intervals, generally, however, after great droughts and violent storms, in Lake Rålang in the Swedish province of Småland. Oceanic floating islands sometimes perform important service in the transportation of vegetable seeds from place to place, also in the distribution of animal species, by carrying insects, land mollusca, and small mammalia, more rarely reptiles. Darwin met with islands floating on Lake Tagua-Cagua in Chile which passed from side to side of the lake and carried cattle and horses as passengers. In Northern India, and on the borders of Tibet, and Persia, floating gardens are often erected by the natives, for the purpose of raising melons, cucumbers, and other similar vegetables and plants, which require a very aqueous soil for their cultivation. These gardens, however, are of a very fragile nature, and rarely exceed a foot in depth of soil, their prime structure being composed of wicker-work, interlaced with reeds and wattles, and covered with matting, over which the earth is placed. In the Vale of Cashmere the lakes contain floating gardens devoted to the same purpose, but these are in reality portions of the marshy ground made to float artificially by cutting through the roots of the reeds and other plants about two feet below the surface. The Chinese, too, devote considerable attention to this style of horticulture, but more by way of ornamentation. Floating gardens, or *chinampas,* also existed in Mexico before the Spanish conquest. Clavigero describes them as formed of wicker-work, the stems of water-plants, and mud, the largest sometimes having on them a tree or a hut. Both flowers and vegetables were grown on them.

Floats. (1) In angling, the quill or cork from which the bait line is suspended, and whose motion indicates the bite of a fish. (2) An inflated bag or pillow to sustain a person in the water. (3) The small piece of ivory on the surface of the mercury in the basin of a barometer. (4) The hollow, metallic ball of a self-acting faucet, which floats on the water in the cistern or boiler. (5) A raft, or collection of timber fastened together for conveyance down a river. (6) In hydraulic engineering, one of the boards or paddles attached to the radial arms of a paddle wheel or water wheel. (7) In machinery, a single-cut file, or one in which the teeth are parallel and unbroken by a second row of crossing teeth. The usual horizontal obliquity of the teeth relatively to the central line of files is 55°, but single-cut files are much less inclined, and the teeth of floats are sometimes square across the face of the file. (8) In plastering, a plasterer's trowel used in spreading or floating the plaster on to a wall or other surface. The long-float is of such a length as to require two men to use it. The hand-float is that in ordinary use. The quirk-float is used in finishing moldings. An angle-float is shaped to fit the angle formed by the walls of a room. (9) In masonry, a polishing-block used in marble working; a runner. (10) In shoe making, the serrated plate used by shoemakers for rasping off the ends of the pegs inside the boot or shoe. (11) In tempering, a contrivance for affording a copious stream of water to the heated steel surface of an object of large bulk, such as an anvil or die in the process of tempering. The rapid production of steam prevents the constant contact of cold water when the object is merely dipped, as a body of steam intervenes. The dashing stream of water constantly exposes a new body of water to the hot surface, and makes the hardening more complete. (12) Theatrical: A stage name for the footlights, derived from the use of a row of oil-pans, with floating wicks, along the stage-front, previous to the invention of gas.

Float-stone, a variety of opal, or hydrated silica, occurring in concretionary masses of such a porous texture that they float on water. They are of a gray or white color, break with uneven fracture, and sometimes have a hard nucleus of a flinty appearance.

Flodden, flod'n, a village in Northumberland, England, about five miles southeast of Coldstream, near which was fought the celebrated battle in which James IV. of Scotland was defeated by the Earl of Surrey (9 Sept. 1513). See SCOTLAND.

Floe-rat. See SEAL.

Flogging, the infliction of stripes or blows with a whip, lash, or scourge, especially as a judicial punishment. In Britain it long existed as a punishment in the army and navy; but it was totally abolished in the former in 1881, and in the latter it is practically extinct. It was made a punishment for certain violent crimes, such as garrotting, in 1863; and for juvenile offenders in 1847 and 1850. In these cases, however, the number of stripes is limited by law, 50 being the maximum in some instances, 25 in others, and so on. A judge in sentencing a prisoner to flogging must specify the instrument and the number of stripes. In the case of juveniles under 14 years of age the instrument must be a birch rod, and the number of stripes must not exceed 12. The punishment of the knout in Russia and of the bastinado in the East are severe forms of this punishment. In the United States, flogging was discontinued in the navy and on merchant vessels in 1850. In the army, it was abolished 1861. As a means of prison discipline, it has been used till very recently, and its disuse is a subject of debate. For the subject of its use as a legal punishment for certain offenses, see FLAGELLATION; WHIPPING-POST.

Flood, flud, **Henry,** Irish orator and politician: b. near Kilkenny 1732; d. Farmky, county Kilkenny, Ireland, 2 Dec. 1791. He was educated at Trinity College, Dublin, and Christ Church, Oxford, entered the Irish parliament in 1759, and soon became the most prominent and eloquent member of the popular opposition. He was privy councilor for Great Britain as well as for Ireland in 1775, and vice-treasurer for Ireland 1775-81. In 1783 he had a personal dispute in the house with Grattan, when a remarkable display of the power of invective was made on both sides. He afterward became a member of the British Parliament for Winchester and Seaford. His speeches were published in 1787. See Lecky: 'Leaders of Public Opinion in Ireland' (1872).

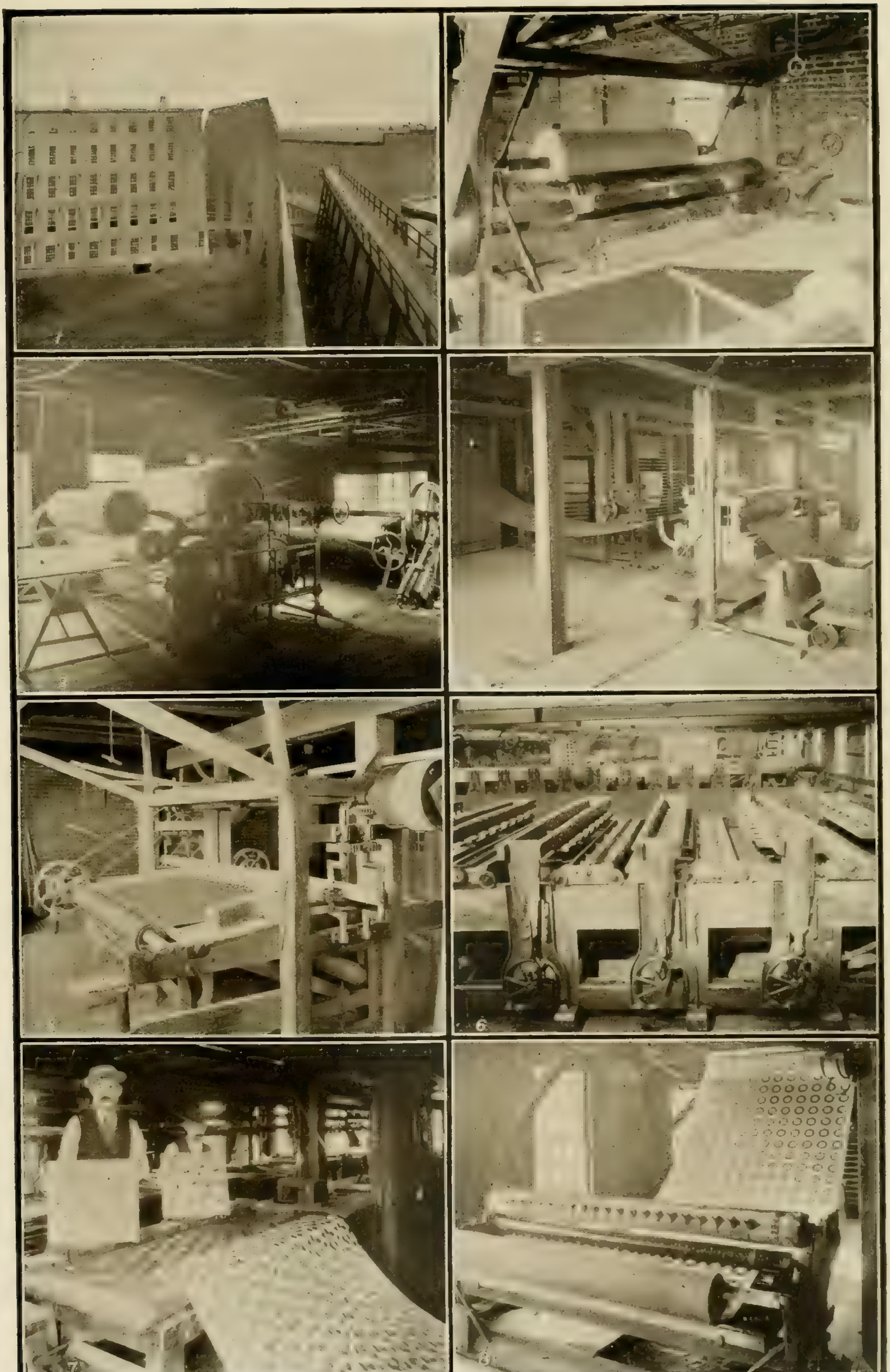
Flood, Theodore L., American Methodist clergyman: b. Williamsburg, Pa., 20 Feb. 1842. He served in the Federal army in the Civil War, entered the Methodist ministry, and after an active pastorate of 15 years became connected with the Chautauqua movement. He edited the Chautauqua Assembly 'Herald,' which began its monthly issue at Meadville, Pa., in 1877, and became 'The Chautauquan' in 1880. He retired from its editorship and ownership in 1899. He has been active in various denominational and commercial enterprises and was an unsuccessful Republican candidate for Congress in 1892.

Flood Plain, the plain formed by a river in broadening its valley. The first work done by a river is to cut a trench-like valley, this having been cut so deeply that the slope of the river-bed toward the sea so slackens the current of the river that it cannot carry its load of detritus, this detritus is partly dropped. Then the upbuilding of the river channel causes the river current to swing from side to side. In this way first one side, then the other of the valley is attacked by the river. In time of flood the plain of waste thus accumulated may be entirely covered by the swollen river. The flood plain of the Mississippi west of Tennessee is 50 miles wide. See RIVER; VALLEY.

Floods and Inundations are caused by excessive rains, giving rise to an overflow of the rivers; by the bursting of the banks of rivers, lakes, and reservoirs; by the sudden melting of ice and snow; and by irruptions of the sea, produced by high tides, wind-storms driving the sea-water inland, earthquakes, volcanic outbreaks, and the bursting of sea banks. The felling of forest trees throughout extensive tracts of mountainous country also tends to make the rivers which have their origin there swell rapidly after a heavy rainfall; good and complete drainage of land has the same tendency. (For the Noachian flood, see DELUGE.) The subjoined list embraces some of the most disastrous floods and inundations of which we have record.

684 A.D. Japan; 780 sq. m. of Isle of Shikoku covered by sea.
968. Persian Gulf; many cities destroyed and new islands formed by irruption of sea.
1014. Many English seaports destroyed by sea.
1098 or 1100. East of Kent inundated; Goodwin Sands formed.
1100 or 1108. Flanders inundated.
1161 or 1165. Sicily; irruption of sea; thousands drowned.
1170. Holland and Friesland; great flood.
1173. Holland; Zuyder Zee much enlarged.
1219. Nordland, Norway; lake burst; 36,000 people perished.
1228. Friesland; invasion of sea; 100,000 people drowned.
1277. Friesland; the Dollart formed.
1286–7. Holland on both sides of Zuyder Zee inundated in consequence of a storm.
1396. Holland; islands of Texel, Vlieland, and Wieringen separated from mainland, and Marsdiep, the channel between Texel and North Holland, formed.
1421 or 1446. Holland; 72 villages inundated, of which 20 permanently, about 100,000 persons drowned, Biebosch formed east of Dordrecht, and this town separated from mainland.
1521. Holland; 100,000 lives lost by an inundation.
1570. Holland; storm drove in the sea, destroying numerous villages and 20,000 people in Friesland.
1617. Catalonia, Spain; 15,000 perished in floods.
1629. Mexico (city) inundated.
1642. China, at Kaifong; 300,000 drowned.
1646. Holland and Friesland inundated; loss of life, 110,000.
1726. Floods and inundations all over Europe.
1745. Peru; Callao destroyed by irruption of sea caused by earthquakes.
1767. England; irruption of sea on east coast.

MANUFACTURE OF OIL-CLOTH.



1. Fire Wall and Railroads.
2. Sizing Machine.
3. Calender End of the Sizing Machine.
4. Painting Machine and Drying Racks.
5. Rubbing Machine.
6. Printing Machine Running Nine Colors.
7. Hand Printing a Mosaic Pattern.
8. Varnishing the Printed Oil-Cloth.

1782. Formosa; west side of island submerged, and Taiwan destroyed.
1787–8. India, in Northwestern Provinces and Punjab; 15,000 lives lost by floods.
1791. Cuba; floods from excessive rain; 3,000 drowned.
1811. Hungary; 24 villages swept away by overflow of Danube.
1813. Austria, Hungary, Poland, and Prussian Silesia; floods caused by rains; 4,000 perished in Poland, 6,000 in Silesia.
1824. St. Petersburg and Cronstadt; 10,000 lives lost from overflow of Neva.
1825. Denmark; sea broke through from North Sea to Limfjord, making northern Jutland an island; one third of Friesland submerged by rising of sea and rivers.
1840. France; overflow of Saône and Rhone swept away many villages and inundated Lyons, Avignon, Nimes, Marseilles, etc.
1851. Northern China; Yellow River burst its banks, and made a new outlet into Gulf of Pechili.
1852. Floods throughout Europe from Belgium to Switzerland.
1856. South of France; floods did damage to extent of $28,000,000.
1868. Peru; Arica and Iquique nearly destroyed by earthquake waves.
1874. United States; Mill River valley (Mass.) inundated by bursting of a dam; 144 drowned. Also floods in western Pennsylvania; 220 drowned.
1875. Disastrous floods throughout central Europe, in United States, Burma, India, and West Indies.
1876. China floods in northern provinces; in Bengal 200,000 persons perished from inundation of a tidal wave.
1883. Java and Sumatra; parts submerged by volcanic wave. (See Krakatoa.)
1887. China; the Hoang-ho in Ho-nan; millions of lives lost.
1889. Johnstown, Pa.; reservoir burst; 2,209 lives lost.
1891. Consuegra, Spain; 1,200 lives lost.
1893. Queensland; great destruction of property.
1896. Japan; 27,000 lives lost.
1900. Galveston, Tex.; 6,000 lives lost and 3,000 buildings destroyed.
1903. Kansas City, Mo., and Mississippi River towns; millions of dollars in property destroyed; few lives lost.
1903. Heppner, Oregon; cloudburst; 300 lives lost.

Floor. (1) In building, the surface on which a person walks in a room or house. It may be of masonry, bricks, tiles, concrete, earth, boards. The term usually refers to boards laid close together and nailed to timbers which are termed joists. (2) In geology and archæology, the part of a cavern corresponding in situation to the floor of a house. Here frequently there is now cave earth, covered, and therefore hermetically sealed for the purpose of the investigator, by stalagmite, which has been formed by droppings from the stalactites hanging from the roof. (3) As a nautical term, the bottom part of the hold on each side of the keelson; the flat portion of a vessel's hold. (4) In hydraulic engineering, the inner piece of the two which together form the bucket of an overshot water wheel. (5) In mining, the bottom of a coal seam; the underlay on which the coal, lead, or iron ore rests. (6) To take the floor: To rise to address a public meeting; also to stand up to dance (Irish).

Floor-cloth, or Oil-cloth. The basis of floor-cloth is a strong, open canvas, woven of flax, with a slight admixture of hemp. Owing to its great width, 6 to 8 yards, it has to be woven in special looms. It is made in lengths of from 100 to 113 yards. A length of 60 to 100 feet is stretched in a frame, brushed with glue-size, and rubbed with pumice-stones. It then receives two or three foundation coats of paint on each side. This is a thick paint, commonly made of linseed oil and ochre, and is laid on with a trowel. Each coat on the front is smoothed with pumice-stone. When this operation is completed the cloth is transferred to the printing-room, where the pattern is printed by blocks, as in calico-printing. There is a block for each color.

Floquet, Charles Thomas, sharl tō-mä flō-kā, French statesman: b. St. Jean de Luz 5 Oct. 1828; d. Paris 18 Jan. 1896. He began life as a lawyer in Paris, where he defended the Republican journalists. On the fall of the empire he was appointed one of the deputy mayors of Paris, but was forced to resign on account of his complaisance toward the Red Republicans. Later he was elected to the Paris municipal council and in 1876 became one of the deputies for Paris. He sat in the Chamber till 1882, when he was appointed Prefect of the Seine; re-entered the Chamber in 1882 and was elected its president in 1885, but resigned in April 1888, to become prime minister. In 1889 he was again elected president of the Chamber. He aspired to the presidency of the republic, for which office he was the Radical candidate in 1887; but his career was cut short by the Panama Canal scandal, and he lost his seat in the elections of 1893.

Floquet, Pierre Amable, pē-ār ä-mäbl, French historian: b. Rouen, France, 9 July 1797; d. Formentin 6 Aug. 1881. He made Normandy's annals and personages the objects of his painstaking study in 'Norman Anecdotes'; 'History of the Parliament of Normandy' (1840-3); and 'Studies in the Life of Bossuet' (1855), the last two of which were crowned by the Academy.

Flo'ra, the Roman goddess of flowers and spring, whose worship was established at Rome in the earliest times. She is represented as a beautiful female, with a wreath of flowers on her head or in her left hand; in her right hand she generally holds a cornucopia. Her temple at Rome was situated near the Circus Maximus, and her festival, the Floralia, was celebrated from 28 April to 1 May. The later Romans identified Flora with the Greek goddess Chloris. In botany Flora signifies the plants of a region collectively, as Fauna signifies the animals. In astronomy an asteroid discovered by Hind, 18 Oct. 1847.

Flore'al, flō-rā-äl («month of flowers»), the eighth month in the calendar of the first French republic (1794). It began 20 April and ended 20 May. See CALENDAR.

Flor'ence, William Jermyn (stage name of BERNARD CONLIN), American comedian: b. Albany, N. Y., 1831; d. Philadelphia, Pa., 1891. He began his career as an actor at Brougham's Lyceum, N. Y., in 1850, and soon became a great favorite with the public, especially in such characters as 'Bob Brierly'; 'Sir Lucius O'Trigger,' which latter he played to Joseph Jefferson's 'Bob Acres' with great success in a series of joint performances during the last two years of his life. He was the author of several Yankee and Irish plays.

Florence of Worcester, English chronicler: d. 1118. He was a monk of Worcester, wrote 'Chronicon and Chronicis,' a compilation from Marianus, an Irish monastic chronicler, which is of the highest authority in early British and Irish history.

Florence, Ala., a city and county-seat of Lauderdale County, on the Tennessee river, and on the Memphis and C., the Louisville, and the

Nashville R.R.'s. Here are the Florence Synodical Female College, the State Normal College, Mars Hill Academy, Florence Institute, Paxton high school, a Congregational school, several churches, and a number of weekly newspapers. The city has manufactories of iron, cotton, wagons, ice, flour, stoves, etc., and an assessed property valuation of over $2,000,000. Pop. (1900) 6,478.

Florence (in Italian, *Firenze*), a province of Italy; area, about 2,262 English square miles. The surface is beautifully diversified by mountains, valleys, and plains. The climate is generally mild and healthy, and the soil very fertile, producing wheat, maize, beans, and all kinds of leguminous crops. The vine, olive, orange, citron, and fig thrive well in the low grounds; while the mountainous districts afford excellent pasture, admirably adapted for the rearing of sheep. The minerals include mines of copper, lead, and mercury; and quarries of marble, alabaster, and fine building stone. Pop. (1901) 939,054.

Florence (Italian, *Firenze*), a famous walled city of central Italy; on both sides of the Arno, 187 miles northwest of Rome. It stands in a richly wooded, well-cultivated, and beautiful valley, encircled by the Apennines. Its shape is nearly a square, the sides of which almost correspond with the cardinal points; the Arno intersects it from southeast to northwest, three of the quarters into which it is divided being situated on the right, and the fourth on the left bank of the river. The communication between the opposite sides of the river is maintained by means of seven bridges. Florence contains a great number of magnificent edifices and squares, generally adorned with statues, columns, or fountains; there are no fewer than 170 churches, 89 convents, 2 royal, and many other palaces, 12 hospitals, and 8 theatres great and small. Each angle of a street presents an architectural view fit to be drawn for a scene in a theatre. Many of the houses are palaces, fitted up with great magnificence, and some of them contain valuable galleries of pictures. The streets are mostly wide and straight; and they are admirably paved with angular blocks of sandstone.

The Piazza Reale is the largest square; it has a fine marble fountain, and an equestrian statue in bronze of Duke Cosmo I., by John of Bologna. The Piazza del Mercato Vecchio, in the centre of the city, has a marble column from which Florence radiates for one mile on each side. The Arno is decidedly superior to the Tiber at Rome. The bridge Santa Trinita, built of marble in 1559 by Ammanate, is designed in a style of elegance and simplicity unrivaled by the most successful efforts of modern artists. The bridges, and quays by which the river is bordered, afford fine views of the river, Florence being in this respect much superior to the "Eternal City." The duomo, or cathedral, a vast edifice, coated with marble, about 500 feet in length, and 384 feet in height to the top of the cross, stands in a spacious square. The church of Santa Croce, called the Pantheon of Florence, is interesting from its containing the remains and tombs of four of the greatest men of modern Italy, or indeed of modern times — Michelangelo, Galileo, Machiavelli, and Alfieri. Among the palaces are the Palazzo Vecchio, or Old Palace, inhabited by the Medici when citizens of Florence, which was begun in 1298, and finished in 1550. It is in a massive, severe, and gloomy style, with a tower 268 feet high, and is now occupied by the principal public offices. Adjoining it is the Piazza del Palazzo Vecchio, a square containing a fine collection of statues, and a noble arcade, the Loggia di Lanzi, under the porticoes of which are magnificent groups of sculpture. The Palazzo Pitti, erected in 1440, the ordinary residence of the king of Italy, is a vast and heavy structure; it is furnished in the most costly manner, and is enriched with a great number of the choicest works of art and vertú and an excellent library. Attached to this palace are the Boboli Gardens, laid out by Cosmo I. in 1550, in the classical style. Connected with these gardens is the botanical garden, a museum of natural history, the Fontana anatomical collection in wax, etc. Another fine palace, the Riccardi (built in 1440), has a noble gallery with a ceiling painted by Luca Giordano, and a library of 40,000 volumes, open to the public. But the crowning glory of Florence is its Grand Gallery, occupying the upper floor of the Ufizi, a building erected after a design of Vasari, by Cosmo I., consisting of two parallel corridors or galleries, each 448 feet in length, and 72 feet apart, united at one end by a third corridor. This contains some masterpieces of statuary, as the world-renowned 'Venus de Medici,' 'The Knife-Grinder,' the 'Fawn,' 'Niobe and Her Children,' etc. The collection of pictures comprises superb examples of all the best schools, and is said to surpass even that of the Vatican. A splendid apartment, known as the Tribuna, contains the rarest treasures of the collection, and is in itself a wonder of art, with its cupola inlaid with mother-of-pearl, and its rich marble pavement. Besides the Riccardi and Laurentian libraries, the Magliabecchi Library, containing a rare, extensive, and valuable collection of books, is also open to the public.

The literary and educational institutions of Florence are both numerous and important. At the head of these is the famous Academia della Crusca. The charitable institutions are numerous, extensive and well conducted. The common people of Florence are well clothed and have a comfortable appearance; and there are, as compared with most other Italian towns, few beggars, priests, and monks. The citizens are friendly, cheerful, and hospitable. The encouragement given under the government, to artistic and scientific studies, has conferred advantages on Florence unknown in most other parts of Italy. All sorts of foreign publications are met with here; and the facilities it affords for gratifying a taste for the fine arts, the beauty and security of the city and environs, and its salubrity and cheapness, make it, on the whole, a more desirable residence even than Rome. Manufactures silks, straw hats, articles of vertú, as intaglios, etc., jewelry, porcelain, perfumery, etc. Florence has produced more celebrated men than any other place in Italy, or, perhaps, of Europe; among others may be specified Dante, Petrarch, Boccaccio, Villani, Cosmo and Lorenzo de Medici; Galileo, Michelangelo, Leonardo da Vinci, Benvenuto Cellini, Alberti, Lapo Brunelleschi, Giotto, Andrea del Sarto, Machiavelli; Popes Leo X. and XI., and Clement VII., VIII., and XI.

Florence owes its origin to a colony of Roman soldiers sent thither by Octavianus after the victory of Perugia, to whom he allotted part of the territory of the colony of Fiesole, established about 40 years before by Sylla. Little more is known of it under the empire, and hardly any remains exist of that period, except some relics of an amphitheatre and a few inscriptions. Christianity was established here in the third century, and early in the fourth a Bishop of Florence attended a council at Rome. In the beginning of the 12th century the city had risen into importance through the industry and enterprise of its inhabitants, who had now commercial establishments in the Levant, France, and other parts, and had become money-changers, money-lenders, jewelers, and goldsmiths. In the latter end of the 14th century the wealthy family of the Albizzi became chief rulers in Florence. These again were overthrown in 1434 by Cosmo de Medici, a popular citizen and princely merchant, who assumed the first place in the state. On the fall of the republic in the 16th century a member of a lateral branch of the Medici, the line of Cosmo having become extinct, was placed by Charles V. as Duke of Florence. The ducal dynasty of Medici continued to rule till the year 1737, when, becoming extinct, they were succeeded by Francis of Lorraine, afterward emperor of Germany. From this period the history of Florence merges into that of Tuscany, until its amalgamation with the kingdom of Italy. From 1865 till 1871 it held the dignity of capital of the kingdom, the seat of government being transferred to it from Turin. It then received a considerable increase of population, and consequently a number of broad new streets have been constructed on the site of the old fortifications, and of late years its precincts have been extended in every direction. Pop. (1901) 205,589.

Florence, S. C., a city and county-seat of Florence County, on the Atlantic C. L. R.R. It has a bank and several newspapers. Pop. (1900) 4,647.

Florentine Experiment, in physics, an experiment made in 1661 by some academicians at Florence to test whether or not water was compressible. They enclosed it in a globe of thin gold, afterward hermetically sealed. In compressing the globe the water, instead of yielding, forced its way through the pores of the gold, and stood in drops on its outer surface. See PHYSICS.

Florentine Fresco, a kind of painting, first practised at Florence during the flourishing period of Italian art, for decorating walls. Like common fresco, the lime is used wet, but in this mode it can be moistened, and kept damp and fit for painting upon. See FLORENCE; ITALY.

Florentine Lake, in painting, a pigment prepared from cochineal. It is now obsolete, the greater durability in oil-painting of the lake prepared from madder having entirely superseded those prepared from cochineal.

Florentine Mosaic, the term applied to the art of inlaying tables and other plane surfaces with *pietra dura* and *pietra commerse,* carried on principally at Florence. See ART; FLORENCE; ITALY.

Florentine School, an Italian school of painting during the 14th and 15th centuries remarkable for greatness; for attitudes seemingly in motion; for a certain dark severity; for an expression of strength by which grace is perhaps excluded; and for a character of design approaching to the gigantic. The Tuscan artists, satisfied with commanding the admiration, seem to have considered the art of pleasing as beneath their notice. This school has an indisputable title to the veneration of all the lovers of the arts, as the first in Italy which cultivated them. See ART.

Flores, Juan José, hoo-än' hō-sā' flō'rāz, Venezuelan soldier and statesman: b. Porto Cabello, Venezuela, 1801; d. Guayaquil, Ecuador, 1 Oct. 1864. He distinguished himself as Bolivar's lieutenant in the war that secured the independence of South America. In 1823 he was governor of Pasto, and head of the army in Ecuador. His victory at Tarqui (1828) ended the war with Peru and he was made president of the republic of Ecuador (1831–5). He filled the same office in 1839 and from 1843 to 1845, when he resigned in consequence of a revolution stirred up by the liberals. He was defeated by Mosqueza in the war with Columbia at the battle of Cuaspuda, in 1863.

Flores, Venancio, vā-nän'thî-ō, South American soldier and statesman: d. Montevideo, Uruguay, 19 Feb. 1868. In 1853 he took part in an insurrection against Giro, the president of Uruguay and was elected president of the republic in January 1854. The two parties in the government were the Colored (Liberals), and the Whites (Conservatives), and the former being the stronger had elected Flores. A division in this party made it possible for a former president, Oribe, to land with troops, and Flores laid down his office, and in 1858 took refuge in Buenos Ayres. He returned later and with the help of Brazil stormed the city of La Florida in 1864 and in 1865 made a triumphant entry into Montevideo, and assumed the title of provisional governor of the republic. On 4 May 1865, he concluded a treaty of alliance with Brazil and the Argentine republic in the war against Paraguay. He won over the party of the Whites by his clemency, regained the presidency in 1866, but was assassinated on his way to the city hall, or capital of Montevideo.

Flores, flō'res. (1) *Endé* or *Mandfirei Floris,* a large island (Dutch) of the Indian Archipelago, forms one of the chain of islands which extend east from Java; length, about 200 miles; breadth, about 50 miles. It has a mountainous surface, with several volcanic peaks, one of which, Lobetobie, is 7,200 feet high. Little is known of the interior. Sandal-wood, once abundant, has become scarce. Endé, near the middle of the south coast, is said to be the principal port, and to have safe anchorage for any number of ships. The passage between the east end of the island and those of Solor and Adenara is called Flores Strait; and the part of the Pacific north of the Flores chain and south of Celebes is called the Flores Sea. (2) The most western island of the Azores, about 30 miles long by 9 miles broad, with a hilly surface, containing an extinct crater now converted into a lake. The chief products are wheat, pulse, and poultry, and great numbers of small cattle are reared. (3) An island of the North Pacific, off the west coast of British America, opposite to Vancouver's Island; lat. 49° 20′ north; lon. 125°

45′ west; length, northwest to southeast, 15 miles; breadth, from 2 miles to 6 miles. (4) A small island off the coast of Uruguay. (5) A river in Brazil in the province of Piauhy.

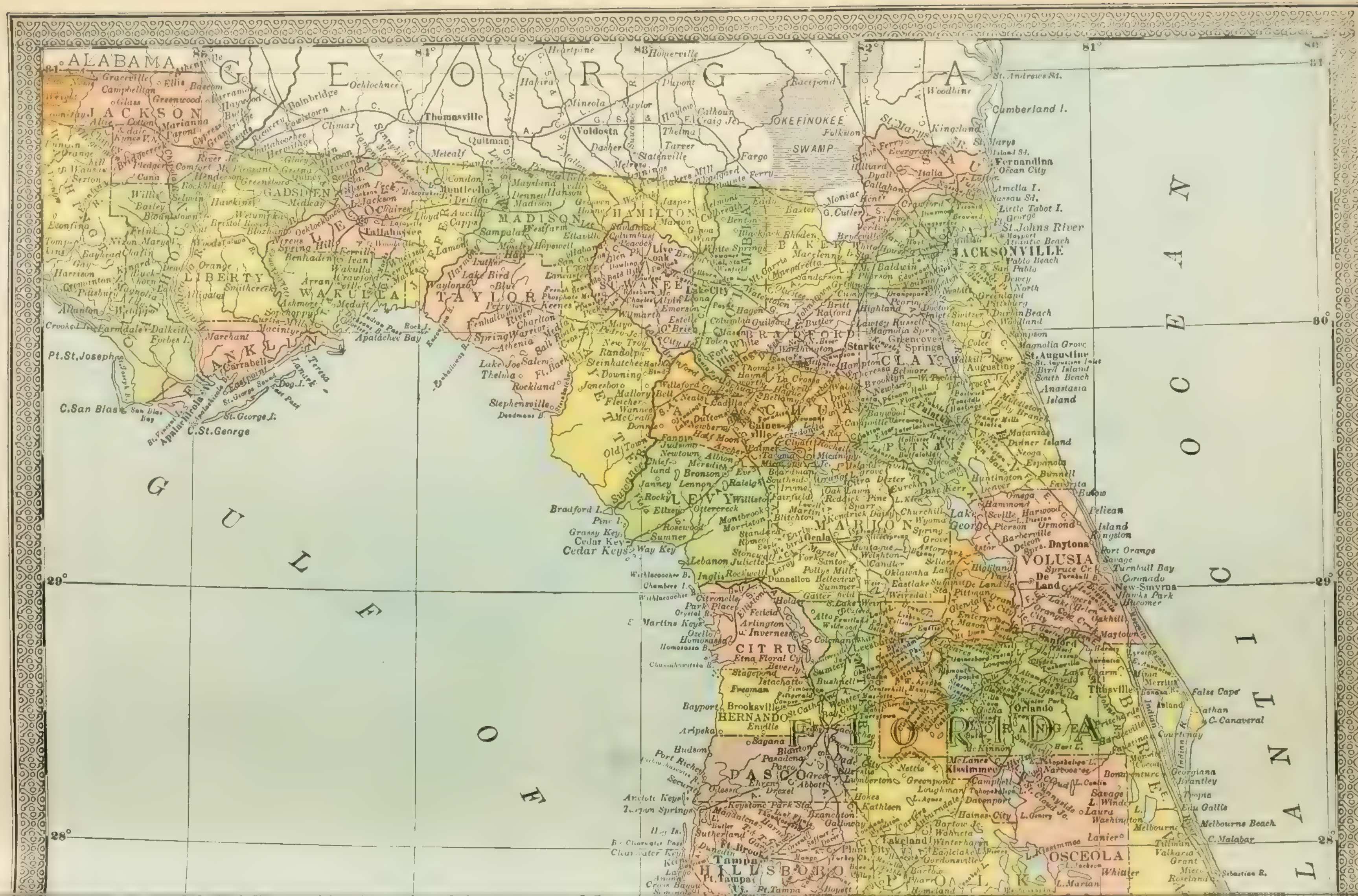
Florez, Henrique, en-rē'keth flō'reth, Spanish historian: b. Valladolid, Spain, 14 Feb. 1701; d. Madrid 20 Aug. 1773. He was an Augustinian ordinary who taught theology and history by presenting dogmas and annals from the standpoint of their human interest. 'Sacred Spain' (1747–73), and 'Memorials of Catholic Queens' are his most important works.

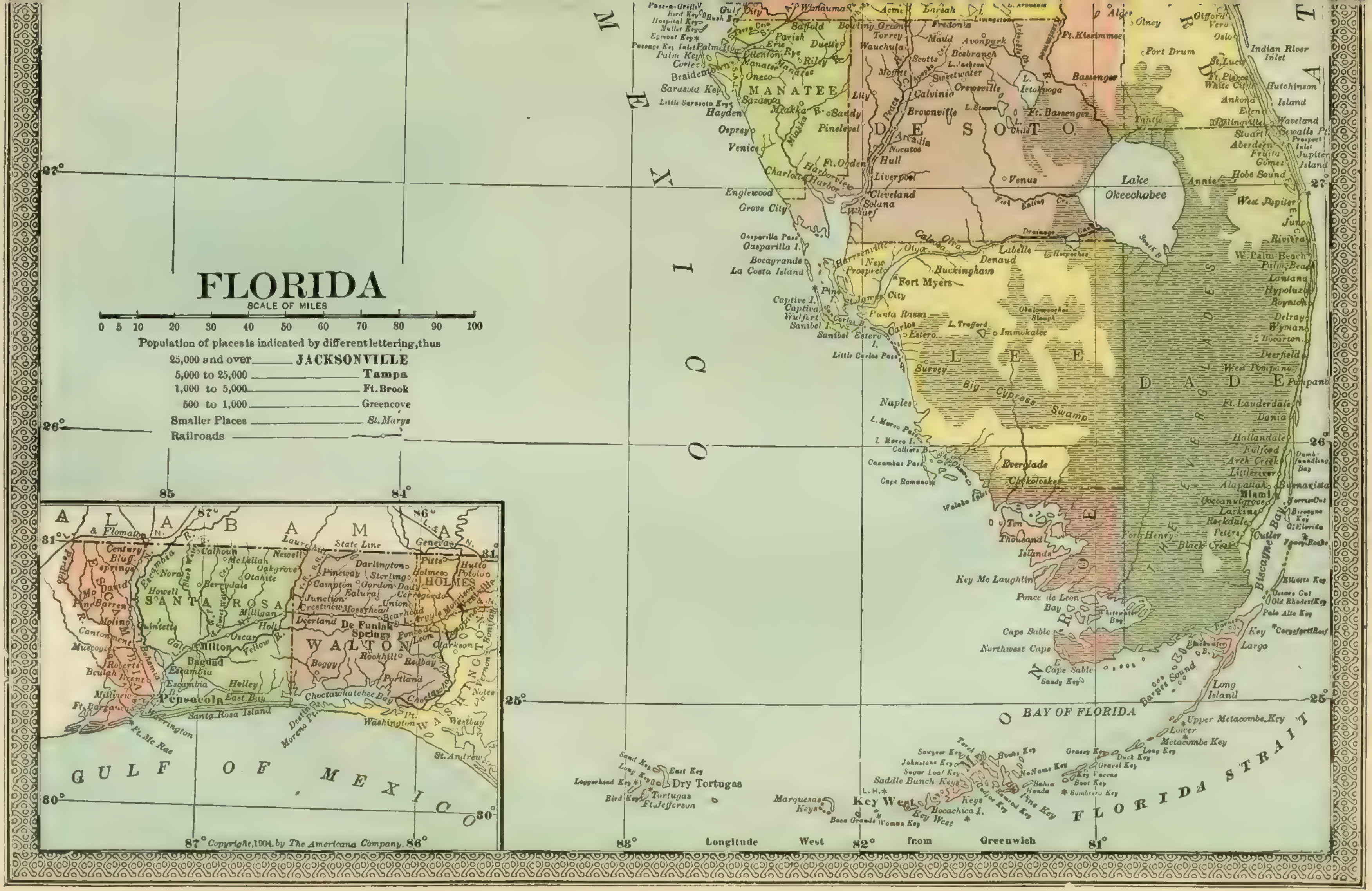
Florian, Jean Pierre Claris de, zhōṅ pē-ār clä-rē dē flō-ryäṅ, French poet: b. near Anduza, Gard, France, 6 March 1755; d. Sceaux, France, 13 Sept. 1794. He made his début with some pleasing farces (1779), and added greatly to his fame with the two pastoral stories, 'Galatea' (1783), and 'Estelle' (1787); sentimental romances in the dominant taste of that time. He also wrote: 'Medleys of Poetry and Literature'; and 'Florian's Youth,' in which he recounts the story of his boyhood. In 1788 he became a member of the French Academy. While there, engaged in finishing his poem, 'Ephraim,' he was arrested by the orders of the Committee of Public Safety, but the fall of Robespierre saved him from the guillotine.

Floriculture in America.— Growing flowers as a business was unknown in America previous to about 1825; and, indeed as late as 50 years ago it was impossible to buy cut flowers in some of our leading cities. Owing to the increase of population of the eastern cities, and consequent increase of wealth and luxury, a demand for flowers began to be felt in the second quarter of the last century; and thus began the development of commercial floriculture in this country. This branch of horticulture first became prominent in the vicinity of Philadelphia and Boston. In the early days more wealth was centered in these cities, and the people there paid more attention to luxuries in home surroundings. New York was less prominent in the development of this industry. From 1830 to 1840 floriculture made considerable progress, owing to improved methods in the construction and management of greenhouses, as well as to the increased demand for flowers. The application of hot-water heat to greenhouses gave an impetus to the work, making it possible to grow better plants than had been done when heated air conducted through brick flues was the only means of keeping out the frost. Since the Civil War the development of the industry has been rapid and varied, as to extent and methods, and as to the kinds of flowers cultivated. Up to about 1885 the cultivation of plants was the leading feature of floricultural work; but since that time the rapid increase of wealth and luxury in the large cities has developed a tremendous demand for cut flowers, thus making this branch of the business the all-important one for the florist. This increased demand for cut flowers has led to specialization in floriculture and has produced the best work of the florist. Older flowers, such as the once popular camellia, have been dropped, and the rose, carnation, violet and chrysanthemum have been substituted. In this way floriculture, as we find it to-day, has been gradually evolved. There are two distinct departments of the word, viz., the growing of plants, and the cultivation of cut flowers. The plants grown mostly are various kinds of palms, ferns, rubber plants and dracænas; also ornamental a. . bedding stock for out-door purposes. There has been specialization in both of these main branches of floriculture. For instance, certain growers devote all their energies to palms; others concentrate on ferns; others raise bedding-plants exclusively. In flower-growing there has been even greater specialization; and it would now be difficult to find an important establishment where more than one of the leading flowers is grown. While one florist will grow roses exclusively, another will devote all his time and ingenuity to the improvement of the carnation, a third will grow nothing but violets, and a fourth will concentrate on chrysanthemums. These four flowers are the most important cut flowers, their commercial importance being in the order named. The most recent statistics on floriculture in the United States are to be found in the United States Census of 1900. At that time there were 8,799 floricultural establishments, representing an investment (land, equipment, etc.), of $52,462,419, and selling flowers and plants to the amount of $18,759,464 annually. About two-thirds of this amount was realized from cut flowers, the rose bringing in $6,000,000, the carnation $4,000,000, the violet $750,000, the chrysanthemum only $500,000, owing to the shortness of the season. The annual expenditure for labor was $4,155,179, or 22.6 per cent. of the total receipts. Since the figures given above are something less than the wholesale price, and the profit of the retailer is about 100 per cent., it is clear that the public spends annually some $30,000,000 on flowers.

There are few adequate treatments of floriculture. As among the best may be mentioned: Henderson, 'Practical Floriculture'; Hunt, 'How to Grow Cut Flowers'; Taft, 'Greenhouse Management.' Consult also Bailey's 'Garden-Craft' series, and his 'Cyclopedia of American Horticulture.' See BOTANY; BREEDING PLANT; HORTICULTURE; FLOWER; FLOWER AND INSECTS; GARDEN; INFLORESCENCE; GREENHOUSE; CROSS-FERTILIZATION; FERTILIZATION, ETC.

Florida (Sp. flowery, a name given to the country by Ponce de Leon because he discovered it on Easter Day, Sp. *Pascua florida* or *de flores*, flowery Easter; or, according to some authorities, on account of the exuberance of flowers which he saw), the southeasternmost State of the Union, sometimes called "the Everglade State," and also "the Peninsular State." It is situated between lat. 24° 30′ and 31° N. and lon. 79° 48′ and 87° 38′ W. Alabama and Georgia bound it on the north, the Atlantic Ocean on the east. On the South, Florida Strait, which connects the Gulf of Mexico with the Atlantic, separates the peninsula from Cuba, and the Bahamas. West of the peninsula and south of the western extension of the State is the Gulf


ALABAMA
GEORGIA
FLORIDA
ATLANTIC OCEAN
GULF OF
OKEFINOKEE SWAMP
JACKSON
GADSDEN
LIBERTY
WAKULLA
LEON
MADISON
HAMILTON
TAYLOR
SUWANEE
BAKER
DUVAL
NASSAU
CLAY
BRADFORD
ALACHUA
LEVY
MARION
PUTNAM
ST. JOHNS
VOLUSIA
CITRUS
HERNANDO
PASCO
ORANGE
BREVARD
OSCEOLA
HILLSBORO
POLK
Thomasville
Valdosta
Bainbridge
Tallahassee
Jacksonville
Fernandina
St. Augustine
Palatka
Gainesville
Ocala
Daytona
De Land
Sanford
Orlando
Kissimmee
Brooksville
Tampa
Lakeland
Titusville
Cedar Keys
Pt. St. Joseph
C. San Blas
C. St. George
Apalachee Bay
C. Canaveral
Cumberland I.
Amelia I.
Anastasia Island
Melbourne Beach



FLORIDA
SCALE OF MILES
0 5 10 20 30 40 50 60 70 80 90 100
Population of places is indicated by different lettering, thus
25,000 and over JACKSONVILLE
5,000 to 25,000 Tampa
1,000 to 5,000 Ft. Brook
500 to 1,000 Greencove
Smaller Places St. Marys
Railroads
MEXICO
MANATEE
DE SOTO
LEE
DADE
MONROE
Lake Okeechobee
Fort Myers
Punta Rassa
Big Cypress Swamp
Key West
Dry Tortugas
BAY OF FLORIDA
FLORIDA STRAIT
Longitude West from Greenwich
ALABAMA
SANTA ROSA
WALTON
HOLMES
WASHINGTON
ESCAMBIA
Pensacola
De Funiak Springs
GULF OF MEXICO
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of Mexico. The extreme western boundary is the Perdido River in Alabama.

Florida is mainly a peninsula of irregularly rectangular form. The northern part is continental, and extends about 400 miles from east to west. From north to south the peninsula extension is about 375 miles in length, and nearly 100 miles in width, the total length of the State north and south being about 450 miles. From Biscayne Bay, near its southeastern extremity, stretches a series of islets or keys, the only one of importance being Key West, situated at the lower end of the chain.

The physical features of the State are decidedly dissimilar to those of the other Southern States. The geological upheaval resulting in its formation left neither table-land nor mountain from which to view ocean and gulf, the most elevated portion of the State barely reaching the dignity of a hill-country. Its area is 58,680 square miles, 4,440 being lakes, lagoons, and rivers. Its coast-line, excluding islands, is 1,145 miles, 470 miles of it being in the Atlantic Ocean. Capital, Tallahassee.

Surface, Soil and Drainage.— The northwestern part, continuing the Alabama uplands, is a hilly rolling country sinking to a flat strip of coast. The east is part of the Atlantic coastal plain. The peninsula is a surface of sand and marsh, lying in the north on a basis of Upper Eocene or Vicksburg limestone; in the south on one of coral whose southern extremity is the bounding wall of the Gulf Stream, silted up at the end into the "keys." These have spread by deposits and vegetable growth into habitable islands, and in the course of ages will be joined to the peninsula, which itself is yet but land in the making. Almost everywhere the water lies close below the surface, which is dotted with springs, some of which are charged with carbonates and sulphuretted hydrogen; many fresh and of immense size, and of crystal clearness. One of the most famous is near St. Augustine, two miles out at sea, and boils so violently that the waves break against it as against a sunken reef. Another large one is in St. George's Sound, opposite Lanark. The wonderful Silver Spring, at the head of navigation on the Ocklawaha River, near Ocala, Marion County, has an estimated outflow of 300,000,000 gallons daily. The Blue, in the same county, the Wekiva in Orange County, and the Wakulla near Tallahassee, are also famous.

As the soil is a mere surface deposit with no volcanic upheaval, the State has no real hills; but the centre has a watershed in the shape of a ridge from 100 to 300 feet high, with a summit level 200 miles north of the strait, from which low sand-terraces decline each way to the sea, with countless lakes and swamps at their bases. Many of the lakes are aggregates of the great springs before mentioned. The largest is Okeechobee in the south, 1,200 square miles in area and 25 feet above the sea-level, its waters sinking into the Everglades; a bordering rim of sand about 25 miles wide divides it from the Atlantic. Others are Monroe, Georgia, Kissimmee, Crescent, Dexter, Apopka, Harris, Orange, and Eustis. Most of them are shallow and usually connected by fresh-water streams. On the higher levels the terraces are covered with a magnificent growth of large pine-trees; on the lower levels are prairies and marshes timbered with cypress-trees, and in which are "hummocks," which are dry elevations, covered with a great variety of hardwood, and cabbage-palms. The basins of the draining streams are mostly marshy jungles of cane-brake and vines and semi-tropical trees. In the southernmost portion are the remarkable Everglades, forming a district 160 by 60 miles in extent, and containing 3,600 square miles, both land and water; and overflowed marsh hidden by tall grass, and thickly dotted with dry "hummocks" ranging in size from those just large enough to stand on, up to those covering a square mile or more, and covered by a jungle of vines and shrubs, pine, and palmetto. The eastern part is a maze of these islands and small shallow bayous. The islands were once really such in the ocean, the water around them having silted up and been overgrown with vegetation. The Everglades are separated from the Gulf by extensive cypress swamps; the forests extend down the west coast, narrowing out around the cape, and stretch up along the Atlantic coast. The latter, except in the extreme north, is almost harborless, a line of narrow sand-spits with interior lagoons, the type of the whole southern coast; but the gulf side, otherwise formed in the same fashion, is pierced with many deep bays and harbors — Pensacola, Santa Rosa, St. Andrew's, St. George's, Appalachee, Tampa, Hillsboro, Charlotte Harbor, Oyster, Ponce de Leon, Cedar Keys, etc.

The great river of Florida is the St. John's, rising in Cypress Swamps, just north of the Everglades, and flowing north parallel with the ocean, threaded on a series of lakes; 150 miles from its mouth becoming a mile wide, and in its lower course six or seven, a miniature Amazon in size and character and draining a similar country. Pleasure-steamers navigate it 250 miles, and the tributary swamp-rivers several hundred more. Its total course is 350. The Kissimmee, flowing into Lake Okeechobee from Kissimmee Lake, is also a favorite of tourists and sportsmen. The leading streams of the west are the Suwanee; the great Appalachicola from Georgia, 90 miles long under that name, with a course of nearly 600 through the Chattahoochee; the Choctawhatchee (180 miles), and Escambia (250 with the Conecuh) from Alabama, the latter navigable to the Conecuh.

Climate.— The climate of Florida is not subject to prolonged and severe winters with great ranges in temperatures. The annual precipitation is from 58 to 60 inches, ranging from 6 to 8 inches in the fall and winter — the dry season — to 18 to 20 inches during the summer. The normal sunshine is about 60 per cent. The normal mean temperature for January ranges from 60° to 70° F., that for July being 80° and above. The hottest months are June, July, and August, the heat being tempered by frequent showers. Already famed as the Riviera of America, offering hope to the invalid and pleasure and comfort to the robust, Florida occupies a unique place among the States of the Union. The large immigration of a rich and cultured class has had a great influence on the social, political, and business development of the State.

Flora and Fauna.— These are naturally affiliated to those of the West Indies and South America. The forests are estimated at 25,000,000 acres, two thirds the area of the State; largely consisting of live-oak, hickory, long-leaved pine, pitch-pine, and cypress. Prof. A. H. Curtis, a distinguished botanist, says that Florida has a greater variety of trees than any other State in the Union. Florida has many trees peculiar to itself, or almost so, in the United States — the wild orange, cocoanut, and Indian almond, mahogany, satinwood, and manchineel, cachibou and kino-gum, etc. The tropical fruit acclimated there is noted below. The alligator, green turtle, and sponge, indicate the tropic nature of the State.

Fish and Fisheries.— Florida's enormous coast-line in the mid-continental seas gives its fisheries the greatest extent and value of any State south of Virginia; they employ seven or eight thousand men. Foremost is that of the red snapper, utilizing some 200 vessels besides hundreds of boats, the headquarters being Pensacola; the catch is over $2,000,000 a year, mostly packed in ice and sent North. Shad, mullet, and green turtle are also caught in large quantities. The sponge fishery is peculiar to Florida, and centres in Key West; it has produced as much as $250,000 a year. Alligators are caught for their skins.

Agriculture and Forest Products.— The rich phosphatic soil mingled with decaying vegetation, the large rainfall, and warm climate render Florida enormously fertile, and dictate its representative crops. It of course raises corn and other cereals for its own use — in 1902 it produced 5,180,000 bushels of corn from 600,000 acres of land — and at last report had over 500,000 neat and 80,000 dairy cattle; but its chief export crops are semi-tropical. Sugarcane, Sea Island cotton, and rice; 160,000 bushels a year of the last named; sweet potatoes, over 2,000,000 bushels a year; Irish potatoes, 200,000 bushels; peanuts, over 1,000,000 bushels; cassava, nearly 10,000,000 pounds; tobacco, 1,600,000 pounds in 1902; with some 7,000,000 watermelons and 3,500,000 muskmelons a year, besides general market-gardening products for the North, are the typical field crops of the State. Several thousand acres are devoted to watermelons for the seed alone, for which there is an extensive northern market. The orchard crops are rich in tropical products — lemons (2,357 boxes in the census year), limes (22,714 boxes), grape-fruit (2,306 boxes), guavas (1,645,000 fruit), Japanese plums (75,110 fruit), olives, figs (66,680 pounds), cocoanuts (136,600 nuts), etc.; but the two leading crops are oranges and pineapples. The former has been subject to immense vicissitudes. Early in the nineties it was the one speculation of central Florida, and the product rose to 5,000,000 boxes in one year; then the terrible cold wave of 1894–5 froze millions of young trees to the roots, often splitting them in two. The older trees, where well handled, generally survived, but another cold wave in 1899 — giving native Floridans the unprecedented sight of several inches of snow — destroyed a large part of those also; the two disasters killed three fourths of all the orange trees in the State. The crop sank to 125,000 boxes or so, and most of the growers abandoned the business, thinking a permanent change of climate had set in; but it is now known that these frosts occurred now and then in earlier times as well, and growers are recovering courage, though the industry is shifting toward the southwest coast. The crop for 1902 was about 750,000 boxes, over treble that for the census year. The next greatest orchard crop — though peaches and pears are considerably grown — is the pineapple, raised mainly in the southeastern counties. Florida in the census year produced nearly 3,000,000 of the fruit, against 440 from California and none from any other State.

In 1902 the Florida East Coast & Drainage Sugar Company was formed to drain the Everglades, which will reclaim some millions of acres of valuable agricultural land.

The forest products are usually ranked under manufactures. The lumber and timber product of Florida in 1899–1900, with the tar, turpentine, and ship stores, amounted to $17,572,999, or nearly as much as all the rest of the State's manufactures together. The turpentine and rosin — 236,778 barrels of the former, 772,537 of the latter — were valued at $6,469,605, and the industry employed 15,073 hands, or toward half the industrial workers of the State. The industry has grown from almost nothing within the decade, there being in 1890 only 484 hands and $191,859 product.

Minerals.— Florida has no metals, and its mineral industries are of rock and earths. The chief is the mining of phosphate rock for fertilizers (q.v.), in which it rivals any other district of the world. It is in various forms — hard and soft rock, land and river pebble, and vertebrate remains. The hard rock — much the most valuable, containing 80 per cent phosphate of lime — is found in a belt skirting the Gulf from Tallahassee nearly to Tampa. It was discovered in 1888, and since then the product has risen to some 750,000 tons a year of all kinds — 500,000 being hard rock, nearly all exported to Europe, principally Germany. The river pebble is only worked on the Peace and Alafia rivers, by dredges and pumps. Most of the fuller's earth used in the United States is also from Florida. At Ellenton, on the Manatee River, 60,000 tons has been produced in a year, and at Quincy 30,000 tons. Some $40,000 a year of kaolin also goes out.

Manufactures.— The greatest industry of Florida, aside from the forest products, is the tobacco and cigar manufacture, of which the heart is Tampa and Key West; it was developed by the immigration of Cuban cigarmakers, and still uses mainly Havana leaf. Some 300,000,000 cigars a year are turned out, and the total value of tobacco products manufactured in the census year was $10,891,286; the industry employed 6,461 wage-earners. The fertilizer industry from phosphate rock amounts to over $500,000 a year, against less than $100,000 in 1890, and nothing two years before. Wooden boxes and barrels, cedar for lead-pencils, sugarcane syrup, cotton-seed oil, and meal are also to some extent exported, though the consumption is largely at home. Jacksonville has two establishments for canning pineapples, guavas, etc.

Commerce and Transportation.— Florida's position makes it the natural outlet for exports to the West Indies; but till late years unimproved harbors and inferior railroad equipment have checked its commerce. Within the past 15 years, however, Congress has expended over $6,000,000 on its river and harbor improvements (appropriating nearly $3,000,000 more in 1902); and its railroad lines have more than trebled in mileage, and increased in even greater ratio in quality of service. The mainland harbors on its immense peninsular coast-line, with its noble

SCENES IN FLORIDA.

1. The Plaza, St. Augustine.

2. Jupiter Light.

island port Key West, do an export trade of toward $20,000,000 a year, with some $2,000,000 of imports. About 3,000 vessels a year, of over 2,500,000 gross tons, clear from Florida ports. The chief exports are timber and lumber (over $7,500,000 a year), naval stores, fruits, corn, cotton, tobacco and cigars, phosphate rock and fertilizer, fish, and horses, mules, and cattle to Cuba. The largest exporting places are Pensacola, Tampa, Jacksonville, and Key West. There are important steamer lines running from Jacksonville to Charleston, New York and Boston; from Tampa to Havana and Porto Rico (great sums having been recently expended on its terminal facilities); from Key West to Havana, Galveston, New Orleans, and New York; and from Miami to Nassau and Cuba; also coasting lines from Fernandina, Apalachicola, Carrabelle, and Punta Gorda. There is much tourist and business navigation on its fine rivers and bays. The railroad mileage is now some 3,500, of which 2,800 is main track; there are several through express trains to and from the North daily, and three great trunk lines traverse the peninsula — the Atlantic Coast Line, Seaboard Air Line, and Florida East Coast.

Banks.— On 1 Jan. 1902 there were 25 incorporated banks in the State, with assets of $6,149,852.82; and capital, surplus, and undivided profits of $1,169,645.70. Five of these were savings banks or had savings departments, with assets of $2,632,928.31.

Finance.— The assessed valuation of the State is slightly over $100,000,000; and there is no floating debt, but a surplus of $228,074.19 in the treasury on 1 Jan. 1903. The bonded debt is $350,000 in 7's of 1871, and $925,000 in 6's of 1873. The State tax is five mills. The county taxes produce over $1,250,000 a year, the school districts over $70,000.

Education.— At the end of 1902 there were about 2,400 public schools, and 2,799 teachers, 1,782 of them female. The average monthly salary was $44.49 for white males and $35.44 for white females. Total paid for salaries, $569,733.33; total expenditure on schools, $775,000, or about $1.35 per capita; about half the average for the Union, and one of the lowest averages among the States. The average attendance for the year was 55 days for white children, 41 for colored. The illiterates above 10 number over one fifth of the population. This is misleading, however, unless classed by color: the illiterate whites numbered 19,184 out of 297,812, or 6.4 per cent, while the illiterate colored numbered 65,101 out of 230,730, or over 35 per cent. The educational status is gradually improving. There are some 30 high schools in the State. The Constitution provides for two normal schools, a white and a colored; the former is at De Funiak Springs, the latter at Tallahassee. There are also three private normal schools. For colored secondary education there are three institutions at Jacksonville and one at Live Oak. For whites there are, besides the State Agricultural College at Lake City, seminaries for East Florida at Gainesville, West Florida at Tallahassee, South Florida at Bartow. There are also several private and denominational colleges, including the John B. Stetson University at Deland, affiliated with the University of Chicago, and Rollins College at Winter Park.

Charitable and Penal Institutions.— There is a State hospital for the insane at Tallahassee accommodating about 1,000 patients, and treating some 300 new ones a year; a school for the blind and for deaf-mutes at St. Augustine; and a State reform school. The State penitentiary at the end of 1902 had 1,033 inmates; 449 received during the year, of whom 413 were colored. The State farms out its convicts for mining phosphate, etc.

Religious Denominations.— The strongest in the State are the African Methodist Episcopal, the Methodist Episcopal South, the Regular Baptist South, the Regular Baptist Colored, Roman Catholic, Methodist Episcopal, Protestant Episcopal, Presbyterian, Disciples, and Congregational.

State Government.—The Constitution is of November 1886, and made sweeping changes from the former one in the direction of democracy. The State and county officers had formerly been mostly appointed by the governor, and the Supreme Court justices were appointed for life; under the present Constitution all are elected, except circuit judges, and the judges' terms are six years. The governor is elected for four years, and cannot be re-elected for an immediately succeeding term. His salary is $3,500. His veto may be overridden by a two thirds vote of the members present in both Houses. In case of vacancy, the succession devolves on the president of the Senate and the speaker of the House successively. The legislature consists of 32 senators and 68 representatives, and meets biennially, with sessions limited to 60 days except at their own expense. There is a railroad commission to enforce reasonable rates of freight and passenger carriage. The divorce law requires two years' residence. Counties have local option at the request of one fourth of the registered voters. There are 1,258 militia. The State has two representatives in Congress. It is overwhelmingly Democratic in politics; in the legislature of 1903 there are 67 Democratic representatives and one Republican.

Population.— 1830, 34,730; 1840, 54,477; 1850, 87,445; 1860, 140,424; 1870, 187,748; 1880, 269,493; 1890, 391,422; 1900, 528,542. The foreign-born numbered 23,832, mostly West Indians. The colored population was 230,730, or a little over two fifths. The present population, based on estimates of the census officials, is about 575,000.

The State has 45 counties, which, with their capitals, are as follows:

Alachua, Gainesville.
Baker, MacClenny.
Bradford, Starke.
Brevard, Titusville.
Calhoun, Blountstown.
Citrus, Inverness.
Clay, Greencove Springs.
Columbia, Lake City.
Dade, Miami.
De Soto, Arcadia.
Duval, Jacksonville.
Escambia, Pensacola.
Franklin, Apalachicola.
Gadsden, Quincy.
Hamilton, Jasper.
Hernando, Brooksville.
Hillsboro, Tampa.
Holmes, Westville.
Jackson, Marianna.
Jefferson, Monticello.
Lafayette, Mayo.
Lake, Tavares.
Lee, Myers.
Leon, Tallahassee.
Levy, Bronson.
Liberty, Bristol.
Madison, Madison.
Manatee, Braidentown.
Marion, Ocala.
Monroe, Key West.
Nassau, Fernandina.
Orange, Orlando.
Osceola, Kissimmee.
Pasco, Dade City.
Polk, Bartow.
Putnam, Palatka.
St. John, St. Augustine.
Santa Rosa, Milton.
Sumter, Sumterville.
Suwanee, Live Oak.
Taylor, Perry
Volusia, Deland.
Wakulla, Crawfordville.
Walton, DeFuniak Springs.
Washington, Vernon.

The chief cities are Jacksonville, on the St. John's, with a population of 28,429, in 1900, increased to about 40,000 in 1903; Pensacola, in the extreme west, 17,747; Key West, 17,114; Tampa, on the west coast, 15,839. No other place has as much as 5,000 people; and only two over 4,000 — St. Augustine, on the east coast, 4,272, and Lake City, between Jacksonville and Tallahassee, 4,013. Between 3,000 and 4,000 are Gainesville, Ocala, Palatka, Fernandina, and Apalachicola. Tallahassee, the capital, has 2,981.

History.— The earliest attempted colonization of the North American mainland was in Florida, and the first white settlement was St. Augustine. Juan Ponce de Leon discovered the coast a little north of St. Augustine 27 March 1512; was made governor, and authorized to colonize the "Island of Florida," as it was then supposed to be, in 1513; and sought there for the "Fountain of Youth." Thenceforward it was the highway of Spanish explorers. Vasquez de Ayllon raided it for slaves 1520–6, Pánfilo de Narvaez began his fatal expedition westward in 1528 from Pensacola Bay; Hernando de Soto his in 1539 from Tampa Bay; Tristan de Luna in 1559 explored northward from Pensacola Bay. Coligny designing to found a Huguenot colony and refuge in the New World, René de Laudonnière in 1564 built Fort Caroline on the St. John's; in 1565 Pedro Menendez de Avilèz captured the fort, massacred the French there and in two detachments outside, "not as Frenchmen but as heretics," and built St. Augustine; in 1567 Dominique de Gourgues in turn exterminated the Spaniards at the settlement that had replaced Fort Caroline, "not as Spaniards but as assassins." St. Augustine was overlooked; but in 1586 Sir Francis Drake destroyed it. All through the 17th and early 18th centuries the Spaniards in Florida harassed, or set on the Indians to harass, the English colonies, from St. Augustine as headquarters, especially after Georgia was settled; and St. Augustine was repeatedly attacked by colonial expeditions. The Spaniards did but little toward settling the country, however. In 1763 East and West Florida — the latter west of the Apalachicola, and including parts of modern Alabama and Mississippi — were ceded to Great Britain, and in the next 20 years more than 25,000 whites had settled there. In 1783 it was retroceded to Spain, and most of the English settlers withdrew. In 1795 West Florida was sold to France. After the Louisiana Purchase of 1803 the United States claimed up to the Perdido as part of "Louisiana"; the claim was not then pressed, for fear of war; but in 1810, the Spanish monarchy being overthrown and the king a prisoner, the United States took possession of all but Mobile, which was occupied in 1813 during the War of 1812. Meantime and afterward, the Southern States found East Florida an intolerable thorn in their flesh. The so-called Spanish "government" there was mere anarchy, partly from there being no stable home government to control it; Indian bands raided Georgia and escaped over the border, British and Spanish traders intrigued with them, and it was an Alsatia for fugitive slaves which drove the slaveholders wild. Congress authorized Madison to take "temporary possession" in 1811, but nothing was done; in 1818 Jackson invaded it to punish Spanish assistance to the Seminole raids and withholding fugitive slaves, captured St. Mark's and Pensacola, and hanged Arbuthnot and Ambrister, two British adventurers making their account by furnishing supplies and possibly other help to the Indians. The district being both profitless and untenable to Spain, she ceded it to the United States by treaty of 22 Feb. 1819, in exchange for government assumption of $5,000,000 claims of American citizens against Spain. The latter only ratified it in 1821 (see ANNEXATION). In March 1822 it was admitted as a Territory. The two sections, East and West Florida, both from geographical and political reasons, had no sympathy with each other, and repeatedly petitioned Congress for separation, without avail. Especially West Florida, as late as 1869, voted for annexation to Alabama, which offered the State $1,000,000 for it; but no further steps were taken. On 11 Jan. 1839 a convention framed a constitution for the State of Florida; but it was not admitted to the Union till 3 March 1845, paired with Iowa, as a slave State with a free State. The Constitution, forbidding emancipation of slaves by the legislature, roused a violent debate in Congress over admission. From 1835 to 1842 raged the bloody Seminole war (q.v.), ending in the deportation of the tribe to Indian Territory in 1843. On 10 Jan. 1861 an ordinance of secession was passed, 62 to 7; and on 4 Feb. the Florida delegates took their seats in the Confederate Congress. The government posts nearly all fell into Confederate hands; but Fort Pickens, off Pensacola, was retained, and formed a nucleus for recapture. After 1863, however, the Union forces were employed in other quarters; and by the battle of Olustee, 20 Feb. 1864, the State was lost to the Union till the close of the War restored it. On 13 July 1865 a provisional government was formed; on 25 October a State convention met, and on the 28th annulled the ordinance of secession. A new constitution was adopted without slavery, and a legislature organized in 1866; but on 2 March 1867 it was brought under the Reconstruction Act, and became a part of the Third Military District. A constitution of 25 Feb. 1868 chose officers to hold till January 1873, and by act of 25 June 1868 Florida reorganized as a State. Reconstruction conditions here were as anarchic and deplorable as elsewhere (see ELECTORAL COMMISSION; RECONSTRUCTION); but in the last 20 years the enormous investments of Northern capital in industries and railroads, the national expenditures on harbors, etc., have made it a strong and thriving State. Consult: Norton, 'Handbook of Florida' (1892); Fairbanks, 'History of Florida' (1871); Barbour, 'Florida' (1884).

CHAS. H. SMITH,
Secretary Board of Trade, Jacksonville.

Florida Agricultural College, an important educational institution at Lake City, Florida, established in 1884. It is under the direct control of a State board appointed by the governor. There are 200 students of both sexes.

Florida Blanca, José Moñino, hō-sā' mōn-yē'nō flō-rē'thä blän'kä, COUNT OF, Spanish statesman: b. Hellin, Murcia, 21 Oct. 1728; d. Seville 20 Nov. 1808. He was Spanish ambassador at Rome during the pontificate of Clement XIV., and particularly distinguished himself by his activity in the abolition of the order of the Jesuits, and in the election of Pius VI. In 1777 he became minister of foreign affairs, and at once acquired almost unlimited authority in Spain. He introduced post-coaches, and caused the post-roads to be made practicable; directed his attention to the most important subjects of general police, particularly in the capital; embellished Madrid, and was on every occasion the active friend of the arts and sciences. His attack upon Algiers in 1777, and the siege of Gibraltar in 1782–3, were unsuccessful; but the result of his co-operation with the English colonies of North America in securing their independence was more favorable to Spain. After the accession of Charles IV., his enemies succeeded, in 1792, in effecting his disgrace. He was imprisoned in the citadel of Pampeluna, but was soon restored to liberty and banished to his estates. He appeared once more upon the political stage in 1808, when he was president of the extraordinary Cortes.

Florida Cape. See CAPE FLORIDA.

Florida, Gulf of. See FLORIDA STRAITS.

Florida Jay. See JAY.

Florida Keys, or **Reefs,** in Florida, a chain of small islands, keys or reefs, and sandbanks, extending southwest from Cape Florida, about 220 miles. They are very considerable in number, but only a few are of any importance. Among these may be mentioned Cayo Largo, Indian Key, Long Island, Old and New Matacombs, Cayo de Boca, and Key West, on which the city of Key West is built.

Florida Straits, or **New Bahama Channel.** The gulf waters separating Florida from Cuba and the Bahamas, and traversed by the Gulf Stream. The total length is 300 miles, with a width of from 50 to 150 miles.

Florida, Treaty of. In American history, a treaty signed between Spain and the United States, 22 Feb. 1819, by which Spain conceded the Floridas to the United States. Until the final ratification of the treaty Congress had passed a law empowering the President to appoint a governor, and Gen. Andrew Jackson assumed command of the Florida region. Gen. Jackson issued a proclamation at Pensacola requiring obedience to United States authority. See FLORIDA; UNITED STATES — ARBITRATION IN THE.

Florin, the name of a coin first struck in Florence in the 13th century. The silver florins of Holland are worth about 40 cents. The British and Austrian florins are each worth 50 cents. The English florin was first coined in 1849. See NUMISMATICS.

Florio, Caryl. See ROBJOHN, W. J.

Florio, John, English lexicographer and translator: b. London of Italian parents about 1553; d. 1625. He taught French and Italian in Oxford University, and was appointed by James I. teacher of languages to the queen and Prince Henry. His chief works are his great Italian and English dictionary, 'A World of Words' (1598, improved edition 1611), and his translation of 'Montaigne' (1603).

Floris, flō'ris, **Frans** (originally **de Vriendt**), Flemish painter: b. Antwerp 1517; d. there 1 Oct. 1570. He was called by his contemporaries the Raphael of Flanders. He went to Italy, where his taste, particularly in design, was improved by the study of the masterpieces of Michelangelo; but he never equaled the grace and purity of form which distinguished the Florentine and Roman masters. His style was grand; but his coloring and his figures are reproached with dryness and stiffness. Most of his works, and in particular his triumphal arches, made on the occasion of the entry of Charles V. and Philip II. into Antwerp, and his 'Twelve Labors of Hercules,' have often been engraved by skilful artists. His paintings are to be met with in Flanders, Holland, Spain, Paris, Vienna, and Dresden.

Flor'izel, in Shakespeare's 'Winter's Tale'; the Prince of Bohemia, hero of the drama, and the lover of Perdita.

Flo'rus, Roman historian, of the 2d century A.D., probably a native of Spain or Gaul. He is variously styled in the manuscripts; in some L. Annæus Florus, in others L. Julius Florus, in others L. Annæus Seneca, and in one simply L. Annæus. He wrote an abridgment (epitome) of Roman history in four books, from the foundation of the city to the first time of closing the Temple of Janus, in the reign of Augustus. His style is florid, and not sufficiently simple for history. The best edition is that of Duker (Leyden 1744); later ones are by Titze (1819) and Seebode (1821).

Floss Silk, the portions of raveled silk broken off in reeling the silk from the cocoons, carded and spun into a soft coarse yarn, and used for common fabrics. See SILK.

Flotow, Friedrich (frēd'riH flō'tō) **von,** German musical composer, b. Teutendorf, Mecklenburg-Schwerin, 27 April 1812; d. Wiesbaden 24 Jan. 1803. His earlier operas (which include one called 'Rob Roy') did not find favor among the Parisian opera-house directors, so he had to content himself with performances in the private theatres of the aristocracy. This brought him gradually into notice, however, and his 'Naufrage de la Méduse' was publicly produced in 1839. 'Alessandro Stradello' was first performed at Hamburg in 1844, and his most successful opera, 'Martha,' was originally given at Vienna in 1847. His subsequent works, such as 'Indra' (1852), 'Rübezahl' (1854), 'Albin' (1856), 'L'Ombre' (1869), achieved but small success.

Flotsam, Jetsam, and **Ligan,** in law, flotsam, or floatsam, is derelict or shipwrecked goods floating on the sea; jetsam, goods thrown overboard which sink and remain under water; and ligan, goods sunk with a wreck or attached to a buoy, as a mark of ownership. When found such goods may be returned to the owner if he appear; if not, in England, they are the property of the crown. See DERELICT; SALVAGE.

Flounder, any of several of the more common and useful flat fishes (q.v.) of northern waters. The commonest American species are the "summer" and "winter" flounders. The latter (*Pseudopleuronectes americanus*) is dark rusty brown, more or less spotted, about 15 inches long when large, and weighs one to two pounds. It is caught in the colder months from Chesapeake Bay to Labrador, and is excellent eating. The "summer" flounder (*Paralichthys dentatus*) becomes twice as large, is light olive brown, studded, when adult, with numerous small white spots, and is excellent eating. The "four-spotted" flounder (*P. oblongus*), and the

Gulf species (*P. albiguttus*), are closely related. On the Pacific coast several good species are known; and the British coast has a valuable species in *Pleuronectes flesus,* closely resembling the plaice (q.v.).

Flour and Meal Insects. Various forms of small whitish caterpillars and darker-colored "worms" are commonly found in flour and meal and manufactured cereal products of different kinds. The most prominent of these is the Mediterranean flour moth (*Ephestia kuehniella*), which has been termed a veritable scourge in flouring-mills. It was practically unknown as a pest until 1877, and in North America is still limited to portions of California, Minnesota, New York, and Pennsylvania, where flour-milling is an important industry. The moth has a wing-expanse of a little less than an inch, and is of a pale lead-gray color. The caterpillars are whitish, with long but inconspicuous hairs, and make the trouble while searching for a proper place for transforming to the pupa stage. Wherever it crawls it drags after it a large quantity of silk, with the result that flour becomes felted together and lumpy and the mill machinery gets clogged, requiring frequent and expensive stoppages. The entire life cycle of this insect may be accomplished in 38 days, hence in well-heated mills or other buildings inhabited by the insects from four to six generations may be produced. When a mill is found infested the entire building must usually be fumigated. Sometimes a whole district becomes overrun, and in this case great care must be observed that the insect does not spread from one mill to another. Various remedies are used for eradicating the pest, including the free use of bisulphid of carbon and hydrocyanic-acid gas, the use of "steam-sweepers" and "elevator brushes."

The Indian-meal moth (*Plodia interpunctella*) somewhat resembles the preceding, but is smaller; the outer halves of the fore-wings are dark greasy brown with metallic reflections, and the larva usually has a reddish or greenish tinge. It has the same habit of webbing up flour, but is not so great a pest as the Mediterranean flour-moth, possibly because it has a larger range of food material, feeding on nearly all forms of dried vegetable matter, among which are dried fruits and jellies, which have earned it the title of "pantry moth." It is to be found in nearly every store and household, and particularly where dried vegetable foods are neglected for any length of time. The meal snout-moth (*Pyralis farinalis*) is rarer than the preceding, and seldom does injury to flour or meal, although it spoils clover hay.

Two species of beetles (*Tenebrio molitor* and *obscurus*) and their larvæ are popularly known as "meal-worms," both in this country and abroad. The former is a shining brown beetle over half an inch long, and produces a yellow meal-worm; the latter is dull black, and produces a dark brown meal-worm. They are most apt to be troublesome in dark locations, in feed-stores and in stables; but are useful when raised under control, since they are salable as food for mocking-birds, nightingales, and other cage birds.

Flour beetles or "weevils" are little flattened reddish beetles of the same family (*Tenebrionidæ*) as the meal-worms and are great pests in mills and storehouses. The chief source of annoyance from these insects is due to their imparting a highly offensive and persistent odor to the substances which they infest, which include various drugs, snuff, capsicum, ginger, dried peas and beans, baking powder, nuts, and cabinets of dried insects. Several species occur in America. They differ somewhat in structure and in habits, but may be controlled by the use of bisulphid of carbon.

Flourens, Marie Jean Pierre, mä-rē zhŏṅ pē-ār floo-roṅ, French physician and physiologist: b. Maureilhan, department Hérault, 15 April 1794; d. Montgeron, near Paris, 6 Dec. 1867. His first scientific writings, which were distinguished by their perspicuous style and analytical precision, appeared in 1819. In 1828 he was elected a member of the Academy of Sciences, in 1830 was appointed to the chair of comparative anatomy at the Jardin des Plantes, and in 1833 succeeded Dulong as permanent secretary to the Academy of Sciences. In 1840 he was admitted a member of the French Academy. In 1846 he was created by Louis Philippe a peer of France, but he was deprived of this dignity by the revolution of 1848. Flourens combined with profound scientific knowledge great literary talent. His works are very numerous, but the following may be mentioned particularly: 'Recherches expérimentales sur les Propriétés et les Fonctions du Système nerveux' (1824); 'Expériences sur le Système nerveux' (1825); 'Developpement des Os' (1842); 'Anatomie de la Peau' (1843); 'Mémoires d'Anatomie et de Physiologie comparées (1844); 'Buffon' (1844); 'De l'Instinct et de l'Intelligence des Animaux' (1841); 'De la Longévité' (1854); De la Vie et de l'Intelligence' (1858); 'Œuvres de Buffon' (1853–5); 'Des Manuscrits de Buffon' (1859); 'Éloges historiques' (1857). Flourens was the first to demonstrate experimentally that the substance of the animal body undergoes a constant process of renewal.

Flour Milling, American. Flour milling is of two kinds; one the primitive, small industry that supplies a natural local demand; the other a commercial enterprise, which goes into the open markets for its raw material and disposes of its product in the markets of the world. One dates from the early settlement of the country, or as soon as wheat was grown in America; while the other had its beginning about the time of the Revolution, though it assumed no really great importance until after the middle of the last century. While the country has, and probably always will have, a large number of small mills situated in the rural districts, the flour-milling industry proper — considered commercially — is on a larger and more important scale than ever before. In fact, the census of 1900 gives it fourth place among the manufactures of the United States in value of products.

The small mill that supplies a purely local village or rural demand, may properly be termed an "agricultural adjunct." Therefore the history of farming in this country is the history of the grist-mill development. Yet its early growth is of some interest. In 1626, a horse-power mill was built on Manhattan Island, and a windmill in New England, near Watertown, about two years later. Windmills soon became common on the Atlantic coast. The first water-mill in New England was probably built on the Dorchester side of the Neponset, in 1634. Before the middle of the century, New England was doing an export business, sending wheat and flour to Portugal. In 1649, Virginia had four windmills, five water-mills, and numerous horse-mills, and was also an exporter of wheat and flour. By 1678, New York had a considerable number of mills, and, moreover, had a monopoly on the process of the bolting of flour. The charter was repealed, however, in 1694.

For nearly 100 years following, the development of milling was but the reflection of the growth of the country, with some extension of trade in the West Indies and South America. Still, the process of milling was crude, and the industry, with perhaps a few exceptions, had hardly gone beyond the agricultural or farm-product basis. Not until the mills began to centralize, until "milling centres" began to form, did the industry commence to shape itself on a commercial basis. This period may be said to have commenced shortly after the Revolution. Yet milling then, as compared with to-day, was as the stage coach of 1776 compared with the luxurious express train of the present century. Still, the mills of Delaware, on the Brandywine, were celebrated for their flour. This district had 130 mills within a radius of 40 miles, and Wilmington was an exporter of "superfine" flour.

The next milling centre of importance, and which later became first, was Baltimore. In 1787 the mills of that city made 325 barrels of flour daily, and it was there that the first marked improvements in the process of making flour were adopted. Up to 1785 the different stages of milling were separate and largely done by hand, as they are even to-day in the Hungarian process. But Oliver Evans introduced the elevator and conveyor, and combined the different steps into a continuous system; thus dispensing with much labor, and making a saving in the cost of production. Owing to this improvement and to the slowness of the Delaware millers to adopt it, Baltimore became the more important centre, and the Patapsco River, with its fine water power, became celebrated during the next 50 years. In 1840, the Patapsco, within 30 miles in which the fall is 800 feet, had 60 mills, which ground several hundred thousand barrels of flour a year. A considerable export trade was done with the West Indies.

Still another milling centre was formed at Richmond, Va., at the falls of the James River. The district is now not known as a milling point; the milling business has passed, leaving nothing but a memory of its one-time importance. In 1845, Richmond had the largest mills in the United States, the "Gallego" and the "Haxall." The number of mills there was 21, and their trade besides the local and nearby territory, was with South America. The "Gallego" mills, in 1864, had 31 pairs of buhrs or millstones, with an annual capacity of 190,000 barrels of flour. The "Haxall" mills had a capacity of 160,000 barrels.

From the Atlantic coast the milling centre began its westward march, following the wheat-fields. Rochester, N. Y., in the Genesee valley, was the next centre, and while it retained its importance for many years, it succumbed to newer districts farther to the west. At one time Cincinnati assumed considerable importance as a milling point, but St. Louis was destined to follow Rochester as the centre of a great milling district. While Rochester at the present writing has lost its importance, St. Louis has retained its mills, but has been outclassed by the younger city of Minneapolis. Milwaukee has also developed a slightly greater milling capacity than St. Louis. Thus the milling centre has finally fixed itself, apparently for all time, at Minneapolis. For many years, however, Rochester was recognized as the first milling city of the country, having as early as 1835, no less than 21 mills, with 95 run of stones. The flour from these mills was sold throughout the Atlantic coast States. In 1865, the flour output of Rochester was 800,000 barrels.

With the development of the great central wheat States, mills were built wherever there was increased population. In 1840, Ohio, Kentucky, Indiana, Illinois, and Michigan had a total of 1,200 mills, producing about 30 per cent of all the flour made in the country, yet very few of them belonged to the commercial class, such as those of the centres. The scattered country mills supplied the farming communities and the small towns, while the few larger mills and those of the centres supplied the large markets and the districts where wheat was not raised.

St. Louis began as a milling point in 1840, with two small mills. The city, due to its location, was then the principal point in the West. By 1860, the St. Louis mills were making 800,000 barrels of flour a year. In 1870 the output was over 1,000,000 barrels, and in 1880 over 2,000,000. St. Louis led all other centres until 1881, when Minneapolis began its rapid development. Among the other important milling centres are Toledo, Buffalo, Detroit, Indianapolis, Chicago, Kansas City, and Milwaukee, already mentioned.

A small, crude mill was built at the Falls of St. Anthony, now Minneapolis, by a detachment of soldiers in 1823, but the first merchant-mill was erected in 1854. The first flour was shipped to the east from Minneapolis in 1859. In 1865, the city had six mills, with a total daily capacity of 800 barrels. It was not until 1878 that the total annual output reached 1,000,000 barrels, and the direct export shipments were about 100,000 barrels.

In tracing the movement of the milling centre, it may be of interest to investigate the causes that brought a large number of milling interests together. The importance of the first milling district, the Brandywine, in Delaware, was evidently principally due to convenient wheat supplies. The Patapsco district owed its importance to fine water power, local wheat supplies, and water transportation, while Richmond would probably never have gained any prominence but for its water power, though its transportation facilities, down the James, enabled it to build up an export trade. The fine water power of the Genesee River, at Rochester, was a natural inducement for the miller to build there, while the rich agricultural valley gave an abundant supply of raw material. Then, too, the opening of the Erie Canal gave Rochester unexcelled transportation facilities to other markets. Until other conditions entered into the situation to affect it, Rochester was particularly favored. St. Louis had no water power, but it had river transportation both for wheat and flour, and it was for years the principal distributing point for a vast territory. Milwaukee was an early wheat market and was the lake outlet for the Northwest before Chicago became a shipping point of importance. It was thus early that mills began to be built at Milwaukee, and its milling importance may be ascribed to its favored position on the lake.

The greatness of Minneapolis as a milling centre is partly due to the water power from the Mississippi River and partly to the position of the city, which is the gateway between the wheat fields and the markets, but it is also largely due to the quality of the wheat of Minnesota and the Dakotas, the greatest spring-wheat territory in the world. Lastly, the pre-eminence of Minneapolis as a milling centre is due to the early business men of genius, who grasped the situation and made the name "Minneapolis" known the world over. Given all the other advantages,— geographical position, water-power, and even the annual production of some 200,000,000 bushels of superb hard spring wheat,— yet without the business genius and enterprise that dominated the early Minneapolis millers, the city might never have been known as the greatest flour-milling centre in the world.

The latest figures at hand show the following flour output at milling centres in the United States for 1902:

	Barrels.
Atlanta	315,000
Buffalo	1,415,300
Chicago	1,300,000
Detroit	567,000
Duluth	1,804,400
Kansas City	1,298,300
La Crosse	435,100
Minneapolis	16,329,800
Milwaukee	1,755,000
New York	1,760,700
Nashville	1,000,000
Philadelphia	301,500
Rochester	402,400
Richmond	218,200
St. Louis	1,625,900
Toledo	1,600,000

The present time may be called a commercial era in the flour-milling industry. The period from 1870 to 1900 might fittingly be termed the mechanical era, for during that time greater changes and improvements were made in the process than in all the 200 years preceding it. During the mechanical period, there was also the export era, when the building of new mills and the increasing output of old ones, together with the increase in wheat raising of the country, caused an over-production of flour, if domestic markets alone were depended upon. In fact, the increased output was to keep pace with the growing export trade. After reviewing the natural development of the milling industry, which up to 1870 was identical with the growth of the country, these three divisions,— the mechanical, the export, and the commercial,— seem most important.

No better review of the mechanical period, up to 1895, can be given that that written by the late Charles A. Pillsbury, of Minneapolis, who did more than any other one man to make the city in which he lived, and the wheat of the Northwest, known in every great market of the world.

In 1895, Mr. Pillsbury wrote:

Down to 1870, the milling process in the United States was that invented by Oliver Evans, with some minor and gradual improvements. From 1787 the nether and upper millstones, the former stationary and the latter balanced to rotate upon it, ground the flour of America. The stones were set close together, to produce as much flour as possible at one grinding. This produced friction and heat, and often brought about chemical changes which injured the color, taste, and quality of the flour. In the early milling history of Minneapolis, when enterprising manufacturers rushed the speed of the stones to secure a large product, the flour came out dark, and so hot the hand could not be held in it.

Minneapolis spring-wheat flour then stood low in the scale, and was sometimes branded, at the request of buyers, "St. Louis flour from winter wheat." The hard spring-wheat, rich in gluten which made it tough, rendered difficult the separation of flour from bran, and thereby yielded a dark-hued flour which brought a low price in the market. The soft and starchy winter-wheat, on the other hand, yielded readily to the old low-grinding process; the bran was more easily separated, and the flour was lighter in color and less damaged by hard-grinding. The color and quality of spring-wheat flour were somewhat improved in the best mills by a reduction in pressure and speed and by scientific stone dressing; but the main difficulty remained. The difficulty in grinding spring-wheat by the old process was with the middlings, or that part of the kernel between the bran covering and the starchy central body. The middlings, although known to be rich in the gluten which gives wheat-flour its chief value with the baker and pastry-cook, were associated with the bran; and the richer the wheat in gluten, as in case of hard spring-wheat, the more difficult was the process of separation, because the gluten was the cause of the toughness.

The first experiments were made with a view to the purifying of middlings. In 1868, E. N. La Croix, a French millwright, came to Faribault, Minn., and experimented in making a middlings purifier, like one he had seen in France. In 1870 he removed to Minneapolis and continued his experiments. At length a machine was made, and a sample shipment of flour was sent to New York. Word came back by wire that the new flour was selling at 50 cents a barrel higher than other brands. The La Croix machine was crude and in some respects unsatisfactory, and George T. Smith produced a superior machine, different in many points, but retaining the same principle, and obtained a patent.

As a result of the new middlings purification process the mills using it added 50 cents a barrel to their profits in the first year, $1 the second year, and from $2 to $4 per barrel the third and fourth years. Thereupon George H. Christian, representing the Washburn mills, a number of head millers from other mills, and myself, representing the Pillsbury mills, went to Europe and made a thorough study of the Hungarian "high-milling" or gradual-reduction roller and middlings process. As a result some of the Minneapolis mills adopted the Hungarian process bodily, middlings purifier and all, and in a few years were compelled to throw away some of the complex machinery with which they were loaded. The Pillsbury mills, however, adopted only what seemed to be the best features of the Hungarian process, such as the rolls, made modifications all along the line, and retained the American middlings purifier invented by Mr. Smith. We found that the Hungarian system needed simplification to increase its efficiency, to save labor, and especially to avoid dangerous accumulation of mill-dust.

The new and improved high-milling system of Minneapolis and Minnesota thus established made the hard spring-wheat of the Northwest the best flour material on the globe, immediately added 10 to 15 cents per bushel to its market value, and gave Minneapolis flour the first place among the cooks and bakers of the world. By the new process chilled iron and porcelain rolls gradually came into use in place of the old millstones. The grain, in place of being ground in a single pair of millstones, was run through six or seven sets of rolls, being sifted and graded after each breaking by the rolls. The old process aimed to get as much flour as possible at one grinding; the new seeks to get as little flour as possible at the first two or three breakings. The old millstones were set so close together that the weight of the upper stone rested almost wholly upon the grain. The first rolls in the new process are set so far apart that the kernel is simply split for the liberation of the germ and crease. The old process sought to avoid middlings as far as possible, because they entailed loss of flour. The new process seeks to produce as much middlings as possible, because out of the middlings comes the high-grade patent flour. In the handlings of the middlings the new process exhibits the highest art. The gluten, which gives flour its strength or rising power, is saved and made available to the baker, and made a prominent source of profit both to the farmer who raises the wheat, the miller who grinds the flour, the baker who makes the bread, and finally to the consumer, in whom it is transformed into brain and muscle.

With the introduction of the new milling process came the big mills which have made Minneapolis famous, and the development of the spring-wheat industry which has made the Northwest known around the globe. In 1884 there were 23 mills equipped with the new process machinery and possessed of a daily capacity of 30,000 barrels.

The number of mills in Minneapolis has not increased since 1884, although the capacity has been largely increased. In 1884 the output was 5,317,600 barrels of flour, while in 1902 it was 16,329,800 barrels. This increase, without even the enlargement of any of the mill buildings, was due to improved and condensed machines. There are seven milling companies in Minneapolis, having 22 mills with a maximum daily capacity of 75,000 barrels of flour. The capacity of the individual mills is from 600 barrels daily to 15,000 barrels. The Pillsbury «A» mill, having the latter capacity, is the largest mill in the world. Four of the seven companies are small ones, having but one mill each. The mills of the three large companies have a maximum daily capacity of approximately 31,000, 27,500, and 18,000 barrels respectively. The greatest actual weekly flour production was 443,800 barrels, for the week ending 11 Oct. 1902.

Since the discovery of patent flour and the introduction of the rolls, particularly during the last 15 years, the energy and inventive genius of the mill furnishers have been directed toward economy of manufacture, to get the best out of the wheat at the least possible expense. As late as 1900, improvements were made that aided in economy of manufacture, but at this time the limit seems to have been reached in the percentage of high-grade flour that can be produced from the wheat. However, in view of what has been done, one dare not say that still further improvement cannot be made. In this connection a word should be said for patent flour. Much has been written denouncing it as unwholesome and inferior to whole wheat flours; and it has been said that it is over-refined; that the best part of the wheat is eliminated to produce a white flour. All this is without foundation. Chemical analysis and extensive digestive experiments by the United States Agricultural Department prove that white flour bread is not only more easily and completely digested than whole wheat or graham flour bread, but that it contains a greater percentage of the properties that go to nourish the human system. Patent flour is made from the middlings, or that part of the wheat lying between the bran and the starchy central portion of the berry, and it is rich in a high quality of gluten. There is probably no other manufactured article in the world that is sold as cheaply, compared with the cost of the raw material, as is patent flour.

Like the development of milling in this country, the export flour business was not placed upon a high commercial basis until the Minneapolis millers, in the early eighties, began a systematic campaign. From that time until 1900, the export trade increased steadily. Since then some adverse factors, which will be touched upon further on, have arisen. The early mills of the Atlantic coast, as already mentioned, were the first to export flour, probably to meet an actual demand because these mills were the most convenient to buy from, rather than to supply a trade that had been built up by the mills. The early export business doubtless came of itself — a natural demand. The uncertain export flour trade of the first part of the last century reached its climax in the forties, and then, when competition of European mills was felt, dropped off markedly, about the year 1850. During the next 25 years large amounts of wheat were exported annually, while the percentage of the flour production that was sent out of the country was small. The flour trade with the United Kingdom which is now an important part of the export flour business of this country, fell almost entirely away by 1865. This, perhaps, was because the American millers could not hold their own on even terms against the foreign millers, who were then becoming more aggressive and progressive than ever before. The building up of the export flour trade, beginning with about 1875, would make an interesting chapter of commercial history, for this time it was built on a foundation that no fair competition could shake.

The following table, which gives the flour output and the direct export shipments of the Minneapolis mills by years for the last 25 years, will furnish some idea of the development of the export business of the country:

Year	Output Barrels	Export Barrels
1902	16,329,800	3,362,300
1901	15,921,900	3,897,900
1900	15,082,700	4,702,500
1899	14,291,800	4,009,100
1898	14,232,600	4,052,600
1897	13,635,200	3,942,600
1896	12,874,900	3,707,300
1895	10,581,600	3,080,900
1894	9,400,500	2,370,700
1893	9,377,600	2,877,300
1892	9,750,700	3,337,200
1891	7,877,900	3,038,100
1890	6,988,800	2,107,100
1889	6,088,900	1,953,800
1888	7,056,700	2,197,500
1887	6,574,900	2,650,000
1886	6,168,000	2,288,500
1885	5,221,200	1,834,500
1884	5,317,700	1,805,900
1883	4,046,200	1,343,100
1882	3,175,900	1,201,600
1881	3,143,000	1,181,300
1880	2,051,800	799,400
1879	1,551,800	442,600
1878	940,800	107,200

A falling off of the exports will be noticed for 1901, which was true also of the general export business of the country. It was not due to the competition of other countries, but to a discrimination in freight rates, inland and ocean, whereby wheat could be exported cheaper, relatively, than flour.

The table which follows gives in condensed form a clear impression of the importance of the flour industry. Only the merchant-mills are considered. Over 5,000 small grist-mills have been omitted, as they properly belong to an agricultural review rather than to a sketch of milling.

A classification of the merchant-mills of the country for 1900 giving the States having a yearly product of $1,000,000 or over, results as shown in the following table — the second column shows the rank of the States.

The census report of 1900 says of flour milling:

"In order to form a correct idea of the magnitude of the milling industry in any given locality, it will be sufficient to compare with the number of establishments, the capital invested and the number of wage-earners employed. For in-

State or Territory	Rank	No. of mills	Raw Material—Wheat: Bushels	Raw Material—Wheat: Cost	Product—Flour: Barrels	Product—Flour: Value	Average daily product	Average value per barrel	Average bus. wheat per barrel	Average cost per bushel
Minnesota	1	324	102,921,426	$66,641,825	22,705,165	$72,381,659	234	$3.19	4.5	$0.65
Ohio	2	744	35,033,213	24,370,443	7,366,474	26,060,827	33	3.54	4.8	70
Illinois	3	404	27,566,764	18,382,716	6,078,423	20,813,984	50	3.42	4.5	.67
Indiana	4	592	29,192,680	19,188,538	5,818,392	20,384,714	33	3.50	5.0	.66
New York	5	205	25,232,677	18,432,502	5,434,827	19,928,981	88	3.67	4.6	.73
Missouri	6	593	25,368,939	16,263,077	5,245,421	17,800,204	28	3.30	4.8	.64
Pennsylvania	7	1,185	22,923,795	16,179,063	4,775,166	17,059,265	11	3.57	4.8	.71
Wisconsin	8	313	22,356,963	14,869,326	3,750,253	15,496,295	39	4.13	6.0	.66
Kansas	9	260	23,459,171	13,157,846	5,034,251	15,089,529	65	3.00	4.7	.56
Michigan	10	479	20,121,661	13,855,780	4,012,867	14,899,096	28	3.71	5.0	.69
Tennessee	11	337	16,546,155	11,778,868	3,512,985	13,220,609	35	3.76	4.7	.71
Kentucky	12	336	12,325,621	8,294,690	2,549,947	9,341,759	25	3.66	4.8	.67
Texas	13	96	12,228,132	8,046,610	2,604,554	8,881,359	90	3.41	4.7	.66
Iowa	14	327	12,521,953	7,005,972	2,503,390	8,244,050	26	3.29	5.0	56
California	15	90	12,786,110	7,649,433	2,660,238	7,952,867	99	2.99	4.8	.60
Virginia	16	317	8,562,519	6,025,314	1,758,946	6,671,815	18	3.79	4.9	.70
Maryland	17	235	7,081,937	4,972,234	1,475,416	5,418,734	21	3.67	4.8	.70
Nebraska	18	242	8,687,731	4,546,481	1,821,107	5,319,911	25	2.92	4.8	.52
Oregon	19	124	8,847,242	4,403,048	1,826,512	4,769,573	49	2.61	4.8	.50
Washington	20	57	8,887,996	4,302,920	1,868,780	4,758,004	109	2.55	4.8	.48
North Carolina	21	551	4,549,396	3,609,061	945,761	4,047 340	6	4.28	4.8	.79
Georgia	22	271	4,136,857	2,880,435	789,191	3,431,754	10	4.35	5.2	70
North Dakota	23	66	4,827,477	2,756,484	1,029,070	3,274,958	52	3.18	4.7	.57
Colorado	24	46	4,869,458	2,716,924	1,012,381	3,063, 00	73	3.03	4.8	.56
West Virginia	25	334	3,813,985	2,680,322	767,160	2,969,298	8	3.87	5.0	.70
Oklahoma	26	30	4,516,858	2,440,518	975,870	2,855,216	108	2.93	4.6	.54
South Dakota	27	80	4,427,426	2,380,818	915,541	2,695,024	38	2.94	4.8	.54
Arkansas	28	158	2,912,566	1,840,529	605,702	2,005,295	13	3.31	4.8	.63
New Jersey	29	119	2,404,670	1,743,080	466,338	1,871,129	13	4.01	5.2	.72
Utah	30	72	2,546,801	1,217,169	513,692	1,413,428	24	2.75	5.0	.48
Total		8.987	481,658,179	$312,632,026	100,823,820	$342,119,777	37	$3.39	4.8	$0.65

stance, in the State of Minnesota, there were 512 milling establishments (including small grist-mills not included in the foregoing table) representing a capital of $24,125,781, and employed 4,086 wage-earners. The average capital invested for each establishment was $47,121, and the average number of wage-earners for each establishment was eight. Compare with this some other locality having approximately the same number of establishments, for instance, Arkansas: the total number of establishments in Arkansas was 410, representing a capital of $1,183,052, the number of wage-earners was 443, the average capital for each establishment was $2,885, and the average number of wage-earners for each establishment was one. Again, in the case of South Carolina, the total number of establishments was 556, the capital invested was $652,553, the number of wage-earners was 281, the average amount of capital invested in each establishment was $1,174, and the average number of wage-earners was only about equal to one for every two establishments in operation."

The following table shows the number of flour-mills having an annual production of 1,000 or more barrels, in States having a cereal mill product of $1,000,000 and over in which wheat flour is the chief product. (Many small mills grind rye and corn principally, and a little wheat):

States and Territories.	1,000 to 4,999 bbls.	5,000 to 19,999 bbls.	20,000 to 99,999 bbls.	100,000 bbls. or more
United States	4,310	2,584	634	135
Alabama	17	3	1	....
Arizona	4	5	1	....
Arkansas	71	34	2	....
California	30	28	11	6
Colorado	12	12	17	1
Connecticut	....	....	....	....
Delaware	27	7	1	....
District of Columbia	....	....	2	....
Florida	....	....	....	....
Georgia	76	9	5	1
Idaho	11	17	4	....
Illinois	129	131	50	12
Indiana	245	235	44	8
Indian Territory	8	12	3	....
Iowa	129	107	21	2
Kansas	73	97	48	13
Kentucky	170	117	17	1
Louisiana	....	....	....	....
Maine	7	1	....	....
Maryland	128	36	6	2
Massachusetts	2	....	....	....
Michigan	236	137	37	4
Minnesota	93	151	52	24
Mississippi	2	....	....	....
Missouri	330	165	44	9
Montana	4	7	4	....
Nebraska	93	110	18	....
Nevada	9	1	....	....
New Hampshire	....	....	1	....
New Jersey	59	27	1	....
New Mexico	19	9	....	....
New York	127	80	23	14
North Carolina	202	36	1	....
North Dakota	23	25	17	1
Ohio	375	282	51	5
Oklahoma	6	14	13	1
Oregon	48	52	13	3
Pennsylvania	556	185	25	5
Rhode Island	....	....	....	....
South Carolina	39	8	1	....
South Dakota	27	55	7	....
Tennessee	209	98	16	6
Texas	23	42	25	6
Utah	42	33	3	....
Vermont	1	....	....	....
Virginia	281	56	12	1
Washington	12	24	16	4
West Virginia	151	29	5	....
Wisconsin	200	103	16	6
Wyoming	4	4	....	....

One of the more recent features of the flour trade has been the considerable business by Minneapolis mills with Australia, the direct result of the crop failure there in 1902. Minneapolis mills also send flour to South Africa, and have made trial shipments to China, and there is a possibility of a trade being developed in the Far East. Pacific coast mills have introduced their flour in China and Japan, but as yet those countries are not bread-eaters. The northern transcontinental railroads, which will soon connect with an Asiatic steamship line owned by one of the roads, promises to revolutionize some of the native customs. And if China can be induced to become a bread-eater, the export flour business via the Pacific will increase very rapidly.

Commercially, the flour-milling industry has made as great progress as it has mechanically. As the skill of the mill furnisher and the operative miller has separated the best parts of the wheat into a refined and delicate product, yet retained the most wholesome and nourishing properties, as compared with the dark and coarse flour of an earlier milling age, so the work of the merchant miller of to-day differs from that of the miller of the early part of the last century.

Milling is now more a commercial and less a mechanical proposition than ever before. Mechanical perfection has nearly been reached; and it is easier to keep a machine running smoothly than to invent and perfect the machine. Perhaps the greatest commercial problem is that of competition, not only of individual millers, but of nations. It is first a competition for the raw material, and then for the flour trade. Almost every country desires to be a manufacturing nation to some extent, whether a wheat-growing country or not, therefore encouragement is given to home industries. Then, too, Europe buys large quantities of American wheat when the price is low, and later this enters into competition with American flour in foreign markets. Therefore, the flour trade is on a world-wide basis, and the large miller, more than ever before, has great commercial, rather than mechanical, problems to solve. Never, however, will he feel they have all been solved, until the United States exports the surplus of its wheat crop as the manufactured article of flour, rather than a large part of it as raw material.

Henry L. Little,
Mgr. Pillsbury-Washburn Flour Mills Co., Ltd.

Flour, Wheat, a finely ground meal used for food. Ordinary white or bread flour, of which there are a number of grades, is composed of the interior portion of the wheat kernel subjected to processes of pulverization and purification. In the preparation of white flour either a portion or all of the bran, germ, and other offal parts are removed. When the entire wheat kernel is ground into a meal, it is called graham flour. When a portion of the bran is removed but the germ and fine bran are retained, the product is called purified graham or entire wheat flour.

The history of wheat milling shows that many and gradual changes have taken place since the early times when wheat was pulverized between stones to the present time when it is reduced by steel rolls. Wheat has variously been reduced to flour by means of stone crushers, saddle stones, and stone mortars. The ancient Greeks, Romans, Chaldæans, and Egyptians used saddle stones for grinding wheat into flour, the wheat being placed in a concave stone and rubbed with a convex stone rocked backward and forward. Saddle stones are still in use among the native Africans, and are known to have been used from earliest times. They are also found among the remains of the prehistoric Swiss lake-dwellers and mention is made of them in the earliest literature. Their use appears to have been common among all primitive races and they are in use to-day by many barbarous and half-civilized nations. Near the beginning of the Christian era, querns or crude crushers in which the parts were fitted mechanically came into use. The upper stone or pestle revolved upon the lower concave stone. The quern was the forerunner of the millstone. Querns are still in use in some Asiatic and European countries. The millstone came into use about the 14th century and was the result of gradual evolution from the stones shaped by nature and operated by hand to specially hewn and dressed millstones propelled by various forms of motive power. In ancient times, flour was prepared in each household, the grinding being done by women, slaves, and menials. During the Middle Ages when the feudal system was at its height, crude flour-mills or querns formed a part of the outfit of each castle or estate. In some countries, the right to operate these mills was vested in the clergy, and in early English history frequent mention is made of contests between the people and the landlords and clergy relative to their right to operate these mills or querns.

Until the beginning of the 17th century wheat milling was simply a crude agricultural industry, the earlier mills being operated by slaves, then by oxen. Later water wheels and windmills were used as motive power. About 1820, a flour-mill was first operated by steam. At the present time, some mills are operated by electric power.

About 1870 the present roller process of flour production was introduced from Hungary into America. The process consists of the gradual reduction or pulverization of the floury portions of the wheat kernel between corrugated and smooth steel rolls and of the purification of the product by means of aspirators, sieves, and bolting cloths. During the process of milling, the granular middlings undergo gradual reduction and are passed from break to break. At each break or grinding, the fine flour is removed by bolting, the middlings are separated and passed to other rolls and the tailings are subjected to further reduction. Before passing to the rolls, the wheat is screened to remove loose dirt and weed seeds, and occasionally washed to remove adhering dirt and debris; then dried or tempered with steam, as may be necessary in order to more easily effect reduction. The first break simply flattens the kernels after splitting them in halves along the longitudinal groove. The germ is pinched off by the rolls and is readily separated. The flour passes automatically from one break or set of rolls to another. Each break is regulated so as to pulverize a little finer than the preceding one. Each stream is purified by passing through reels and by subjection to aspirators which remove the fine dust and dirt by suction. Finally the various streams are blended so as to form different grades of flour. In large mills, the cleaned wheat is usually elevated to the top of the mill, and then passed on to the rolls, and the various streams blended in such a way that the final flour product is obtained after being separated into 40 or more separate streams.

The introduction of the roller process of miling has made it possible to use varieties of wheat from which high-grade flour could not be made by the old stone process. By the roller process of reduction, the granular middlings which were formerly excluded from the flour and sold as a distinct product for animal feeding are now reduced and added to the patent grades of flour. About 75 per cent of the cleaned wheat is returned as merchantable flour, 72 per cent being straight grade or ordinary white flour. In ordinary milling, the grades are as follows: (1) first patent; (2) second patent; (3) straight, sometimes called standard patent; (4) first clear; (5) second clear; (6) red dog. First patent flour is the highest grade manufactured. Its gluten has greater power of expansion and absorbs more water than that from any other grade. First patent flour produces the whitest and largest sized loaf of bread. Second patent flour is similar to first patent, but the bread is slightly darker in color and the gluten does not possess quite so high a power of expansion. First clear grade flour is obtained after the removal of the first and second patent grades. This flour is slightly darker in color and produces a smaller sized loaf than the patent grades. Second clear or low grade is the name given to a small amount of flour obtained after the removal of the first clear. About 12 per cent of the cleaned wheat is recovered as first clear flour and about .5 per cent as second clear or low grade. When the wheat is milled so that the first and second patents and the first clear are all obtained as one flour, the product is called straight grade. This is the flour that is most extensively used for bread-making purposes. Straight flour is the sum of the first and second patents and the first clear. The lowest grade of flour manufactured is called red dog; it is dark in color and possesses but little power of expansion. It is secured largely from those portions of the wheat kernel adjacent to the germ and aleurone layers. Red dog flour is not generally used for human food, but is employed in the arts, as for foundry purposes, for the feeding of animals and occasionally in the preparation of some cereal breakfast food. It has a high per cent of protein or nitrogenous material, but is not valuable for bread-making purposes because the gliadin and glutenin (see Bread and Bread Making) are not present in the right proportions to form a balanced gluten. By blending the different standard grades of flour, various commercial grades sold under different trade names are secured. The composition and properties of different kinds of flour result from the kind of wheat used in preparation (see Wheat) and the method of milling employed. The percentage amounts of bran, shorts, and standard grades of flour obtained by the roller process vary with different kinds of wheat. Some wheats yield more flour than do others. The average yields are approximately as follows:

	Per cent of cleaned wheat recovered
1. First patent	56.0
2. Second patent	60.8
3.* Straight or standard patent	72.6
4. First clear or first bakers	11.8
5. Second clear or low-grade	0.5
6. Red dog	1.9
7. Shorts middlings	11.6
8. Bran	13.4

*Straight grade flour is composed of first and second patents and first clear grade.

By the roller process of milling, the germ is excluded because of its poor bread-making properties and its fermentable nature. The wheat offals of which shorts and bran form the main portion are by-products used for the feeding of animals. About 25 per cent of the cleaned wheat finds its way into the offals. Bran is the episperm or outer covering of the wheat kernel. As human food, it is indigestible and does not contain any appreciable amount of available nutrients. As an animal food, however, it has a high value. Shorts consist mainly of the fine bran mixed with some of the floury portions of the wheat kernel. When the wheat screenings, consisting of weed seeds and other refuse are ground and mixed with the shorts, the product is known as shorts feed. When the germ is mixed with the shorts, the term shorts middlings is used. By some processes of milling, the germ is obtained separately. From 5 to 7 per cent of the weight of the cleaned wheat is recovered as germ.

Wheat flour is composed of starch, gluten proteids, water, fat, ash, or mineral matter, and small amounts of other compounds, as sugars, cellulose, organic acids, amids, etc. The proximate composition of the different kinds of flour when milled from the same lot of hard wheat is given in the following table:

	Water, Per Cent	Protein (Nx 5.7) Per Cent	Fat Per Cent	Carbohydrates Per Cent	Ash Per Cent	Phosphoric Acid Per Cent	Acidity Per Cent	Heat of Combustion per Gram. Determined. Calories
Wheat	8.50	12.65	2.36	74.69	1.80	0.75	0.18	4.140
First patent flour	10.55	11.08	1.15	76.85	.37	.15	.08	4.032
Second patent flour	10.49	11.14	1.20	76.75	.42	.17	.08	4.006
Straight flour	10.54	11.99	1.61	75.36	.50	.20	.09	4.050
First clear grade	10.13	13.74	2.20	73.13	.80	.34	.12	4.097
Second clear grade	10.08	15.03	3.77	69.37	1.75	.56	.27	4.267
Red dog flour	9.17	18.98	7.00	61.37	3.48	....	.59	4.485
Shorts, middlings	8.73	14.87	6.37	65.47	4.56	....	.14	4.414
Bran	9.99	14.02	4.39	65.54	6.06	2.20	.23	4.198

From the table, it will be observed that there is a gradual increase in the amount of ash, proteids, and fat from the first patent flour to the red dog or lowest grade of flour. In fact, the variations in ash content of the different grades of flour are so regular that the percentage of ash can be taken as an index to the grade of flour. The highest grade flours, as first patent, contain least ash because of the more perfect exclusion of the bran and endosperm parts. There is but little difference in chemical composition between the first and second grades of patent flour, second patent, containing more fat, slightly more protein and germ, and less carbohydrates than first patent. In the straight grade or ordinary bread flour, there is only from .6 to .7 per cent less nitrogenous material as proteids than in the wheat from which it was milled. Second clear and red dog flours contain a large amount of protein, fat, and ash, and judged by their proximate composition only, would appear to have a higher nutritive value than the patents or straight grade flours. But when judged on the basis of digestibility, available nutrients and physical character of the bread, these flours are found to have a much lower value than the patents or straight grade flours. For nutritive values, see article on BREAD AND BREAD MAKING. During the process of milling, the flour particles pass through bolting cloths containing from 12,000 to 16,000 meshes per square inch, which results in even and fine granulation of the flour particles. The character of the flour particles as angular or spherical depends largely upon the character of the wheat, as hard or soft, and to a less extent upon the method of milling. The flour granules from hard wheat are angular and have a sharp feeling akin to fine sand, while soft wheat flours produce small spherical particles lacking in gritty feeling.

In the testing of flour, particular attention is given to physical characteristics, as color, purity as indicated by absence of dirt and fine pieces of bran, capacity to absorb water, quality of gluten and character of the bread product. For bread-making purposes, the quality of the flour depends largely upon the amount and quality of the gluten. The gluten is obtained by making a stiff dough of the flour and then washing this dough with an abundance of water, which removes the starch, leaving the gluten in the form of a gum-like mass. Gluten from high-grade flours is firm, elastic, white or of slightly yellowish tinge and possesses good qualities of expansion. Poor gluten is dark in color, sticky and lacking in elasticity. The color of the flour depends largely upon the quality of the wheat and the method of milling employed. Some wheats produce creamy or yellowish flours, others chalk white flours and others dark-colored flours. Dark-colored flours, however, produce bread of inferior quality; creamy and white flours producing the best grades of bread. The granulation of the flour is also taken as an index of its quality, as it reveals to the experienced miller and baker the character of the flour. Comparative baking tests are generally resorted to in order to determine the bread-making value of flours. By these tests, under uniform conditions with the same amount of flour, yeast, water, etc., in each case, differences in the bread-making qualities of the flour are readily revealed. When flour is stored for a long time, it sometimes becomes inferior through fermentation changes. Ordinarily, flour will not deteriorate until after it has been kept for 10 months or more. Some wheats produce flours of better keeping qualities than do others. The soundness of the wheat, as freedom from rust, smut or other blemishes, influences the keeping qualities of flour as well as does also the process of milling, particularly the extent to which the cleaning and purification are perfected.

Wheat flour is not ordinarily adulterated, although at times attempts have been made to add other cereals and mineral adulterants. The national flour law requiring all mixed flours to be branded has prevented extensive adulteration. At one time, corn flour produced by milling corn, was used for adulterating wheat flour. This, however, was only practised for a very short time when corn was cheap and wheat was high in price. The blending of wheat and corn flours has never proven successful and the practice since the passing of the national flour law has been discontinued. Wheat flour appears to be less subject to adulteration than many other articles of food. See ADULTERATION.

Wheat flour is used not only for bread making but for other purposes. Crackers, cakes, pastry and many food articles are made largely of flour. Flour is also used in the arts and industries and in various manufacturing operations. The comparative value of bread made from different kinds of flour, as graham, entire wheat and straight, is discussed in the article BREAD AND BREAD MAKING.

It is estimated that four and a half bushels of wheat, equivalent to about 200 pounds of flour, are consumed annually per capita in the United States. The consumption of flour as food has, during recent years, gradually increased. Some political economists and scientists have feared that at no distant date the consumption of flour would exceed the production of wheat. But improved methods of agriculture and the opening up of large tracts of land suitable for wheat culture, as in northwestern Canada, render this improbable. From earliest times wheat and wheat flour have taken an important part in the dietary of man and there is every reason to believe that it will continue to be one of his staple articles of food. The extent to which it should be used in the dietary depends largely upon the individual and the cost of food. Ordinarily wheat flour is one of the cheapest articles of food, and when it forms a part or even the main portion of a ration, it supplies a large amount of nutrients in a digestible form and at a low cost.

HARRY SNYDER,
Professor of Agricultural Chemistry, University of Minnesota.

Flow'er, Benjamin Orange, American editor and author: b. Albion, Ill., 19 Oct. 1858. He was for some years the publisher and editor of the 'Arena' at Boston. Among his numerous works are: 'Civilization's Inferno; or Studies in the Social Cellar' (1893); 'The New Time' (1894); 'Persons, Places, and Ideas'; 'Gerald Massey: Poet, Prophet, and Mystic' (1895); 'The Century of Sir Thomas More' (1896); 'Lessons Learned from Other Lives.'

Flower, Frank Abial, American historical writer: b. Cottage, N. Y., 11 May 1854. Has written several local histories: 'Old Abe, the Wisconsin War Eagle' (1880); 'The Life of Matthew H. Carpenter' (1883); 'History of the Republican Party' (1884).

Flower, Roswell Pettibone, American financier: b. Jefferson County, N. Y., 7 Aug. 1835; d. Eastport, Long Island, 12 May 1899. He began his business and political career in Watertown, N. Y., where he organized the Jefferson County Democratic Club. His success in politics attracted the attention of Samuel J. Tilden, through whose influence he was appointed chairman of the Democratic State Committee in 1877. Four years later he was elected to Congress, and in 1886 was appointed president of the Subway Commission. He was re-elected to Congress in 1888 and 1890, and in 1891 was elected governor of New York. From the close of his term till his death he applied himself to the interests of his large banking house and to a systematic course of philanthropy.

Flower, Sir **William Henry,** English zoologist: b. Stratford-on-Avon 30 Nov. 1831; d. London 1 July 1899. After a medical training he served as an assistant-surgeon in the English army during the Crimean war; in 1861 was appointed conservator of the museum of the Royal College of Surgeons; and in 1870 Hunterian professor of comparative anatomy in the same institution. In 1884 he was appointed director of the natural history departments of the British Museum, which two or three years before had been removed to their new quarters at South Kensington. From this post he retired in 1898. In 1889 he was president of the British Association meeting at Newcastle-on-Tyne. He was made a knight commander of the Bath in 1892. Several important treatises came from his pen, including 'Introduction to the Osteology of the Mammalia' (1870, 3d ed. 1885); 'Fashion in Deformity' (1881); 'Introduction to the Study of Mammals, Living and Extinct' (1891); 'The Horse: a Study in Natural History' (1892); and 'Essays on Museums and other Subjects connected with Natural History' (1898).

Flower, that part of the spermatophytous (phanerogamous) plant which consists of the organs of reproduction, frequently, but not necessarily, accompanied by protecting envelopes. In common usage, the word "flower" is applied to those related structures only in which one or both sets of floral envelopes are present and rather conspicuous.

Parts: Their Position and Functions.— The end of the flower stalk upon which the parts of the flower are grouped is known as the torus or receptacle. In a complete flower the floral envelopes are double, composed of two whorls or circles, alternating with each other; the outer series consisting commonly of green or greenish leaves named sepals, and together forming the calyx; and the inner series, of leaf-like parts, usually of a delicate texture, and of some other color than green, named petals, and together constituting the corolla. The term perianth is sometimes applied to the floral envelopes taken together, but it is generally restricted to those flowers in which only one of the series is present, at least in appearance, as in the lily, and in the common marsh-marigold; or in other instances where the limits of the calyx and the corolla are not easily distinguished. The organs of reproduction are the stamens, or fertilizing organs, forming a whorl within the floral envelopes and known collectively as the andrœcium; and the pistils at the centre of the flower, containing the ovules or undeveloped seeds, and known as the gynœcium. The essential part of the stamen is the anther or pollen sac, having usually two cells attached by a connectile to one another and to the stalk, called a filament, at the summit of which they are placed. The insertion or place of attachment of the stamens varies. In the lily, the buttercup, and the marsh-mallow the stamens are seen to arise directly under the gynœcium, and are accordingly described as hypogynous; in the strawberry and cherry they arise in a higher circle and upon the calyx and are termed perigynous; while in the iris, the rose, and blueberry they are inserted upon the top of the ovary, and are said to be epigynous. (Plate I., Figs. 3, 4, 5.) In the absence of the filament the anther may be sessile on the receptacle, calyx, petals, or ovary, or be adherent to the style (as in *orchis*). The essential parts of the pistil are the ovary and the stigma. The former is the rudimentary seed vessel. The latter, which is intended to receive the pollen upon its viscid surface, is connected with the ovary by a stalk known as the style, or is sessile upon it, as in the poppy. The pistil may be formed of a single carpel or of a number of carpels united by their lower parts to form a compound pistil. The number of carpels represented in such a pistil may be determined by the number of styles; by the number of free stigmas (though a single carpel is sometimes accompanied by a two-lobed stigma); by the seams, lobes, or angles of the ovary; by the cells, by the character of the placenta, or ovule-bearing portion of the carpel. The ovules, or rudimentary seeds, are borne upon the inner or ventral suture formed by the united edges of the carpellary leaf constituting the seed-vessel. In a "compound" pistil the single carpels may be closed, as in a "single" pistil, and joined at their sides and ventral sutures; or they may be open and joined by their edges. In the first case there will be in the compound ovary, as many cells as there are carpels, and the placentæ will meet at the axis. In the second there will be but one cell and the placentæ will be parietal. There are, however, many intermediate conditions, as in the poppy where the inflected margins of the carpels carry the placentæ to the centre. The apparent anomaly of a free axial placenta in the single cell of a compound ovary is found in the purslanes and in the pinks. The delicate partitions or dissepiments have very early disappeared. The ovules vary in number from one to hundreds. They are sessile or borne on a stalk called the funiculus. In direction they are horizontal, ascending (pointing obliquely upward), erect from the base of the cell, pendulous from near the top of the placenta, or suspended from the summit. The ovule-body is surrounded by an integument of one or two coats, which does not meet at the summit. The minute opening thus left is known as the micropyle. Within the ovule-body is the embryo-sac, which contains the endosperm and one or more germ-cells. The simplest form of pistil is that of the gymnosperms, which consists of open scales bearing two or more ovules on the inner face next the scales.

The chief function of the calyx is protection, an office which it shares with the corolla, especially while the more delicate organs are in the bud. When the corolla is lacking, the calyx frequently assumes some of its characteristics, becoming more conspicuous and of finer color and texture, the marsh-marigold and purple clematis furnishing examples in point. The bright hues or markings of the corolla serve to attract the insects that play such an important part in the pollination of the flower. The andrœcium has for its function the producing and scattering of the fructifying pollen, which falls from the anthers when they open at maturity. The gynœcium is devoted to the development of seed from the ovules.

Evolution of the Flower.—The recognition of the flower as a modification of the stem and leaves, adapted to the purposes of reproduction, gives a key to its morphology, throwing light on

MORPHOLOGY OF FLOWERS.—I.

1. Ash flower. 2. Section of flower of Hippuris. 3. Hypogynous flower (sun-rose). 4. Perigynous flower (cherry). 5. Epigynous flower (whortleberry). 6. Flower of Elm. 7, 9. Funnel-shaped corollas of Gentian. 8. Bell-shaped corolla 10. Rotiform corolla. 11. Tubular corolla (bluebottle). 12. Sections of bluebottle. 13. Two-lobed flower. 14. Labiate flower. 15. Papilionaceous corolla. 16. Parts of a papilionaceous corolla. 17. Personate corolla (spurred). 18. Male (staminate) flower (melon). 19. Female (pistillate) flower (melon).

innumerable variations of arrangement and structure and even on such details as scent, color, and the production of nectar. This conception of the flower was of fundamental importance in the transition from the artificial to the natural system. The shortening of the axis aggregates the transformed leaves and a growth is produced in which the arrangement of the true leaves on the stem is still the regulating principle, whether there be an alternating succession or a whorled (cyclic) grouping, the more developed flowers following the latter order, with limited number of parts, generally definite for certain large groups. Flower buds, like leaf buds, are terminal or axillary. The prefloration or æstivation of the sepals and petals, individually considered, is similar to that of leaf buds, being convolute, revolute, or involute. The metamorphosis of the leaf is easily traced in certain flowers. In the peony the transition from leaves to bracts and thence to petals is gradual, as is the change in the sweet-scented shrub (*Calycanthus*) from sepals to petals. In the white water-lily the gradations between the pistil and stamen are finely illustrated. It does not follow that the order of development is from the former to the latter. That the essential organs are of earlier origin than the floral envelopes is indicated by the fact that the latter are wanting in the gymnosperms, which are older and less developed forms than the phanerogams (spermatophytes). In the anther we recognize the infolded leaf-blade, in the filament its petiole, and in the pollen a development from the parenchyma. In the pistil the carpellary leaf may be traced, with its lengthened apex forming the style. The double-flowering cherry offers an interesting example of the reversion of the pistil to the form and color of the true leaf. The interpretation of the ovule as a transformed bud upon the edges of the carpellary leaf is confirmed by the fact that the leaves of *Bryophyllum* and certain other plants produce buds upon their margins or upper surface. Even the stipule of the leaf has its homologue in the floral structure. What is called the outer calyx or epicalyx of the strawberry may be regarded as the united stipules of adjacent sepals. That portion of the stem which becomes the floral axis sometimes undergoes striking modifications in its function as a receptacle. In the wild geranium it is extended into a slender beak, while in the rose-hip it becomes urn-shaped. The fig and the strawberry are succulent receptacles, the one hollow and the other convex. In investigating the morphology of the flower it was formerly the method of botanists to start from an ideal type and to consider as mere modifications of that type all forms that differed from it. A later view admits the probability of various independent lines of development. Those types are the simplest in which the floral structure is nearest to the original arrangement, the parts being more definitely separated. Union of parts indicates as a rule greater complexity of type, though simplicity of structure may in some cases be an indication of degeneration. Simplicity of type is illustrated by the water-lily family (*Naiadaceæ*), and complexity by the orchids (*Orchidaceæ*) and the thistle family (*Compositæ*).

Although the morphology of the flower continues to be of paramount importance in the classification of plants, the application of the principles of evolution to the study of botany has inevitably led to a method differing from that formerly in use. The 24 classes into which Linnæus divided plants were (with the exception of the cryptogams) based on the length, number and other characteristics of the stamens; and the classes were divided into orders chiefly according to the characteristics of the pistil. In the system worked out by the French botanists and known as the "natural" system stress was laid upon the characteristics of the perianth, the presence or absence of a corolla and the union or separation of petals. In a system based on the facts of development the fundamental division into monocotyledons and dicotyledons may still be maintained, though late methods do not recognize the likeness existing between adult forms as sufficient to place them in the same group, classification proceeding rather on the principle that relationship is more convincingly shown by similarity in manner of reproduction and in laws of growth.

Variation in Structure and Arrangement.— Flowers are said to be perfect when they are provided with both kinds of essential organs; complete when calyx and corolla are also present; regular when all the parts of each set are alike in shape and size; and symmetrical when they have an equal number of parts of each kind. In the monocotyledons the parts are in threes; in the dicotyledons mostly in fives or fours. The perianth of the lily, though apparently having six in a set, has really three sepals and three petals, as is plainly shown in the bud. Apparent violation of the law of symmetry may in certain cases be due to adhesion, abortion or non-development of floral plants. In the mustard family, though the calyx and corolla are in fours, the stamens are generally six. The suppression of two stamens would account for lack of symmetry. An instance of non-development is found in the monkshood, where the sepals number five and the petals two, while three very minute rudimentary petals are sometimes discernible. The violet, although symmetrical as to sepals, petals, and stamens, which are in fives, has a simple stigma and three-valved seed-vessel. The flax is a good example of a symmetrical and regular flower. The irregularity of the flower may be shown in any of its parts, but is most striking in the peculiar forms often assumed by the corolla and calyx, most curious instances being seen in the orchids, a family in which the morphology of the andrœcium and gynœcium are also of especial interest.

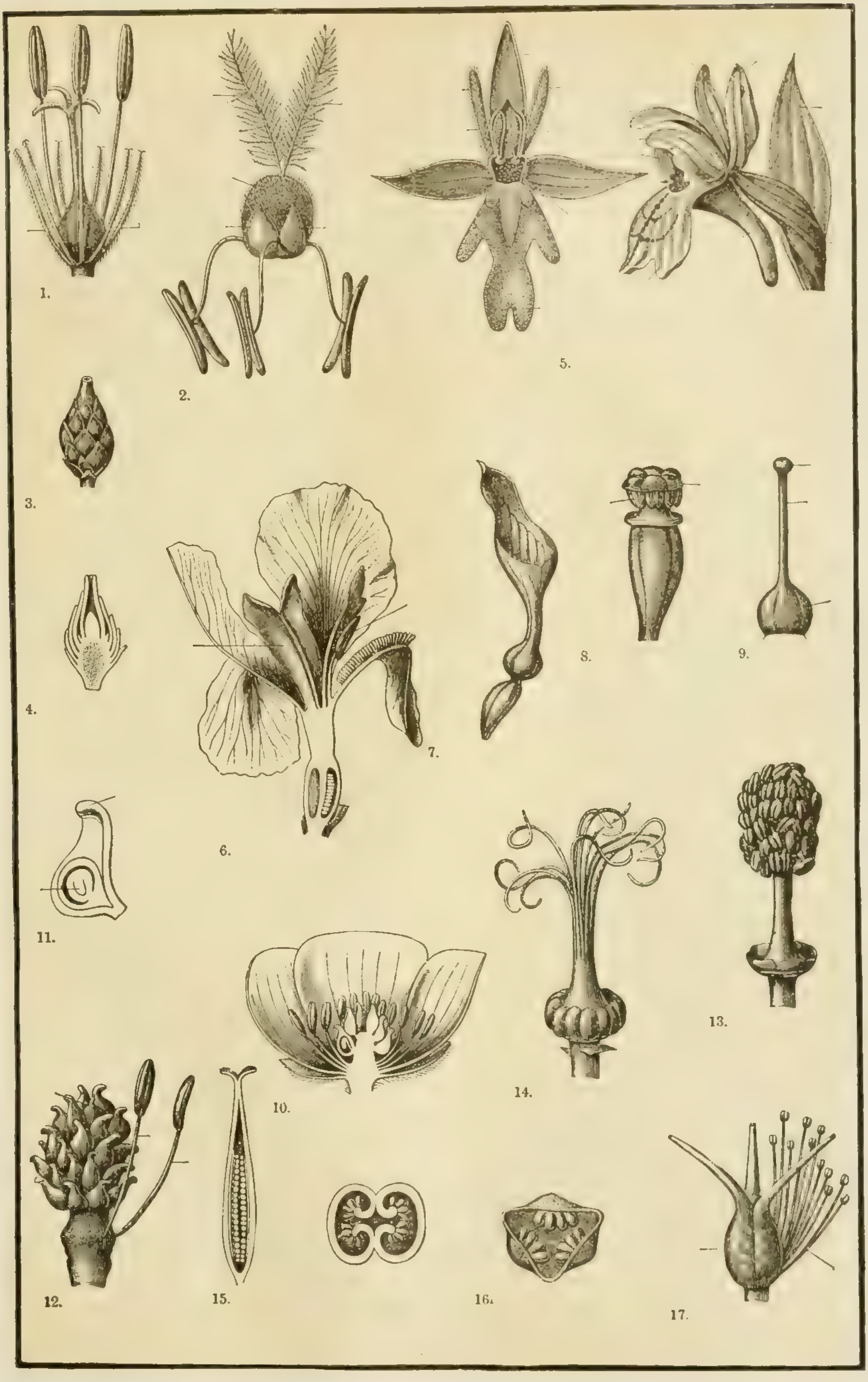
Certain variations of form may be traced to the visits of insects, as where such a visitant alighting always on the same side of the flower tends by its weight to increase the size of that part or to thicken the tissue, etc. The chief irregularity of some corollas consists in having one or more spurred petals. This deviation from the ordinary petal shape is common and sometimes serves the purpose of providing flowers with nectaries, as in the case of the violet, the toad-flax, and the columbine. In the nasturtium it is the calyx spur that constitutes the nectary. Less noticeable modifications in the petals of other flowers have the same function, as the scales on the petal-claws in the crowfoots and the pits in the petals of lilies and fritillaries. The irregularity illustrated in the blossoms of the pea and the bean is of a very common kind. This butterfly or papilionaceous corolla marks the family to which these legumes belong. In the case of gamopetalous (sympetalous) corollas it is convenient to speak of the parts of the more primitive or separated type as having coalesced, even if the growth be regarded as undivided from the beginning. The regular five-petaled corolla has its homologue in such a gamopetalous corolla, as that of the campanula (Plate I., Fig. 8), where the five lobes correspond to the separate petals and maintain the numerical scheme of the flower. The labiate or bilabiate (two-lipped) corolla is the characteristic form of the mint family (*Labiatæ*), and of the figworts (*Scrophulariaceæ*), the ringent or gaping corolla of the dead-nettle (Plate I., Fig. 14) and the personate corolla of the snapdragon and toad-flax being variations of the type. Not only is a union of parts frequent in the corolla and the calyx, but it has its counterpart in certain forms of the andrœcium and the gynœcium. The filaments of the lupine arise as a single cylindrical growth and the syngenesious anthers of the *Compositæ* are a pre-eminent characteristic of that large family. The combination of several carpels to form one pistil has already been referred to, complete union being found in the rhododendron among other instances, and the gynœcium takes a great variety of forms according to the degree of distinctness maintained by the separate parts of the contiguous carpels.

Fertilization.— Flowers which are achlamydeous, that is, destitute of floral envelopes, may be unisexual or bisexual (androgynous). The male (staminate) flowers and the female (pistillate) flowers may be found upon the same plant, which is then termed monœcious, the alder, oak, ragweed and begonia being examples; or the staminate flowers of a species may be produced by one plant and the pistillate by another, the plants being then diœcious, as in the willow family (*Salicaceæ*). The neutral flower is one lacking both kinds of essential organs, as is the case with the ray flowers of many *Compositæ*. The showy snow-ball tree and the garden hydrangea are examples of development of such flowers by cultivation, the neutral flowers being found only on the margin of the flower cluster in the wild species. Close fertilization, that is, the fertilization of a flower by its own pollen, is rendered impossible by the unisexual arrangement, but so long as the transfer may be from flower to flower on the same plant the advantages of cross-fertilization strictly so-called (that is, from plant to plant) are not positively insured. Diœcious flowers might be expected to prove better producers of seed, as close fertilization would naturally be looked for in bisexual flowers, and indeed was formerly considered the normal method, but it is doubtful if there is any species of which it could be proved that its flowers are without exception self-fertilized. By the dichotomy of some species of bisexual flowers (that is, by a difference in the time when the essential organs mature) the pollen is set free before the stigma is ready for pollination, the latter being accordingly obliged to rely upon pollen from without. In other cases the structure of flowers is of such a nature that fertilization by their own stamens is guarded against.

Agencies for the transportation of pollen are various. Flowers dependent upon the wind, like those of the date-palm, are known as «anemophilous»; those for which insects are the carriers are «entomophilous.» (See FLOWERS AND INSECTS.) Many plants bear two kinds of blossoms, conspicuous, nectar-producing flowers, which are entomophilous, and inconspicuous, later-blooming blossoms in which close fertilization takes place. Certain species of violets have the two forms, their later flowers never opening nor developing petals, but becoming fertilized in the bud. Contrary to the law which generally controls fertilization, these cleistogamous blossoms are more fruitful than those on the same plant open to cross-fertilization. Whatever be the method of pollination, the pollen-grain when it falls upon the stigma absorbs the moisture of the surface and germinates. It then sends down a tube which passes through the tissues of the style and stigma and on reaching the cavity of the ovary enters the micropyle and penetrates to the embryo sac. Sometimes the latter has grown out to the micropyle, or even through it, to meet the pollen-tube. The chalaza, or point of attachment of the ovule, is in a few instances the place of entrance for the pollen-tube. The transfer of the contents of the pollen-tube to the germ-cell in the embryo sac takes place, thus fertilizing the cell, which begins to grow and divide, developing the embryo plant, at first nourished by the endosperm, or albuminous contents of the sac.

Colors of Flowers.— The colors of flowers have been arranged in two series, the blue and the yellow, in both of which red and white are found, green being produced by a blending of the two. It has been estimated that in an average collection of 1,000 plants about 284 have white flowers, 226 yellow, 220 red, 141 blue, 73 violet, 36 green, 12 orange, 4 brown, and 2 black. White flowers are more generally odoriferous than those of other colors, and their odors are almost always agreeable. Red flowers, though less numerous than yellow ones, are more often fragrant. The tints are due to fluid or viscous matters contained in superficial cells and can be separated in certain cases by solution in water and in others by solution in alcohol and ether. Attempts have been made to refer the coloring matters to one or two principles, which have been described under the names of xanthin, xanthein, anthoxanthin, and cyanin and anthocyan. These bodies, however, are very ill defined and are in all probability mixtures, even supposing that when obtained from different sources they are essentially the same. The chief difficulty is to obtain the coloring matters in sufficient quantity for investigation and then to separate them accurately from each other which, as they are amorphous, uncrystallizable bodies, is not easy to accomplish satisfactorily. Of the coloring matters from flowers one of the most individualized is the yellow body obtained from saffron. See BOTANY; FLOWERS AND INSECTS; FRUIT; GARDEN; INFLORESCENCE; SEED.

Flower Beetles, scarabeid beetles of several genera One of the most abundant and destructive of these insects is the rose-chafer (q.v.), which annually does great damage to roses and other flowers and fruits. Several species of the genus *Euphoria,* more especially *E. inda,* is frequently found on flowers eating pollen, but it also attacks corn in the milk, and eats into various forms of fruit. Other flower beetles belonging to the genera *Hoplia* and *Trichius* are commonly found on flowers through-



1. Hypogynous bristles of Bulrush. 2. Hypogynous scales of Grass. 3. Flower of the Yew. 4 Section of the same. 5. Perianths of Orchids. 6. Iris. 7. Aristolochia. 8. Fruit of Aristolochia, showing sessile anthers. 9. A single pistil. 10. Section of Ranunculus. 11. A single carpel of Ranunculus. 12. Gynœcium of Ranunculus. 13. Andrœcium with united filaments. 14. Gynœceum with united carpels. 15. Ovary of Gentian with two united carpels. 16. Ovary of Violet with three united carpels. 17. Gynœceum of Hypericum with a part of the stamens.

out the country and take some part in the cross-fertilization of useful plants. Numerous other beetles frequent flowers, among which are beautiful species of the genera *Clerus* and *Trichodes* of the *Cleridæ; Leptura* and many related genera of long-horned beetles; and many genera of small families such as the *Mordellidæ.*

Flower-bug, a very minute bug (*Triphleps insidiosus*) also called "insidious flower-bug," and related to the bedbug. It is found on the foliage of various plants, and preys upon other minute insects.

Flower Month, in general any month in any country in which flowers are springing most abundantly; in the United States, June is specially the month of flowers. Specifically, the month Anthesterion, the eighth of the Attic year, corresponding nearly to February; so called because that time was, in that country, the season of flowers.

Flower-peckers, general name for a large family (*Dicæidæ*) of small insectivorous birds allied to the creepers (q.v.) which get their food largely by searching flowering plants and their blossoms, picking up minute insects largely by aid of a curious tongue which is separated at the end into four tubular projections. They inhabit the Indo-China region and thence throughout the archipelagoes to Australia, where the white speckled diamond-birds (*Pardalatus*) and the swallow-dicæum (*Dicæum erythrorhynchum*) are familiar friends of the gardener. They frequent bushes and trees, hopping briskly about the branches, and creeping and clinging like titmouses. Some make extremely beautiful, highly decorated nests, while others are content to deposit their eggs, which in most of the species are white, in holes in trees, or earthen banks, or old birds' nests. Some are plainly dressed, but most of the flower-peckers are gaudily colored, and several sing sweetly.

Flowering Ferns. See *Filicales* (1), under FERNS AND FERN ALLIES.

Flowers, in chemistry, a term formerly applied to a variety of substances procured by sublimation in the form of slightly cohering powder, hence in all old books we find mention made of the flowers of antimony, arsenic, zinc, and bismuth, which are the sublimed oxides of these metals in a more or less pure state. We have also still in use though not generally the terms flowers of sulphur, of benzoin, etc.

Flowers and Insects: Their Relations. In order to appreciate the intimate relations between flowers and insects we should bear in mind the fact that in all probability the earliest plants known were flowerless, and that the earliest known insects never visited flowers. The most primitive reproductive parts of plants were minute structures, simply greenish, and without colors. From the cryptogamous plants somehow arose the flowering plants, and when flowers did appear, they were of regular shape, with the corolla made up of separate petals: then finally appeared the irregular flowers like those of the monkshood, the pea, bean, wistaria, etc. The simpler forms of flowers were those of the grasses. Such plants are fertilized by the wind, but in the higher modern flowering plants the floral organs are fertilized by insects. What attracts insects to flowers, and thus causes them to carry the pollen from the stigmas to the pistil? Is it the nectar or the odor given out by the flower, or the colors of the petals?

Insects Attracted by the Sweets of Flowers. — According to Darwin, Lubbock, and others, the brightly colored petals of flowers are necessary to attract bees, butterflies, moths, beetles, etc. Thus the petals of many flowers are beautifully marked with highly colored hues, which are thought to be "guiding lines," by which the bee was guided to the nectary at the bottom of

A hawk-moth sucking nectar from a tiger-lily.

the flower. But this view has been called in question by a Belgian naturalist, Plateau. To test the matter Darwin and others had removed the petals, or corolla, and watched to see whether insects continued to visit the flower, but this, owing to want of care in removing the petals, had led to contradictory results. Plateau experimented more carefully; he avoided handling the flowers, or doing anything which might influence an insect's sense of smell. He removed the brightly colored corollas from the flowers of lobelia, ipomæa, larkspur, foxglove, etc., and in every case, except that of *Antirrhinus majus,* the mutilated flowers were observed to be freely visited by various kinds of insects (bees, bumblebees, syrphus flies, and an occasional butterfly), no special preference being exhibited for flowers that were left intact. The insects not only sucked honey from the mutilated flowers, but they often circled around them without alighting. In the case of the snapdragon, several bumblebees hovered around the mutilated heads but afterward left them for those with entire flowers, a result explained by the peculiar mode in which bees have to enter the corolla, which would render the absence of that structure perplexing to them. Plateau covered several of the large umbels of Hieracium with rhubarb leaves, when it was found that even when thus masked they were freely visited by insects. The result shows that insects are in reality guided to flowers in the great majority of cases by their sense of smell, the scent of the nectar attracting them. Some insects, as the white cabbage butterfly, are attracted by the white color of the flowers they visit, and yellow butterflies by yellow flowers. Undoubtedly some butterflies and moths have the color-sense, but probably those insects such as beetles, bugs, etc., which are most concerned in fertilizing flowers, are attracted by the odors emanating from the nectary and glands of such flowers.

Of flower-haunting flies (*Diptera*) the color-sense is shown in the case of certain higher types of flies which prefer red and blue flowers, and they oftener visit the more complicated kinds of flowers than do the smaller bees. These flies seem to possess greater importance for the function of pollination than previously supposed. In Africa some kinds of orchids are fertilized by flies.

It thus appears that though the colors of some flowers attract certain insects which have the sense of color, the most efficient insect-aids to fertilization of flowers are those which are attracted mainly if not solely by smelling the nectary or odor of the flower.

Plateau indeed claims that any flower is freely visited by insects if it be nectariferous, no matter how colorless or inconspicuous it may be. There are, on the other hand, flowers which seem to be wholly avoided by insects, many of which are gay and attractive enough in their

Bee rifling a blossom.

shapes and colors; but when Plateau placed nectar at the base of these flowers, visits of insects were at once begun. Meehan states that in the United States a single plant of the common sumac (*Rhus glabra*) was growing in an isolated spot almost hidden by other vegetation, and far away from any flowers visited to any great extent by insects. The flowers of this shrub are small, green, entirely inconspicuous, and so far as human olfactories go, odorless. But he observed an extraordinary number of kinds of insects visiting the flowers. He infers that this remarkable collection of insects, including honey-bees and wasps, could only have been guided by the sense of smell, and he infers that all plants with nectar have odor, though it may not be strong enough to be perceptible to man.

The nectary is a specially modified scent-gland, and the nectar is a specialized form of the sap or juice of the plant. As stated by Henslow, the nectaries probably originated from the visits of insects, and the local irritation set up by these visits gradually led to the origination of the glandular secreting organ called the nectary. When the entire flower degenerates and becomes self-fertilizing, not needing the help of insects, the nectary also disappears. Ant-plants are so-called because they are due to the modifications occasioned by the visits of ants.

Fertilization of Flowers by Insects.— We have seen that insects are strongly attracted to flowers by smelling the sweets secreted by glands or nectaries. How important this nectar is to bees is proved by the fact that the honey they produce is nectar changed to honey in their digestive organs. Many insects subsist on the pollen of plants; such are bees of all kinds which use it in making bee-bread as food for their young; multitudes of wasps, flies, and beetles gather also the pollen of flowers, and eat it, this being their only food, or they store it up as nourishment for their young.

Their visits to flowers result in their carrying the pollen from one flower to another, and thus fertilizing the plant. Hence owing to the visits of honey-making bees, of wasps, of moths, and butterflies, and of pollen-eating flies and beetles, the flowers become indirectly fertilized, and were it not for their visits, such flowers would be sterile, and the species die out.

As early as 1793 Sprengel discovered the main facts and many details as to the relations between flowers and insects. As Wallace states, he noticed the curious adaptation of the structure of many flowers to the particular insects visiting them; he proved that insects cross-fertilize flowers, and that the presence of nectar and pollen ensured the continuance of their visits. Afterward it was shown that cross-fertilization of plants was a benefit to them, while Darwin (saying that "nature abhors perpetual self-fertilization") proved that this was a general occurrence not only among ordinary plants but with orchids. It thus appears that insects have been the cause of, and are the means of maintaining, the present wealth of flowers which enliven the tropical forests, and adorn our northern gardens and fields.

Colors of Flowers and the Visits of Insects.— Although it is generally claimed that sweet odors are, as Wallace says, usually supplementary to the attractions of color, yet this view, as we have seen, will have to be modified. Gaudily colored flowers, like the sunflower, poppies, and peonies, are nearly scentless compared with plants like the mignonette, which are so fragrant. White flowers are fertilized by moths, and very frequently give out their scent only at night, as in the case of the butterfly-orchis. Bright red flowers are very attractive to butterflies, and are sometimes specially adapted to be fertilized by them, as many kinds of pinks, the corn-cockle, etc. Blue flowers are especially attractive to bees and other hymenoptera, as many as 67 species having been observed to visit the common European sheep's bit. Dull yellow or brownish flowers, some of which smell like carrion, attract flies, while the dull purplish flowers of the Scrophularia attract many wasps. (Wallace.)

It is interesting to learn that many change their colors as soon as fertilized; in this way bees avoid wasting their time in visiting such flowers as have already been fertilized and their nectary exhausted. The common lung-wort is at first red, but afterward turns blue. In southern Brazil grows a species of Lantana whose flowers are yellow the first day, orange the second, and purple the third, while F. Müller observed that many butterflies visited the yellow flowers only, some both the yellow and the orange flowers, but none the purple. Moreover many flowers have been specially adapted to the kinds of insects that most abound where they grow. Thus in the Swiss lowlands the gentians, although with us they flourish in the White Mountain region, are adapted to bees, but those of the high Alps to butterflies only, as this zone is the home of Alpine butterflies. The visits of insects to flowers in fine weather are incessant and hence economy of time is, as Wallace states, very important both to the insects and the flowers, because the fine working days are comparatively few. For example, bees keep to one flower at a time, visiting hundreds of blossoms in succession; they thus acquire quickness in going at once to the nectary, and the change of color in the flower, or incipient withering when fertilized, enables them to avoid those flowers that have already had their honey exhausted.

Perforation of Flowers by Bees.— If one will watch a wistaria when in blossom, he will notice that the bumblebees, in order to get at the nectar without loss of time, perforate the corolla right over the nectary, and thus speedily rifle the flower of its sweets. So well trained is the bee that the hole is always made right opposite or over the nectary. On the other hand the honey-bee, with its shorter and weaker maxilla, cannot make a hole through the walls of the corolla, but partly enters the flower on one side or the other and with more or less trouble laps up the nectar. At the end of the season, provided bumblebees are plenty, nearly every flower on a large vine will be found to have been perforated. Similar flowers, as the clover, touch-me-not, etc., are thus perforated. Lovell states that the maxillæ alone are employed in this act, being moved slowly backward and forward in puncturing the tissue. Thus the stout strong maxillæ of the bumblebee are adapted for this purpose.

Click-beetle and orchid.

Irregular Flowers due to Visits of Insects.— It is now thought by some observers that owing to the strains, pressure, and irritation caused by the visits of insects, flowers like those of the pea, bean, etc., have been formed. Henslow points out that the lower petal or lip of these irregular flowers forms a platform on which the bee rests while engaged in probing the corolla for nectar. In the irregular flowers of the foxglove, petunia, etc., the tube of the corolla has enlarged so as to allow the ingress of an insect which partly crawls into it, hence the tubular corolla having to bear the strain upon it bulges outward, while the lip or anterior petal is not much if at all enlarged. Even if, says Henslow, no more than the head of an insect enter the flower, then the corolla shapes itself to fit it. He explains the formation of the deep tubular corolla of the evening primrose or the honeysuckle by the fact that butterflies, in probing their depths while on the wing, irritate the tube only, which is thus made to become longer and correspondingly to contract in diameter, the result being that there is but little irregularity in the shape of the flower. The immediate mechanical cause of the shape of the wing-petals of many pea-blossom-like flowers is probably due to the weight of the insect in front, the local irritations believed due to the thrust of the insect's head and its probing for nectar, united with the absence of all strains upon the sides. An example of the great thickening of the tissue just where the strain will be most felt is the flower of the lady's slipper and Calceolaria.

Origin or Modification of Insects by Flowers. — We have seen that flowers attract insects by means of their nectar and sweets and also their pollen; that the visits of insects are in favorable days practically incessant, though owing to the weather more or less intermittent; the result seems to be that the forms of insects, especially of their accessory jaws (maxillæ and labium), as well as of their legs, are wonderfully adapted to their habits. It is not improbable that by these simple mechanical causes, that is, the use or exercise of the parts concerned in gathering pollen and nectar, a number of groups of insects (bees, certain flies, and the moths and butterflies, and certain families of beetles) have been brought into existence. We know that in all probability flowers and the insects which visit them, came into existence after the coal period, owing to the reaction of flowers upon these kinds of insects, causing the exercise and modification of the structures actively employed in collecting pollen. Among the flower-visiting flies and beetles the proboscis of the former, and the maxillæ of the latter, are wonderfully adapted for scraping off the pollen from the anthers of flowers.

Consult: Darwin, ‹Forms of Flowers› (London 1877); Müller, ‹The Fertilization of Flowers› (London 1883); Henslow, ‹The Origin of Floral Structures Through Insect and other Agencies› (New York 1893).

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Flowers, Artificial, flowers made from various materials to imitate natural blossoms. These are not a modern invention. The famous floral wreaths made by the ancient Egyptians were formed from thin plates of horn stained in different colors, sometimes also of leaves of copper, gilt or silvered over. The Romans excelled in the art of imitating flowers in wax and in this branch of the art attained a degree of perfection which has not been approached in modern times. Crassus, renowned for his wealth, gave to the victors in the games he celebrated at Rome crowns of artificial leaves made of gold and silver. In modern times the Italians were the first to acquire celebrity for the skill and taste they displayed in this manufacture, but they are now far surpassed by English and French manufactures, more especially by the latter.

The first artificial flowers made in modern times in civilized countries were manufactured out of many-colored ribbons which were twisted together and attached to small pieces of wire. But these first attempts were decidedly crude. In course of time feathers were substituted for ribbons, a more delicate material, but one to which it was not so easy to give the requisite shades of color. The plumage of the birds of South America is admirably adapted for artificial flowers on account of the brilliancy and permanence of the tints, and the natives of that continent have long practised with success the making of feather flowers. The Zoological Gardens in Regent's Park, London, contain a magnificent collection of artificial flowers made out of the feathers of humming-birds. In South America artificial flowers are also composed of the wing cases and other parts of some brilliant specimens of beetles. In Italy the cocoons of silkworms are frequently used for the purpose, as these take on a brilliant color and have a velvety appearance. Among the other materials used in this manufacture are cambric, muslin, satin, velvet, and other woven fabrics, blown glass, mother of pearl, brass, thin layers of whalebone, etc., beside the various vegetable and mineral coloring matters. Flowers were at one time made of porcelain and were perfumed. Great skill has been attained in the making of glass flowers and a remarkable collection of this kind is owned by Harvard University.

Flowers, Symbolism of, a special significance attached to flowers by means of which they are made to represent various ideas and sentiments. This mode of communicating thought has developed in certain countries into a language of remarkable elaboration. Among the Greeks and Romans the use of flowers was full of significance. Though the well-developed floral speech of the Romans was probably lost to a great extent, the study was revived in Europe during the Middle Ages, being especially appropriate in connection with such a romantic institution as chivalry. The Orientals have developed the language of flowers into a vehicle for communicating sentimental and amatory expressions of all degrees of warmth. Still further complexity is added by the habit of employing flowers the Turkish or Arabic names of which rhyme with the other really significant words. The language of flowers is, of course, arbitrary, and a bouquet which a Persian girl would understand would be unintelligible to an Egyptian inmate of the harem. Yet among European nations certain flowers have a common significance. The rose is widely accepted as the symbol of love and beauty; the forget-me-not of true love; the lily of purity; the violet of modesty; the daisy and white violet of innocence; the rosemary of remembrance; the amaranth of immortality; the asphodel of death and the unseen world; the pansy of thought; the hyacinth of sorrow; the narcissus of self-admiration; the poppy of oblivion. The almond expresses hope; the lily-of-the-valley unconscious sweetness; the wallflower, love faithful in spite of adversity; the primrose, early youth; and the cyclamen, diffidence. So surely as the orange-blossom is associated with marriage does the finding of white heather betoken good-fortune to come, while the future chances of love may be revealed from the daisy and poppy by a simple method of divination The laurel has long been accepted as the emblem of glory, and the oak of patriotism. In the Grecian games wreaths were placed upon the brows of the victors, but these were of leaves rather than blossoms. Floral garlands were much used at the feasts of the ancients, and in India it is customary to show special honor to a guest by encircling his neck with a wreath of flowers. Historical and national associations cluster about certain flowers. The violet was the flower of Athens. The red and the white roses of Lancaster and York gave name to a great civil war. Particular families and clans have their floral badges and there are national and heraldic emblems drawn from the floral kingdom, such as the rose of England, the thistle of Scotland, the shamrock of Ireland, and the fleur-de-lis (q.v.) of France, the latter being associated for centuries with the royal crown. The pomegranate became a Spanish national emblem having previously been the emblem of Moorish Granada. In Japan, the chrysanthemum is the flower of the nation, and in India the lotus has an especially sacred significance, as it had formerly in Egypt. In the latter country it often figured in architecture. In the decorative art of India it is represented in bronze and in paintings in connection with divinities or exalted sages. The cactus is the national emblem of Mexico. No flower will ever become the national emblem of the United States in the manner in which such floral emblems have become connected with other nations, but an attempt has been made to gain an expression of popular opinion on the subject of a national flower and the golden-rod appears to lead in the contest, as it has done in the case of the Empire State, of which it has been chosen as an emblem. The legislatures of certain States have taken action on the choice of a State flower, Utah selecting the seg lily; Vermont, the red clover; Oregon, a native grape; Nebraska, the golden-rod; Michigan, the apple-blossom; Maine, the pine tassel and cone, and Iowa the wild rose. In England what may be called a party emblem is illustrated in the adoption of the primrose, generally known as Lord Beaconsfield's flower, by the Conservatives. Before the «Hundred Days» in French history, the violet was used by the adherents of Napoleon I. to symbolize the hope of his return from exile.

Floyd, John Buchanan, American statesman: b. Smithfield, Montgomery County, Va., 1 June 1807; d. near Abingdon, Va., 26 Aug. 1863. He was educated at Columbia College, S. C., graduating in 1829. Studied law and settled in southwest Virginia. Was a member of the Virginia legislature several terms, and was governor of the State 1850–3, his term being notable for his advocacy of the policy of public im-of war in the cabinet of President Buchanan, provements. In 1857 he was appointed secretary and remained in it until 29 Dec. 1860, when he resigned because he considered the action of Maj. Anderson in occupying Fort Sumter a breach of faith to South Carolina. He went to Abingdon, Va. On 29 Jan. 1861 the grand jury of the District of Columbia indicted him as privy to a defalcation in the Department of the Interior. He returned to Washington, gave bail and demanded a trial, and the government thereupon, on 7 March 1861, entered a *nolle prosequi.*

After his departure he was also accused of having transferred arms from Northern to

Southern arsenals in order to arm the South for the Civil War. This charge was investigated by a Congressional committee, which, on 18 Feb. 1861, made a report showing it to be groundless, the arms transferred having been condemned arms, removed in order to make room in the Northern arsenals for modern ones.

In the summer of 1861 he was appointed a brigadier-general in the Confederate army, and raised a brigade which served in West Virginia until ordered to join the army of Gen. A. S. Johnston in the West. He was sent to Fort Donelson, arriving there after fighting had begun. When surrender was discussed, he transferred the command to Buckner and extricated his brigade; in consequence of which he was removed from command by Jefferson Davis. The State of Virginia thereupon appointed him a major-general in its service.

Floyd, William, American statesman: b. Brookhaven, Long Island, N. Y., 17 Dec. 1734; d. Weston, Oneida County, N. Y., 4 Aug. 1821. He entered political life as a delegate to the Philadelphia congress of 1774. The next year he was appointed a delegate to the first Continental Congress, and continued by successive reappointments a member of every Continental Congress up to 1782 inclusive. From 1777 to 1788 he also was a State senator under the first Constitution of New York, and in the Presidential elections of 1792, 1800, and 1804 was a Presidential elector.

Flück'iger, Friedrich August, ow'goost frēd'rɪʜ, German pharmacognosticist: b. Langenthal, Switzerland, 1828; d. 1894. He was educated at Berlin, Ban, Geneva, and Heidelberg, became president of the Swiss Association of Apothecaries in 1857, and in 1881 was member of a committee appointed to revise the pharmacopœia of the German empire. He wrote, in conjunction with Hamburg, 'Pharmacography: A History of the Principal Drugs of Vegetable Origin met with in Great Britain and British India' (1879), and works in German and French on the nature and history of drugs.

Flue. (1) A passage for the conveyance of the volatile results of combustion from the fireplace to the open air, or into another passage; a smoke duct, a chimney; one of a cluster of smoke ducts in a stack of chimneys. Also a passage in a wall for the conveyance of heat from one part of a building to another. (2) In music, one of the divisions of organ-stops, so called because the sound is produced by the wind passing through a fissure, flue, or windway, and striking against an edge above. (3) In a steam-engine, a pipe for the conveyance of the caloric current through a boiler, to heat the surrounding water. It is usually secured in the sheets of the fire box and smoke box respectively, as in the locomotive.

Fluel'len, a humorous character in Shakespeare's play 'Henry the Fifth.' He is a disputatious little soldier, pugnacious, and as voluble as his Welsh accent permits him to be when attempting to speak English.

Flü'gel, Johann Gottfried, yō'hän gōt'frēd, German lexicographer: b. Barby on the Elbe 22 Nov. 1788; d. Leipsic 24 June 1855. He spent many years in the United States prior to 1820 in business, diplomatic and official occupations, and became professor of English in the University of Leipsic in 1824. He compiled a 'Complete English-German and German-English Dictionary' (1830), besides publishing 'A Series of Commercial Letters' (9th ed. 1874); 'Practical Handbook of English Business Correspondence' (9th ed. 1873); 'Triglot; or Mercantile Dictionary in Three Tongues — German, English, French' (2d ed. 1854); and other useful manuals, all revised, or brought down to contemporary needs, by his son.

Flügel, Otto, German philosopher: b. Lützen 1842. He studied at Schulpforta and Halle, and took up pastoral work; was made editor of the 'Zeitschrift für exacte Philosophie im Sinne des Neueren Philosophischen Realismus,' and in 1894 was one of the founders of 'Zeitschrift für Philosophie und Pädagogik.' He supports Herbartian realism, as opposed to New-Kantian speculations, yet he believes in the necessity of a revelation. Among his works may be mentioned: 'Die Spekulative Theologie der Gegenwart'; 'Das Ich und die sittliche Idee im Leben der Völker' (1892); 'Über die persönliche Unsterblichkeit' (1902).

Flüg'gen, Gis'bert, German painter: b. at Cologne 9 Feb. 1811; d. Munich 3 Sept. 1859. In his youth he learned the manufacture of novelties in his native town, and in 1833 began his art studies at Munich, which he made his permanent home. He is a German counterpart of Hogarth and Wilkie, whom he rivals in masterly grouping and life-like expression, while in the technique of the brush he excels them both.

Fluid, a substance devoid of rigidity, or whose modulus of rigidity (see Elasticity) is zero. The word includes both gases and liquids, since these bodies, while resisting compression, offer no sensible resistance to change of form, but yield continuously and without limit to any force which tends to alter their shape while leaving their volume constant. The word "fluid" is also figuratively applied to other things which may be conveniently represented to the mind as fluids, even though it is known that they are not such. We speak, for example, of the "electric fluid," thereby meaning electricity, whose motions and general properties are known to conform to certain differential equations that are strongly suggestive of those governing the motions and properties of true fluids. This figurative use of the word is now avoided b the best writers, because, while it is convenient from certain points of view, it connotes properties that the things that it stands for do not possess. It dates from the time when electricity, magnetism, nervous energy, and certain other obscure manifestations of nature were actually believed to be due to imponderable fluids that were supposed to have a real, objective existence. See Critical Point; Elasticity; Gas; Gases, Kinetic Theory of; Liquid; Matter; Thermodynamics; etc.

Fluid Lens, in optics, a lens in which a liquid is imprisoned between circular glass disks of the required curvatures. Attempts to obtain achromatism have been made by using metallic solutions and other liquids having a higher dispersive power than flint glass.

Fluke, or Pole Flounder, a fish, one of the smaller deep-water flounders (*Glyptocephalus cynoglossus*), common near both coasts of the North Atlantic, caught by means of beam-trawls in great quantities, and highly prized as food, especially in Great Britain, where it is considered little inferior to the sole. It is the "craig fluke" of Scotland. See FLOUNDER.

Fluke-worm. See DISTOMA; TREMATODEA.

Flume (Latin *flumen*, stream), an artificial channel or conduit used to convey water for power development, hydraulic mining and irrigation. Flumes are commonly built of wood, but may be of steel and are placed above ground, frequently over trestles. See IRRIGATION; LOGGING; MINING.

Flu'or-spar. See FLUORITE.

Fluores'cence, that property of certain bodies in virtue of which they become self-luminous when exposed to light of certain wave-lengths. All bodies reflect a part of the incident light, but fluorescence is more than a mere reflection, as may best be shown by an example. "Canary glass" (glass colored slightly with oxid of uranium) exhibits a beautiful yellowish-green surface color when well illuminated, and for this reason it is much used for the production of ornamental effects. If a ray of sunlight be admitted into a darkened room through a piece of cobalt glass that is so dense that the feeble violet light that it transmits is barely visible, the canary glass shows its yellow-green color brilliantly when placed in its path. This shows that the phenomenon is not simple reflection, and further evidence of the same sort may easily be had. Glass that is tinged brownish-yellow by oxid of gold is almost perfectly transparent to the golden light from the canary glass, but if the violet light from the cobalt glass is caused to traverse the gold-oxid glass before striking the canary glass, the fluorescence is no longer observed. Furthermore, light that has passed through one piece of canary glass is incapable of exciting fluorescence in a second piece. These and other equally remarkable phenomena indicate that a fluorescent substance absorbs a portion of the light that strikes it, modifies it profoundly in some manner, and then radiates it again. Stokes has shown that the modification consists in increasing the wave-length of the incident light; and it is now known that fluorescent light invariably has a greater wave-length than the primary light that excites the fluorescence. This fact has an important bearing upon many of the phenomena of physics. When it had been determined, for example, that the "X-rays" differ from ordinary light merely by having a very different wave-length, the question whether their wave-length is longer or shorter was immediately answered by the fact they can excite brilliant fluorescence. Knowing that the X-rays are either too long or too short to affect the eye, and knowing also that fluorescent light always has a longer wave-length than the light that excites it, it follows at once that the X-rays have a shorter wave-length than ordinary light.

Many substances exhibit fluorescence to a greater or lesser degree. An aqueous infusion of horse-chestnut bark shows it brilliantly, and so also does a solution of sulphate of quinine. Certain of the coal-tar colors (q.v.) are conspicuously fluorescent, fluorescein taking its name from this fact. Kerosene is fluorescent, and sometimes strongly so. Most fluorescent substances cease to emit light almost instantaneously when the incident light is cut off from them. Some, however, such as calcium tungstate and the sulphids of calcium, barium, and strontium, continue to emit their rays for a sensible time, fading gradually away into darkness after the incident light ceases to excite them. Instruments consisting of screens that are coated with some fluorescent material and protected from ordinary light by shields, or by enclosure within a light-tight box, are known as "fluoroscopes," and are used for studying the X-rays (or Röntgen rays), and the shadows cast by them. It is to be observed that fluorescence differs from phosphorescence (q.v.) not only because it is usually of very short duration, but primarily because it is induced by the exciting action of light-rays. Phosphorescence may be due to very different causes. The light emitted by phosphorus, for example, is probably due to the slow oxidation of that substance. That which is observed in the ocean at night, and in connection with various fungi and insects, is due to causes which are more or less obscure; but in any event these various phosphorescent phenomena are quite different from true fluorescence. The name "fluorescence" was coined by Sir George G. Stokes in 1852, from the fact that the mineral fluorite sometimes exhibits the phenomenon. Previous to 1852 fluorescence was known as "epipolic dispersion." Consult: Tait, 'Light'; Preston, 'The Theory of Light.'

Flu'orides. See FLUORINE.

Flu'orine, a gaseous, non-metallic element, possessing properties resembling those of chlorine, and exhibiting powerful chemical affinity. It occurs abundantly in nature, notably in the minerals fluorite and cryolite, from the former of which it takes its name. The elementary character of fluorine was first recognized by Ampère and Davy about 1810; but although many attempts were made to isolate it, none was certainly successful until 1887, when Moissan succeeded in preparing it in the elementary state by electrolyzing a solution of hydrogen potassium fluoride, HF.KF, in perfectly anhydrous hydrofluoric acid, the solution being contained in a platinum vessel whose temperature was maintained at 10° F. below zero, and the electrolysis conducted by means of 20 Bunsen elements connected in series. When thus prepared fluorine is a gas, variously described as colorless, or as of a light greenish-yellow color. Many of the elements take fire when immersed in it, and burn with the formation of the corresponding fluorides. Water is decomposed by it, with the formation of hydrofluoric acid, HF, and the liberation of ozonized oxygen; and in fact fluorine appears to combine with all known elements except oxygen and carbon, and argon, helium, and the other recently discovered inert gases of the atmosphere. Fluorine has the chemical symbol F, is a monad, and has an atomic weight of about 19. Few of the physical properties of the element are yet known, on account of the difficulty of handling it. It corrodes glass rapidly, for example, and for this reason glass vessels cannot be used in experimenting with it.

Fluorine combines with hydrogen directly even in the dark, the compound, HF, that is formed being known as hydrofluoric acid. Hydrofluoric acid is more conveniently prepared by means of the action of strong sulphuric acid upon the mineral fluorite (calcium fluoride, CaF_2). The reaction is as follows: $H_2SO_4 + CaF_2 = 2HF + CaSO_4$. Hydrofluoric acid is a colorless gas at ordinary temperatures and pressures, fuming strongly in the air. It condenses at 5° F. below zero to a colorless, mobile liquid having a specific gravity of about 0.988, and boiling, at ordinary atmospheric pressure, at 67° F. As thus prepared, liquid hydrofluoric acid contains traces of water; but these may be removed by electrolysis, the liberated fluorine combining with the water as noted above, and the oxygen of the water escaping in the free state. When the water has all been eliminated, electrolysis ceases. The commercial importance of hydrofluoric acid depends upon the fact that this substance attacks glass so freely that it must be prepared and stored in vessels of lead or rubber. It is much used for etching upon glass, the reaction between the glass and the acid being $4HF + SiO_2 = 2H_2O + SiF_4$; the acid attacking the silica of the glass, with the formation of water and a gaseous compound of silicon, known as silicon tetrafluoride. When silicon tetrafluoride is passed into water, it is decomposed according to the equation $3SiF_4 + 4H_2O = 2H_2SiF_6 + H_4SiO_4$; the substance represented by the last term in this equation, silicic acid, separates out as an insoluble precipitate, while the compound H_2SiF_6, known as hydrofluo-silicic acid, remains in solution. Hydrofluo-silicic acid forms salts which are known as silico-fluorides. Potassium silico-fluoride, K_2SiF_6, is one of the few potassium compounds that are insoluble in water.

Liquid anhydrous hydrofluoric acid does not attack glass, but the action is vigorous when traces of water are present. The diluted acid is therefore used in practical etching, the article that is to be treated being immersed in it, after the parts that are not to be attacked have been protected by a coating of wax, or of a special "etching varnish." Hydrofluoric acid in aqueous solution acts very similarly to hydrochloric acid, forming salts which are known as fluorides; hydrogen being liberated when the acid acts upon a metal, and water when upon an oxid.

Fluorite, or **Fluor Spar,** a native fluoride of calcium having the formula CaF_2, crystallizing in the isometric system with cubical habit, and also occurring massive. It has a hardness of 4. and a specific gravity varying from 3.00 to 3.25. It has a vitreous lustre, and is transparent to subtranslucent, varying in color from white through yellow, green, red, blue, and brown. The green and violet-blue varieties are most common, and the red is rare. Certain specimens exhibit a bluish fluorescence (q.v.), and the mineral develops differences of electrical potential under the influence of heat and of light. Fluorite occurs in England, Germany, and many parts of the United States, and the commercial supply comes chiefly from Kentucky, Illinois, Arizona, Tennessee, and New Hampshire. It is a chief source of fluorine and hydrofluoric acid (see FLUORINE), and is also used as a flux for promoting the fusion of certain refractory minerals, deriving its name from this latter circumstance (Latin, *fluor*, a flow). Colorless specimens have been used for the manufacture of lenses, for which they are well adapted on account of their small dispersion.

Fluor'oscope. See FLUORESCENCE.

Flürsheim, Michael, mēи'ä-el flürs'hīm, German social reformer: b. Frankfort-on-Main 24 Jan. 1844. He emigrated to the United States in 1867, and resided there for five years. He then returned to Europe and established an iron foundry in Gaggenau, Baden (1888). Since 1892 he has lived at Castagnola, near Lugano, Switzerland, engaged in disseminating his ideas through his writings. He believes private property is the cause of immense wealth to some and profound poverty to others, and advocates the government possession of land. His works are: 'Auf friedlichem Wege' (1884); 'Deutschland in 100 Jahren' (1894); 'Papst und Sozialreform' (1891); 'Der Einzige Rettungsweg' (1894); 'Rent, Interest, and Wages' (1891).

Flush'ing, Netherlands, a flourishing seaport town in the province of Zeeland, on the south coast of the island of Walcheren, at the mouth of the West Schelde. It has long been a place of importance, but has few buildings or institutions of note. The town-house is a roomy, suitable edifice; the exchange is a simple building, and near it is a statue, erected in 1841, of Admiral van Ruyter, born in Flushing in 1607. The inhabitants are chiefly engaged in commerce, for the encouragement of which much has been done in recent times by the construction of docks, etc. Flushing has suffered several times from fire, water, and war, and in 1809 was bombarded by a British fleet, under Lord Chatham. Pop. (1901) 18,893.

Flushing, N. Y., a former village on Long Island, now a part of the borough of Queens, New York. It was settled in 1645 and was called Vlissingen.

Flute, a musical wind instrument, consisting of a tube furnished with a number of holes in it for the purpose of varying its sounds. The oldest form of the English flute had seven holes which could be stopped by the fingers, but it had no finger-keys. This was in use till about the beginning of the 18th century, when it gave place to the German flute, an instrument which, in its best form, was 27 inches in length, consisted of 4 pieces fitting into one another, and had 6 finger-holes for the normal tones, and from 6 to 12 keys for the semitones, with a compass of nearly 3 octaves, counting from middle C upward, the higher octaves being obtained by overblowing. The improvements made on this instrument, by Böhm, a German, acting in conjunction with Gordon, an Englishman, enable the player to perform music on any key, with all the chromatic intervals. The chief improvement consisted in the application of a system of keys, by which several holes could be stopped at one time, by one movement of the finger. The flutes made by Böhm are now taken as the models by most makers in all countries. In modern flutes the number of keys varies. The materials of which flutes are made are box, ivory, ebony, silver, glass, and a kind of red ebony.

Fluted Scale. See SCALE INSECTS.

Fluting, in architecture, channels or furrows cut perpendicularly in the shafts of columns, particularly Doric, Ionic, and Corinthian.

It seems probable that this kind of ornament had some relation to the original type; perhaps the furrowed trunk might have suggested the idea. It is, however, a beautiful ornament, which is applied with equal happiness to break the otherwise heavy mass of a Doric shaft, or to obviate an inconsistent plainness in the other orders. When the lower parts of the flutes of a column are filled with a convex bead, they are said to be cabled. See ARCHITECTURE.

Fluting Machine, a machine for corrugating or crimping metals. It has a pair of rollers, each one having projections which enter the interdental spaces of the other. By turning the operating screw the bent bar, and with it the upper roller, can be adjusted up or down at will to regulate the distance between the two rollers.

Flux, a substance or mixture added to assist the fusion of minerals. In the large way, limestone, and fluor-spar are used as fluxes. In the smelting of iron great attention has to be paid to the fluxes, because on their character depends to some extent the complete separation of the metal. To accomplish this the flux must be such that it will combine with the earthy matter of the ore, and form a slag, which must neither be too refractory nor fusible. Hence if the ore abound in clay or sulphur, lime, or limestone, and possibly sand, must be added; if in quartz, lime and clay are requisite, otherwise the quartz is slagged by combining with part of the iron, which is thus lost. Frequently ores are so selected that the earthy matters present may flux each other, but this requires skill and experience. The fluxes used in pottery are very various, and are distinguished by different names; but they almost all consist of litharge or red-lead, with sand or boracic acid, sometimes singly, sometimes together. They are, therefore, essentially colorless glasses used as vehicles for infusible colors. See COPPER; IRON; etc.

Fluxion, fluk'shôn, (1) in medicine, an unnatural flow or determination of blood or other humor toward any organ; a catarrh. (2) In mathematics, a method of calculation resulting from the operation of fluents, or flowing numbers. Thus a mathematical line may be considered as produced by the fluxion or flowing of a point; a surface by the fluxion of a line, and a solid by the fluxion of a surface. A mathematical point in motion will really make a line; a revolving radius which is a line will make a circle which is a surface, and its revolution about its diameter will generate a sphere which is a solid. The same principle may be applied to purely numerical calculations, like the formulæ of algebra. This branch of the higher mathematics was invented by Newton in 1665. In 1676 he communicated his method to Oldenburg in a sentence with all the letters disarranged so that his correspondent could not possibly have put them in order. If he had succeeded in doing this the sentence would have been *Data æquatione quotcunque fluentes quantitates involvente fluxiones invenire et vice versa.* ["Given it makes no matter how many equations involving fluent quantities, fluxions are to be discovered, and the reverse is true" (that is, where fluxions occur the fluents are to be found).] Leibnitz received this letter in 1677, and in 1684 explained a discovery which he had made. It was that of the differential calculus, which was essentially the same as that of fluxions. What Newton called fluxions, Leibnitz called differences. An angry controversy subsequently arose between Newton and Leibnitz as to the priority of discovery, the Royal Society of London taking the part of the former, who was then its president, and the scientific men of Germany that of the latter, who was their countryman. Both appear to have made the discovery independently. In the slight differences of method which exist, the advantage lay with Leibnitz, and while the term fluxions is now scarcely ever used, that of differential calculus is in common use. The first elementary treatise on fluxions published in England was by John Harris in 1702. A description of the process by Newton himself followed in 1704, in his 'Quadrature of Curves.' See CALCULATION; MATHEMATICS.

Fly, an insect. See DIPTERA; FLIES; and the names of various groups and species of flies.

Fly-blister, a collection of blood-serum between the layers of the skin, caused by the application of some preparation of the Spanish fly. It is used to extract fluid from underlying tissues, and to cause desired changes in local circulation. Absorption from applications sometimes takes place, giving rise to the irritation and inflammation of the kidneys, bladder and genital organs which characterize the drug when taken internally.

Fly-casting, the art of throwing an artificial fly in angling. (For the various methods employed see ANGLING.) Aside from its use in actual fishing the art is employed by some in competitive contests, and "national tournaments" are held annually in both Great Britain and the United States, sustained by a federation of clubs devoted to the sport, in which the championship and prizes are competed for.

Fly River, a considerable stream in New Guinea (British) which has its source in the Victor Emanuel Mountains and empties into the Gulf of Papua. Its length is 150 miles. There is a delta at the mouth of Fly River in which lies the island of Kiwai.

Fly Sheet, a paper broadside or bill. Certain publications of this sort advocating changes in the English Wesleyan Methodist constitution and practice were published in 1847–8. Those who were suspected of having them issued were expelled in 1849, and taking the name of Methodist Reformers laid the foundation of a new denomination, which has, however, since been amalgamated with others, the designation of the collective body being the United Free Church Methodists.

Fly, Spanish. See BLISTER BEETLE.

Fly-up-the-Creek, a local name for the little green heron (*Ardea virescens*), a common bird throughout eastern North America. See HERON.

Flycatcher, popularly and broadly used, birds which catch insects in the air. More restrictedly, in ornithology, birds of the Old World insectivorous family *Muscicapidæ*, allied to the thrushes; but this is a group very difficult to limit or define. All these are small, active

FLYCATCHERS.

1. Spotted Flycatcher. 2. Pied Flycatcher. 3. White-collared and Red-breasted Flycatchers
4. Kingbird. 5 Bienteveo.

birds, with great activity in flight and skill in seizing their agile prey; and all have broad flattened beaks, at the base of which is a growth of long stiff rictal bristles. The feet are usually weak and the wings long and pointed. Four or five species are common summer visitors to Europe, including the familiar and typical spotted flycatcher (*Muscicapa grisola*) and the pied or blackcap (*M. atricapilla*). In all the hotter latitudes of the Old World the species are very numerous, and ornate, many being crested, or having, in the case of the males at least, very long tail-feathers, which are handled most gracefully. Such are the paradise flycatchers (genus *Tersiphone*) of India and eastward, the Japanese species of which is so commonly represented on painted or embroidered screens. The "fantail" (q.v.) is another species remarkable in its flight. Most of these flycatchers are birds of the woods, and are usually solitary and silent, feeding on little except insects, which are habitually caught upon the wing with an audible snap of the bill. Some of the smaller ones are sometimes called "fly-snappers" (q.v.). They nest in various situations, and many make highly beautiful receptacles for their variously decorated eggs.

None of the muscicapids is to be found in the New World, but America has a large family of flycatchers (the *Tyrannidæ*) just as suitably so-called as are the others, so far as habits are concerned; nor are they far removed in structure. This family contains some 400 species, mainly tropical, and chiefly of an olive-green, or black-and-gray complexion, often with ornamental touches of scarlet on the head or wings. The bill is rather stronger as a rule than in the Old World flycatchers, and often decidedly hooked, like that of vireos or shrikes. The wings are usually short, and the tail varies greatly, sometimes being beautifully prolonged, as in the scissor-tailed flycatcher of the western United States. The genus *Alectrurus* presents still more striking examples of very long and beautifully modified tail plumes. Good examples of this group are the king-birds, pipiris, pewees, vermilion flycatcher, and scissor-tail, elsewhere described. An excellent general account of these families will be found in Evans' 'Birds' (1900).

ERNEST INGERSOLL.

Flying Bridge. See BRIDGE; MOVABLE BRIDGES.

Flying Buttress, a contrivance by means of which the thrust of a vault or arch is carried across an open space to a buttress (q.v.). Nearly every instance of the use of the flying buttress is in connection with Gothic architecture, and some of the earliest forms are very curious and illustrate well the growth of the style. The "high vault" over the nave or choir should have a buttress on each side to resist its thrust, but to build one there would be to obstruct the aisle on either side, which it was important to leave open and free as a part of the great interior of the church. The buttress, therefore, was built outside of the aisle, where it took up the thrust of the aisle vault and was made much larger than necessary for that purpose so as to receive also the thrust of the high vault, which was transmitted to it by means of a sloping bar of stone carried on a separate arch or half-arch. This bar and half-arch taken together form the flying buttress. In large churches the flying buttress is sometimes double or two-fold, leaping over two aisles, or an aisle and a row of chapels; and again it is sometimes repeated in height, one flying buttress coming above another — these being sometimes an addition where a slight yielding was visible.

Flying Dragon, a flying lizard (q.v.) of the Oriental genus *Draco*.

Flying Dutchman, a phantom ship said to be seen in stormy weather off the Cape of Good Hope, and thought to forebode ill luck. One form of the legend has it that the ship is doomed never to enter a port on account of a murder committed on board; another, that the captain, a Dutchman, swore a profane oath that he would weather the Cape though he should beat there till the last day. He was taken at his word, and there he still beats, but never suceeds in rounding the point. He sometimes hails vessels and requests them to take letters home from him. The legend is supposed to have originated in the sight of some ship reflected from the clouds. It has been made the groundwork of one or two novels and of Wagner's opera 'Der Fliegende Holländer.'

Flying-fish, a fish able to leave the water when alarmed or pursued, and sustain itself for several seconds in the air. In tropical seas the flying-fish rise from the water in flocks, or, more properly, shoals, of many thousands at a time, when disturbed by the passing of a ship, or pursued by such foes as the bluefish and albicore. They spring from the crest of a wave, and, darting forward, plunge into another to wet the membrane of the fins, and in this manner continue their flights for several hundred yards, often pursued by marine birds in the element to which they are driven for protection against the tyrants of their own. The sole motive power is the propulsion obtained by the work of the tail in giving the rushing leap from the water; but the great pectorals act to some extent as parachutes. In all the species belonging to the genus *Exocœtus* (which is typical of the family *Exocœtidæ*, allied to the sauries), the pectoral fins are very much developed, and the superior lobe of the caudal fin shorter; the head and body are invested with large soft scales, and the body has a ridge or carina extending longitudinally along each flank, which gives it somewhat of an angular appearance. Head, when viewed from the front, triangular; eyes very large; air-bladder very large. Flying-fish are inhabitants of every temperate sea, though abounding in the vicinity of the equator. In length they rarely exceed 13 inches, and are commonly found about 8. The flesh is pleasant. Several species are described by naturalists, some of which have very long fleshy filaments depending from the lower jaw, the use of which is not known. The *Exocœtus volitans*, or common flying-fish of the Atlantic, is also known in Pacific waters; and the coast of California is visited by a large species, 18 inches long (*E. californicus*) called *volador* by the Spanish fishermen. About 65 species are contained in this and other genera, among which is *Fodiator*, with at least one common flying-fish (*F. acus*), distinguished by sharpness of its snout. Another sort of flying-fish is the gurnard or sea-robin (qq.v.).

Flying-fox, or **Fox-bat,** one of the great fruit-bats (q.v.) of the Oriental region; specifically the kalong (*Pteropus edulis*), which is regarded as good food by the people of Java and neighboring islands. It is the largest of known bats, measuring five feet in expanse of wings, has rusty red fur, woolly upon the neck, and a long pointed fox-like muzzle, short, triangular ears, and large eyes. These bats belong to a very large widespread genus, and have the general characteristics and habits of the fruit-bats (q.v.).

Flying Frog, a Malayan tree-dwelling frog of the genus *Rhacophorus*, which has large webbed feet with adhesive disks. Some 20 species are known in various parts of the tropics, one of which was believed by Wallace to sail down from trees in a long slanting flight; but there is no direct evidence of it as to any species. A full account of the varied habits of the genus will be found in Gadow's 'Amphibia and Reptiles' (1901).

Flying Gecko. See FLYING-LIZARD.

Flying Gurnard, or **Robin.** See FLYING-FISH.

Flying-lemur. See COLUGO.

Flying Lizards. Various lizards are provided with something more or less elaborate in the way of a parachute assisting them in springing from branch to branch, and perhaps in frightening off would-be enemies. Thus a Malayan gecko (*Ptychozoon homalocephalon*), about eight inches long, with membranous expansions along the sides of the neck, body, tail and limbs, which are supposed to enable it to make long, sliding leaps; but its habits are very little known. The term applies especially, however, to the East Indian "flying-dragons" or showy lizards of the genus *Draco*, which have loose folds of skin distensible by the erection of several movable ribs, and spread as a parachute. There are various species, harmless, pretty and tamable.

Flying Machine, a device for enabling man to navigate the air. The feat of flying has been often attempted; even among the ancients it was tried, and we are informed, succeeded to some slight extent. Friar Bacon affirms in his writings that this feat is not only possible, but he also informs us that he himself knew how to construct a machine in which a man, in a sitting position, might be able to transport himself through the air like one of the feathered tribe. The secret of Friar Bacon consisted of a very simple mechanical contrivance: It was a pair of globes made of hollow copper, exhausted of air, on which a chair could be supported, by which means a man could float in the atmosphere above the earth, and could buoy himself along. Another friar asserts the truth of this invention, or, at least, of one similar. Father Francisco Lana declares that a round vessel of plate-brass, 14 feet in diameter, weighing 3 ounces per square foot, will only weigh 1,848 ounces; whereas a quantity of common air of the same bulk will weigh 2,155 2-3 ounces; consequently he deduces the fact that the globe will not only be sustained in the air, but that it will be capable of supporting a weight of 373 2-3 ounces; and also that a globe of the same weight, but greater in capacity, would support a man. This, however, is a fallacy; for, from the fact of nature abhorring a vacuum, the globe would be crushed in by the superior force of the atmosphere. At many periods this subject has been taken up by philosophers, particularly in the reign of Charles II. For modern inventions under this heading see AËRIAL LOCOMOTION; AERODROME; AEROPLANE; BALLOONS; LANGLEY, S. P.; SANTOS-DUMONT.

Flying Mouse. See PHALANGER.

Flying Phalanger. See PHALANGER.

Flying-squid, a squid of the genus *Ommastrephes*, having two large lateral fins, which enable it to leap so high out of the water that sometimes these mollusks fall on ships' decks. See SQUID.

Flying Squirrel, a small squirrel with soft, dense fur; the skin on the sides capable of being drawn out by extending the legs, so as to form a "parachute," like that of the bat. There are various species native to America, Europe, and Asia, all falling within two genera, *Pteromys*, and *Sciuropterus*. In the latter genus are the European and American flying squirrels. The American species (*S. volucella*) is found from Maine to Florida and westward to the plains. It is entirely nocturnal in habits, and so closely resembles, in color, the bark of the dead trees wherein it makes its home that it is well-nigh invisible. Hence, less is known of it than of other squirrels. Yet when caught it proves to be a gentle, soft-eyed little creature easily tamed. All flying squirrels live in the woods, and gnaw into decayed tree-trunks, where such are obtainable, to make their nests. They feed on nuts, leaf-buds; and, sometimes, on birds' eggs, and even on small birds. Their sailing flight may extend as far as 60 feet, and they cover this distance with a rapid, graceful motion. Wherever found, flying squirrels seem to be fairly numerous, except in Alaska, where one species is found, but is very rare.

Flynt, Josiah. See WILLARD, JOSIAH FLYNT.

Flysnapper, a remarkable bird (*Phænopepla nitens*) of the southwestern United States, which belongs to the wax-wing family (*Ampelidæ*), but has the shy yet active movements of a flycatcher with a habit of jerking its tail. The male is shining bluish-black, with white wing-quills and vent, and a noble crest; his mate is gray, brown and white. It catches insects on the wing, by leaping from its perch and snapping at them noisily; but also eats mistletoe berries, etc. It makes a shallow nest in a low tree and lays eggs with dark dots about the small end. The term "flysnapper" is also given to some of the smaller flycatchers (q.v.).

Fly-wheel, a wheel employed in machinery, which by means of its great momentum renders equable and regular the motion which is generated by an irregular or intermittent force, or meets with an irregular or intermittent resistance. In order to effect this object its rim is made heavy, its circumference proportionately long, and it is hung on the revolving shaft of the machine it controls. Thus by its inertia it opposes any sudden acceleration of speed, and by its accumulated momentum it prevents sudden diminution of speed; acting in the latter case as a store of power to continue the movement when the motor temporarily flags, or in passing dead centres when the motor is inoperative.

Fo, the name given by the Chinese to Buddha. Originally, the name Buddha was expressed in the Chinese language with sufficient exactness by the term *Fô-thau,* pronounced *Fôudah;* but, as is usual in China with proper names, the last syllable was subsequently dropped. See BUDDHISM.

Foa, Eugénie, ė-jā-nē fōä, French author: b. Bordeaux 1708; d. 1853. Her maiden name was Fradis, and she was of Spanish-Jewish descent. Separated from her husband she supported herself by her pen, often writing under the name "MARIA FITZCLARENCE." Her tales for young children are delightfully clever. Notable among her works are: 'Les Mémoires d'un Polichinelle' (1839); 'Le Petit Robinson de Paris' (1840); and 'Le Vieux Paris' (1840).

Focus, a word introduced into science by Kepler in 1604. It literally means a hearth, round which all the members of a family gather, and takes the acquired meaning of the centre, into which certain activities are gathered. In optics it denotes the point at which divergent rays of light are brought to meet again, and from which they appear to proceed. The principal focus of a lens is the focus of rays falling upon the lens in a line parallel to its axis. The conjugate foci of a mirror or lens are two points so situated that the rays emitted from a light, or a luminous object, at either point, are reflected or refracted to the other. In photography the word is familiarly used of the image reflected on the screen of ground glass, which is said to be in focus when it is fixed at a true focal point, and so as to procure a focal or undistorted effect. It is also used of the lens, with regard to its distance from the screen of ground glass. The lens is in focus when it transmits to the screen an image without blurring or aberration. See LENS; LIGHT; MIRROR; OPTICS.

The term is employed in geometry in the description of the ellipse, which has two foci, of which it can be proved that the sum of the distances of any point of an ellipse from its foci is constant, and the difference of the distances of any point of a hyperbole from its foci is constant.

Fodder (A. S. *fódor,* cog. with Ger. *futter*), the food collected by man for the use of the domestic herbivorous quadrupeds. In English the term is commonly restricted to dried herbage, as hay and straw; but in other languages it is more comprehensive, and includes all the food of cattle, except what they gather for themselves in the field. The principal part of the food of the domestic herbivora is furnished by grasses, most of which are eaten by them when fresh and green. Besides the supplies which they receive of the surplus of corn cultivated for human food, they are also, to a considerable extent, dependent on the straw or dried herbage of the corn-plants for their winter provender; and that of many other grasses, cultivated on this account alone, is converted into hay for their use. Hay, being cut and rapidly dried while the plant is still full of sap, contains more nutritious matter than the ripened straw of the cereals. In the United States the best grasses are timothy, red top or Rhode Island bent, white top, orchard grass, and June grass or Kentucky blue grass. In California the best fodder grass is the alfalfa, of which three or even four crops a year are obtained.

Next to the grasses are ranked the *Leguminosæ,* affording food for cattle in their seeds — as beans, peas, lentils, lupines, etc. — and in their herbage, on account of which many of them are cultivated, as clover, lucerne, vetch, tares, sainfoin, etc. When consumed green, the produce of these crops is usually termed forage or green forage. (See SILAGE.) Some of them enter also largely into the composition of hay, being cut and dried with the grasses along with which they have been sown. Some of the *Cruciferæ* are cultivated to a considerable extent as forage-plants, cattle being fed on their green herbage, although they are not suitable for drying as fodder. Among these are kale and cabbage, rape, etc. In some parts of the world cattle are not unfrequently fed on the leaves of trees, as in the Himalayas, where the leaves of different species of Aralia, Grewia, elm, and oak are chiefly employed for this purpose, and are collected, dried, and stacked for winter fodder. In seasons of drought in India cattle are kept alive on the green leaves and pods of acacia and *Inga dulcis.* See ALFALFA; CLOVER; GRASSES; HAY; PASTURE; etc.

Fodder, Green. See SILAGE.

Fodientia, the aard-varks (q.v.); also EDENTATA.

Fœniculum. See FENNEL.

Foehn (fėn) **Wind,** a warm wind that blows from the Alps in some of the northern valleys of Switzerland. At one time the *fœhn* was supposed to be an air-current that had been warmed by passing over the Desert of Sahara. Now it is known that the *fœhn* is warm because it is a south wind which, robbed of its moisture by expansion and cooling in passing over the Alps is warmed by compression in descending through the increase of atmospheric pressure with decreased altitude. It corresponds to the Chinook wind of Montana, Washington, and British Columbia. See CHINOOK WIND.

Fœtus, fē'tus, **Development of,** the growth of the unborn child from the fourth month until its birth. The convolutions of the brain, distinguishable organs of sex, ossification, and muscular movement advance in the fifth month, during which nails and hair appear. During the sixth month the pubic bones ossify, eyelids and eyelashes form, fat develops under the skin. In the seventh month, the fat increases, the eyelids are open. During the eighth month the nails are fully developed, and the fœtus attains a weight of from 5 to 9 pounds. See also EMBRYO.

Fog, a very thick mist; small hollow vesicles of water suspended in the air, but so low as to be but a short distance from the earth in place of rising high above it and becoming so illuminated by the sun as to constitute clouds of varied hue. Fogs often arise when the air above warm, moist soil is colder than the soil itself. The hot vapors from the ground are then condensed by coming in contact with the colder air above, as the warm steam of a kettle is by the comparatively cold air of a room. But no fog arises till the cold air has absorbed vapor enough to bring it to the point of saturation. Fogs often hang over rivers. Their cause is the condensation by contact with the cold water, of the vapor in a hot and moist air current passing over the river. The "pea-soup" fogs of London life are produced by the carbon of the smoky atmosphere coloring the fog vesicles; a fog which is brown in London's business district is generally white a few miles off, and wanting altogether at the further extremities of the city. On hills and mountains of any size it is easy to rise above a fog, and see it like an ocean beneath one's feet.

Fog-signals, signals given by means of sound or light to warn vessels of danger during fogs. Various kinds of fog-signals are used, among which may be mentioned bells, drums, gongs, guns, compressed-air whistles, steam-whistles, and fog trumpets or horns, and latterly powerful electric flashlights. Gongs are not very powerful as signals, often failing to be heard at more than the distance of a quarter of a mile. Bells may be heard during fogs at a distance of from 1 to 3 miles. Guns have been heard as far as 10 miles, with a light breeze blowing across the sound. One of the most powerful signals is the siren fog-horn, the sound of which is produced by means of a disk perforated by radial slits made to rotate in front of a fixed disk exactly similar, while a long iron trumpet forms part of the apparatus. The disk is made to revolve rapidly, and when the slits are opposite each other openings are formed through which electricity, steam, or compressed air is forced. This causes a sound of very great power, which the trumpet collects and compresses, and which under favorable circumstances is heard from 20 to 30 miles out at sea. Fog-signals are also used on railways during foggy weather. They consist of cases filled with detonating powder, which are laid on the rails and exploded by the engine when it comes up to them. Bell-buoys, common to the coasts of the United States, are operated by the current, by the ebbing and flowing tide, by the swaying of the waves, by the wind, and by clockwork impelled by weight or spring. As to construction, they are adapted for anchorage on spits, sand-bars, or shoals. The use of electricity in fog-signals is well illustrated at Sandy Hook, N. J., where a powerful searchlight flashes every few moments in varying directions. In clear weather this flashlight can be observed a distance of 50 miles at sea. There are in the United States under government control nearly 10,000 fog-signals of all kinds, 3,000 of which are lighted. Eleven buoys are operated by electric light. Germany erected in 1903 a fast flashing light on the island of Helgoland in the North Sea. The system or principle employed is said to be entirely new. Not only that, but it was said to present absolutely insurmountable difficulties. The revolving light on Helgoland is not only the largest in the world, it is the most unique, for Germans claim that it never had a model.

They built upon the superiority of the German reflector, with its exactly parabolic ground-glass mirror or speculum, and the marvelous success of the Helgoland fast-flashing light has justified German effort, skill, and courage. In these lines, for a long time, France was in the lead. It looks as if she would have to guard her laurels. The reflector invented by Schuckert, with its parabolic mirror, is easily earning a place by the side of the world's very best work. It took a long time to get a hearing for the glass parabolic mirror in the lighthouse world. The bright fires — *feux éclairs* — of the system, based upon a combination of Fresnel lenses and totally reflecting ring prisms, which were built by the French with marvelous skill and accuracy, blocked the way to the new lights. About the middle of the nineties German experts were sent to France by the German imperial government for the express purpose of studying flashlights. The experts stayed long enough to find out all that was best in the French system, aided thereto by the kindness of the scientific men of the republic. Before their return they were convinced that by means of two or more reflectors, erected upon a reflector with Schuckert's glass parabolic mirror, results equal to those of France could be produced.

Experiments were made in Nuremberg. They went far beyond what the most sanguine had believed possible. The revolving reflector of the German apparatus was fully equal to the Frenchman's revolving light. As soon as the experts had demonstrated their point, work was begun on a light reflector or projector equal to the largest ever used. It was to represent 30,000,000 candlepower and to last no longer than one tenth of a second. The flashes must follow each other every five seconds. When the weather is favorable the beams go far beyond the central fires of light rays. On the first night that the new light was used, its peculiar, flashing beams were seen by people standing on the mole at Busum, a distance of 65 kilometres, or a trifle over 40 miles. The watchers in the lighthouse at Amrum, about the same distance, were able in unfavorable weather to see the same beams as they rapidly appeared and disappeared. It was noted that the otherwise bluish-white light of the electric arc appeared red. See BUOY; ELECTRIC LIGHTING; FOG; LIGHTHOUSE; MEGAPHONE; SIREN; TOPOPHONE.

Fogarassy, János, yän'ōsh fō'-gä-rŏsh-ī, Hungarian lawyer and philologist: b. Käsmark, in Austria-Hungary, 1801; d. 11 June 1878. He studied at Sáros-Pátak, and was graduated in law, became an advocate, and was appointed to an office in the government bureau of finance. His principal claims upon the memory of posterity are his legal works written in the Hungarian tongue. He also published a 'Hungarian Dictionary' (1836), and began, at the suggestion of the Hungarian Academy, a complete dictionary of the language in collaboration with G. Ezuczor, after whose death he finished the work single-handed. It was published in 1861, and for this achievement he was awarded a gold medal by the Academy.

Fogazzaro, Antonio, än-tō'nē-ō fō-gä-tsä'-rō, Italian poet: b. Vicenza, Italy, 1842. He first came into notice with 'Miranda,' a story in verse (1874), and added greatly to his reputation as a poet with 'Valsonda,' a volume of lyrics (1876). He was author of several novels which were received with marked favor, among them: 'Master Chicco's Fiasco' (1885); 'Daniel Cortis' (1887); 'The Poet's Mystery' (1888).

Fogelberg, Bengt Erland, bengt ĕr'länt fō'-gĕl-bĕrg, Swedish sculptor: b. Grotenburg 8 Aug. 1786; d. Trieste 22 Dec. 1854. He began his art studies in the Academy at Stockholm and in 1820 went to Rome, where he soon made a name. He was among the first to invest the mythologic figures of the North with the graces of the Grecian antique, and the influence of Thorwaldsen is plainly seen in his 'Odin and Thor' in the museum at Stockholm. He also vied with Thorwaldsen in such purely classic subjects as: 'The Dying Argus'; 'Venus'; 'Cupid and Psyche.' He executed two statues of Gustavus Adolphus, and, in collaboration with Byström, the series of colossal statues of the Swedish kings at Stockholm.

Foggia, fōd'jä, or **Capitanata,** cäp-ē-tän-ä'tä, Italy, a province on the Adriatic, between the provinces of Campobasso and Bari. It possesses rich pastures. Among its special products are wines, saffron, and fruits. The principal town is Foggia. Area, 2,688 square miles. Pop. (1901) 425,450.

Foggia, a city of southern Italy, capital of the province of the same name, in the centre of the great Apulian plain, 46 miles east by south of Campo Basso. It is well built, most of the houses being reconstructed since an earthquake which happened in 1732. It has large storehouses for keeping corn, and is the place where the flocks that feed on the great plain of Apulia are registered. Pop. (1901) 53,151.

Foglar, Ludwig, lood'-vĭg fō'glär, Austrian poet; b. Vienna 24 Dec. 1819; d. Kammer 15 Aug. 1889. Among his poems, mostly lyric, are: 'Cypresses' (1842); 'Sunbeams and Shadows' (1846); 'Clara von Vissegrad,' an epic (1847); 'Freedom's Breviary' (1848); 'Joyful and Sorrowful' (1867); 'Saint Velocipede' (1869), a satire (under the pseudonym "Lebrecht Flott").

Fo'go, Fuego, fwā'go, or **St. Philip,** (1) One of the Cape Verde islands, in the Atlantic Ocean, and the highest of the group, being 9,760 feet above sea-level, and presenting the appearance of one single mountain, though, on the sides, there are deep valleys; area, 170 square miles. Pop. estimated at 16,000. It has no rivers, and a scarcity of fresh water prevails, yet it is one of the most fertile islands of the archipelago, producing excellent maize and fruits. The chief town is Nossa Senhora da Luz. (2) Fogo, a port of entry and capital of Fogo Island, Newfoundland, at the southwest entrance to Notre Dame Bay, 122 miles northwest of St. John's, N. B. Pop. (1901) 1,118.

Fohi, fō'hē, the first Chinese emperor and legislator. He is said to have founded this kingdom 2,207 B.C. Nothing certain is known of his reign; but there are attributed to him the institution of marriage, the invention of fishing, hunting, music, and writing. He acknowledged and worshipped a supreme deity. He is supposed to be the Noah of the Bible.

Föhr, fėr, Germany, an island of Schleswig, in the North Sea; area 31 square miles. The town of Wyk is a fishing centre. The population numbers 4,200, mostly Frisians.

Foil. (1) A leaf or thin sheet of metal placed beneath transparent jewels to heighten their color and improve their brilliancy; also applied to those sheets of tin amalgam placed behind mirrors to make them reflect perfect images. They are made of copper, tin, and silvered copper, and are much used in imitations of precious stones. Colored foils are made by coating the white with any varnish of the required tint. The sheet lead which is used for the lining of tea-chests is a species of foil, and the Chinese purchase about 4,000 tons of lead annually from England for this purpose. (2) In architecture a small arc in the tracery of a window or panel. (3) In fencing. See Fencing.

Foix, Gaston, gas-täṅ fwä, Count de, and Viscount de Béarn, French military officer: b. 1331; d. 1391. Acquired the surname of Phœbus. He spent his life in war and the chase. His first service in arms was against the English in 1345. During the revolt known as la Jacquerie he contributed to the rescue of the Dauphin at Meaux. He wrote a book on the pleasures of the chase, of which several editions were published.

Foix, Gaston de, French soldier: b. 1489; d. Ravenna, Italy, 11 April 1512. He had the command of the army of Italy, and on account of the daring exploits was denominated the "Thunderbolt of Italy." After performing prodigies of valor he was killed at the battle of Ravenna.

Fokien. See Fu-Kien.

Fokshani, fōk-shä'nē, town in Rumania, population 23,800. Extensive vineyards are in the neighborhood and much wine is produced here. The town is well-known historically. It was destroyed by the Russians in 1789 and by the Turks in 1822.

Fold, in geology, a term used to denote an inclined position into which various disturbances may have moved rocks previously horizontal. Even very brittle rock may be thus folded, rather than broken, under a severe, steady pressure. Three kinds of fold are generally distinguished: (1) monocline, in which the rocks are inclined in one direction only; (2) anticline, in which they are bent up in the manner of an arch; and (3) syncline, in which the arch is bent downward instead of up. Folds are rarely symmetrical. See Dip; Fault.

Folding Machines. The folding of printed sheets for books or newspapers was performed by hand up to 1856, when Cyrus Chambers, Jr., of Philadelphia, invented a practical folding machine, which was manufactured by him and his brother Edwin, who within a few years produced a considerable line of folders of various sizes and capacities. The folding machine of C. S. Forsaith, of Manchester, N. H., designed for folding newspapers only, came out some years later. A good many Stonemetz folders were sold between 1880 and 1890. The leading folders on the American market to-day are the Dexter, the Chambers, and the Brown. The vital principle on which nearly all paper folders are based is the descent of a dull blade on the paper sheet at the point where the fold is to be made, the blade thrusting the paper between rotating rollers, which draw it in folded. The making of a second fold is accomplished in the same way, the paper being passed along by traveling tapes from one stage to another, up to three or four folds. The earlier machines were not positive in their register, that is, the fold was apt to vary slightly in position, but the modern machines are very accurate, and large 64-page sheets are commonly folded on the machines with entire satisfaction. The heavy coated paper introduced about 1890 to 1895 developed a tendency to buckle or crease slightly on the last fold of a large sheet, and the most recent folding machines have introduced devices to overcome this difficulty. The most conspicuous improvement of recent years has been the drop-roll, which has added materially to the speed of the machines. This was introduced by Dexter, and enabled the sheet to be fed sideways — that is, the shortest way. Registering by means of points, that slip into holes or slits in the sheet, is another feature of modern machines. The equipping of machines with pasters was accomplished early in the history of the folding machine, and this feature has been brought to a high degree of perfection. The paste is held in fountains and laid on the paper in strips as it passes by.

Folders are now made in so many styles that the mere enumeration of them requires considerable space. They may be either drop-roll or point-feed; there are quadruple 16s and double 32 folders, some of which insert one sheet within another; there are marginal folders for books and pamphlets and for jobbing work; also large single and combination periodical folders, rapid circular folders, plain circular folders, jobbing circular folders, and various so-called newspaper folders. Then there are special newspaper and periodical folders, combinded folding and wire-stitching machines, combined folding and feeding machines, and combined feeding, folding and wire-stitching machines.

The Dexter combined folding and wire-stitching machine was introduced in 1897, and it is continuous and strictly automatic. It takes the sheets from the platforms of the feeders, and folds, gathers, collates, covers, and wire-stitches, delivering completed copies without intermediate handling.

There are various other combinations and arrangements for special work, which, together with those above named, have greatly reduced the cost of binding books, pamphlets, and periodicals.

On fast web newspaper printing presses there is used a rotary type of folder, that was brought out by the Hoes, and controlled by them for many years, being probably their most valuable patent in connection with these presses. Three folding blades were mounted on a single cylinder, catching the paper three times in a single revolution, thus securing immense speed. The device is not accurate enough for book folders, but it made possible the enormous speeds obtained by the so-called lightning newspaper presses.

The job folding machines for doing odd work of varying sizes, have come into extensive use within a few years. They are small and comparatively simple machines capable of operating at high speed. See AMERICAN NEWSPAPERS.

Földvar, fėld'vär (ancient SUSSUINUM), a walled town of Hungary, on the slope and summit of a hill, on the right bank of the Danube, 49 miles south of Budapest. Pop. (1900) 12,364.

Folengo, Teofilo, tā-ō'fē-lō fō-len'gō (pseudonym «MERLINO COCCAJO»), Italian poet: b. near Mantua, Italy, 8 Nov. 1491; d. near Bassano, Italy, 9 Dec. 1554. He was the first to win fame as a writer of macaronic verses. His ‹Macaronic Work of Merlino Coccajo, Mantuan Poet› (1517–25) comprises the comico-heroic poems, ‹Baldus› and ‹Moscæa› (War of the Midges). His satire is mostly against monachism. He writes in cynic humor, but under his burlesque lies a vein of serious purpose. Under the pseudonym «LIMERNO PITOCCO» he wrote in Italian the epic satire ‹Orlandino› (1526), in ridicule of the story of ‹Roland›; then, partly in macaronic, partly in pure Italian, partly in pure Latin, ‹The Chaos of Three by One› (1527), in which he darkly recounts the events of his own life.

Foley, John Henry, Irish sculptor: b. Dublin 24 May 1818; d. Hampstead, England, 27 Aug. 1874. His ‹Ino and Bacchus› (1840) attracted much notice, and was followed by a succession of admirable classical and ideal works, including: ‹A Youth at a Stream›; ‹Caractacus›; and several excellent subjects from Shakespeare. The most noteworthy feature of his work, however, was his careful and artistic execution of his statues and busts, which incuded the Hampden and Selden figures in St. Stephen's Hall, Westminster; Goldsmith, Burke, and O'Connell, in Dublin; and the equestrian statues of Lord Hardinge and Sir James Outram, for India, which rank among the finest equestrian sculptures of modern times. The statue of the Prince Consort for the Albert Memorial is also Foley's work, and one of his latest works was a bronze statue of Stonewall Jackson for the State of South Carolina.

Folger, fōl'jėr, **Charles James,** American jurist: b. Nantucket, Mass., 16 April 1818; d. Geneva, N. Y., 4 Sept. 1884. He was graduated at Hobart College in 1836; and admitted to the bar in Albany, N. Y., in 1839. He became judge of the court of common pleas of Ontario County in 1843; was a member of the State senate in 1861–9; elected associate judge of the State court of appeals in 1871; succeeded to the chief justiceship of that court in 1880; and was secretary of the United States treasury in 1881–4. In November 1882 he was the Republican candidate for governor of New York, but was defeated.

Folger, Peter, American colonist and author: b. England 1617; d. Nantucket 1690. He emigrated from Norwich, Norfolk, to America and settled at Martha's Vineyard in 1635. He was grandfather of Benjamin Franklin, his daughter Abia having married Josiah Franklin and borne the illustrious statesman and philosopher among her 17 children. He was clerk of the courts in 1673 and possessed a literary sprightliness which descended to his grandson, as may be seen from a perusal of his ‹A Looking-glass of the Times, or the Former Spirit of New England Revived in this Generation› (1875).

Folgore, fōl'gō-rā, Italian poet. He flourished at the end of the 13th century, but the dates of his birth and death and the incidents of his life are unknown. He wrote a number of sonnets, all of which have been translated into English by Dante Rossetti and J. A. Symonds. Their poetic merit is far from contemptible, and they are particularly interesting from the vivid light which they throw on Italian society. Their prevailing tone is one of refined epicureanism, and their style is mainly remarkable for affluence of imagery. «Every line,» says Mr. Symonds, «presents a picture, and each picture has the charm of a miniature fancifully drawn and brightly colored on a missal marge.› See Rossetti, ‹Dante and His Circle› (1874); and Navone, ‹Le Rime di Folgore› (1880).

Folia'tion, a term restricted by Darwin, and subsequently by geologists, to the arrangement of the constituent portions of a rock in alternating and more or less parallel layers or folia of different mineralogical nature. It differs from cleavage (q.v.), which is applied to certain superinduced divisional planes that render a rock fissile; and from lamination, in which the planes of separation in a rock are the result of deposition in successive layers. If foliation postdate the formation of the rock, the structure is practically the same as that known as schistose. The folia are conspicuously lenticular, thickening and thinning out, and reappearing after an interval on the same or a different plane. These alternately lenticular folia are usually more or less closely welded or felted into each other, so that they are not readily separable; and they frequently present the appearance of being puckered or crumpled. The crystalline texture and the foliated character of the schists distinguish them at once from any ordinary bedded "fragmental rock." See SCHIST; SCHISTOSE.

Folio, (1) in printing: *a.* The running number of the pages of a book. The even folios are on the left-hand pages, the odd upon the right. The folios of prefatory matter are frequently in lower-case Roman numerals. *b.* A sheet of paper once folded. *c.* A book of the largest size, whose sheets are folded but once, four pages to the sheet; hence it is used generally for any large volume or work. (2) In bookkeeping, a page or opening in an account book. (3) In law, a certain number of words in legal documents. The number varies in the States; thus in some of them, as in England, in law documents, conveyances, deeds, etc., the folio is 72 words; in chancery and parliamentary proceedings 90 words. In New York and other States 100 words constitute a folio.

Fo'lium of Descartes, dā-kart, in mathematics, a curve such that the simultaneous increments of two lines drawn from the generating point of the curve to two fixed points, have always to each other a constant ratio. If the ratio is equal to -1, the oval becomes an ellipse; if it is equal to $+1$, it is an hyperbole.

Folk, Joseph Wingate, American lawyer and political leader: b. Brownsville, Tenn., 28 Oct. 1869. He was graduated at Vanderbilt University, studied law, and was admitted to the bar in 1890. Later he removed to Missouri, where he became prominent in his profession and in political life. As district attorney at Saint Louis, he was active in exposing political corruption and punishing the offenders. Owing to his efforts nearly 20 officers of corporations and city officials were convicted of bribe giving and taking; and afterwards similar corrupt practices in the State legislature were exposed. His fearlessness in attacking a long established evil and his success in accomplishing results won for him the confidence and admiration of the people of the State, and in 1904 he was nominated for governor by the Democratic Party in spite of the opposition of the party machine. He was elected governor of Missouri by a good majority, though the State went Republican in the national election at the same time.

Folk-lore, the science which embraces all that relates to ancient observances and customs, to the notions, beliefs, traditions, superstitions, and prejudices of the common people. Gomme's divisions are: (1) Traditional narratives: (a) folk-tales, (b) hero tales, (c) ballads and songs, (d) place legends; (2) traditional customs: (a) local customs, (b) festival customs, (c) ceremonial customs, (d) games; (3) superstitions and beliefs: (a) witchcraft, (b) astrology, (c) superstitious practices and fancies; (4) folk-speech: (a) popular sayings, (b) popular nomenclature, (c) proverbs, (d) jingle rhymes, riddles, etc.

Folk-lore had been observed and noted by countless writers of early days, but it was not till after the beginning of the 19th century that its value for the elucidation of the social history of mankind had become apparent to thinkers, and its systematic study been seriously begun. Meantime the reawakening to natural poetry, and to the beauty of free emotional expression in literature, which lay at the foundation of what it is usual to call romanticism, had already commenced even in the 18th century, and the publication of Percy's ‹Reliques of Ancient English Poetry› (1765) had given a powerful impulse to Scott and others in England, to Herder, and to Arnim and Brentano in Germany, who found a rich wealth of traditional poetry, the poetic value of which they fortunately had the eyes to see. But the study of folk-songs really began with Scott's ‹Minstrelsy of the Scottish Border› (1802-3). It was perhaps an advantage rather than a disadvantage that the first worker in this new field was but the folk-lorist unawares and mere great poet and romancer of genius that he was; for our folk-poetry would never have enriched and permanently influenced all later English literature but for its own intrinsic and genuine poetic quality, any more than our detached folk-lore facts would ever have risen above the dignity of the whimsical pastime of an idle hour but for their inherent though unsuspected faculty for throwing light backward on the history of human civilization. All, or nearly all, the facts of comparative mythology are to be found in folk-belief in solution; a great many facts of folk-belief are to be found in comparative mythology crystallized. The facts are essentially the same in both cases, but the one study deals with them at one, the other at another stage.

First in importance of the collections of material is still the earliest, the ‹Children and House Tales› (1812-14) of the brothers Grimm (q.v.). Grimm's ‹German Mythology› (1835) is still unequaled in the range of its erudition and in the systematic thoroughness with which the mythology and superstitions of the ancient Teutons are traced back to the dawn of direct evidence and downward in decay and diminution to the popular tales, traditions, and phrases in which they still unconsciously survive. These two works of Grimm created a school, whose abundant labors later folk-lorists have entered into, while they have enlarged the horizon of the science, because the stamp of soundness and sufficiency so far as it goes is impressed in all the work of Grimm and his successors, of whom, in Germany, the most eminent were Kuhn, Mannhardt, J. W. Wolf, and W. Schwartz. To the English-speaking world Max Müller's essays revealed a new world of undreamt-of affinities, and the combined charm of their literary grace, wide learning, and rare powers of exposition converted every reader to a theory which, as has been seen, is only now being displaced by another with a sounder basis of real philosophy and facts. Since then the study of folk-lore has become fashionable, indeed almost an article of patriotism, and societies have been formed in most countries to further its study. Of these the most important is still the Folk-lore Society of England, established in 1878, with its official organ, the 'Folk-lore Journal.' The American Folk-lore Society was instituted at Cambridge, Mass., early in 1888: (1) For the collection of the fast-vanishing remains of folk-lore in America, namely: (a) Relics of old English folk-lore (ballads, tales, superstitions, dialect, etc.); (b) lore of negroes in the Southern States of the Union; (c) lore of the Indian tribes of North America (myths, tales, etc.); (d) lore of French Canada, Mexico, etc. (2) For the study of the general subject, and publication of the results of special studies in this department. Already its journal has amply justified its existence by a series of articles of striking originality and value.

Folk-lore, though it takes cognizance of many apparently trivial matters, is of great importance in the science of comparative mythology, and helps to throw much light on the relationships between races, and on the origin and development of religious beliefs and ceremonies. It is, therefore, of great assistance to the ethnologist, the sociologist, and the historian, as well as to the student of comparative mythology and of the science of religion. It has attracted much attention in recent times. See ASTROLOGY; FABLES; FAIRY TALES; LEGENDS; MYTHOLOGY; SUPERSTITION; WITCHCRAFT.

Bibliography. — Aubrey, 'Miscellanies' (1696); Browne, 'Pseudodoxia Epidemica' (1646); Brand, 'Popular Antiquities'; Chambers, 'Book of Days'; Hone, 'Everyday Book'; Hone, 'Year Book'; Lang, 'Custom and Myth'; 'English Folk-lore Journal'; 'American Folklore Journal.'

Folk-music. The music of a nation is generally based on folk-music, or the folk-tunes that are handed down from generation to generation along with folk-lore. Hungarian folk-music has provided material not only for native composers but for the Germans. Haydn, Liszt, and Schubert utilized the melodies of the Magyars and the Gypsies. Brahms and others did the same thing in Russia. Beethoven went to Scotland and Ireland for melodies and Puccini traveled as far as Japan for one of his operas. Of all European countries Germany and Ireland have probably the greatest variety of folk-songs. (See FOLK-LORE; MUSIC.) Consult: Engel, 'Study of National Music' (1886); Tinck, 'Songs and Song Writers' (1900); Parry, 'Evolution of the Art of Music' (1896).

Folk-psychology, an ethnological study of the psychology of races and people, differing from folk-lore, which studies survivals. Among modern students of this science are Baldwin, Wundt, Lombroso, Lazarus, Steinthal and Felix Adler. Folk-psychology considers the habitat and food conditions of a people, its somatology, sex, technology, æsthetics, jurisprudence and pathology. Nearly all the books written upon this subject have been published only in German. See ETHNOLOGY.

Folk-right, the native laws and customs in Early English history as distinguished from the rules and observances introduced by William the Conquerer and his followers. See ENGLAND.

Folkestone, or **Folkstone**, fōk'stōn, a fortified seaport town of England, in Kent County, 62 miles southeast of London, and 7 west of Dover. It possesses a spacious harbor and fine pier whence the tidal steamers sail twice a day to Boulogne on the French coast. It was the birthplace of William Harvey (b. 1578), the discoverer of the circulation of the blood. Pop. (1901) 30,694.

Folk'land, or **Folcland**, fok'land, the land of the people, that portion of Anglo-Saxon England which was retained on behalf of the community. It might be occupied in common or possessed in severalty, but could not become allodial estate or absolute private property except with the consent of the Witan or highest council in the land. From time to time large grants were made both to individuals and to communities; and land thus cut off from folcland was called bocland or "book-land." Ultimately the king practically acquired the disposal of it, and the remnant of folkland became crown lands.

Folkmar, Daniel, American anthropologist: b. Roxbury, Wis., 28 Oct. 1861. He was graduated at the Western College of Iowa in 1884 and continued his studies at Paris and Berlin. He subsequently taught in several western institutions of learning (1895–1900) and was professor of anthropology in the Université Nouvelle of Brussels 1898–1901. Among his many writings are: 'L'Anthropologie Scientifique' (1899); and 'Leçons d'Anthropologie Philosophique' (1900).

Folkmoot, fōk'moot', or **Folcmote**, in Anglo-Saxon England, an assembly of the people to consult respecting public affairs.

Folks, fōks, **Homer**, American sociologist: b. Hanover, Mich., 18 Feb. 1867. He was graduated from Albion College (Mich.), in 1889, from Harvard in 1890, was superintendent of the Pennsylvania Children's Aid Society 1890–3, and in 1893 became secretary of the New York State Charities Aid Association. In 1900 he assisted the United States military government of Cuba in reorganizing the public charities of the island. He has written a 'History of the Care of Destitute, Neglected and Delinquent Children in the United States during the 19th Century.'

Fol'len, August, ow'goost, later **Adolf Ludwig**, German poet: b. Giessen, Germany, 21 Jan. 1794; d. Bern, Switzerland, 26 Dec. 1855. He became extremely popular as the author of 'Sons of Fatherland,' a patriotic hymn; 'Malegys and Vivian' (1829), a romance of chivalry; and numerous translations and poetic appeals to the instinct for liberty. He was a brother of Charles T. C. Follen (q.v.).

Follen, Charles Theodore Christian, American professor and Unitarian clergyman: b. Romrod, Hesse-Darmstadt, 4 Sept. 1786; d. 13 Jan. 1840, in the burning of the steamer Lexington, on Long Island Sound. He was educated at

Giessen, and became professor of Latin and history at Coire, Switzerland. His liberalism in politics and theology caused him to be driven from that town, and he was afterward forced to leave Basel, where he lectured on law and metaphysics, for the same reason. He finally took refuge in the United States and for five years (1830–5) was successful as professor of German at Harvard. He then took charge of the First Unitarian Church of New York, a position which he retained for a year (1836–7). He removed to East Lexington, Mass., in 1839.

Follen, Eliza Lee Cabot, American author: b. Boston, Mass., 15 Aug. 1787; d. Brookline, Mass., 26 Jan. 1860. She was married to Charles T. C. Follen (q.v.) in 1828. She published: 'Poems' (1839); 'Twilight Stories' (1858); 'Home Dramas' (1859), etc.

Folly Island, a small island off the coast of South Carolina, in Charleston harbor. It is separated from the mainland by Folly Island channel. It was the scene of several engagements during the Civil War.

Folsom, Charles, American scholar: b. Exeter, N. H., 1794; d. 1872. He was graduated from Harvard in 1813, was in the navy as chaplain and midshipmen's instructor in mathematics, was tutor at Harvard in 1821–3, and librarian in 1823–6. In 1824 he was associated with William Cullen Bryant in the editorship of the 'United States Literary Gazette.' As a member of the printing firm of Folsom, Wells & Thurston he long prepared for the press the classical works used at Harvard. Publications: An edition of Cicero's selected orations (1811), and an edition of selections from Livy (1829)

Folsom, Charles Follen, American physician: b. Haverhill, Mass., 3 April 1842. He was graduated from Harvard in 1862, was in the Southern States in connection with the Freedmen's Bureau from 1862 to 1865, and after study in the Harvard Medical School practised medicine in Boston from 1870. In 1877–82 he was lecturer in hygiene at Harvard, and in 1879–88 lecturer in and assistant professor of mental diseases. Among his writings is a volume on 'Mental Diseases.'

Folsom, George, American antiquary: b. Kennebunk, Maine, 23 May 1802; d. Rome, Italy, 27 March 1869. He was graduated 1822, studied law, and removing to New York in 1837 became librarian of the New York Historical Society. He was a member of the New York State senate 1844–8, and was appointed *chargé d'affaires* at the court of the Netherlands 1850–4, and was for some years president of the American Ethnological Society. Among his publications are: 'History of Saco and Biddeford, Maine' (1830); edition of the 'Collections of the New York Historical Society' (1841), translation of 'Despatches of Hernando Cortes'; 'Political Condition of Mexico' (1843); 'Documents Relating to the Early History of Maine' (1858).

Folsom, Joseph L., American soldier: b. Meredith, N. H., 19 May 1817; d. San José, Cal., 19 July 1855. He was educated at West Point, and served four years in Florida against the Indians (1840–4), and in California in the Mexican war. He communicated officially to the government the discovery of gold in that State: and Folsom City on the American River, near the earliest found gold deposits, is named after him, as one who became identified with the development of the State and especially of San Francisco, where he was a large property owner.

Folsom, Nathaniel, American soldier and statesman: b. Exeter, N. H., 1726; d. there 26 May 1790. He was in command of a company at Fort Edward 1755, and of a regiment later, being brigadier-general of the New Hampshire Contingent in the siege of Boston, and was elected to the Continental Congress 1774–5 and 1777–80.

Foltz, Philipp von, fē'lēp fōn fōlts, German painter: b. Bingen 11 May 1805; d. Munich 5 Aug. 1877. At Munich he was a pupil of Cornelius, whom he assisted in the decoration of the Glyptothek and the arcades in the Hofgarten. He was later a professor in the Academy, and in 1865–70 director of the Centr l Gallery. His historical paintings are minute and faithful in detail and skilfully designed in their pictorial arrangement, but they fail of proper effect from stilted drawing and dryness of color. The Cologne Museum possesses his 'Minstrel's Curse' (after Uhland's ballad); the Maximilianeum, Munich, his 'Humiliation of the Emperor Frederick I. before Duke Henry the Lion,' and 'Pericles attacked by Cleon and his Followers.'

Fol'well, William Watts, American educator: b. Romulus, Seneca County, N. Y., 14 Feb. 1833. He was graduated at Hobart College, later becoming assistant professor of mathematics there; was appointed professor of mathematics at Kenyon College, Ohio, 1869, becoming president of the University of Minnesota the same year, later, professor of political economy there. Author of 'Public Instruction in Minnesota' (1875); 'Lectures on Political Economy.'

Fond du Lac, fŏn'do-lăk, a city and county-seat of Fond du Lac County, Wis., on Winnebago Lake, at the mouth of Fond du Lac River, and on the Chicago, M. & St. P., the Chicago & N. W., and the Wisconsin C. R.R.'s: about 60 miles northwest of Milwaukee. Fond du Lac was first settled in 1836 by Germans; became a village 1 March 1847, and a city in April 1852.

Industries, etc.— Fond du Lac has important manufactures and is noted for its dairy and agricultural products. The chief industries, besides agriculture, are lumber, grain, flour, leather, paper, machinery, refrigerators, sash and doors, shoes, wagons, furniture, shirts, etc. The city has four banks, with a combined capital of $500,000, and an annual business of $15,000,000.

Buildings, Churches, etc.— The principal buildings are the Carnegie Public Library, Elks' Club House, Saint Mary's Springs Sanitarium, Saint Agnes' Hospital, and Henry Boyle Roman Catholic Home for the Aged. The city has also an excellent public school system (10 buildings), a parochial school and a cathedral school.

Government.— The city is governed by a mayor, elected annually, and a council of 32 members elected biennially, half each year. Pop. (1900) 15,110; (1903 est.) 16,037.

E. M. Jenison,
Editor 'Daily Commonwealth.'

Fon'da, N. Y., a town and county-seat in Montgomery County, on the New York C. & H. R. R.R. It is a thriving centre of a large agricultural district, has one bank and several newspapers. Pop. (1900) 1,190.

Fondi, fōn'dē, the ancient FUNDI, a town of Italy, Naples, in the province Terra di Lavoro, near a lake to which it gives name. It is a bishop's see, and contains a cathedral. The Lake of Fondi (ancient *Lacus Fundanus* or *Amyclanus*) lies between the road and the sea; it sends forth noxious exhalations. Pop. (1901) 9,930.

Fonseca, Antonio Manuel da, äṅ-tō'nē-o mä-noo-äl' dä fōṅ-sā'kä, Portuguese artist: b. Lisbon 1796; d. 1893. He studied in the Academy at Lisbon, became a professor there, was in 1839 appointed court-painter and in 1862 was elected corresponding member of the Academy of Fine Arts at Paris. Several of his pictures, which are chiefly of a historical character, were exhibited in the Paris Exposition of 1855.

Fonseca, Juan Rodriguez, hoo-än' rō-drē'geth fōn-sā'kä, Spanish ecclesiastic and statesman: b. Toro, near Seville, 1451; d. Burgos 4 Nov. 1524. He passed through many grades of preferment from the archidiaconate of Seville, to the archbishopric of Burgos, where he became *limosiuero* or private chaplain to the king and queen. In 1493 Ferdinand and Isabella appointed him to superintend the preparations for the second voyage of Columbus and practically to administer the affairs of the New World. He became first president of the Council of the Indies (q.v.), organized in 1511. His conduct in the discharge of this office has been stigmatized by modern historians, and he has been charged with shortsightedness, if not with malignity in his treatment of Columbus, Cortes and Las Casas.

Fonseca, Manuel Deodoro da, mä-noo-äl' dā-ō'dō'-ro dä fōṅ-sā'kä, Brazilian soldier and politician: b. province of Alagoas 5 Aug. 1827; d. Rio de Janeiro 23 Aug. 1892. He was educated as a soldier and graduated with the rank of sub-lieutenant of artillery in 1849. He saw active service in the Paraguayan war (1868–70), and attained the rank of major-general. In 1887, although a conservative and personally attached to the Emperor Dom Pedro II., he and others felt bound to protest against the acts of the government. They were punished for insubordination, revolted, and proclaimed a republic, which was recognized by the United States and later by the powers of Europe. Dom Pedro was banished and Fonseca was elected president of the government 24 Feb. 1891. In November of the same year he was accused of arbitrary acts and compelled to resign. He was succeeded by the vice-president, Peisoto.

Fonseca Lima e Silva, Manuel da, mä-noo-äl' dä fōṅ-sā'kä lē'mä ā sēl'vä, Brazilian soldier: b. Rio Janeiro 1793; d. 1862. He entered the Portuguese army in Brazil, and was apointed lieutenant-colonel in the struggle which subsequently took place for the independence of the country. Under the new régime the Emperor Pedro I. chose him as lord chamberlain. When Pedro abdicated (1831) Fonseca sided with the Liberals and rose to high rank in the government, being minister of war (1831), minister of the interior (1836), and in 1851 he was apointed general and commander-in-chief of the army.

Fonse'ca, fōn-sā'kä, or **Conchagüa,** cōn-chä'gwa, a bay on the Pacific coast of Central America, the proposed terminus of a projected interoceanic railway through Honduras. It is one of the largest bays in the South Pacific and affords one of the finest harbors in the world.

Font. (1) In church architecture, the vessel which contains the water for baptism. It is frequently sculptured in stone or marble, with richly decorative designs. The form of font with which we are now familiar seems to have been introduced in mediæval churches. In the early Latin Church, from the time of Constantine, baptism was administered in baptisteries, which were buildings separate from but adjoining the church. (See BAPTISTERY.) (2) An assortment of any particular kind or size of type used in printing, each font containing a proportionate number of letters, figures, spaces and punctuation marks. See TYPE.

Fontaine, Pierre François Léonard, pēār fräṅ-swä lā-o-nar fôṅ-tān, French architect and author: b. Pontoise, France, 20 Sept. 1762; d. Paris 10 Oct. 1853. He took the second grand prize of Rome 1785, going to Italy in 1786, and there connecting himself with Percier (q.v.), who, as director of the decorations of the Opera, Paris, called him to his aid, a partnership then being formed which lasted till 1814, when Percier retired. They constructed a beautiful stairway in the Louvre; the Arc du Triomph du Carrousel; the arcades of the Rue de Rivoli as far as the Rue de l'Echelle. He retained the favor of Louis XVIII. and Louis Philippe, constructing the Galerie d'Orleans at the Palais-Royal, the Chapelle Expiatoire, the Chapelle Ferdinand, repairs of the Louvre and the Tuileries, and the hospital at Pontoise. He wrote: 'L'Histoire du Palais-Royal'; and, in collaboration with Percier, 'Palais, maisons et autres edifices de Rome moderne' (1802); 'Choix des plus celebres maisons de plaisance de Rome et ses environs' (1809–13); 'Descriptions de cerémonies et de fetes' (1807–10); 'Recueil des decorations intérieures' (1812–17); 'Residences des souverains' (1833).

Fontainebleau, fôṅ-tān-blō, a town of France, in the department of Seine-et-Marne, and in the midst of the forest of same name, about 2 miles from the left bank of the Seine, and 37 miles east of Paris. It is well built, partly of stone and partly of brick, with spacious and regular streets; is the seat of a court of first resort, and several public offices; contains fine barracks, a communal college, school of design, public library of 28,000 volumes, public baths, and several hospitals; and has manufactures of calico, porcelain, and stoneware; quarries of sandstone, extensively used in paving the streets of Paris and the roads of the surrounding districts; and a trade in wine, fruit, preserves, cattle, etc. Pop. (1901) 14,160. The castle or palace of Fontainebleau, from which the town derives its chief importance, is one of the most magnificent in France. Many of its sovereigns have made it their favorite residence, and vied with each other in lavishing upon it all the embellishments that art could furnish, without any limitation as to expense. Henri IV., Louis XIV., Napoleon I., Louis Philippe, and Napoleon III. all expended large sums upon it. It is now a summer residence of the president of the republic.

Fontainebleau, School of, a group of artists assembled at Fontainebleau in France by Francis I., where they were employed in decorating the palace. There were two branches, Flemish and Italian; the influence of the latter, led by Rosso dei Rossi (1495–1541), eventually dominated French art (q.v.). See FRANCE: *Painting and Sculpture.*

Fontana, Carlo, kar'lō fōn-tä'nä, Italian architect: b. Brusciato, Italy, 1634; d. Rome 1714. He was a pupil of Bernini. While still very young he executed important commissions, including the Grimazzi and Bolognetti palaces, the monument of Queen Christina of Sweden in St. Peter's, and the fountains of St. Peter, and Santa Maria in Trastavere. He also built the cathedral at Fulda. Among his published works are: 'Il Tempio Vaticano e sua origine, con gli edifici piu cospicui antichi e moderni' (1694); 'Ultissimo Trattato delle acque correnti' (1697); 'L'Anfiteatro Flavio' (1725).

Fontana, Domenico, dō-men-ē'kō, Italian architect: b. Mili, Italy, 1543; d. Naples 1607. Cardinal Montalto (afterward Pope Sixtus V.) engaged him to construct a chapel in the Church of Sta. Maria-Maggiore, and a palace in the garden of the same church. But the pecuniary resources of the cardinal failed and the undertaking would have been interrupted had not Fontana himself supplied the means for continuing the work. Sixtus V. wished to remove the great obelisk now in front of St. Peter's Church, which was then nearly buried under the rubbish, to the middle of the square. Fontana happily executed this gigantic operation in 1586. Among other buildings erected by Fontana by the command of Sixtus V., the library of the Vatican and the aqueduct (*acqua felice*), deserve particular mention. Having been accused of converting to his private use the money received for public purposes, he was deprived of his office by the Pope, but immediately received the offer of the post of architect and chief engineer of the king of the Two Sicilies, and in 1592 went to Naples. He there constructed several canals to prevent inundations, a new road along the bay, and the royal palace in the capital.

Fontana, Felice, fā-lē'chā, Italian physiologist: b. Pomarolo, in the Italian Tyrol, 1730; d. 1805. He was appointed professor of natural philosophy in the University of Pisa, and while retaining this position he formed the museum at Florence which contains an immense number of anatomical preparations in colored wax, which exhibit all parts of the human body in the minutest detail, and in all imaginable positions. They are executed with the greatest skill, and were made by different artists under the direction of Fontana. Fontana wrote several works on scientific subjects, some of which have been translated into German and French. He also made discoveries relative to the application of carbonic acid, and different sorts of gas. He was buried in the Church of Santa Croce by the side of Galileo and Viviani.

Fontane, Marius, mä-rios fôṅ-täṅ, French writer and administrator: b. Marseilles 4 Sept. 1838. He met Ferdinand de Lesseps in the Orient and became his secretary, shortly afterward being appointed chief of exploitation and secretary-general of the Suez Canal Company and later administrator and member of the Committee of Direction of the Panama Canal Company. He was implicated with the other officers in the downfall of that company, was condemned in 1893 to two years' imprisonment, but this verdict was set aside on appeal, and after another trial he was acquitted. Among his works are: 'Les Marchands de Femmes' (1863); 'Confidences de la vingtieme annee' (1863); 'Selim l'egorgeure' (1865); 'Zara la rebelle' (1866); 'La Guerre d'Amerique' (1866); 'Le Canal maritime de Suez' (1869); 'Essais de poesie vidique' (1876); 'L'Histoire universelle' (Vol. I. 1881, Vol. X. 1899).

Fontane, Theodor, tā'ō-dōr fōn-tä'nĕ, German author: b. Neuruppin, Prussia, 30 Dec. 1819; d. Berlin 21 Sept. 1898. Among his writings are three volumes on England, one 'A Summer in London' (1854); 'The Sleswick-Holstein War of 1864' (1866); 'The War with France' (1876); and other war histories. His first volume of lyrics, 'Men and Heroes,' was published in 1850; his collected 'Ballads' in 1892. He wrote stories of North German life, as 'Count Petöfy'; 'Under the Pear-Tree' (1885); 'Mrs. Jenny Treibel' (1892).

Fontanes, Louis, loo-ē fôṅ-tän, MARQUIS DE, French writer: b. Niort, Poitou, 6 March 1757; d. Paris 17 March 1821. He went in 1777 to Paris, where he acquired a reputation by his poems: 'Le Cri de mon Cœur' (1778); 'Le Verger' (1788); 'L'Essai sur l'Astronomie' (1789); and 'L'Epitre sur l'Edit en Faveur des Non-Catholiques' (1789). He also wrote a metrical translation of Pope's 'Essay on Man' (1783). In 1802 he was made a member, and in 1804 president, of the legislative body. His admiration of Napoleon was great; and his oratorical talents were often employed in eulogizing the emperor's acts. In 1810 he entered the senate, and, passing on the fall of Napoleon into the service of the Bourbons, was raised to the peerage by Louis XVIII. His writings, prose and poetic, which are regarded as models of elegance and correctness, were edited by Sainte-Beuve in 2 volumes in 1837, with a critical and biographical memoir.

Fontarabia. See FUENTERRABIA.

Fontenelle, Bernard le Bovier de, bär när lė bō-vyā dė fôṅt-nel, French poet and miscellaneous writer: b. Rouen 11 Feb. 1657; d. Paris 9 Jan. 1757. Although he lived to the age of nearly 100 years, and retained, till his death a remarkable degree of activity, he came into the world so weak that it was not thought possible that he could survive. In 1674 he went to Paris, and soon became known by his poetical effusions and learned works. Before the age of 20 he had assisted in the composition of the operas of 'Psyche' and 'Bellerophon,' which appeared under the name of his uncle, Thomas Corneille (q.v.). In 1683 appeared his 'Dialogues of the Dead,' which were favorably received, although his continual straining after wit and novelty deprives them of the charm of natural ease. His 'Entretiens sur la Pluralité des Mondes' (1686) was the first book in which astronomical subjects were discussed with taste and wit.

Fontenoy, fôṅt-nwä, **Battle of,** one of the most famous battles in the war of the Austrian succession. It was fought at a small village of the same name, in western Belgium. Here 11

May 1745, the French under Marshal Saxe defeated the Allies under the Duke of Cumberland, with very heavy loss on both sides.

Fontevrault, fônt-vrō, a commune of France, in the department of Maine-et-Loire, with 3,581 inhabitants, situated in the middle of a forest occupying a valley in which flows a perennial fountain, 10 miles southeast of Saumur. This valley is celebrated as the site of the rich Benedictine abbey founded by Robert d'Arbrissel in 1099.

Fontevrault, Order of, a branch of the Benedictine order of monks; so named from the place in France where the first monastery of the sect was erected. The order was started in the 12th century by Robert of Abrissel, who brought monks and nuns under one roof, and placed them under the government of a female, because Jesus placed John in subjection to the Virgin Mary, saying: "Woman, behold thy son" (John xix. 26). The founder of the monastery was suspected of immorality, a charge which his followers strenuously denied. In 1106 the order received the sanction of Pope Pascal II.; in 1113 it was exempted from episcopal jurisdiction. In 1177 some monks connected with it came over to England by invitation of Henry II. It was remodeled in 1507 by the Abbess Renée of Bourbon.

Fonvielle, Wilfried de, wēl-frēd dė fôṅ-vyĕl, French scientific writer: b. Paris 21 July 1824. He aimed to popularize scientific truths by his writings, of which the best known are: 'Fossil Man' (1865); 'Balloons in the Siege of Paris' (1871); 'The Physics of Miracles' (1872); 'The Conquest of the North Pole' (1877); 'The Wonders of the Invisible World' (5th ed. 1880); 'Thunders and Lightnings' (4th ed. 1885); 'History of the Moon' (1885); 'Hypnotizers' (1887); 'The South Pole' (1888); 'Famous Vessels' (1890); besides one or two minor historical works.

Fonviz'in, Denis Ivanovich, Russian author: b. Moscow, Russia, 14 April 1745; d. St. Petersburg 12 Dec. 1792. His fame as the Molière of his country arises from two comedies: 'The Brigadier' (1766), and 'The Minor' (or 'Mother's Favorite Son') (1782). He wrote also a burlesque, 'Court Grammar,' and mock correspondence of a facetious sort.

Foochow, foo-chow', or **Fu-Chau,** town in China, capital of the province of Fu-Kien, in a plain surrounded by an amphitheatre of hills, on the left bank of the Min, 125 miles northeast of Amoy. It consists of the town proper, surrounded by walls, and of extensive suburbs, which, stretching along both sides of the river, communicate by a stone bridge. The walls, 30 feet high and 12 feet wide at top, are overgrown with grass, and the gates, seven in number, are overlooked by high towers. The streets are extremely dirty, and the lines of shops, crowded with goods or with workmen in the act of making them, make the whole place look like one vast series of market-stalls. The principal edifices are the Ching-hwang Miau, and several other temples. Foochow is one of the five ports thrown open by the Treaty of 1843. The trade is very extensive, but the navigation of the river from the sea to the harbor is difficult. Principal exports — timber, bamboo, fruits, tobacco, potash, paper, and especially for the foreign trade — tea. In 1900 the exports amounted to $3,889,490. The imports in 1900 were of the total value of $4,088,560. Pop. (1900) 650,000.

Food, any substance which, taken into the body, is capable of sustaining or nourishing or which assists in sustaining or nourishing the living being. Foods may be classed under three heads, gaseous, liquid, and solid, the first two consisting of the air we breathe — the oxygen of which is so essential to life — and the water we drink. Milk, tea, coffee, cocoa, etc., are popularly called liquid foods, but each of these is simply water in which various solid substances are dissolved, or held in suspension. The solid foods are of three kinds — namely: nitrogenous, non-nitrogenous, and mineral. Nitrogen compounds, or flesh formers, are essentially composed of carbon, hydrogen, oxygen, and nitrogen. They possess the only ingredients capable of building up and repairing the nitrogenous tissues of the body, but they also furnish a limited supply of heat, especially when heat-giving compounds are deficient in the body. Nitrogenous compounds are found both in the animal and vegetable kingdoms under the forms of albumen, fibrin, casein, gelatine, and chondrin. Non-nitrogenous compounds, or heat givers, sometimes called carbonaceous compounds, are composed of carbon, hydrogen, and oxygen. They serve to keep up the heat of the body, and so produce energy or force; but they contribute also to the repair and growth of the body. The chief heat givers are starch, sugar, and fat. None of these substances will of itself sustain life. The mineral foods are the salts of soda and potash, the phosphates of lime and magnesia, iron, etc. Common salt is the only mineral substance purposely added to food, the other mineral substances being found in nearly all parts of plants and animals used as food. Milk is a natural model food, as it furnishes all the nourishment required, and in due proportion. Oatmeal may also be called a model food, as it contains one part flesh formers and 5½ parts of heat givers. In fine wheaten flour the proportion is as one to eight, a part of the flesh-forming body having been removed in its preparation. The adulteration of any article of food reduces one or both of its essential constituents. The National Pure Food Law, which went into effect in the United States 1 Aug. 1900, was aimed against adulteration (q.v.). For a more extended description and classification of foods see the article NUTRITION.

Food of Plants. See PLANT FOODS.

Food-poisoning, a form of poisoning from food, which in times past was thought to be extremely common, but at the present time is known to occur but rarely. One of the most important features in food-poisoning is individual idiosyncrasy. It is well known that certain foods, such as strawberries and tomatoes, affect susceptible people uncomfortably, but instances of this are rare, and are often of mental origin. Epidemics of food-poisoning have occurred, as when, for instance, a baker has used a yellow coloring matter in his cake to obviate the necessity of using eggs, which coloring matter was largely made up of lead.

Food-poisoning may be classified under three main types: (1) Poisoning by means of metals; (2) poisoning by means of animal parasites; (3) poisoning by means of plant parasites, bacteria and fungi and allied organisms. The metals which have been known to cause poisoning in food are particularly arsenic, lead, copper, antimony, tin, and zinc. During 1900 there was a widespread epidemic from poison by arsenic, in Manchester, England, and neighboring cities, from the drinking of beer. On investigation it was found that the arsenical poisoning, which in some cases proved fatal, was due to the glucose used in the manufacture of the beer. This glucose had been prepared by a sulphuric acid which had in turn been made from iron pyrites containing large amounts of arsenic. It entered into the glucose, and thus became an ingredient of the beer. This epidemic was extremely severe, thousands of cases of arsenical poisoning having been observed. Lead-poisoning very frequently follows the use of water which has been conveyed through new lead pipes. It may also result from the use of leaden coloring matters used in bread, biscuit, cake, etc. Zinc and copper poisoning have resulted from the use of canned vegetables, copper frequently being used to impart a good color to the vegetable.

Food-poisoning resulting from animal parasites or from animal poisons are of extreme interest. Trichinosis from the flesh of hogs, which has been imported in pork and pork sausages, while rare in this country, is common among those people who habitually eat their sausages without thorough cooking. A form of poison results from the eating of mussels which have developed the ptomaine mytilotoxine, and similar forms of poisoning from decomposition products in meat have been observed. A special form of meat-poisoning, botulism (q.v.), is extremely common in certain countries. It seems to be due to the development of the *Bacillus botulinus*. This form of poisoning has been observed in those who have eaten ham. The symptoms are late in onset; from 24 to 36 hours after eating gastric pains with frequent vomiting occur; and constipation is at first obstinate. Practically all the cases of botulism have shown eye-symptoms. There is disturbance of vision, the eyes become fogged, the lids droop, people see double, and there is dilatation of the pupils, while burning thirst and constriction of the throat are frequent signs. Extreme muscular weakness with perhaps loss of ability to speak, or of power to empty the bladder, may develop.

Other forms of food-poisoning have been described resulting from eating sausages and other meats which were diseased at the time of killing, or which have become tainted afterward, and a number of poisonous bacteria have been isolated. *Bacillus enteritidis, Bacillus morbificans, Bacillus breslaviensis, Bacillus Friedebergensis*, have been some of the forms that have been obtained in poisonous meat. Fish-poisons are not unknown, and in Russia and Switzerland and the West Indies a number of cases have been described as resulting from fish-poisoning. A peculiar type of poisoning from milk, ice-cream, cream-puffs, frozen custards, and cheeses is known. This poison seems to be due to the presence of a toxic substance which has been named by Vaughan of Ann Arbor, Mich., as tyrotoxicon.

As to poisoning from vegetable foods, the most important general poisons are those due to eating the poisonous mushrooms, and the grains affected by ergot and allied species. Thus ergotism as found in Russia, Spain, Italy, and its close ally pellagra are types of this form of food-poisoning. A well-known disease in eastern Japan and neighboring parts of Asia, termed beriberi (q.v.), is thought to be due to poisonous rice. See FUNGI; MUSHROOM; PTOMAINES; TOXICOLOGY.

Food Preservation is the method adopted for the preservation of organic substances used as food, either animal or vegetable, and may be considered under the following heads: (1) Preservation by cold; (2) Preservation by drying; (3) Preservation by salting; (4) Preservation by smoking; (5) Preservation by sterilization by heat and the exclusion of air; (6) Preservation by chemical or antiseptic substances.

1. *Cold.*— The application of cold for the preservation of meat and vegetables may now be conducted under modern methods of applying this agent, at temperatures varying from 0° F. (—18° C.) to 40° F. or more. In the large cold storage plants now established in many cities, in which ammonia is chiefly used for the production of variable degrees of cold, it is customary to provide several large chambers for the preservation of food in which different temperatures are required, fruit being kept at temperatures a little above the freezing point, and meats, fowl and especially fish at considerably lower temperatures.

In densely settled countries like England, where the land is insufficient to produce the necessary amount of meat for the food supply of the people, frozen meat from other countries forms a very large part of the food supply. If the meat is frozen before *rigor mortis* (rigidity following death) supervenes the meat keeps well, but if it is frozen later it rapidly decomposes after thawing. Freezing arrests putrefaction and has a tendency to conceal the odor of decomposition. Hence the bad condition of frozen fish may not be detected until the heat necessary for cooking is applied. Meat which has been frozen, is often unusually tender, on account of the loosening of the intermuscular tissue by freezing; bacteria can more readily penetrate into the interior of the thawed meat, and bring about rapid decomposition. Such meat and fish, especially when thawed too suddenly, lack the flavor of fresh meat. Bacteria in general and especially those which are concerned in the production of putrefaction, seem to be endowed with extraordinary powers of resistance to the action of cold. Colemann and Mickendrick kept flesh six hours in hermetically sealed boxes at temperatures from —6° to —130° C., but in every instance the flesh after being kept at a slightly warm temperature began to decompose in from 10 to 12 hours, though protected from subsequent infection. But cold, though it may not destroy micro-organisms, prevents their development, or at least does so in the case of putrefactive bacteria. There are, however, certain bacteria which are capable of developing in frozen meat, and especially in that which is kept at about 0° C. Lafar attributes to this cause, the unpleasant flavor sometimes acquired by meat which has been kept in a refrigerator for several days. This is confirmed by Popp, who says that the walls of such ice chambers when moist, swarm with bacteria, which in his opinion produce the objectionable flavor often developed in stored meat.

The Detection of Frozen Meat.— Maljean describes a method of detecting frozen meat by microscopic examination of the blood of the meat. A drop of the blood is expressed from the meat upon a glass slide, covered with a thin glass, and examined as soon as possible to avoid solidification. The juice of fresh meat shows numerous red corpuscles of normal color and shape floating in a nearly colorless serum. But the corpuscles of frozen meat are more or less distorted in form and are completely decolorized, while the surrounding fluid is relatively dark in color. On placing a fragment of frozen meat in a test tube, containing some water, the liquid becomes colored more rapidly and intensely than when fresh meat is used.

2. *Drying.*— This is one of the oldest and best known of the various processes of preservation, and applies equally to animal and to vegetable products. By this means, beef and fish of many kinds, grapes, figs, apples, peaches, currants, and many other kinds of fruit are annually preserved by drying, and are thus rendered more suitable for transportation to distant markets, in consequence of great reduction in weight, as well as preservation from decay. The more rapidly the drying process is conducted the better. Drying is conducted in the open air by the aid of the sun's heat, or by artificial means. The curing of fish by drying constitutes an important industry in most northern maritime countries, the principal edible fish employed for this purpose being cod and herring, of which large numbers are dried in the fishing ports of the Atlantic coast north of Cape Cod, and in the British Islands and on the coast of Norway and Sweden. Fish are prepared for drying by the removal of the entrails, slitting them lengthwise, and then drying them in the open air.

3. *Salting.*—Salting is one of the oldest and best-known methods of preserving meat and fish. The most common method of preserving meat, especially pork, is by placing the meat in casks in layers, with salt between each layer. The salt withdraws water from the meat, and the brine thus formed penetrates the fibres of the meat. In Eckart's Munich quick-salting process, the meat is impregnated under pressure with a 25 per cent solution of common salt for 24 hours and then smoked. It is claimed that by this process the loss consists, mainly, of only water and a little phosphoric acid, that the meat has a better flavor, and that trichinæ are completely destroyed. As one of the results of salting meat is the removal of its natural color, it is quite customary to add a small quantity of saltpetre to counteract this effect. According to Lehmann, a small percentage only should be used on account of its harmful effect. Five grams of this salt have caused severe illness and eight grams have been known to cause death. The effect of the continued use of meat containing saltpetre, upon the human system, has not been determined by observation or by experiment.

Influence of Salting Upon Bacteria.— Forster's experiments show that the streptococci of erysipelas and many other well-known bacteria can live for weeks and even months in salted meat. The bacilli of tuberculosis retain their virulence for more than two months, and while the bacteria of anthrax perish in less than a day, their spores retain their vitality for a much longer period.

Effect of Salting Upon Flesh.— Salted meat is harder and more difficult of digestion than fresh meat. Voit shows by analysis that the nutritive value of meat is only slightly diminished after 14 days' salting. He found the percentage loss to be for water 10.4, organic matter 2.1, albumen 1.1, extractives 13.5, phosphoric acid 8.5. The amount of salt taken up by 1,000 grams of fresh meat was 43 grams. Polenske, on the contrary (Jahresbericht Nahr. u. Genussmittel 1891, p. 40), found that the meat, after being salted for three weeks lost 7.7 per cent of its nitrogenous constituents, and 34.7 per cent of its phosphoric acid, and after three months and six months the loss was still greater. He therefore concluded that the meat was greatly altered in its nutritive character, and that it could not be used continuously without injurious effects. Salted pork constituted a very important part of the food ration of the Union army in the Civil War, and when accompanied with an abundant supply of fresh vegetables, it was considered a wholesome article of food. Absence of the latter, however, was often the cause of serious illness. Strohmer gives the following analysis of fresh and salted herring:

	Fresh herring	Salt herring
Water	80.7	46.2
Nitrogenous substances	10.1	18.9
Fat	7.1	16.9
Ash	2.1	16.4
Salt	....	14.0

Caviare.— This is the salted roe of the sturgeon and other fish. It is prepared by washing the roe with salt water, leaving it in the brine for some time, pressing it, again treating it with salt water, passing it through a hair sieve, and finally packing it in salt. The most highly prized is the Astrakhan caviare, which is prepared at the mouth of the Volga. The following analyses of caviare are compiled from the works of Gobley and of König:

	Caviare	Pressed caviare
Water	43.89	30.89
Nitrogenous substances	30.79	40.33
Fat	15.66	18.90
N-free substances	1.67	....
Ash	8.09	9.88
The dry substance: N-substances	54.89	58.36
The dry substance: Fat	24.02	27.35
The dry substance: Nitrogen	8.78	9.36

4. *Smoking.*— The preservative qualities imparted to meat or fish by smoking are due partly to the drying action of heat, and partly to the antiseptic action of some of the substances of which smoke is composed, namely, creosote, formaldehyde, and pyroligneous acid. The smoke coagulates the albumen of the meat, and forms a protecting envelope. The best woods for the production of such smoke for preserving are beech, birch, and poplar, the conifers being unsuitable in consequence of the resin which they contain. There is no loss of nutriment, and Strohmer found that smoked meat is as digestible as fresh meat. Smoking may be con-

ducted in two ways: (1) by slowly smoking the meat for 24 hours at 25° C., or in the case of sausages and fish at 70° C., and then for a short time at 100° C.; (2) the meat may be placed directly in the hot smoke. Products prepared by the slow process have been found to contain more micro-organisms than those made more rapidly. The smoking should be continuous and not intermittent.

Action on Bacteria.— Serafini and Ungaro found that smoke acts energetically on pure cultures of bacteria, those of anthrax being killed in 2½ hours, and anthrax spores in 18 hours. Bacilli in the interior of the meat were not killed. Forster found the bacilli of tuberculosis still virulent in the interior of meat after it had been salted and smoked.

The following analyses of smoked and salted meats and fish are from the works of Strohmer and König:

	Water	Nitrogenous substances	Fat	Ash	Common Salt
Ham	59.73	25.08	8.11	7.08	....
Smoked beef...	47.68	27.10	15.35	10.59	....
Smoked herring	64.49	21.12	8.51	1.24	....
American bacon	9.15	9.72	75.75	5.38	....
Mackerel	44.45	19.17	22.43	13.82	11.42
Salmon	51.46	24.19	11.86	12.04	10.87

During the process of salting and smoking the coloring matter of meat is changed, as shown by the spectroscope. Smoked ham and other meats have an alkaline reaction.

5. *Preservation by Exclusion of Air After Sterilization by Heat.*— In early times food was preserved to a limited extent by heating in earthen vessels, and sealing hermetically by such crude processes as were available. At the present day such methods have given place to preservation, either in tin cans or boxes or in glass. In the former instance food may be preserved for long periods, by means of soldering, and in the latter by means of tight-fitting joints and rubber rings. The latter method is not so much used in trade, but is largely employed for domestic purposes. The prudent housewife also makes use of surface layers of paraffine and waxed paper for the temporary exclusion of air. Tin cans are stronger, and more tight, and more economical. Almost every kind of perishable food is now preserved in this manner.

In the United States the preservation of meats, poultry, fish, vegetables, and fruits in this manner has become an important industry and branch of commerce, both domestic and international. The canning of meats is conducted to a great extent in those cities where great slaughtering establishments are located. The canning of vegetables and fruits is carried on at places located among the great fruit-producing regions, while the fish canneries are mostly upon the rivers and in the seacoast towns of the northeast and northwest States and Provinces where the fish are taken from the water. The cans filled with their contents are either heated in steam retorts or immersed in boiling water. A small hole is left in the cover, and while still hot, the hole is closed with a bit of solder. In a few days the cans are tested by tapping them with a wooden mallet or hammer. If the cap sinks slowly, the can has been properly sealed, but if it is elastic, and springs back, it is rejected as a "swell-head." In the preservation of corned beef, the cans are pierced to allow the water and fat to escape, and are then soldered and placed in boiling water again for several hours.

Canned roast beef is largely used as a part of the army and navy ration, especially during the time of war, and upon the frontier. The method of preparation is thus described by Munson: "The beef is first placed in water and maintained at a temperature of 95° C. until well cooked. It is then removed, trimmed and placed in cans, a little gelatine being added to bind the meat together. The cans are then sealed and either submerged in boiling brine, or placed in superheated steam at 125° C. The steam in the can escapes through a puncture made in the top of the can which is immediately afterward closed with solder. The meat being sealed while hot, any portion of enclosed space is a partial vacuum; consequently a good can of meat will usually present a concave appearance on the outside, from atmospheric pressure.

When a can is bulged it is bad — unless frozen — and should be rejected. Freezing causes a bulging of the ends of the cans without injury to their contents. The ends, after the contents are thawed, return to their former shape, unless this process has been several times repeated.

The process of canning involves the making and soldering of two punctured holes in the top of each can. The presence of three such holes is evidence that the can had been imperfectly treated, and that it was reheated, the gas allowed to escape and the hole punctured for this purpose again sealed. The contents of such reheated cans are more likely to be of inferior quality than those of properly prepared cans. On this account the packers are careful to make the third puncture as inconspicuous as possible, and often to conceal it entirely by making it on the side of the can near the top and pasting the label over it. This may usually be detected by running the finger around the rim of the can.

Sometimes newly packed cans are so much swollen that reheating is not sufficient. In such cases the cans are opened, the contents sorted and the sound parts repacked in cans as before. The quality of such articles can only be determined by opening the cans and examining their contents, which present an overcooked appearance. First-class canned goods have the name of the manufacturer and often that of the wholesale house through which they are sold upon the labels, while doubtful goods have a fictitious factory name and no dealer's name.

Canned peas are subject to great variations in quality. Dried peas are bought in large quantities, soaked, heated and canned. Such articles can usually be recognized by their appearance and taste on opening the cans. To such an extent is this done as to have led to legislation in some States requiring all such cans to be legibly marked "soaked."

French canned peas and beans are often colored with sulphate of copper, which improves their appearance, but not their taste. The sale of such articles is forbidden in some countries.

The Composition of Canned Meats.— König found the following results in samples of canned meats and salmon. From 48 to 65 per cent of water, from 15 to 33.8 per cent of nitrogenous substances, from 0.2 to 21.6 per cent of fat, and from 2.3 to 21 per cent of ash. Of the water-free substances, there were from 43 to 78 per cent of nitrogenous substances, and from 0.3 to 43 of fat. The albuminous substances were generally less than those of fresh meat, the actual figures varying in different kinds of meat, from 87.06 to 93.94 per cent as much as that of fresh meat. The preservation of food by hermetic sealing in cans has, within the last half century grown to be an important factor in the commercial and industrial development of the United States. Before 1795 drying and the use of salt and sugar were the only methods used to any considerable extent in the preservation of food. Nicholas Appert, a Frenchman, stimulated by the offer of a reward for a mode of preserving food for use at sea in the navy, submitted to his government a treatise upon the hermetic sealing of all kinds of food. His principle, as set forth in this work, was practically the same as that which is now in use, the exclusion of air, and the application of heat for the purpose of sterilization. France first purchased his process and the industry soon spread to England and Ireland.

One of the first persons who introduced the industry into the United States was Ezra Daggett, who arrived in New York between 1815 and 1818. In 1819 he was engaged in the manufacture of hermetically sealed goods, chiefly salmon, oysters, and lobsters. William Underwood arrived at New Orleans from London in 1817, having learned the trade of pickling and preserving with the house of Mackey & Company. Not liking the climate of the South he walked from New Orleans to Boston, where he and Charles Mitchell introduced the same industry, applying it to pickles, sauces, jams, and fruit. Glass jars were at first used, but on account of their expense and fragile nature, they were soon largely supplanted by tin cans, which were introduced in 1825 by Thomas Kensett. The making of tin cans for this purpose became an important industry, various improvements being made from time to time in the processes of manufacture.

During the Civil War large quantities of canned meats, tomatoes and other vegetables and fruits were furnished both to the army and to the navy, and during the Spanish war the use of preserved meats treated with chemical antiseptics at one time threatened to become a lively campaign issue.

According to the census of 1900 there were in that year 2,195 establishments for the canning and preserving of fruits and vegetables, fish and oysters in the United States, having an aggregate capital of $48,497,978. The value of their products was $82,592,196. The number of wage-earners averaged 52,581, and $12,910,399 were paid for wages. Of the total capital, $27,743,067 was devoted to the canning of fruits and vegetables, $19,514,215 to fish, and $1,240,696 to oysters. The exports of canned or preserved fish, fruits, and vegetables in 1900 exceeded the imports by about $2,500,000.

The capital devoted to the canning of fruits and vegetables had increased from $2,335,925, in 1870, to $27,743,067 in 1900, and the number of establishments from 97 to 1,808.

The number of establishments in the New England States in 1900 was 80, in the Middle States 945, in the Southern States 204, Central 380, Western 28, Pacific 171. The largest numbers in single States were in New York 511, Maryland 271, California 136, Michigan 98, Virginia 88, New Jersey 73, Ohio 70, Illinois 61, Indiana 60, Maine 59, and Delaware 51. The value of the products was, in California $13,081,829, in Maryland $11,996,245, in New York $8,975,321 and in Illinois $3,730,030. The principal preserved fruits and vegetables in value were tomatoes $13,926,749 (641,219,993 pounds), corn $8,230,975, peas $4,679,426, beans $2,124,208, peaches $4,414,277, pears $2,233,166, apples $1,160,728, apricots $1,591,567, dried apples $1,913,142, dried prunes $970,927, and raisins $720,268.

The drying of fruit is confined chiefly to California and New York, these States reporting 87.2 per cent of the total number of pounds. Maryland leads in oyster canning and is among the first in the canning of tomatoes, corn, peaches, peas, lima beans, pears and pineapples. Maine is the leading State in sardine canning, and New York leads in canning corn, apples and pears.

Fish Canning and Preserving.— The number of establishments devoted to fish canning and preserving in the United States in 1900 was 348, having increased from 110 in 1890. Of the total number in 1900, 117 were in Maine, 61 in Massachusetts, 36 in Alaska, 36 in Washington, 24 in Oregon, and 19 in California. The value of products in 1900 was $22,253,749, of which Maine produced $4,779,733, Washington $4,831,038, Alaska $3,821,136 (or more than half the amount paid Russia for this territory), and Oregon $1,788,809.

By far the greatest capital employed in any single city in fish preservation was in Gloucester ($1,479,647), and secondly in Seattle, Wash., $336,620.

The canning of fish was introduced at Eastport, Maine, in 1843, lobsters and mackerel being preserved in this manner. Establishments for salmon canning were started on the Columbia River in 1866, and at Klawak, Old Sitka and Cook Inlet in Alaska in 1878 and 1882. The labor in these salmon canneries is chiefly performed by Chinese. The sardine canning of Maine is next in importance to the salmon canning of the Pacific coast. Sardine is a general term applied to various small fishes, the best known being the young of the pilchard (French) and the young of the sea-herring (coast of Maine). The fish are first fried in oil, and then placed in a can with oil. Olive oil or peanut oil are chiefly used in France for this purpose, and cotton-seed oil in Maine.

The number of establishments engaged in oyster canning in the United States in 1900 was 39, of which 16 were in Maryland, 6 in Florida, and 4 in Mississippi; $1,240,696 in capital was devoted to this industry, and the products were valued at $3,670,134, of which two thirds were produced in Maryland. In canning oysters in large quantities, steam is employed, the oysters being put into a steam-tight box and submitted to the action of steam for 15 minutes, by which process they are more readily opened and made ready for canning.

The extent and importance of the food canning industry of the United States may be estimated by the fact that 400,000 persons are employed in the work of canning, manufacture of cans, packing boxes, etc. It would require 60,000 freight cars to transport a year's product: 750,000,000 cans, 2,000,000 boxes of tin plate for the cans, and 30,000,000 wooden packing boxes.

6. *Preservation by Chemical Substances.*—For many years it has been the custom to employ salt, sugar, alcohol, and saltpetre for the purpose of preserving meat and fish, and some of these substances for the preservation of fruits and vegetables, and no objection has been made to this practice; but in more recent times, and since preserved food has come into more general use, the practice of using other substances has also largely increased. The question whether the use of such articles for this purpose may be injurious to the health of the consumer does not appear to have been yet satisfactorily settled. The experiments of Tunnicliffe and Rosenheim would appear to show that food mixed with boric acid and borax, taken separately and together in such quantities as are ordinarily employed, may be eaten with impunity, but earlier observers have arrived at contrary conclusions. On account, therefore, of the possibility of the use of such chemicals in the preservation of food by persons wholly unacquainted with their physiological properties, legislation appears to be tending in the direction either of prohibition of the use of chemical preservatives or of regulating their use by making their presence known to the consumer. Many substances have been experimented upon with reference to their preservative quality, among which are sulphur dioxide, sulphites and bisulphites, boric acid and its compounds, fluorides, chlorides, alum, lime, sodium carbonate, formaldehyde, benzoic and salicylic acid and their compounds. At the present time boric acid, salicylic acid, and formaldehyde appear to be most frequently used.

Boric acid is most often used for the preservation of meats, certain kinds of fruits and catsup, and upon hams and fish. The latter are found to keep longer if the boric acid is rubbed over the outside. Two grams per kilo is sufficient for fish. According to le Féré boric acid is eliminated slowly from the system, having been detected in the urine 40 to 50 days after it had been taken. It does not appear to interfere seriously with digestion so far as could be concluded from experiments. Cases of flesh poisoning have been reported from Switzerland, where meat had been preserved with borates, which had not acted sufficiently as preservatives, but had only masked incipient putrefaction.

Sulphur and its compounds have been used to some extent for the preservation of food, but not so much at present as formerly. These compounds and especially sulphur dioxide have a powerful germicide action. Authorities differ as to their physiological action. Polli found that 8 to 12 grams of sulphite were not injurious to adults. Ostertag, Bernatzik, and Braun found that one gram of magnesium sulphite caused disorders of the stomach in women. Fischer found that 50 per cent of the preserved meat products sold in Breslau in 1895 contained sulphites, the quantity of sulphur dioxide varying from .34 to .01 per cent. According to Riche, sulphurous acid and its salts, especially calcium bisulphite, have a considerable action on meat, altering its normal condition. This action causes changes in the soluble proteid substances. An addition of 1 per cent of a sulphite to meat is not perceptible to taste or to smell. On cooking the meat the sulphite is only partially decomposed and expelled. Fischer states that meat containing more than 0.1 per cent of sulphur dioxide should be regarded as injurious to health.

Salicylic acid is one of the constituents of many of the modern meat preservatives. Bersch placed a portion of the flesh of a recently slaughtered animal in a concentrated aqueous solution of salicylic acid, and found that after four days the exterior of the meat was perfectly sound, but the interior showed signs of putrefaction, and contained many micro-organisms. He therefore concluded that the preservation of fresh raw meat by salicylic acid was not practicable. In such meat compounds as sausages and potted meat, where the salicylic acid is uniformly distributed through the mass, its germicidal properties would obviously exert a more decided action. On account of its decided taste it cannot be used so freely in meat preparations as in other kinds of food in which the taste of the preservative is concealed. Here again authorities differ as to the action of this preservative on the human economy, when used in connection with food substances. The Paris Academy has forbidden even the least addition of salicylates to food, on account of their liability to injure the kidneys or digestive organs, when any weakness of these organs exists.

Formaldehyde.— In recent years formaldehyde has been introduced as a preservative in consequence of its powerful antiseptic action. A proprietary preservative known as "Carnolin" consists of a 1.5 per cent solution of formaldehyde slightly acidified. It exerts a decided antiseptic action on milk in very small amounts. The effect of salicylic acid upon the system, when employed in the small proportions required for food preservation has not yet been well determined, but its power of forming insoluble compounds with proteid substances, and its hardening power upon animal tissues, would seem to render meat treated with it much less digestible than otherwise. Mahery and Goldsmith found that formaldehyde in the proportion of 0.2 gram limited the artificial peptic digestion of blood fibrin. Ludwig states that formalin is not applicable to the preservation of meat products. Ehrlich tried the effect of an 8 per cent. solution of formaldehyde on various food substances. He found that horseflesh was completely preserved by it, but that the odor developed was such that the meat could not be eaten. Beef thus treated did not develop this odor, but was only fit to be eaten for a short time after addition of the preservative, on account of the chemical changes which it produced. According to Bloxam formaldehyde causes fish to become so hard as to be unsalable even if the solution contains only one part in 5,000.

British Investigation Relative to the Use of Preservatives.— A committee was appointed in 1899 to report to Parliament upon the "Use of preservatives and coloring matters in food," the object of the investigation being to ascertain:

1. Whether the use of such materials, or any of them, for the preservation and coloring of food, in certain quantities, is injurious to health, and if so, in what proportions does their use become injurious?

2. To what extent and in what amounts are they used at the present time?

This committee held many hearings and examined 78 witnesses, among whom were the principal experts in England, physicians, health officers, chemists, grocers, dairymen, and representatives of different food interests.

The committee reported that the preservatives found in use other than alcohol, oils, vinegar, salt and sugar, were boric acid and other boron preservatives, sulphurous acid and sulphites, fluorides, salicylic acid, benzoic acid, and formalin or formaldehyde. A list of 4,251 articles of food examined at the government laboratory for preservatives was presented, of which 1,659, or 39 per cent, were found to contain preservatives. These consisted of 35 different kinds of food and beverages. The articles in which the greatest ratio of preservatives was found were lime and lemon juice, 88.5 per cent, ham 82.7 per cent, cream 77.9 per cent, margarine 74.4, pork-pies 70.8, cordials 70.8, bacon 70.5, sausages 66.4, fruit syrup 65.2, butter 57.1.

Of the 1,659 samples treated with preservatives, 1,249 contained boron compounds, 320 salicylic acid, 20 formalin and 143 sulphites.

The committee were of the opinion that preservatives should not be used in milk, since the milk producer might be liable by such use to protect himself against the immediate results of scrupulous cleanliness. Under the influence of preservatives milk may be exposed without sensible injury to conditions which would otherwise render it unsalable. It may remain sweet to the taste and smell, and yet may contain disease germs of various kinds, whereof the activity may be suspended for a time by the action of the preservative, but may be resumed before the milk is digested.

The following were the general conclusions of the committee, so far as preservatives are concerned:

a. That the use of formaldehyde or formalin or preparations thereof, in food and drink be absolutely prohibited, and that salicylic acid be not used in a greater proportion than one grain per pint of liquid food, and one grain per pound of solid food; its presence in all cases to be declared.

b. That the use of any preservative or coloring matter whatever in milk offered for sale in the United Kingdom be constituted an offense under the food and drug acts.

c. That the only preservative which it shall be lawful to use in cream be boric acid or mixtures of boric acid and borax, and in amount not exceeding 0.25 per cent expressed as boric acid, the amount of such preservative to be notified by a label upon the vessel.

d. That the only preservative permitted to be used in butter and margarine, be boric acid, or mixtures of boric acid and borax, to be used in proportions not exceeding 0.5 per cent expressed as boric acid.

e. That in the case of all dietetic preparations, intended for the use of invalids or infants, chemical preservatives of all kinds be prohibited.

The following statement appears in the 33d annual report of the State Board of Health of Massachusetts (1901). Out of 7,323 samples of milk examined with special reference to the presence of preservatives, 184, or 2.5 per cent, contained formaldehyde; 42, or .6 per cent, contained boric acid, and 7 contained carbonates. These samples were all obtained in the summer months.

Legislation Relative to the Use of Preservatives.— At present Austria has no law upon this subject. In Belgium the use of preservatives in milk is forbidden. In Denmark a law of 1897 prohibits the use of all preservatives except salt in butter and margarine. The use of several specified preservatives in wine is also forbidden. In France the sale of food containing either salicylic acid or formalin is prohibited. In Germany, by a law of 1879, spoiled goods sold in a state concealing their real condition make the vendor liable to a penalty. The addition of alum, boric acid and salicylic acid to wine is also forbidden. The following conclusions have been reached by the Imperial Health Board of Germany regarding the use of sulphurous acid in mince meat:

1. From fresh butcher meat without chemical preservatives, but with due observance of cleanliness, mince meat can be produced, which, if kept at a low temperature, will retain its natural color for more than 12 hours.

2. The addition of preservatives which contain sulphurous acids and similar salts can improve the natural color of the meat, but not the meat itself. By their means mince meat can appear to be of better quality than it really is.

3. The frequent consumption of mince meat which is treated with sulphurous acid salts may be injurious, particularly to people of delicate health.

The Imperial Health Board is also carrying on a series of experiments relative to boric acid and its compounds.

There is no law in Norway prohibiting the use of preservatives in food, unless they can be shown to be injurious to health. In Switzerland each canton acts for itself and there is no general law upon the subject.

Legislation in the United States.— At present there is no law of the general government upon the subject. In the report of the secretary of agriculture in 1899 were the following suggestions:

"It is not regarded as a wise thing to absolutely prohibit the use of preservatives in food. Since, however, all chemicals which have the property of preserving food have also a tendency to interfere with the process of digestion, it is held to be imperative that no food should be offered for sale which contains a preservative without having this fact plainly stated upon the label of the package. Not only should the label state that the food product contains a preservative, but it should also give the name of the preservative, and the quantity employed. In this way the intending purchaser is fully informed in regard to the character of the product which he buys. While it has been established that a healthy stomach can from time to time receive with impunity food containing small quantities of preservatives, it is by no means certain that the continued practice of ingesting preservatives in foods would not produce serious injury. On the other hand, it is also quite certain that weak or diseased stomachs may suffer temporary or permanent injury from minute quantities of preservatives. See Adulteration.

In the different States of the Union there is very little uniformity in the legislation relative to the use of preservatives in food, many States having no laws whatever upon the subject.

In Minnesota by a law of 1899 the sale of milk, cream or food products of any nature whatever "to which has been added any preparation in powdered or liquid form, known as preservatives, except salt in butter" is forbidden. In Nebraska the sale of cider containing preservatives is forbidden. In New York the use of certain preservatives in wine is forbidden. In North Carolina the name of any preservative "must be made clearly known by conspicuous labeling, or made known to the purchaser when the article is not capable of being labeled." In Ohio the use of salicylic acid or any other antiseptic in wine is forbidden. In Oregon the use of preservatives in butter is forbidden. In Pennsylvania refrigeration is the only allowable mode of preservation for fresh meats. Canned meats, pickled and salted meats and meat extracts must contain no other preservatives than salt, sugar, spices, vinegar, smoke, or saltpetre. In South Dakota no preservatives are allowed in jellies or meats. In Utah they are forbidden in milk. In Washington certain drinks as well as cream and milk must not contain salicylic, benzoic, or boric acid. In Wisconsin, the use of any preservative is forbidden in milk, cream and catsup. See ADULTERATION; FISH AS FOOD; FOOD; MEAT; MILK; REFRIGERATION, etc.

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Foods for the Sick. See SICK, FOODS FOR.

Fool. See JESTER.

Fool of Quality, The, a curious novel by Henry Brooke, published originally in five volumes (1760–77). It was considered of such spiritual value by John Wesley, the founder of Methodism, that he prepared a special edition of it for the use of his followers. Toward the close of the book its mysticism becomes exceedingly exalted and visionary, suggesting the author's acquaintance with the teachings of the German mystic, Jacob Boehme. The work as a whole is hardly capable of holding a modern reader's interest. It had, however, no mean place in the popular fiction of the 18th century.

Fool's Cicely. See DOG PARSLEY.

Fool's Errand, A, a story by Albion W. Tourgee, published in 1879. It is the first of a series dealing mainly with events connected with the Civil War. "The Fool" is Comfort Servosse, a Union colonel, who removes from Michigan to a southern plantation after peace is declared. The story of his reception there and the difficulties encountered, arising out of old prejudices upon the one hand and his own training and convictions upon the other, is told with much detail and strong local coloring.

Fools, Feast of. Festivals, under this name were regularly celebrated, from the 5th to the 16th century, in several countries of Europe, by the clergy and laity, with the most absurd ceremonies, and form one of the strangest phenomena in the history of mankind. Among the heathen festivals which the Christians could not easily abolish, were the Saturnalia, which, in the confusion of all distinctions of ranks, and in extravagance of merriment, exceeded the gayest carnivals. The feast of fools, among Christians, was an imitation of the Saturnalia, and, like this, was celebrated in December. The chief celebration fell upon the day of the Innocents, or upon New Year's Day; but the feast continued from Christmas to the last Sunday of Epiphany. At first only the boys of the choir and young sacristans played the principal part in them; but afterward all the inferior servants of the Church, and even laymen, engaged in them, while the bishop, or the highest clergyman of the place, with the canons, formed the audience. The young people, who played the chief parts, chose from among their own number a bishop or archbishop of fools, or of unreason, as he was called, and consecrated him, with many ridiculous ceremonies, in the chief church of the place. This officer then took the usual seat of the bishop, and caused high mass to be said, unless he preferred to read it himself, and to give his blessing to the people, which was done with the most ridiculous ceremonies. During this time the rest of the performers, dressed in different kinds of masks and disguises, engaged in indecent songs and dances, and practised all possible follies in the church. Except from their association with the Saturnalia nothing is known of the origin of these extravagancies, which appear to have been very ancient. The most celebrated, and probably one of the most ancient of these festivals, was held in the city of Sens, in France. By an ordinance in 1245, intended to abolish it, it is alluded to as a very ancient celebration. So general was the custom of these celebrations in France, that it is said there were few towns at the end of the 17th or even as late as the middle of the 18th century, in which associations did not exist. Similar antics seem to have been played in other countries, as Germany, England, and Scotland, but it is to be hoped that the height of profanity reached in some of the extant liturgies and rubrics was not commonly attained in these fooleries. The *fête des fous* at Sens was suppressed in 1547. These fêtes were frequently prohibited, but until the Reformation period, when they were considered dangerous by the ecclesiastical authorities, they were commonly tolerated. To account for these celebrations, so opposed to all our ideas of religion, decency, and common sense, we must transfer ourselves to times when men combined, with childish simplicity, the most ridiculous with the noblest subjects, and often with less injury than we should suppose to the latter. Similarly, grotesque or indecent figures are to be seen among the sculptures of old Gothic churches, and may not unfrequently be detected in the work of the large initial letters of the breviaries and religious books of this period.

Fool's Parsley. See DOG PARSLEY.

Foot, Solomon, American statesman: b. Cornwall, Vt., 19 Nov. 1802; d. 1866. He was graduated at Middlebury College in 1826 and in 1831 was admitted to the bar, and settled in Rutland. For several terms he represented the town of Rutland in the Vermont legislature, and in 1842 and again in 1844 was elected a representative in Congress. From 1851 till his death he sat in the United States Senate where he made many important speeches, and bore a conspicuous part in the Lecompton debate of 1858.

Foot. In the human foot the bony structure is made up of three divisions, the tarsus, metatarsus, and phalanges. Seven bones form the tarsus: the os calcis or heel-bone, the largest and strongest of all, carries the principal part of the body's weight. On its posterior surface the large muscles of the calf find their attachment through the tendon Achillis. Half in front of the os calcis and superimposed upon it is the next largest bone, the astragalus. This bone bears directly the weight of the body through the large leg-bone, the tibia, resting on the upper surface. On the outer side in front of these two bones is the cuboid, and on the inner side the scaphoid or navicular bone. In front of the scaphoid there are the three small cuneiform bones, internal, middle, and external. These three bones with the cuboid form articulations with the next row or division. The metatarsus is formed of five so-called long bones; that is, each bone has a shaft and articulating extremities. To each of these is joined one of the next division or phalanges. These are also long bones, the great toe made up of two bones, and the others of three each. Strong ligaments bind these bones to one another in such a way as to form and maintain an arch from before backward, and somewhat from side to side, the points of contact with the ground being only with the os calcis behind and the metatarsus and phalanges in front — the so-called ball of the foot. By this arrangement shock is transmitted through an arch or spring, pads at these two points also further eliminating jars. The sole of the foot is also covered with small muscles, which move the toes, and tendons that flex the toes and extend the foot on the ankle. Across the dorsum or instep pass the flattened tendons that flex the foot and extend the toes. The chief artery to the sole comes down on the inner side of the heel, passing across to the outer side, then arching across to the inner side again, giving off branches to the toes. On the dorsum the main artery comes to the surface at the instep and forms an arch of supply to the toes. The nerves on both surfaces closely follow the arteries.

Among the lower animals, monkeys have feet that approach nearest to those of the human. The separation of the great toe, in a way corresponding to the thumb, and the absence of the arch are the points of difference. In many of the animals, as in the cat tribe, there is a greater or less tendency toward a rudimentary inner toe, and an increase of the function of the ball of the foot, with a lessening of the importance of the heel. In the cattle and equines the toes are fewer, and the nails or claws become converted into hoofs. The horse walks on the end of his single digit.

In measure of length, the name foot is derived from the length of the human foot, containing 12 linear inches. Square foot is a square whose side is one foot, and is therefore equal to 144 square inches. Cubic foot is a cube whose side is 1 foot, and the cube contains 1,728 cubic inches. The foot is a common measure in various countries, but its dimensions often vary somewhat. In poetry, a measure consisting of a variety of syllables, two, three, or four, in combinations of long and short, or accented and unaccented syllables. The number of possible varieties of feet is reckoned at 28. See RHYTHM.

Foot and Mouth Disease. See MURRAIN.

Foot-pound, the unit of work or of energy that is commonly used in engineering calculations in England and the United States. It is defined as the quantity of work expended in raising a weight of one pound through a vertical distance of one foot. As the attraction of the earth for a pound of matter varies somewhat in different latitudes and at different heights above the sea, the foot-pound is subject to corresponding variations as we pass from one locality to another. To give the unit greater definiteness it has been proposed to define it as the quantity of work done in raising one pound of matter through a vertical distance of one foot, at the level of the sea in latitude 45°. This definition differs from the ordinary one, it will be observed, solely by specifying the locality at which the experiment is supposed to be performed. See UNITS.

Foot-rot, a disease in the feet of sheep, the more common form of which is an inordinate growth of hoof, which at the toe, or round the margin, becomes turned down, cracked, or torn, thus affording lodgment for sand and dirt. In the second form of the disease the foot becomes hot, tender, and swollen, with ulcerations between the toes, followed by the sprouting of proud flesh. The inflammation is due to suppression of the secretion of the gland between the toes, usually the result of standing too much in wet ground. The best remedy is to pare away the diseased and ragged parts of the hoof, thoroughly applying a lotion made by dissolving one pound of blue vitriol in a quart of water, and keeping the animal always in a dry place.

Foot-wall. In mining language, the foot-wall of a vein is the rock boundary of its lower side, the side on which a miner would stand in breaking down the ore. The term is also used in speaking of a fault or rock dislocation, the foot-wall of a fault being formed by the edges of the rock strata that underlie the plane of displacement. See FAULT; MINING; ORE DEPOSIT.

Foota-Jallon. See FUTA-JALLON.

Football in America, as in England, is of different varieties, but by far the most prominent is the game played in the colleges. This type is the outgrowth of the English Rugby and still possesses points of similarity to the game from which it was derived. Association football is played in and around some of the mill towns where the foreign population predominates, and previous to 1870 a mongrel kind of football made up of a combination of Association and Rugby had some vogue, and was the original form of the sport in America.

The type, however, known as American football suggests now only one variety and that is the one mentioned above as prevailing in colleges and universities. This sport draws to each of its chief annual contests from 25,000 to 40,000 spectators. During its season, which consists of October and November, it temporarily eclipses all other athletics in interest. For this reason it is the money maker in college athletics, in a great number of universities the receipts from the football contests practically supporting the other athletic branches throughout the year.

This sport, developed as it now stands, was originally introduced into American colleges by Harvard, whose team, having visited Canada and played under the Canadian rules, became enamored of the style of the English Rugby, and, although in 1875, as a matter of consideration for her ancient rival, Yale, Harvard agreed to compromise between what was then known as American football and English Rugby, in the next year, 1876, both teams adopted the Rugby Union rules as they stood at that day. Unfortunately for the peace of mind of the legislators, but probably fortunately in another way, in that the final result was the development of still another distinct type of football, there were no traditions in America regarding the English Rugby code and what was forbidden by letter was accepted as barred, whereas anything that was not thus distinctly prohibited the American player thought was perfectly legitimate. Contentions arose over the interpretation of the rules and these discussions led to conventions, and, in the settlement of the problems arising, the rules rapidly multiplied, until in a few years there were more than twice the original number. While this was happening, some of the old English rules apparently became dead letters and were, therefore, dropped. When captains and players attended any of these conventions it was only human that they should contend for possible advantages for their own teams rather than for the improvement of the game as a sport and this led to the appointment of an advisory committee of graduates. In their hands was placed the matter of rules to this extent, that yearly they met and recommended changes which were then submitted to an intercollegiate association for discussion and usually for approval. This lasted as long as there was an intercollegiate association or league of colleges indulging in football. This league finally dissolved and for the season following there were two codes of rules in existence adopted by two different sets of universities. This was wholly unsatisfactory and led to the intervention of the University Athletic Club of New York. This club selected football enthusiasts and asked from them a recommendation as to a code of rules. These gentlemen met and framed such a code, which was then adopted by the various colleges throughout the country. This method of procedure lasted for several years, even after the dissolution of the University Athletic Club, and it is from this body that the football rules emanated, until at the end of the season of 1905 a general conference of colleges not represented upon the Rules Committee appointed seven delegates with whom the old committee amalgamated, forming a new committee of 14. This committee made the rules for 1906 and introduced what was known as the 10-yard rule, which practically did away with the old mass plays that had caused the game to become too contracted.

As for a brief description of the game and the way in which it is played, the following gives the main points:

The game is played on a field rectangular in shape, 160 feet wide and 330 feet long. The outline of this field is made by heavy white lines marked, as are the lines in a tennis court, with lime. This field is also traversed by transverse lines five yards apart marked for the convenience of the referee in judging the distance gained or lost by either side. In addition to these transverse lines the field is marked by longitudinal lines also five yards apart in order to assist the referee once more in measuring distance rapidly with his eye. This latter marking was rendered necessary by a rule providing that within that section of the field the quarter-back may run with the ball provided he goes a certain distance out, that is, toward the side line, from the man who puts the ball in play in the centre. This same five yard distance governs a forward pass. The lines which mark the ends of the field are called goal lines, and in the middle of each is a goal made by erecting two posts 18 feet, 6 inches apart with a cross bar 10 feet from the ground. The ball is a prolate spheroid in shape consisting of a rubber bladder in a leather cover.

The game is played by 11 men on a side, these 11 men being called a team. For the purpose of general distinction, although different formations are possible, the seven men who play in the forward line, that is on a line with the ball when it is put in play, are called the rushers, the men behind them the backs. The distinguishing terms for the men in the line are of interest. First there is the centre rusher, or centre, or snap-back, which term designates the man who stands in the middle of the line and usually puts the ball in play in a scrimmage. The men on his right and left are called guards, the men next beyond them towards the ends are called tackles and the two men on the ends of the line are called the ends. The man close behind the centre rusher is called the quarter-back. The two men some feet behind him are called the half-backs and the fourth man behind the line is called the full-back. In executing various plays the men take up different positions on the field, but they are usually distinguished by their positions as above.

The game is started by placing the ball in the middle of the field and a man of the side in possession must then kick it at least 10 yards into the territory of the opponents, his own men being behind him when he kicks the ball and the opponents standing at least 10 yards back from the middle line of the field. The choice of goals and the possession of the ball having been determined by the toss of a coin, the side winning has the privilege of thus either kicking off or selecting either goal. When the ball is once kicked off any man who is on side, that is, between the ball and his own goal, may secure it and run with it and when he is thus running may be tackled by his opponents and brought to a stop. If he is thus tackled and stopped he calls "down" and the ball is placed on that spot for a scrimmage. When the ball is thus down the two teams line up opposite each other, the side with the ball endeavoring to protect its men so that one of the backs may be able to secure the ball and make a run with it, kick it, or pass it, while members of the opposing side are endeavoring to break through and stop this. The men of the side which has the ball in its possession may not use their hands or arms to obstruct their opponents, but may do this with the body only. The players of the side not in possession of the ball on the other hand are privileged to use their hands and arms to break through the ranks of their opponents. The man who has the ball in his possession, that is running with it, may use his hands and arms to ward off the opponents, but the rest of his side may not. The play thus continues by a succession of downs and runs interspersed with kicks, for a side may kick or pass the ball under certain limitations instead of running with it if they so desire.

In order to prevent a side holding the ball indefinitely without making progress there is a rule providing that in 3 attempts the side must advance the ball 10 yards or surrender it to the opponents. For this reason it is quite customary after two attempts, if the desired ground has not been gained, for the side in possession to kick the ball, thus transferring it to the possession of their opponents as far into the opponents' territory as possible. One forward pass is allowed to a scrimmage under certain restrictions, and a kicked ball striking the ground puts all the players of the kicker's side «on side,» otherwise a man who gets ahead of the ball when last touched by one of his own side behind him may not touch the ball. When the ball goes across the side line it is out of bounds and if it has gone out of bounds through being kicked, it belongs to the opponents, but if a man carries it out of bounds, in his possession, his own side has the right to it. The ball is brought back to the spot where it crossed the line and is put in play by the holder walking in a certain distance and putting it on the ground for a scrimmage as already described.

The game thus proceeds until the ball approaches one or the other goal line and here begins the question of generalship for scoring. If the ball be kicked by a drop kick over the cross bar of the opponent's goal it counts the side thus kicking it four points. If the ball be carried by the player of that side across his opponent's goal line or secured by him after it has been kicked across it scores a touch-down, which counts five points and also entitles the side making it to a try at goal. This is performed either by kicking the ball out to a player who catches it and makes a mark with his heel, the ball then being kicked from any point behind that mark, or being brought directly out by a player of the side which has touched it down and held on the ground for another of his side to kick. In either event if the touch-down be converted into a goal by the kicking of the ball over the cross bar it adds an additional point for this scoring.

There is one other possible means of scoring and that is when a side is pressed by the opponents, and, instead of the opponents securing the ball, the defenders of the side secure it and either kick, pass, or carry it across their own goal-line and touch it back behind their own goal. This entitles them to carry the ball out 25 yards for a kick. The opponents stand on the 25 yard line while this kick is made. This safety, however, as it is called, counts two points against the side making it.

The game is divided into 2 halves of 35 minutes each with a 10-minute intermission, and the side which has scored the greater number of points at the end of the full period of play wins the game.

American football, while it started from the English Rugby Union rules, has developed in many directions so that the game would not now be recognizable to an Englishman. The one thing that he would see that possibly reminded him of Rugby would be that occasionally a man runs in the open field with the ball. But the various formations and the tactics adopted would puzzle him exceedingly. Like the Rugby Union, however, there is some kicking in it, but far less than in the English Association. In the English scrimmage the two lines of forwards push until the ball pops out somewhere, whereas in the American scrimmage the man in the center who has possession of the ball snaps it out with his hand whenever he is ready to do so to the quarter-back who stands directly behind him and this man passes it to some other player of his own side. This enables the Americans to carry out their very elaborate system of plays because the ball can be absolutely directed at any time to any spot. So perfect has this development become that the quarter-back gives signals for the plays by means of which signals the entire team knows exactly what man is to receive the ball and where he is to run with it when he has received it. Thus the others may assist him very materially in making his gain. Some idea of the variety of plays can be gathered from the fact that teams can without difficulty execute no less than 40 or 50 plays, each distinct from the other. It is not difficult to imagine that with this highly developed form of attack a most thorough and well-studied plan of defense is equally necessary. It is also not difficult to understand that this development on both sides has brought about specialization in the work of various players so that almost every position on the field has a distinct line of duties which its incumbent must be able to perform with skill and accuracy. The signals are quite elaborate codes, devised for easy memorizing, but at the same time sufficiently intricate and bewildering as to render the liability of discovery by the opponents very small.

In the American game the quarter-back usually gives these signals, although the captain sometimes prefers to give them himself.

The history of the game in America as in England and elsewhere has been one of discussion and opposition, the latter coming from those who believe that the sport is too strenuous. Kingly edicts were issued in the old days in England and in the United States State legislatures have been asked at various times to forbid the pastime. Yet it has lived on. In America the game has had already three great epochs as it were. The first in the eighties when the «block game» was legislated out of existence, then in the early nineties when «momentum mass» plays were excised and finally in 1906 when the ten yard rule was adopted.

A widespread public sentiment was advanced in favor of such a change in the rules as might bring about more «open play,» and it was further felt by the committee and their advisers that the rules should be so modified and the powers of the officials so increased as to eliminate to the greatest possible extent unsportsmanlike tactics, and with these ends in view the committee decided upon the incorporation of two important changes. The first of these was the adoption of the 10-yard rule together with the forward pass and on side kick. The second general change was the incorporation of rules that in some cases greatly increased the penalty for unfair tactics, and in others did away with all excuses for indulgence in certain rough plays, at the same time providing for more efficient work by officials. To make sure that the wishes of the committee were carried out in this matter, the duties of the linesman were enlarged and he was made practically an assistant to the umpire and given absolute power to deal with certain classes of fouls. A second umpire was added. The American game thus has for its conduct four officials, the referee whose duties are principally related to the progress of the ball, the umpires who have charge as it were of the conduct of the players, the linesman who acts as an added umpire, at the same time assisting the referee in the matter of measurements and time keeping. WALTER CAMP,
Yale University.

Foote, füt, **Andrew Hull,** American naval officer: b. New Haven, Conn., 12 Sept. 1806; d. 26 June 1863. He entered the navy as a midshipman in 1822, and in 1849-52 he was engaged in the suppression of the slave trade on the coast of Africa. In command of the China station in 1856, when the Chinese and English were at war, he exerted himself to protect American property, and was fired upon by the Celestials. His demand for an apology was refused and he stormed and captured four Chinese forts. In 1861 he commanded the expedition against Forts Henry and Donelson on the Tennessee and Cumberland rivers, and directed the attack on Island Number 10. In 1862 he was promoted rear-admiral. He wrote 'Africa and the American Flag' (1854).

Foote, Arthur, American composer: b. Salem, Mass., 5 March 1853. He was graduated at Harvard 1874, became a teacher of the piano and organist of the First Church in Boston and has devoted much time to composition, in which field he has been very successful, having published a cantata 'Hiawatha,' a trio in C major for piano, violin, and 'cello; suites for the orchestra; an overture, 'In the Mountains'; songs, and pianoforte pieces.

Foote, Henry Stuart, American statesman: b. Fauquier County, Va., 20 Sept. 1800; d. Nashville, Tenn., 20 May 1880. He was admitted to the bar in 1822; removed to Mississippi in 1826 and entered politics. In 1847 he was elected to the United States Senate, and in 1852 was elected governor of the State. He was a strong opponent of secession at the convention held at Knoxville, Tenn., in 1859, but when secession was an assured fact, he accepted an election to the Confederate Congress, where he opposed most of President Davis' measures.

Foote, Lucius Harwood, American diplomatist: b. Winfield, N. Y., 10 April 1826. He was educated at Knox College and at the Western Reserve University; went to California in 1853; and was admitted to the bar in 1856. He was a municipal judge in Sacramento 1856-60; and collector of the port of Sacramento 1861-5. He became adjutant-general of California in 1861, and was consul to Valparaiso, Chile, 1878-81. Appointed minister to Korea in 1882, he distinguished himself in the protection of Japanese and other foreigners in the nationalist revolt in Seoul in 1883, and received the thanks of the emperor of Japan, the Chinese government, and the emperor of Korea for his services. He resigned in 1884 and returned to California, where in 1890 he was made treasurer of the San Francisco Academy of Sciences. He has written 'Red Letter Day and Other Poems' (1882); 'On the Heights' (1887); etc.

Foote, Mary (HALLOCK), American novelist: b. Milton, N. Y., 19 Nov. 1847. In 1876 she was married to Arthur D. Foote, a mining engineer. She has published: 'The Led Horse Claim' (1883); 'John Bodewin's Testimony' (1886); 'The Last Assembly Ball' (1889); 'In Exile and Other Stories' (1894); 'The Chosen Valley'; 'Cœur d'Alène' (1894); 'The Cup of Trembling and Other Stories' (1895); 'The Little Fig Tree Stories' (1900); 'The Prodigal' (1900); 'The Desert and the Sown' (1902); 'A Touch of Sun and Other Stories' (1903); etc.

Foote, Samuel, English actor and playwright: b. Truro, England, 27 Jan. 1720; d. Dover, England, 21 Oct. 1777. From Oxford he turned his attention to the stage; tried tragic parts and failed; then began to give entertainments of a sort now familiar but then new, impersonating real and imaginary people and acting little farces by himself. He wrote many farces, the most notable being: 'The Minor' (1760), a skit at the Methodists; 'The Liar'; 'The Mayor of Garratt.'

Foote, Samuel Augustus, American statesmen: b. Cheshire, Conn., 8 Nov. 1780; d. there 15 Sept. 1846. He was graduated at Yale College in 1797; served in the legislature for many years; was member of Congress in 1819-21 and 1823-5; served one term in the United States Senate, was governor of Connecticut, and one of the presidential electors on the Clay and Frelinghuysen ticket in 1844. It was he who in 1829 introduced the bill «on the public lands» that occasioned the famous debate between Hayne and Webster.

Footmen, a collector's name for the small gray and yellowish moths of the family *Lithostidae*, which have simple antennæ, rather narrow fore wings, beneath which the broad hind wings are folded when at rest.

Foraging Ants, the large, powerful ants of the tropical American genus *Eciton,* which from time to time march in hosts across the country, with the precision of an army under the control of officers. These marching columns are composed almost wholly of workers, apparently directed by a larger, lighter-colored kind; and they search every inch of ground, rubbish-heap or thicket, searching for what they can eat and driving every living thing out of their way in terror. Several species exist, differing in various respects. One, for example, devotes its forays entirely to finding and robbing the homes of a smaller and very different ant (*Hypoclinea*), whose larvæ and pupæ it carries off, but lets the adults go free. Ordinarily no insect that can be caught is spared. These ants have no settled abode, but make nests in hollow stumps, or underground, and change them each season or oftener. Their colonies exhibit a high degree of organization, and contain five separate castes, instead of the three of ordinary ants. See ANTS, and the works referred to thereunder; and especially Belt, 'Naturalist in Nicaragua' (1888).

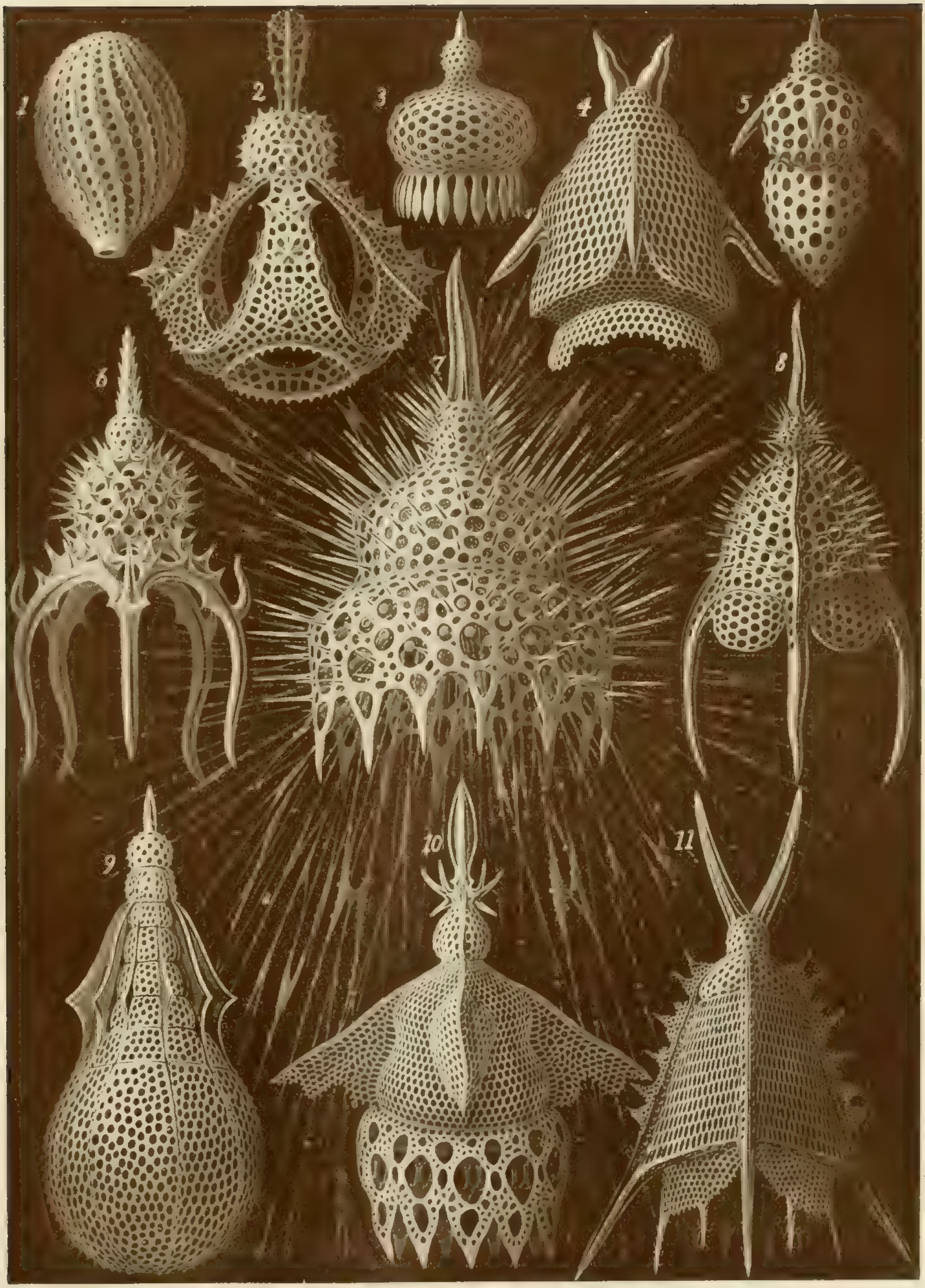
Foraker, Joseph Benson, American politician: b. near Rainsboro, Highland County, Ohio, 5 July 1846. He enlisted in the 89th Ohio infantry in 1862, participated in the battles of Missionary Ridge, Kenesaw Mountain, and Lookout Mountain and in Sherman's "march to the sea," served on the staff of Gen. Slocum, and was mustered out in 1865 with the rank of first lieutenant and brevet captain. Subsequent to the War he studied for two years at the Ohio Wesleyan University, in 1869 was graduated from Cornell University, and in the same year was admitted to the bar at Cincinnati and there began the practice of law. In 1879 he was elected judge of the superior court of Cincinnati, from which post he resigned in 1882. He was Republican candidate for the governorship of Ohio in 1883, but was defeated by Hoadly, Democrat; was elected in 1885 and re-elected in 1887; and was again defeated in 1889, this time by Campbell. In 1896 he was elected United States senator to succeed Calvin S. Brice, and in 1902 re-elected. He was chairman of the Ohio Republican State conventions of 1886, 1890, 1896, and 1900; a delegate-at-large from Ohio to the national Republican conventions of 1884, 1888, 1892, 1896, and 1900, being chairman of the Ohio delegation in 1884 and 1888; and presented to the conventions of 1896 and 1900 the name of William McKinley for nomination to the Presidency. He attained the largest law practice in southern Ohio, and became well known in that State as a corporation attorney and a vigorous orator on political questions. His election to the Senate at once made him the Republican leader of Ohio. In the Senate he took a prominent part in the discussions connected with the Spanish-American war, of which he was a conspicuous advocate. His name has been mentioned for the Presidential nomination.

Foraminif'era, an order of animals in the phylum *Protozoa* and the class *Rhizopoda.* The body is contained within a calcareous test or shell, which is many chambered. It may be cylindrical or spiral, or it may tend to the pyramidal form. The outer surface presents a punctate or dotted appearance, produced by the presence of very numerous small apertures, or "foramina." The chambers in some are perfectly distinct from others, though so aggregated as to form a compound shell; in others they are connected with a funnel-like tube. The texture of the shell in one group is porcelain-like, in another glassy. The inside of the shell has an extensile and contractile sarcode (protoplasm) of a reddish or yellow color, which streams through the openings and thinly covers the outside. Foraminifers are always of small size, and often microscopic. With the exception of *Gromia* and one or two related genera which occur both in fresh and salt water, they are exclusively marine and many dwell only in the abysses. Sometimes their shells constitute sea-sand. In the Atlantic, at a depth of 3,000 fathoms, there is an ooze composed almost entirely of *Globigerinæ,* which belong to this order. See GLOBOGERINA.

The exceedingly antique *Eozoon* (q.v.) of the Laurentian rocks, if organic, as is generally believed, was apparently a foraminifer. Forms more unequivocal, some of them very like recent species, occur in the Silurian, the Carboniferous, and other strata. They are found through all the Secondary Period, chalk (q.v.) being almost entirely composed of their cases. They increase in number and importance in the Tertiary. The flat, coin-shaped nummulites of the Middle Eocene form the principal bulk of great series of limestone rocks that furnish excellent building-stone. The type of the order has remained wonderfully constant from the earliest times till now.

Foran, Joseph Kearney, Canadian author: b. Aylmer, P. Q., 1857. Among his poems the best known are a 'Lament for Longfellow' and 'Indian Translations.' He is the author of two novels, 'Tom Ellis, a Story of the Northwest Rebellion,' and 'Simon, the Abenakis.' 'The Spirit of the Age' (1894); 'Poems and Canadian Lyrics' (1895).

Forbes, fôrbz, **Archibald,** English journalist and war correspondent: b. Morayshire 1838; d. London 30 March 1900. From 1859 till 1864 he served in the Royal Dragoons, but, abandoning the army for journalism, joined the staff of the *Daily News,* as war correspondent. In this capacity he accompanied the German army through the war of 1870–1, and a little later, in Paris, was present at the downfall of the Commune. He was in India during the 1874 famine, and shortly afterward the Carlist and other troubles kept him for a time in Spain. He accompanied the Prince of Wales on his Indian tour in 1875–6, and on returning described as an eye-witness the Servian war of 1876. In the following year he was with the Russians in their campaign against the Turks, being present at the battle of Plevna, and in 1878 he went to Cyprus. He was under fire during the Afghanistan campaign of 1878–9, next visited Mandalay, and then went to Zululand. He afterward devoted himself mainly to lecturing at home and in America and Australia. His chief publications are: 'My Experiences in the Franco-German War' (1872); 'Glimpses through the Cannon Smoke' (1880); 'Chinese Gordon' (1884); 'Souvenirs of Some Continents' (1885); 'William I. of Germany' (1888); 'Barracks, Bivouacs, and Battles' (1891); 'Havelock' (1891); 'Afghan Wars' (1892); 'Colin Campbell, Lord Clyde' (1895); 'Camps,



RHIZOPODS.

1 Cyrtophormis spirall. 2 Clathrocanium reginae. 3 Anthocyrtium campanula. 4 Pterocorys rhinoceros
5 Lithornitbium falco. 6 Alacorys Bismarckii. 7 Calocyclas monumentum. 8 Pterocanium trilobum.
9 Stichophaena Ritteriana. 10 Dictyocodon Annasethe. 11 Artopilium elegans.

Quarters, and Casual Places' (1896); 'Memories and Studies of War and Peace' (1896); 'The Black Watch' (1896); 'Life of Napoleon III.' (1898).

Forbes, David, English geologist: b. Douglas, Isle of Man, 6 Sept. 1828; d. London 5 Dec. 1876. As a civil engineer he traveled all over the world, studying rock formations and fossils, and writing: 'On the Relations of the Silurian and Metamorphic Rocks of the South of Norway' (1855); 'On the Geology of Bolivia and Southern Peru' (1861); and kindred treatises.

Forbes, Duncan, Scottish jurist: b. near Inverness, Scotland, 10 Nov. 1685; d. 10 Dec. 1747. He studied at Paris, Utrecht, and Edinburgh, and rose, in 1737, to the rank of president of the Court of Session. It was mainly owing to his exertions that the rebellion of 1745 was prevented from spreading more widely among the clans; but so ungratefully was he treated by the government, that he was never able to obtain repayment of the various sums he had expended to uphold it. He was the author of: 'Thoughts on Religion'; the 'Culloden Papers'; etc.

Forbes, Edward, English naturalist: b. Douglas, Isle of Man, 12 Feb. 1815; d. Wardie, near Edinburgh, 18 Nov. 1854. He was a brother of David Forbes (q.v.). He became professor of botany in King's College, London, in 1843, and curator of the Geological Society; in 1851 professor of natural history in the School of Mines; and in 1853 he was elected to the chair of natural history in the University of Edinburgh. He did much to advance and systematize special departments of natural history, both by his own labors and by the stimulus which he imparted to his associates and pupils. His classification of the British star-fishes opened a new era in that branch of zoology; and his discovery that air-breathing mollusks lived at the period of the Purbeck beds rectified many erroneous hypotheses. Of his separate works, papers, and monographs upward of 200 were published; among them: 'Star-fishes' (1841); 'The Radiata and Mollusca of the Ægean' (1843); 'Travels in Lycia' (1846); 'Naked-eyed Medusæ' (1847); 'British Mollusca' (1853); 'Literary Papers by E. Forbes' (1855).

Forbes, Edwin, American landscape and genre painter: b. New York 1839; d. Flatbush, L. I., 1895. He was a pupil of A. F. Tait, and became special artist for 'Frank Leslie's Magazine' during the Civil War. The drawings which he made during that time are now in the war office at Washington, and are of historic value.

Forbes, Evelina Louisa Michell, English novelist: b. Tettenhall. She was married to Hon. Walter Forbes in 1888. Her published books include: 'Fingers and Fortune' (1886); 'Her Last Run' (1888); 'Blight' (1897); 'A Gentleman' (1900); 'Dumb' (1901); 'Unofficial' (1902).

Forbes, Harriette Merrifield, American writer: b. Worcester, Mass., 22 Oct. 1856. She was married to W. T. Forbes 5 Feb. 1884. She has published: 'The Hundredth Town' (1889); 'The Diary of Rev. Ebenezer Parkman' (1899).

Forbes, James David, Scottish physicist: b. Colinton, near Edinburgh, 20 April 1809; d. Clifton, England, 31 Dec. 1868. He was admitted to the Scottish bar in 1830; in 1833 was appointed to the chair of natural philosophy in the University of Edinburgh, and in 1860 became principal of the United Colleges of St. Salvador and St. Leonard, in the University of St. Andrews. His fame rests chiefly on his study of glaciers. His chief publications on this subject are: 'Travels through the Alps of Savoy' (1843); 'Norway and its Glaciers' (1853); 'Tour of Mont Blanc and Monte Rosa' (1855); and 'Occasional Papers on the Theory of Glaciers' (1859). Forbes' theory was that glacier ice moves in its channel like a viscous fluid, the middle moving faster than the sides, and the upper portions faster than the lower.

Forbes, John Colin, Canadian artist: b. Toronto, Canada, 23 Jan. 1846. He studied at the Royal Academy, London, England, and on the continent, and returning to Canada he became a successful landscape and portrait painter. Among his works are: 'Foundering of the Hibernia'; 'The Mount of the Holy Cross'; 'The Glacier of the Selkirk'; 'The Lily'; and portraits of Gladstone, Sir John A. Macdonald, the Marquis of Dufferin, Lady Helen Blackwood, and Sir Charles Tupper.

Forbes, John Franklin, American educator: b. Middlesex, N. Y., 13 June 1853. He was graduated at the University of Rochester in 1878; and in 1885 was made president of the John B. Stetson University in Deland, Fla.

Forbes, John Murray, American clergyman: b. 5 May 1807; d. 1885. He was graduated at Columbia College 1827, and at the General Theological Seminary of the Protestant Episcopal Church 1830. He was ordained to the ministry in the year last named, and became rector of St. Luke's Church, New York, 1834. He adopted the Roman Catholic faith in 1849, and was appointed pastor of St. Ann's Church in New York shortly afterward. Returning to his earlier faith in 1859, he was restored to the ministry 1862 and was dean of the General Theological Seminary of the Protestant Episcopal Church 1869–72.

Forbes, John Murray, American merchant: b. Bordeaux, France, 23 Feb. 1813; d. 12 Oct. 1898. He entered a Boston counting room at 15 and in 1834 became a partner in the firm of Russell & Company, china merchants in Boston. He built many clipper ships for the California trade, and was later prominent in railway managements. Naushon, the largest of the Elizabeth Islands, Mass., was owned by him and constituted his summer home where many notables were entertained by him. See Hughes, 'Letters and Recollections of John Murray Forbes' (1899).

Forbes, Stanhope Alexander, English artist: b. Dublin, Ireland, 18 Nov. 1857. He was educated at Dulwich College and studied art at the Royal Academy Schools, and under Bonnat in Paris. Among his pictures exhibited at the Royal Academy are: 'The Fish Sale'; 'The Health of the Bride'; 'By Order of the Court'; 'The Salvation Army'; 'Forging the Anchor.'

Forbes-Robertson, John, English art critic: b. 30 Jan. 1822; d. London 25 Feb. 1903. He was educated at the University of Aberdeen.

went to London at 21, and after visiting various art centres devoted himself to literature and criticism. He has published: 'The Great Painters of Christendom'; and lives of Gustave Dore, Rosa Bonheur, etc.

Forbes-Robertson, Johnston, English actor: b. London 16 Jan. 1853. He is the son of John Forbes-Robertson (q.v.) and has been prominent on the English stage since he was 21.

Force, Manning Ferguson, American soldier and author: b. Washington, D. C., 1824; d. 1899. He was the son of Peter Force (q.v.). He was graduated at Harvard College 1845 and at the Harvard Law School, entering the army in the Civil War as major of the Twentieth Ohio Volunteers, and attaining the rank of brevet major-general of volunteers. He was judge of the court of common pleas of Hamilton County, Ohio, 1867–77, and judge of the superior court of Cincinnati 1877–8. He published: 'From Fort Henry to Corinth' (1881); 'Marching Across Carolina' (1883); 'Personal Recollections of the Vicksburg Campaign' (1885); etc.

Force, Peter, American historian: b. near Little Falls, N. J., 26 Nov. 1790; d. Washington, D. C., 23 Jan. 1868. His life work, entitled 'American Archives,' a valuable collection of 22,000 books and 40,000 pamphlets, was bought by the government (1867) and placed in the library of Congress. He published also: 'Grinnell Land: Remarks on the English Maps of Arctic Discoveries in 1850–1' (1852); and 'Notes on Lord Mahon's History of the American Declaration of Independence' (1855).

Force, the immediate agency by which the motion of a body is increased or diminished, or changed in direction, or by which such changes are opposed. A force is measured, in theoretical mechanics, by the increase of velocity that it can produce upon a body of unit mass, when it acts upon that body for one second. Suppose, for example, that a uniform force of magnitude F acts for T seconds upon a body of mass M, thereby increasing (or diminishing) its velocity by V units. Then the magnitude of the force is defined by the equation $F = \frac{MV}{T}$.
If M is expressed in grams, and V is expressed in centimetres per second, then F, as calculated by means of this equation, is expressed in dynes. If M is expressed in pounds, and V in feet per second, then F, as calculated from this equation, is expressed in «poundals»; the word «poundal» (for which we are indebted to Prof. James Thomson) denoting the force which will increase (or diminish) the velocity of one pound of matter by one foot per second, when it acts upon it for one second. It is known by experiment that when a body falls freely under the influence of gravity, its velocity, at the end of one second, is about 32.2 feet per second. Let the body in question have a mass of M pounds, and let F be the attraction of the earth upon one pound of matter, as expressed in «poundals.» Then the total force, F, that is acting upon the body is $F = Mf$; and hence the foregoing equation gives us, for this case (remembering that $T = 1$), $Mf = 32.2M$, or $f = 32.2$; and hence it follows that the attraction of the earth upon one pound of matter is 32.2 poundals in a region where gravity, when acting freely upon a body for one second, increases its velocity by 32.2 feet per second. If we follow the usual custom and represent the accelerative effect of gravity at any place by the letter g (instead of by the particular value 32.2), we may make the following general statement, which may also be taken as the definition of the poundal: In a region in which gravity increases the velocity of a falling body by g feet per second, per second, the earth attracts one pound of matter with a force of g poundals.

A force is said to be «central,» when it acts always toward a definite centre, which may be either fixed or in motion. The gravitative forces with which the heavenly bodies act upon one another are of this character, and are often popularly called «centripetal» (that is, «centre-seeking») forces for this reason. When a body is caused to move in a curved path, it exerts a force which acts along the radius of curvature of the path, and in a direction away from the centre of curvature. Forces of this nature are called «centrifugal» (or «centre-fleeing»), and familiar examples are afforded by the pressure of swiftly moving water against the curved vanes of a turbine water-wheel, and by the tension produced in a string when a stone that is attached to the string is whirled rapidly about in a circle. The nature of centrifugal force has been the subject of more or less controversy, some authorities maintaining that it should not be classed as a true force, since it does not produce any acceleration in the direction in which it acts; — that is, a particle on the rim of a swiftly revolving wheel does not fly off radially when it is liberated, but merely continues its motion with unaltered speed, in the direction in which it was moving at the instant of its liberation; — or tangentially to the wheel. The subject is too technical for discussion in this place, but it may be pointed out that such a particle is actually subject to a radial acceleration, if its motion is considered *relatively to the wheel.*

Forces are said to be «conservative» when the principle of the conservation of energy holds true for the systems in which they occur (see ENERGY). All of the forces of nature are believed to be fundamentally conservative, although this has not yet been rigorously proved for the forces that prevail within animals and plants.

A «field of force» is any region in which a given force has a sensible magnitude. A conductor charged with electricity, for example, exerts an attractive (or repulsive) force upon all bodies that are exterior to it, and, from the point of view of theoretical physics, this force still exists at an infinite distance from the charged body, though at such a distance it becomes infinitesimal in intensity. From a practical standpoint, however, the «field of force» due to the charged body can be considered to be limited by an indefinite but finite boundary, whose distance from the body depends upon the intensity of the charge, and also upon the order of minuteness of the forces that can be regarded as negligible, so far as any effect upon the problem that happens to be under consideration is concerned. Within a closed conductor there is no field of electric force, so long as the charges upon the conductor itself, and in the region external to it, are in equilibrium. This fact may be demonstrated mathematically, and it was also abundantly proved, experimentally, by Faraday. (See ELASTICITY; ELECTRICITY; ETHER; GRAVITATION; MECHANICS; etc.) Consult, also, Mach, 'Principles of Mechanics'; Pearson, 'The Grammar of Science'; Ziwet, 'Elementary Treatise on Theoretical Mechanics.'

Force Bill, a popular name in the United States for four different congressional bills, used at the time of their passage; all aimed at the South, and intended to suppress by national force direct or indirect nullification (q.v.) of national laws. (1) The bill of 2 March 1833 to enforce the tariff law; drawn out by Calhoun's nullification ordinance passed by the South Carolina legislature (See COMPROMISE OF 1833); also called the "Bloody Bill." It was not put in action, because South Carolina first suspended and then repealed the Nullification Ordinance. (2) The bill of 31 May 1870 to put down the forcible resistance which the Southern leaders were preparing to offer to the reconstruction governments. It punished by fine and imprisonment, or both, and gave the Federal courts exclusive cognizance of any interference with the registration, voting, etc., of any one, or going on his premises to intimidate him, or personating him in voting or violating State or Federal election laws, or violating the Civil Rights Bill of 1866. (3) The bill of 20 April 1871 to suppress the Kuklux Klan (q.v.). It gave the Federal courts cognizance of suits against any one depriving another of any constitutional rights; punished as conspiracy any combination to delay the execution of any Federal laws, or deter any one from voting, holding office, or acting as Federal juror or witness; (this clause was held unconstitutional by the Supreme Court); authorized the President to employ the national forces to suppress disorders intended to deprive any class of their constitutional rights, in case the State authorities were unable or unwilling; suspended the habeas corpus "during the continuance of such rebellion" — this provision to remain in force only till the end of the next regular session; authorized the judges to exclude from the juries persons they suspected to be in complicity with the proscribed acts; authorized civil action for damages against all persons who neglected to give warning of such a conspiracy or intended injuries, if they had good reason to suspect them; and confirmed former civil-rights legislation. An attempt was made to extend the fourth suspension of the habeas corpus to May 1872, and the Senate did so, but the House refused. (See RECONSTRUCTION.) (4) The Lodge Election Bill, 2 July 1890, "to amend and supplement the election laws of the United States, and to provide for a more efficient enforcement of such laws." It passed the House, but was tabled in the Senate by a free-coinage fusion of Democrats and Republicans who wished to pass to currency legislation.

Force of Gravity. The determination of the force of gravity from point to point over the earth's surface is a matter of importance. The force of gravity is not the same all over the surface of the earth. It is least at the equator, and it gradually increases as we recede toward the poles. Thus a given mass, if tested by means of a spring-balance of sufficient delicacy, would appear to weigh least at the equator, and would seem to get heavier and heavier as the latitude increases. This is due to two causes: (1) owing to the rotation of the earth on its axis every particle of matter tends to fly off from the surface by centrifugal force. The apparent force of gravity at any place is therefore the force of gravity at that place diminished by the centrifugal force. The centrifugal force at the equator is greater than that in high latitudes, because of the greater radius of the circle described at that place. The second cause is the oblate form of the earth. The earth is not a true sphere, but is flattened at the poles. Hence the distance of any attracted point at the equator from the centre of the mass is greater than that of points situated at or near to the poles; the attraction is, therefore, less at the equator than in high latitudes. Experiments to determine the force of gravity from point to point are made by determining the length of a pendulum, that beats seconds at each place. This being known, the force of gravity is easily calculated. See PENDULUM.

The following table gives the lengths of the seconds pendulum at different places, as determined by various experimenters, and also the force of gravity as deduced from their observations:

THE VALUE OF THE ACCELERATING FORCE OF GRAVITY AT DIFFERENT PLACES.

OBSERVER	PLACE	Latitude	Length of seconds pendulum in inches.	Acceleration of gravity in feet per second.
Sabine	Spitzbergen	N. 79° 50′	39.21469	32.2528
Sabine	Hammerfest	N. 70° 40′	39.19475	32.2363
Svanberg	Stockholm	N. 59° 21′	39.16541	32.2122
Bessel	Königsberg	N. 54° 42′	39.15072	32.2002
Sabine Borda	Greenwich	N. 51° 29′	39.13983	32.1912
Biot and Sabine	Paris	N. 48° 50′	39.12851	32.1819
Biot	Bordeaux	N. 44° 50′	39.11296	32.1691
Sabine	New York	N. 40° 43′	39.10120	32.1594
Freycinet	Sandwich Islands	N. 20° 52′	39.04690	32.1148
Sabine	Trinidad	N. 10° 39′	39.01888	32.0913
Freycinet	Rawak Island (Pacific)	S. 0° 2′	39.01433	32.0880
Sabine and Duperrey	Ascension	S. 7° 55′	39.02363	32.0956
Freycinet and Duperrey	Isle of France	S. 20° 10′	39.04684	32.1151
Brisbane and Rümker	Paramatta	S. 33° 49′	39.07452	32.1375
Freycinet and Duperrey	Falkland Islands	S. 51° 35′	39.13781	32.1895