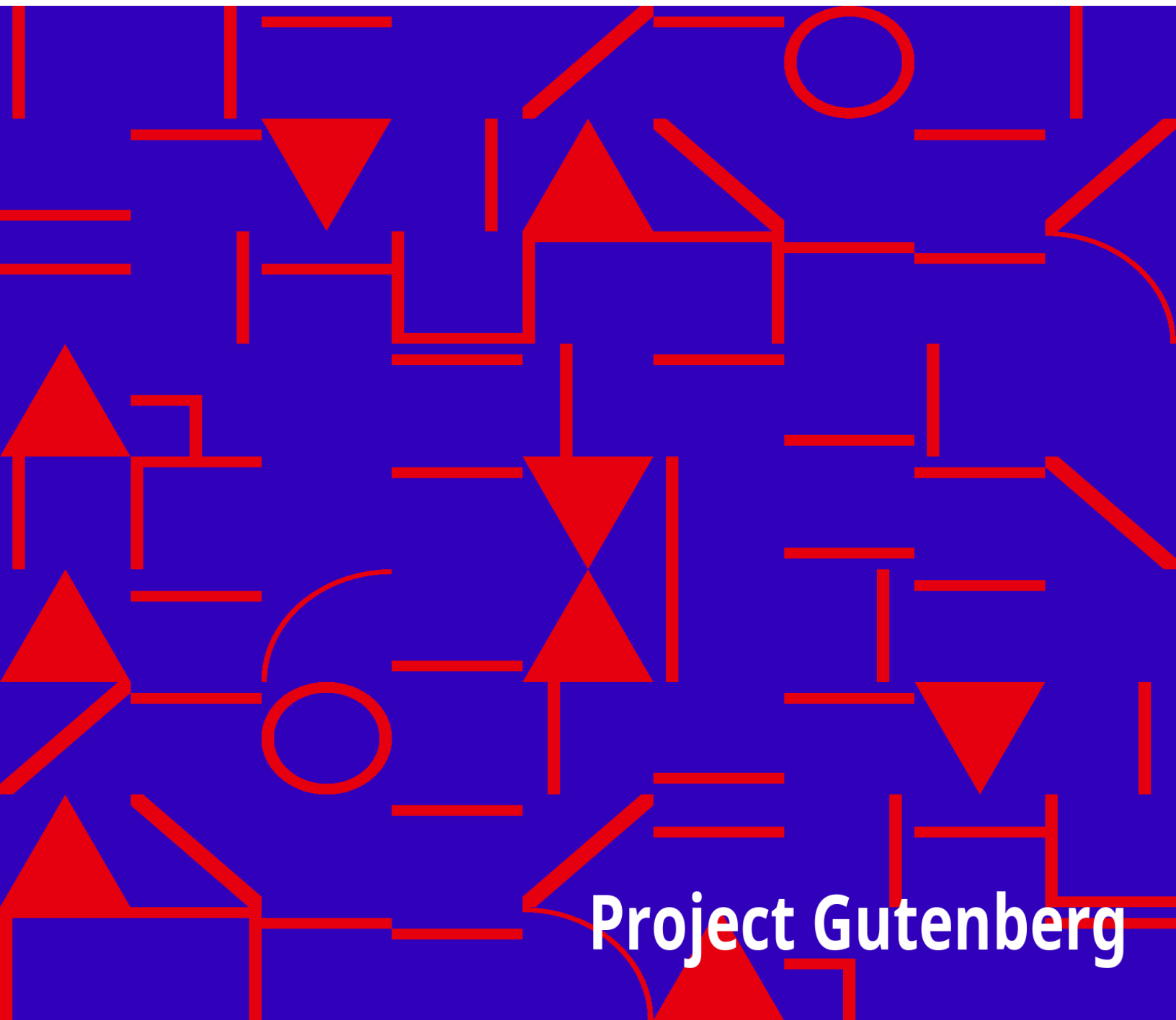


The New Gresham Encyclopedia. Ebert to Estremadura

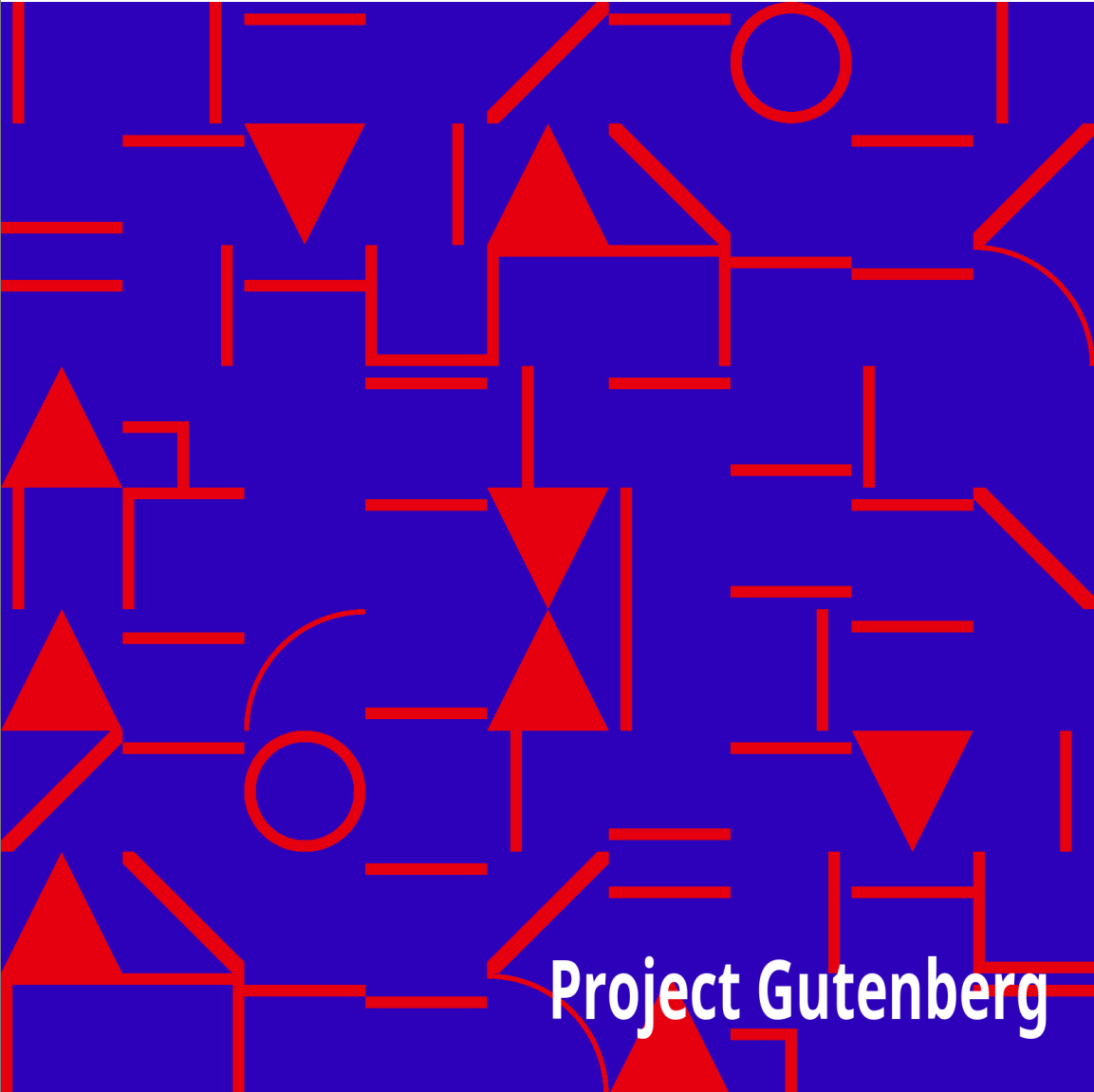
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Transcriber's
note:

A few typographical errors have been corrected. They appear in the text like this, and the explanation will appear when the mouse pointer is moved over the marked passage.

The colour plate ENTOMOLOGY was originally the Frontispiece to the Volume.

THE
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ENCYCLOPEDIA

VOLUME · IV · PART · 2



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VOLUME IV PART 2

EBERT to ESTREMADURA

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KEY TO PRONUNCIATION

The method of marking pronunciations here employed is either (1) by marking the syllable on which the accent falls, or (2) by a simple system of transliteration, to which the following is the Key:—

VOWELS

ā, as in *fate*, or in *bare*.

ä, as in *alms*, Fr. *âme*, Ger. *Bahn* = á of Indian names.

a', the same sound short or medium, as in Fr. *bal*, Ger. *Mann*.

a, as in *fat*.

a", as in *fall*.

ā, obscure, as in *rural*, similar to *u* in *but*, è in *her*: common in Indian names.

ē, as in *me* = *i* in *machine*.

e, as in *met*.

è, as in *her*.

ī, as in *pine*, or as *ei* in Ger. *mein*.

i, as in *pin*, also used for the short sound corresponding to *ē*, as in French and Italian words.

eu, a long sound as in Fr. *jeûne* = Ger. long *ö*, as in *Söhne*, *Goethe* (Goethe).

eu, corresponding sound short or medium, as in Fr. *peu* = Ger. *ö* short.

ō, as in *note*, *moan*.

o, as in *not*, *soft*—that is, short or medium.

ö, as in *move*, *two*.

ū as in *tube*.

u, as in *tub*: similar to *è* and also to *a*.

u", as in *bull*.

ü, as in Sc. *abune* = Fr. *û* as in *dû*, Ger. *ü* long as in *grün*, *Bühne*.

u', the corresponding short or medium sound, as in Fr. *but*, Ger. *Müller*.

oi, as in *oil*.

ou, as in *pound*; or as *au* in Ger. *Haus*.

CONSONANTS

Of the *consonants*, **b, d, f, h, j, k, l, m, n, ng, p, sh, t, v, z**, always have their common English sounds, when used to transliterate foreign words. The letter **c** is not used by itself in re-writing for pronunciation, **s** or **k** being used instead. The only consonantal symbols, therefore, that require explanation are the following:—

ch is always as in *rich*.

d, nearly as *th* in *this* = Sp. *d* in *Madrid*, &c.

g is always hard, as in *go*.

h represents the guttural in Scotch *loch*, Ger. *nach*, also other similar gutturals.

n', Fr. nasal *n* as in *bon*.

r represents both English *r*, and *r* in foreign words, which is generally much more strongly trilled.

s, always as in *so*.

th, as *th* in *thin*.

th, as *th* in *this*.

w always consonantal, as in *we*.

x = ks, which are used instead.

y always consonantal, as in *yea* (Fr. *ligne* would be re-written *lēny*).

zh, as *s* in *pleasure* = Fr. *j*.

Ebert, Fritz, first President of the new German Republic, born at Heidelberg in 1870, the son of a tailor. Having received an elementary education in his youth, he first worked in his father's shop, and was then apprenticed to a saddler. He spent his spare time in reading and acquiring knowledge, entered journalism, and in 1892 became editor of the *Bremer Bürgerzeitung*. In 1908 he was elected to the Reichstag, and in 1916 became president of the Socialist group of this Assembly. He appealed for peace in the Reichstag in Sept., 1918, and having thus become rather prominent, he succeeded Prince Max of Baden as Chancellor of the Empire. The office was suppressed a few days later, and Ebert became Provisional President of Germany. He crushed the efforts made by the Spartacus group to prevent the elections for the National Assembly, and altogether showed tact and energy in those critical days. The National Assembly met at Weimar, and elected Ebert as first President of the Reich on 11th Feb., 1919.

E'bionites (Heb. *ebyonim*, poor), a sect of the first century, so called from their leader, Ebion. Irenæus described them as Jewish Christians. They held several dogmas in common with the Nazarenes, united the ceremonies of

the Mosaic institution with the precepts of the gospel, and observed both the Jewish Sabbath and Christian Sunday. They denied the divinity of Christ and rejected many parts of the New Testament.

Eblis, or **Iblis**, in Mohammedan mythology, the chief of the evil spirits; also the name given to the prince of darkness, or Satan.

Eb'oli, a city of Campania, Southern Italy, a few miles from the Gulf of Salerno. Pop. 12,741.

Eb'ony, the popular name of various plants of different genera, agreeing in having wood of a dark colour. The best-known ebony is derived from plants of the genus *Diospyros*, nat. ord. Ebenaceæ. The most valuable is the heart-wood of *D. Ebënum*, which grows in great abundance in the flat parts of Ceylon, and is of such size that logs of its heart-wood 2 feet in diameter and from 10 to 15 feet long are easily procured. Other varieties of valuable ebony are obtained from *D. melanoxydon* of Coromandel, *D. tessellaria* of Mauritius, and other species. Ebony is hard, heavy, and durable, and admits of a fine polish or gloss. The most usual colour is black, red, or green. The best is jet black, free from veins, very heavy, astringent, and of an acrid pungent taste. On burning coals it yields an agreeable perfume, and when green it readily takes fire from its abundance of fat. It is wrought into toys, and used for mosaic and inlaid work.

Ebony Lore. In ancient times ebony was a sacred wood. The Indians carved from it images of gods and drinking-cups. It was first used by the ancient Egyptians, who called it *heben*, and imported it from 'God-land' (Punt). The Hebrew name is *hobnîm*, the Greek *ebenos*, the Hindi *ābanūsa*. Ezekiel (xxvii, 15) connects ebony with Tyre. The ebony displayed in Rome by Pompey in his triumph over Mithridates came, according to Solinus, from India. The Chinese call it *Wu-men* ('black-streaked wood'), and anciently imported it from India and Indo-China.

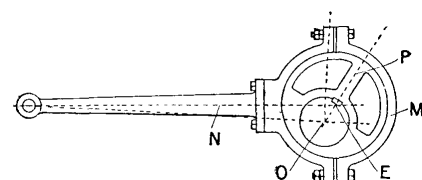
E'bro (Lat. *Ibërus*), one of the largest rivers in Spain, which has its source in the province of Santander, about 25 miles s. of the Bay of Biscay, and after a south-easterly course of about 500 miles enters the Mediterranean. Its navigation is much interrupted by rapids and shoals, to avoid which a canal about 100 miles long has been constructed nearly parallel to its course. Saragossa is the principal town on the river.

Écarté (ā-kär'tā), a card-game for two players, is played with thirty-two cards, the smaller ones, from two to six inclusive, not being used. The remaining cards rank as follows: king (highest), queen, knave, ace, ten, &c. In the English mode of playing, the players cut for the deal, which is decided by the lowest card. The dealer gives five cards to either player, three and two at a time, and turns up the eleventh card for trump. If he turns up a king he scores one; and if a king occurs in the hand of either player, the holder may score one by announcing it before the first trick. The non-dealer leads; trumps take all other suits, but the players must follow suit if they can. Three tricks count one point, five tricks two points; five points make game. Before play begins, the non-dealer may claim to discard (écarter) any of the cards in his hand, and to replace them by fresh ones from the pack. This claim the dealer may or may not allow. Should he allow it, he can himself discard as many cards as he pleases. Sometimes only one discard is allowed, sometimes more. Cf. Cavendish, *The Laws of Écarté adopted by the Turf Club*.

Ecbat'ana, the chief city or ancient metropolis of Media, the summer residence of the Median and Persian and afterwards of the Parthian kings. It was a place of great splendour at an early period. Its site can no longer be fixed with certainty, though many explorers agree in identifying it with the modern Hamadan.

Ecce Homo (ek'sē; Lat., 'Behold the man!'), a name often given to crucifixes and pictures which represent Christ bound and crowned with thorns. The most celebrated of these paintings are by Sodoma, Correggio (in the National Gallery), Titian, Tintoretto, Guido Reni, and Murillo. The expression is derived from the words spoken by Pilate when he showed Christ to the multitude before he was led forth to Crucifixion (*John*, xix, 5).

Eccen'tric, a term in mechanics applied to contrivances for converting circular into reciprocating (backwards and forwards) rectilinear motion, consisting of circular discs attached to a revolving shaft, not centrally, i.e. eccentrically.



Eccentric and Rod
P, Pulley. M, Strap. N, Rod. O,
Centre of shaft. E, Centre of

Ecchymosis is extravasation of blood into the tissues underlying the skin. It is most frequently produced as the result of a bruise from injury, but may be due to some pathological condition.

eccentric. O, E, Is the throw or radius of the eccentric.

Ecclefechan (ek-l-feh'an), a Scottish village in Dumfriesshire, near the Caledonian Railway main line, noteworthy as the birth-place and burial-place of Thomas Carlyle. Pop. 670.

Eccles, a town of England, in Lancashire, 4 miles from Manchester, of which it may be considered a suburb. The town, engaged in textile industries, is famous for its cakes. Since 1918 it returns one member to Parliament. Pop. 41,946.

Ecclesias'tes (-tēz), the title by which the *Septuagint* translators rendered the Hebrew *Kohleth* ('the gatherer of the people'), a symbolic name explained by the design of the book and the dramatic position occupied by Solomon in it, one of the canonical books of the Old Testament. The book consists of 12 chapters, being a series of discourses on the vanity of earthly things, and the tone, which is sceptical, is such as is found in Omar Khayyám. According to Jewish tradition, it was written by Solomon; but the best modern criticism has decided that its style and language, no less than its thought, belong to a much later date.

Ecclesiastical Commissioners, in England, a body corporate, constituted in 1836, with extensive powers in regard to the organization of the Church, the distribution of episcopal duties, and the formation of parishes. It consists of all the bishops of England and Wales, five cabinet ministers, four judges, and twelve others. Their decisions are ratified by orders in council, and acquire the force of Acts of Parliament. The Commissioners deal with an annual income of about 2 million pounds.

Ecclesiastical Courts, courts in which the canon law is administered and which deal with ecclesiastical cases, affecting benefices and the like. In England they are the *Archdeacon's Court*, the *Consistory Courts*, the *Court of Arches*, the *Court of Peculiars*, the *Prerogative Courts of the two archbishops*, the *Faculty Court*, and the *Privy Council*, which is the court of appeal, though its jurisdiction may by Order in Council be transferred to the new Court of Appeal. No separate ecclesiastical courts existed in England

before the Norman Conquest, but by a charter of William I a distinction was made between courts civil and courts ecclesiastical. In Scotland the ecclesiastical courts are the *Kirk-session*, *Presbytery*, *Synod*, *General Assembly* (which is the supreme tribunal as regards doctrine and discipline), and the *Teind Court*, consisting of the judges of the Court of Session, which has jurisdiction in all matters affecting the teinds of a parish. In the Isle of Man ecclesiastical courts still have, as formerly in England, jurisdiction in probate and matrimonial cases.

Ecclesiastical Law may, in the broad sense of the term, be taken to include the regulations existing in any Church or sect, however small, for the formation of its own polity and for the control of its members. It is, however, more generally applied to those legal bonds which exist between Established Churches and the State. The Roman Catholic Church claims to be the one and only true Church, regards her laws as being of universal application, and herself as an equal with the State; nevertheless she has, in non-Catholic countries, no higher legal standing than any small and obscure dissenting congregation, and is in this respect a 'free' Church. Protestant ecclesiastical law claims no such sovereign power, and in no way interferes with the State law. In England the Convocations of York and Canterbury have no authority to change the law, their power being limited to the making of recommendations. All changes in Church law are made by Parliament. Laymen can be, and often are, officials of the ecclesiastical courts. The civil law is subject to the canon law, above which is the common law, with, yet higher, statute law. Over all is the nominal supremacy of the Crown. Ecclesiastical law deals with such affairs and property of the Church of England as ecclesiastical parishes, churches, and matters matrimonial; but only so far as these are not controlled by common or statute law. It has long ceased to have any practical control of the laity. In Ireland, ecclesiastical law disappeared with the disestablishment of the Church.

Ecclesiasticus, a book placed by Protestants and Jews among the apocryphal scriptures. The author calls himself Jesus the son of Sirach, Originally written in Hebrew, it was translated into Greek by the author's grandson in the second century B.C. In 1896 fragments of four MSS. in the Hebrew original were discovered in the *Geniza*, or hiding-place for worn out copies of biblical books, in the synagogue at Cairo. Another fragment

was discovered in Palestine by Mrs. Agnes Lewis.—Cf. Schechter and Taylor, *The Wisdom of Ben Sira: Portions of the Book Ecclesiasticus*.

Échelles, Les (lā-zā-shāl; 'the Ladders'), a village, France, department of Savoie, 12 miles south-west of Chambéry, in a valley from which egress at one end was formerly by means of ladders, but now by a tunnel. Pop. 798.

Échelon (esh'e-lon), a formation of successive and parallel units facing in the same direction, each on a flank and to the rear of the unit in front of it.

Echeneis, the type genus of a small family (Echeneididæ) of aberrant spiny-finned fishes, in which the first dorsal fin is modified into a transversely ridged suction disc. See *Remora*.

Echeveria (ech-e-vē'ri-a), a genus of succulent plants, ord. Crassulaceæ (house-leek), chiefly natives of Mexico, but now cultivated in European and other gardens and greenhouses, some for their flowers, others for their foliage.

Echidna (ē-kid'na), a genus of Australian toothless mammals, in size and general appearance resembling a large hedgehog, excepting that the spines are longer and the muzzle is protracted and slender, with a small aperture at the extremity for the protraction of a long flexible tongue. The habits of the Echidna are nocturnal; it burrows, having short strong legs with five toes, and feeds on insects, which it catches by protruding its long sticky tongue. It is nearly allied to the Ornithorhynchus, the two forming a peculiar class of animals, having in their structure some peculiarities at once of mammals, birds, and reptiles. In 1884 it was found that, as Geoffrey St. Hilaire had suspected, the Echidna, the closely related Proechidna of New Guinea, and the Ornithorhynchus constitute the lowest sub-class of mammals, the Prototheria or Monotremata, which present many reptilian characters. They possess a cloaca into which the intestine and urinogenital ducts open and are oviparous. During the breeding season a temporary pouch is formed, and into this the milk-glands open, but there are no teats. The egg when laid is put into the pouch by the mother, and is there hatched in a very immature state. It feeds by licking up the milk in the pouch. Later on, the mother digs a burrow, where she leaves the young at night, returning during the day to suckle it. One species (*E. hystrix*), from its appearance is popularly known as the *porcupine ant-eater*.

Echinocactus (e-kī'-), a genus of cactaceous plants inhabiting Mexico and South America, and remarkable for their peculiar forms, being globular, oblong, or cylindrical, and without leaves, fluted and ribbed, with stiff spines clustered on woolly cushions. Some of them are very bulky. The flowers are large and showy. See *Cactus*.

Echinococcus, the very large compound cyst which forms the bladder-worm stage in the life-history of a small tapeworm (*Tænia echinococcus*) living in the intestine of the dog. The cysts are found in various abdominal organs of herbivorous animals, and sometimes infest human beings, especially in Iceland.

Echinodermata (e-kī-nō-dēr'ma-ta), a phylum or sub-kingdom of invertebrate animals characterized by having a tough integument in which lime is deposited in scattered plates (sea-cucumber), flexibly articulated plates (star-fishes), or so as to form a rigid test or shell like that of the sea-urchin; and by the radial arrangement of many of the parts of the adult. Movable spines are commonly present. There is a system of tubes into which seawater is admitted (ambulacral system), and commonly tube-feet, that are put into use by being distended with fluid. Some of them, as the encrinites or sea-lilies, are permanently fixed by a stalk when adult. Their development is accompanied by metamorphosis, and the embryo shows a distinctly bilateral aspect, though the radiate arrangement prevails in the adult. By some they are classed with the Scolecida in the sub-kingdom Annuloida. The phylum is divided into nine classes: Asteroidea (star-fishes); Ophiuroidea (brittle-stars), Echinoidea (sea-urchins), Holothuroidea (sea-cucumbers), Crinoidea (sea-lilies, feather-stars, the latter free-moving), Thecoidea or Edrioasteroidea (extinct, stalkless but fixed), Carpoidea (extinct, stalked), Cystoidea (extinct, stalked), Blastoidea (extinct, stalked). All are marine.

Echinomys, or **Spiny Rat**, a genus of South American rodent mammals distinguished by the presence of spines among the coarse fur. The long tail is covered by scales and hair intermixed, the ears are large, and all the extremities possess five digits.

Echinus (e-kī'nus), **Sea-urchin**, or **Sea-egg**, a genus of marine animals, the type of an order (Echinoidea) of the phylum Echinodermata (see above). In

this type the body is spheroidal and invested in a test or shell composed of regularly arranged plates closely united together. It is covered with movable spines articulated by ball-and-socket joints. The mouth is situated in the centre of the under surface, and there is a complicated masticatory apparatus (Aristotle's lantern) consisting of five chisel-ended teeth supported by an elaborate framework. The anus is similarly placed on the upper side, and is surrounded by a circlet of ten plates (apical disc), one of which bears a furrowed tubercle (madreporite) perforated by small holes through which water enters the water-vascular system. Locomotion is effected by meridional rows of tube-feet, aided by the spines. *E. esculentus* and some other species are edible. See *Sea-urchin*.

Echinus (e-kī'nus), in architecture, the *ovolo* or quarter-round convex moulding, seen in capitals of the Doric order. It is especially frequently found carved with the egg-and-dart ornament.



Echinus

Echo (ek'ō), the repetition of a sound caused by the reflection of sound-waves from some surface, as the wall of a building. The echo may, however, be very distinct when the reflecting surface is very irregular, and it is probable that the resonance of the obstacles and the masses of air which they enclose contribute in producing the echo. The waves of sound on meeting the surface are turned back in their course according to the same laws that hold for reflection of light. In order that the echo may return to the place from which the sound proceeds, the reflection must be direct, and not at an angle to the line of transmission, otherwise the echo may be heard by others but not by the transmitter of the sound. This may be effected either by a reflecting surface at right angles to the line of transmission, or by several reflecting surfaces which in the end bring the sound back to the point of issue. Sound travels about 1125 feet in a second; consequently, an observer standing at half that distance from the reflecting object would hear the echo a second later than the sound. Such an echo would repeat as many words and syllables as could be heard in a second. As the distance decreases, the echo repeats fewer syllables till it becomes mono-syllabic. The most practised ear cannot distinguish in a second more than from nine to twelve successive sounds, so that a distance of not less than 60 feet is needed to enable an average ear to distinguish between the echo and the original sounds. At a near distance the echo only clouds the original sounds,

and this often interferes with the hearing in churches and other large buildings. Woods, rocks, and mountains produce natural echoes in every variety, for which particular localities have become famous.

Echo, in Greek mythology, a mountain nymph (one of the Oreads). Legend relates that by her talking she detained Hera, when the latter sought to surprise Zeus among the mountain nymphs. To punish her the goddess deprived her of speech, unless first spoken to. She subsequently fell in love with Narcissus, and because he did not reciprocate her affection she pined away until nothing was left but her voice.

Echuca (e-chö'ka), an Australian town, colony of Victoria, on the Murray, over which is an iron railway and roadway bridge, connecting it with Moama in New South Wales; trade (partly by the river) in timber and wool. Pop. 4137.

Écija (ā-thē-ha'), an ancient town of Southern Spain, province of Seville, on the Genil, with manufactures of textile fabrics and a good trade. It is one of the hottest places in Spain. Pop. 23,217.

Eck, Johann Maier von, the celebrated opponent of Luther, born in 1486, died in 1543. Having obtained a reputation for learning and skill in disputation, he was made doctor of theology, canon in Eichstädt, and pro-chancellor of the University of Ingolstadt. He went to Rome in 1520, and returned with a Papal bull against Luther, in attempting to publish which he met with violent popular opposition. In 1530, while at the Diet of Augsburg, he made the remarkable admission that he could confute the Augsburg Confession by the fathers but not by the Scriptures. Eck was present also at the Diets of Worms (1540) and Ratisbon (1541).

Eck'ermann, Johann Peter, German writer, born in 1792, died in 1854. In 1813 he served in the army against the French, and was afterwards appointed to a small governmental post. He finally settled in Weimar, where he became private secretary to Goethe. After Goethe's death he published his *Conversations with Goethe*, a book which has been translated into all European languages.

Eckmühl (ek'mül), a village of Bavaria, circle of Lower Bavaria, on the Gross Laber, 13 miles S.S.E. of Ratisbon, the scene of a sanguinary battle

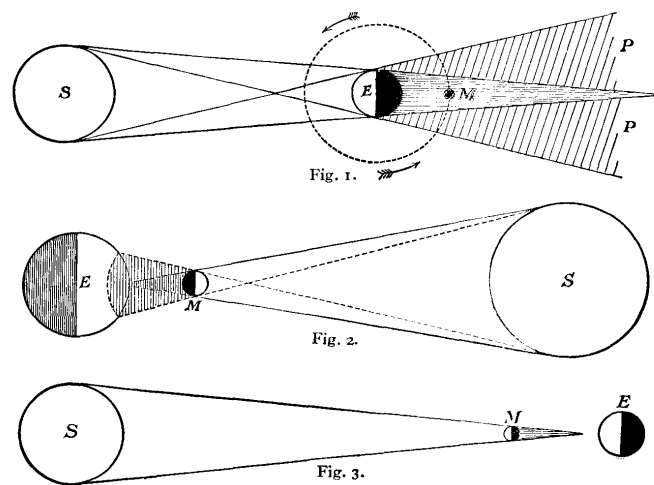
between the French and Austrians on 22nd April, 1809, in which the latter were defeated.

Eclamp'sia, a medical term applied to convulsions that seem to be of an epileptic character, but differ from true epilepsy as being due to some special poison. The use of the term is now practically restricted to puerperal eclampsia, convulsions occurring in pregnant women, generally those suffering from kidney disease.

Eclectic's (Gr. *eklektikos*, select) is a name given to all those philosophers who do not follow one system entirely, but select what they think the best parts of all systems. The system is called *eclecticism*. In ancient philosophy Cicero was the most conspicuous representative of eclecticism, and in modern times the eclectic method found a notable supporter in the French philosopher Victor Cousin.

Eclipse (ek-lips'; Gr. *ekleipsis*, a failing, *ekleipō*, I fail), an interception or obscuration of the light of the sun, moon, or other heavenly body by the intervention of another and non-luminous body. A star or planet may be hidden by the moon; in this case the phenomenon is called an occultation.

An Eclipse of the Moon is an obscuration of the light of the moon occasioned by an interposition of the earth between the sun and the moon; consequently, all eclipses of the moon happen at full moon. Further, the moon's direction from the earth must make only a very small angle with the axis of the earth's shadow, or line joining centres of sun and earth produced. But as the moon's orbit makes an angle of more than 5° with the plane of the ecliptic, it frequently happens that though the moon is in opposition it does not come within the shadow of the earth. The theory of lunar eclipses will be understood from fig. 1, where s represents the sun, E



Diagrams illustrating the Theory of Eclipses

But as the moon's orbit makes an angle of more than 5° with the plane of the ecliptic, it frequently happens that though the moon is in opposition it does not come within the shadow of the earth. The theory of lunar eclipses will be understood from fig. 1, where s represents the sun, E

the earth, and M the moon. If the sun were a point of light, there would be a sharp outlined shadow or *umbra* only, but since the luminous surface is so large there is always a region in which the light of the sun is only partially cut off by the earth, which region is known as the *penumbra* (P P). Hence during a lunar eclipse the moon first enters the penumbra, then is totally or partially immersed in the umbra, then emerges through the penumbra again.

An Eclipse of the Sun is an obscuration of the whole or part of the face of the sun, occasioned by an interposition of the moon between the earth and the sun; thus all eclipses of the sun happen at the time of new moon. Fig. 2 is a diagram showing the cause of a solar eclipse. The dark or central part of the moon's shadow, where the sun's rays are wholly intercepted, is here the *umbra*, and the light part, where they are only partially intercepted, is the *penumbra*; and it is evident that if a spectator be situated on that part of the earth where the umbra falls, there will be a total eclipse of the sun at that place; in the penumbra there will be a partial eclipse, and beyond the penumbra there will be no eclipse. As the moon is not always at the same distance from the earth, and as the moon is a comparatively small body, if an eclipse should happen when the moon is so far from the earth that her shadow falls short of the earth, a spectator situated on the earth in a direct line with the centres of the sun and moon would see a ring of light round the dark body of the moon. Such an eclipse is called *annular*, as shown in fig. 3; when this happens, there can be no total eclipse anywhere. An eclipse can never be annular longer than 12 minutes 24 seconds, nor total longer than 7 minutes 58 seconds. The longest possible entire duration of an eclipse of the sun is a little over 4 hours.

An eclipse of the sun begins on the western side of his disc and ends on the eastern; and an eclipse of the moon begins on the eastern side of her disc and ends on the western. The largest possible number of eclipses in a year is seven, four of the sun and three of the moon, or five of the sun and two of the moon. The smallest is two, both of the sun. But a solar eclipse affects only a limited area of the earth, while a lunar eclipse is visible from more than a terrestrial hemisphere, as the earth rotates during its progress. Therefore at any given place eclipses of the moon are more frequently visible than those of the sun.—BIBLIOGRAPHY: R. Buchanan, *The Theory of Eclipses*; W. T. Lynn, *Remarkable Eclipses*.

Eclip'tic, the sun's path, the great circle of the celestial sphere, in which the sun appears to describe his annual course from west to east—really corresponding to the path which the earth describes. (See *Earth*.) The Greeks observed that eclipses of the sun and moon took place near this circle; whence they called it the *ecliptic*. The ecliptic has been divided into twelve equal parts, each of which contains 30°, and which are occupied by the twelve celestial signs, viz.:

- ♈ Aries (the Ram), 21st March.
- ♉ Taurus (the Bull), 20th April.
- ♊ Gemini (the Twins), 21st May.
- ♋ Cancer (the Crab), 21st June.
- ♌ Leo (the Lion), 23rd July.
- ♍ Virgo (the Virgin), 23rd Aug.
- ♎ Libra (the Balance), 23rd Sept.
- ♏ Scorpio (the Scorpion), 23rd Oct.
- ♐ Sagittarius (the Archer), 22nd Nov.
- ♑ Capricornus (the Goat), 22nd Dec.
- ♒ Aquarius (the Water-carrier), 20th Jan.
- ♓ Pisces (the Fishes), 19th Feb.

These are also called signs of the *zodiac*, the zodiac being a belt of the heavens extending 9° on each side of the ecliptic. The days of the month annexed show when the sun, in its annual revolution, enters each of the signs of the zodiac. From the First Point of Aries, or the place of the sun at the vernal equinox, the degrees of the ecliptic are counted from west to east. The plane of the ecliptic is that by which the position of the planets and the latitude and longitude of the stars are reckoned. The axis of the earth is not fixed in direction in space, but performs a slow conical motion about the pole of the ecliptic in about 26,000 years. In consequence of this the points at which the equator intersects the ecliptic, viz. the First Point of Aries and First Point of Libra, recede westwards upon the ecliptic at the rate of about 50 seconds a year. The signs of the zodiac, therefore, do not now coincide, as they did some 2000 years ago, with the constellations of the same names, and the First Point of Aries has now regressed through the greater part of the constellation Pisces. The angle at which the ecliptic and equator are mutually inclined is also variable, and has been diminishing for about 4000

years at the rate of about 50 seconds in a century. Laplace gave a theory to show that this variation has certain fixed limits, and that after a certain time the angle will begin to increase again. See *Precession* and *Nutation*.

Eclogue (ek'log), a term usually applied to what Theocritus called *idyls*—short, highly finished poems, principally of a descriptive or pastoral kind, and in which the loves of shepherds and shepherdesses are described. Eclogues flourished among the ancients (*Bucolics* of Virgil), and, under the name of pastorals, were fashionable in the sixteenth century, Spenser's *Shepherds' Calendar* being a good example. They were revived in the eighteenth century by Pope.

École des Beaux Arts ('School of Fine Arts'), the French Government school of fine arts at Paris, founded by Mazarin in 1648, and provided with an extensive staff of teachers. The competitions for the *grands prix de Rome* take place at this school. All artists between the ages of fifteen and twenty-five, whether pupils of this school or not, may compete, after passing two preliminary examinations. The successful competitors receive an annual allowance from the State for three or four years, two of which must be passed at Rome. The Palais des Beaux Arts, the home of the École, was begun in 1820 and finished in 1863.

École Normale Supérieure ('Superior Normal School'), a school at Paris for the training of those teachers who have the charge of the secondary education in France, founded by decree of the Convention in 1794, reorganized by Napoleon in 1808, and again in 1830 by the Government of Louis-Philippe. By the decree of 1903 the school forms part of the University of Paris. It maintains a hundred students and has a course of three years' duration.

École Polytechnique ('Polytechnic School'), a school in Paris established with the purpose of giving instruction in matters connected with the various branches of the public service, such as mines, roads and bridges, engineering, the army and the navy, and Government manufactures. It was founded in 1794, and is under the direction of the Minister of War. Candidates are admitted only by competitive examination, and have to pay for their board 1000 francs a year. The pupils who pass satisfactory

examinations at the end of their course are admitted to that branch of public service which they select.

Ecology, or **Æcology**, the study of the relations of plants to their surroundings, a branch of plant geography.—BIBLIOGRAPHY: Horwood, *British Wild-flowers*; Tansley, *Types of British Vegetation*; Warming, *Æcology*.

Economics is the name applied, in substitution for the older one of political economy, to the scientific study of men in relation to the production, exchange, distribution, and consumption of wealth. The origin of both names lies in the analogy between provision for the needs of a household and for those of a State. To the former the term 'economy' was originally applied, as in Xenophon's treatise on the subject. But it was soon adopted to describe that branch of the art of government which dealt with public revenue and expenditure, and a matter intimately connected therewith, the enrichment of the community as a whole.

This conception of economics inspired all economic writings until late in the eighteenth century, a typical example being Thomas Mun's *England's Treasure by Foreign Trade* (1664), containing an exposition of the mercantile system which sought to increase natural wealth by regulation of the balance of trade. The treatment of economics as a science had its origin in the writings of the Physiocrats, a group of French philosophers of whom Quesnay (1694-1774) was the most prominent, and with whom Turgot (1727-81), the great minister of Louis XVI, held many doctrines in common. The Physiocrats argued that the wealth of the community was raised to the maximum, not by State regulation, but by entire freedom in the economic sphere. But the chief importance of the Physiocrats lay in their paving the way for Adam Smith (1723-90), who in 1776 published *The Wealth of Nations*, a book which has exercised profound and widespread influence on thought and action, and is still a leading authority on the subject. Adam Smith definitely retained the conception of economics as part of the art of government. "Political economy", he says, "proposes two distinct objects: first, to provide a plentiful revenue or subsistence for the people ... and secondly, to supply the State or Commonwealth with a revenue sufficient for the public service. It proposes to enrich both the people and the sovereign." But the book is also largely occupied with an investigation

of the production, distribution, and exchange of wealth when free from all regulation and restriction, together with a powerful indictment of such regulation. This doctrine of non-interference by the State came to be known as the *laissez-faire* doctrine, from a phrase used by Gournay, one of the Physiocrats. Mainly through Adam Smith's influence, it became the orthodox view of the State's relation to trade and industry. This meant that the aims of economics, in its older sense, were best achieved without State action at all; and, consequently, economics came to mean simply the study of what are in fact men's activities in relation to wealth. This conception is clearly expressed in such writers as Ricardo (1772-1823), whose *Principles of Political Economy and Taxation* enunciates the theory of rent which has formed the basis of all subsequent reasoning on the subject, and states a theory of wages which gave colour to Karl Marx's doctrine of the exploitation of wage-earners by capitalists. It is also evident in the work of Nassau Senior (1790-1864), in the important *Principles of Political Economy* of John Stuart Mill (1806-73), and is most fully expressed by J. E. Cairnes (1823-78).

This conception has formed the basis of all modern economics, despite important differences in the method of treating material. The modern view of the matter is well stated by Dr. Alfred Marshall in his *Principles of Economics*, a most important contribution to the subject, which has exercised much influence. Economics he defines as "a study of mankind in the ordinary business of life; it examines that part of individual and social action which is most closely connected with the attainment and with the rise of material requisites of well-being". The separation between economics and the investigation of social phenomena in general is not so rigidly maintained to-day as in the past. It is realized that men's activities in relation to wealth are affected by other than purely economic considerations, and that political, moral, religious, and æsthetic forces must be taken into account. At the same time, the science deals only with what is, and not with what ought to be done; and is therefore distinct from *Ethics*, which is concerned with moral judgments. Of late years, interest in the application of ethical considerations to economic problems has increased considerably, using the conclusions of economic science as its material, mainly in connection with problems of distribution, especially wages. One of the most important of modern political movements, Socialism, makes a

just distribution of wealth the keynote of its doctrines. In so far as man's conduct is studied in economics, the science is concerned with psychological considerations; but it is distinct from *psychology*, taking the principles thereof as data rather than establishing them as conclusions. The traditional arrangement of the subject matter of economics into the production, exchange, and distribution of wealth is still maintained; but in recent years consumption, the end of almost all man's productive activity, has received much attention, notably from W. S. Jevons (1835-82) and Marshall. Important conceptions in this connection are those of the *diminishing utility* to an individual or group of individuals of each successive increment of any commodity received beyond a certain point; and of *consumer's surplus*, measured by the difference between the price a person pays for a thing and what he would pay rather than go without it. Any rigid distinction between the different branches of economics is, however, impossible. For example, all processes of exchange may be considered as part either of distribution or of production.

The central problem of economics is really that of how the exchange value of commodities and services is determined; since in this determination all the forces regulating production, distribution, and consumption are brought to a focus, and their action and interaction can be investigated. The study of value covers that of all forces affecting either the demand for or the supply of a commodity, including its cost of production. On the side of production, technical processes are not studied in detail, though some knowledge of them is indispensable; but matters common to all production are dealt with, such as the so-called *laws of increasing and diminishing return*, which are statements of the relation between the amounts of labour, land, and capital used in production, and the amount of product. Other questions considered are transport, markets of all kinds, banking, currency, finance, and trusts and combinations. The study of distribution includes the methods by which wages, interest and profits, and rent are determined; and since each of these is payment for a service (of labour, capital, and land respectively) it is really an aspect of the study of value. Distribution also covers such subjects as trade unionism, co-operation, and labour disputes. Economics also deals with public finance (including taxation), treating of the effects of different methods of collecting and expending the State revenue. In considering the above-mentioned subjects, the method of economics is strictly that of a

science, in that it aims partly at a descriptive analysis of material, and partly at a statement of cause and effect. The laws of economics are, like other scientific laws, statements of tendencies. They are not laws such as the commands or prohibitions of the State, though they are often loosely referred to in this way. That economics should be able to generalize and to predict about the action of men is due to its dealing not with individuals, but with large groups, so that individual peculiarities can be neglected and the general characteristics of the group ascertained. It is in this connection that considerable controversy has arisen. The older writers on economics were mainly deductive in method, i.e. they took a few general principles, such as that every man follows his own interest and knows where that interest lies, and made certain assumptions, such as the existence of free competition; and on this basis worked out a group of principles which were sometimes quite unrelated to actual facts. This method is undoubtedly a most powerful one, and of great value provided that the original assumptions are kept clearly in mind, and variations from them in a particular case allowed for in applying conclusions. But the unreality of some of its results produced a reaction, of which an early instance is the famous *Essay on the Principle of Population* by T. R. Malthus, published in 1798. This book inaugurated the rise of a school of economists who treated their subject from an inductive and historical point of view. The historians, who have been especially prominent in Germany, and of whom representatives are Roscher (1817-94), de Laveleye (1822-92), and Cliffe Leslie (1825-82), hold that economics should in the main be descriptive, and not attempt to formulate laws. The inductive school, of whom J. S. Mill is an important member, base their work upon more extensive investigation than the older writers, and constantly test their conclusions by reference to facts. Another important reaction against the early economists arose from the identification of the latter with the doctrine of *laissez-faire*. Alexander Hamilton (1757-1804) and Friedrich List (1789-1840) argued in favour of an extension of State activity, especially for the purpose of protecting industry against foreign competition, and may be considered the fathers of modern protectionist doctrine. In most modern treatment of economics, the deductive and inductive methods are employed side by side. The study of economic history has developed as a separate branch, but economists recognize that it provides them with much valuable material. Important recent developments in method are the increased use of statistics, made

possible by their more widespread and careful compilation, and the application of mathematical methods to economic data. It is recognized that, with due care, many conceptions which are with difficulty expressed in words can be treated on mathematical lines to yield results of great service. In this work the researches of Italian writers, such as Pantaleoni and Pareto, are of conspicuous importance.—BIBLIOGRAPHY: A. C. Pigou, *Wealth and Welfare*; *Preferential and Protective Import Duties*; E. Cannan, *Wealth*; J. N. Keynes, *Scope and Method of Political Economy*; G. Cassel, *Nature and Necessity of Interest*; W. Smart, *Distribution of Income*; C. R. Fay, *Co-operation*; A. Andreades, *History of the Bank of England*; H. Levy, *Monopoly and Competition*; C. F. Bastable, *Public Finance*.

Écraseur is a wire loop or chain for amputating a growth suitably situated for such an instrument. The chain is passed round the base or pedicle of the growth, and gradually tightened by a screw till the growth falls off. Its application in surgery is limited.

Ectocarpaceæ, a family of Brown Algæ, section Phæosporeæ. The typical genus is *Ectocarpus*, comprising small, branched, filamentous plants of salt or brackish water. According to the species, growth of the filaments may be apical, intercalary, or common to all cells, whereas among the more advanced members of the Brown Algæ either apical or intercalary growth is characteristic of entire families. The gametes show every gradation from complete similarity (isogamy) to a condition like that of *Cutleria*.

Ecuador (ek-wa ' -dōr') (*Republica Del Ecuador*), a republic of South America, situated under the equator, whence it takes its name, between Peru and Colombia. It is of triangular shape, its base resting on the Pacific, but the boundaries between it and its neighbours are not very definitely fixed; estimated area, about 116,000 sq. miles. The state has still a boundary dispute with Peru, that with Colombia having been settled by treaty in 1917. The country is divided into fifteen provinces, one territory—'El Oriente'—and the Archipelago of Galapagos, officially called 'Colon'. It falls, as regards the surface, into three sections: the comparatively narrow and low-lying coast regions, the mountain region, and the extensive plains on the east. The mountain region is formed by a double range of snow-clad mountains—several of them active volcanoes—which enclose a longitudinal valley or tableland, with a breadth of 20 to 40 miles, and

varying in elevation from 8500 to 13,900 feet. The most elevated of these mountains are, in the western range, Chimborazo, Pichincha, and Cotacachi, Chimborazo being 20,703 feet high. In the eastern range are Cayambe, Antisana, and Cotopaxi (19,500 feet). The cultivated land and the population of Ecuador lie chiefly in this elevated region, which extends along between the summits of the Cordillera, and may be considered as divided by transverse ridges or dikes into the valleys of Quito, Hambato, and Cuenca. The chief towns here are Quito, the capital, with a pop. of 70,000, Riobamba, and Cuenca, all situated at a height of 9000 feet or more above the sea. The chief ports of Ecuador are Guayaquil and Esmeraldas. The most considerable rivers, the Tigre, Napo, Pastaza, &c., belong to the basin of the Amazon; and some of them, notably the Napo, are navigable for long distances. On the western slope of the Andes the chief rivers are the Esmeraldas and the Guayaquil. Ecuador is comparatively poor in Mammalia; although various kinds of deer as well as tapirs and peccaries are found in the forests. Parrots and humming-birds are also numerous, but perhaps the most remarkable of the birds in Ecuador is the condor, which dwells on the slopes of the Andes. Reptiles, including serpents, are numerous. The forests yield cinchona bark, caoutchouc, sarsaparilla, and vegetable ivory. The climate on the plains, both in the east and the west, is moist, hot, and unhealthy. In the higher regions the climate is rough and cold, but in great part the elevated valleys, as that of Quito, enjoy a delightful climate. Here the chief productions are potatoes, barley, wheat, and European fruits. In the lower regions are grown all the food-products of tropical climates, cocoa, coffee, and sugar. The foreign commerce is not large, the exports and imports being annually about £2,700,000 and £1,670,000 respectively. In 1919 the imports from Ecuador to the United Kingdom amounted to £1,257,350, and the exports to Ecuador to £373,346. Cocoa forms three-fourths (or more) of the whole export; the remainder is made up of tagua or ivory-nuts, rubber, straw hats, coffee, and gold. A little gold is mined, and Panama hats are made. The State recognizes no religion, but grants freedom of worship to all. A system of education was organized in 1897 and improved in 1912. There are three universities: the Central University, at Quito; the Guayas University, in Guayaquil; and the Azuay University, in Cuenca. There are schools for higher education and primary schools. The executive government is vested in a President elected for four years, who is assisted by a Council of State. The Congress is the legislative

body, and consists of two Houses, one formed of Senators, two for each province, the other of Deputies, one for every 30,000 inhabitants, both elected by universal suffrage. The Congress has extensive privileges, and cannot be dissolved by the President. The seat of government is Quito. In 1920 both the revenue and expenditure amounted to nearly £2,000,000. The debt amounts to about £5,620,000. The monetary standard is gold, the gold *condor* of ten *sucres* being equivalent to a sovereign. The metric system of weights and measures is the legal one. Railways and telegraphs have made little progress.—Ecuador at the time of the conquest of Peru by the Spaniards formed part of the great empire of the Incas. As the Presidency of Quito it was long included in the Vice-Royalty of Peru. From 1710 it became part of the Presidency of New Granada (or Santa Fé de Bogotá). In the revolutionary war against Spain, Ecuador, along with the neighbouring territories, secured its independence (1822), and was ultimately erected into a separate Republic in 1831. The present Constitution of the Republic was promulgated on 6th May, 1906. Of the present population, the aboriginal red race form more than half; the rest are negroes, mulattoes, mestizoes, a degenerate breed of mixed negro and Indian blood, and Spanish Creoles or whites. The last-named are the chief possessors of the land, but are deficient in energy. Pop. (estimated) 2,000,000.—BIBLIOGRAPHY: F. Garcia-Calderon, *Latin America: its Rise and Progress*; C. R. Enock, *Ecuador*; T. H. Stabler, *Travels in Ecuador*.

Ecumenical Council, a general ecclesiastical council regarded as representing the whole Christian world or the universal Church; specially applied to the general councils of the early Christian Church, beginning with that of Nicæa in 325, and later to those of the Roman Catholic Church, of which the most recent was the Vatican Council at Rome in 1870.

Ec'zema is a skin eruption marked by the appearance of papules or vesicles and accompanied by irritation of the affected part, frequently very severe. The characteristic watery discharge of the disease is produced by the bursting of the vesicles. There is difference of opinion among dermatologists as to whether or not it is primarily caused by germs. Various predisposing causes, like digestive disturbances, anæmia, and nervous disorders are important factors in determining the course of the disease. Eczema may affect practically any part of the skin, but is most frequently

seen on the scalp, ears, face, hands, nipples, armpits, and the genital regions.

Ed'am, a town of North Holland, near the Zuider Zee, 12 miles N.N.E. of Amsterdam, noted for its cheese markets; but 'Edam cheese' is mostly made elsewhere. Pop. 6623.

Edda (meaning 'great-grandmother'), the name given to two ancient collections of Icelandic literature, the one consisting of mythological poems, the other being mainly in prose. The first of these collections, called the *Elder* or *Poetic Edda*, was compiled in the thirteenth century, and discovered in 1643 by Brynjulf Sveinsson, an Icelandic bishop. For a long time an earlier date was given, the compiler being erroneously believed to have been Sæmund Sigfusson, a learned Icelandic clergyman, who lived from about 1056 to 1133. It consists of thirty-three pieces, written in alliterative verse, and comprising epic tales of the Scandinavian gods and goddesses, and narratives dealing with the Scandinavian heroes. These poems are now assigned to a period extending from the ninth to the eleventh century. The *Prose Edda*, or *Younger Edda*, presents a kind of prose synopsis of the Northern mythology; a treatise on the Scaldic poetry and versification, with rules and examples; and lastly a poem (with a commentary) in honour of Haco of Norway (died 1263). In its earliest forms this collection is ascribed to Snorri Sturlason, who was born in Iceland in 1178, and was assassinated there in 1241 on his return from Norway, where he had been scald or court poet. Cf. S. Bugge, *Home of the Eddic Poems*.

Eddy, Mary Baker, founder of Christian Science (q.v.), born at Bow, New Hampshire, United States, 16th July, 1821, died 3rd Dec., 1910. She was married three times, to Mr. Glover, Mr. Patterson, and Mr. Asa Gilbert Eddy, all of whom she survived. She began to teach her system of psychotherapeutics in 1866, and founded the first Christian Science Church in Boston in 1879. In 1881 she established the Metaphysical College at Massachusetts. Her works, besides *Science and Health with Key to the Scriptures*, include: *Unity of God, No and Yes, Pulpit and Press, The First Church of Christ, Christian Science versus Pantheism*.—Cf. G. Milmine, *Life of M. B. G. Eddy and the History of Christian Science*.

Eddystone Lighthouse, a lighthouse in the English Channel, erected to mark a group of rocks lying in the fair-way from the Start to the Lizard. The rocks are covered only at the flood. The first lighthouse was of wood, and built by Henry Winstanley in 1696. It was carried away in the storm of 1703. Another lighthouse, also of wood, was built in 1709 by Rudyard, but was burned down in 1755. It was succeeded by one built by Smeaton between 1757 and 1759, a circular tower 85 feet high; but, as the foundations on which it stood became much weakened, a new structure, designed by Sir J. N. Douglass, was built between 1879 and 1882 on the neighbouring reef. Its light is visible 17½ miles.

Edelweiss (ā-dēl-vīs; Ger., 'noble white'), *Leontopodium alpīnum*, a composite plant inhabiting the Alps, and often growing in the most inaccessible places. Its flower-heads are surrounded by a spreading foliaceous woolly involucre, and its foliage is also of the same woolly character. It is not difficult to cultivate, but is apt to lose its peculiar woolly appearance.

E'den (Heb. *eden*, delight), the original abode of the first human pair. It is said to have had a garden in the eastern part of it, and we are told that a river went out of Eden to water this garden, and from thence it was parted into four heads, which were called respectively Pison, Gihon, Hiddekel, and Euphrates (Phrat), but this does not enable us to identify the locality. It was not the whole of Eden that was assigned to man for his first habitation, but the part towards the east, to which the translators of the Authorized Version have given the name of the Garden of Eden, and which Milton, in *Paradise Lost*, calls Paradise, that word (originally Persian) having in its Greek form (*paradeisos*) been applied to the Garden of Eden by the translators of the *Septuagint*.

Eden, a river in England, in Westmorland and Cumberland, falling into the Solway Firth after a course of 65 miles.—Also, a river in Fifeshire, Scotland.

Edenta'ta (ē-), or **Toothless Animals**, the name applied to a primitive order of mammals mostly native to the neotropical region, but also represented in South Africa and South Asia. The body is often covered by horny scales or bony plates, the digits are clawed, and the teeth either

imperfect or absent altogether. I. New World forms.—(1) *Ant-eaters*. Toothless, with long narrow snout, and protrusible tongue. Covered with dense fur. The great ant-eater (*Myrmecophāga jubata*) lives on the ground; the much smaller Tamandua and Cycloturus are arboreal. (2) *Sloths*. Toothed arboreal leaf-eaters, covered by coarse fur, and provided with very strong curved claws, by which they hang upside down from branches. The three-toed sloth (*Bradypus*) has three digits in the fore-limb, the two-toed sloth (*Cholæpus*) only two. (3) *Armadillos*. Burrowing forms protected by a strong carapace of bony plates, and possessing numerous imperfect teeth. (4) *Extinct types*. The so-called ground sloths were of large size, Megatherium being nearly as large as an elephant, and Mylodon not much smaller. Glossodon, allied to the latter, survived into the human period. Glyptodon resembled a gigantic armadillo. II. Old World forms.—(1) The *aard-vark* (*Orycteropus*) is a burrowing African form about the size of a pig, covered with coarse hair; long ears and snout; 20 imperfect grinding teeth. (2) *Scaly ant-eaters* or *pangolins* (*Manis*), native to South Africa and South Asia, are toothless forms not unlike the American ant-eaters in build, but the body is covered dorsally and laterally by large overlapping scales.

Edes'sa, the name of two ancient cities.—1. The ancient capital of Macedonia, and the burial-place of its kings, now *Vodhena*. It is probably the same as the still more ancient Aegæ. Philip II was murdered at Edessa in 336 B.C.—2. An important city in the north of Mesopotamia, which, subsequent to the establishment of Christianity, became celebrated for its theological schools. In 1098, in the first Crusade, Edessa came into the hands of Baldwin, but ultimately became part of the Turkish Empire. It is thought to be the modern Urfah or Orfa.

Edfu, or **Edfoo'** (ancient **Apollinopolis**), a village in Upper Egypt, province of Assouan, on the left bank of the Nile, with manufactures of cottons and pottery. Its ancient magnificence is attested by several remains, especially a temple, founded by Ptolemy Philopator (181-145 B.C.), the largest in Egypt after those of Karnak and Luxor. Pop. 12,594.

Ed'gar (*the Peaceful*), one of the most distinguished of the Saxon Kings of England, was the son of King Edmund I. He succeeded to the throne in 959, and managed the civil and military affairs of his kingdom with great vigour and success. In ecclesiastical affairs he was guided by Dunstan, Archbishop

of Canterbury, and he was a great patron of the monks. He died in 975, and was succeeded by his son Edward the Martyr.

Edgar Atheling, grandson of Edmund Ironside and son of Edward the Outlaw, was born in Hungary, where his father had been conveyed in infancy to escape the designs of Canute. After the battle of Hastings, Edgar (who had been brought to England in 1057) was proclaimed King of England by the Saxons, but made peace with William and accepted the earldom of Oxford. Having been engaged in some conspiracy against the king, he was forced to seek refuge in Scotland, where his sister Margaret became the wife of Malcolm Canmore. Edgar subsequently was reconciled to William and was allowed to live at Rouen, where a pension was assigned to him. In 1097, with the sanction of William Rufus, he undertook an expedition to Scotland for the purpose of displacing the usurper Donald Bane, in favour of his nephew Edgar, son of Malcolm Canmore, and in this object he succeeded. He afterwards took part in Duke Robert's unsuccessful struggle with Henry I, but was allowed to spend the remainder of his life quietly in England.

Edgehill, a ridge in Warwickshire, England, 7 miles north-west of Banbury, where was fought a fierce but indecisive battle on 23rd Oct., 1642, between the Royalists under Charles I and the forces of the Parliament under the Earl of Essex.

Edgeworth, Maria, Irish novelist, born at Black Bourton, Oxfordshire, 1st Jan., 1767, died 22nd May, 1849, at Edgeworthstown. She was the daughter of Richard Lovell Edgeworth (1744-1817) of Edgeworthstown, County Longford, Ireland. Her first novel, *Castle Rackrent*, a tale of Irish life, published in 1800, immediately established her reputation. Her later works include: *Belinda*, *Moral Tales*, *Leonora*, *Popular Tales*, *Tales of Fashionable Life*, *Patronage*, *Harrington*, *Ormond*, and *Helen*, besides an *Essay on Irish Bulls*, and a work on *Practical Education*, largely based on Rousseau's *Émile*. Miss Edgeworth's characteristics are a simple and lucid style and considerable power of observation, but she was not a great creative artist.

Edinburgh, the metropolis of Scotland, and one of the finest as well as most ancient cities in the British Empire, lies within 2 miles of the south

shore of the Firth of Forth. It is picturesquely situated, being built on three eminences which run in a direction from east to west, and surrounded on all sides by lofty hills except on the north, where the ground slopes gently towards the Firth of Forth. The central ridge, which constituted the site of the ancient city, is terminated by the castle on the west, situated on a high rock, and by Holyrood House on the east, not far from which rise the lofty elevations of Salisbury Crags, Arthur's Seat (822 feet high), and the Calton Hill overlooking the city. The valley to the north, once the North Loch, but now drained and traversed by the North British Railway, leads to the New Town on the rising ground beyond, a splendid assemblage of streets, squares, and gardens. The houses here, all built of a beautiful white freestone found in the neighbourhood, are comparatively modern and remarkably handsome. The principal streets of the New Town are Princes Street, George Street, and Queen Street. From Princes Street, which is lined by fine gardens adorned with Sir W. Scott's monument and other notable buildings, a magnificent view of the Old Town with its picturesque outline may be obtained. The principal street of the Old Town is that which occupies the crest of the ridge on which the latter is built, and which bears at different points the names of Canongate, High Street, Lawnmarket, and Castle Hill. This ancient and very remarkable street is upwards of one mile in length, rising gradually with a regular incline from a small plain at the east end of the town, on which stands the palace of Holyrood, and terminating in the huge rock on which the castle is built, 437 feet above sea-level. The houses are lofty and of antique appearance. Amongst the notable buildings are the ancient Parliament House, since the Union the seat of the supreme courts of Scotland; St. Giles' Church or Cathedral, an imposing edifice in the later Gothic style, dating from the fourteenth century and carefully restored between 1879 and 1883; the Tron Church; Victoria Hall (where the General Assembly of the Established Church meets), with a fine spire; and also John Knox's House, besides some of the old family houses of the Scottish nobility and other buildings of antiquarian interest. From this main street descend laterally in regular rows numerous narrow lanes called *closes*, many of them extremely steep, and very few at their entrances more than 6 feet wide; those which are broader, and admit of the passage of carriages, are called *wynd*s. In these and the adjacent streets the houses are frequently more than 120 feet in height, and divided into from six to ten stories, or *flats*, the communication between which is maintained by broad

stone stairs, winding from the lowest part of the building to the top. In the Old Town the most remarkable public building is the castle, an extensive mass, of which the oldest portion—and the oldest building in the city—is St. Margaret's Chapel, the private oratory of the Saxon princess Margaret, queen of Malcolm Canmore; another portion being a lofty range of old buildings, in a small apartment of which Queen Mary gave birth to James VI in 1566; while in an adjoining apartment are kept the ancient regalia of Scotland. Here is also the old Parliament Hall, restored during 1888 and 1889. The castle as a fortress contains accommodation for 2000 soldiers, and the armoury space for 30,000 stand of arms. An old piece of ordnance built of staves of malleable iron, cask fashion, and known as *Mons Meg*, stands conspicuous in an open area. The palace of Holyrood, or Holyrood House as it is more generally called, stands, as already mentioned, at the lower or eastern extremity of the street leading to the castle. No part of the present palace is older than the time of James V (1528), while the greater portion of it dates only from the time of Charles II. In the north-west angle of the building are the apartments which were occupied by Queen Mary, nearly in the same state in which they were left by that unfortunate princess. Adjoining the palace are the ruins of the chapel belonging to the Abbey of Holyrood, founded in 1128 by David I. On the south side of the Old Town, and separated from it also by a hollow crossed by two bridges (the South Bridge and George IV Bridge), stands the remaining portion of the city, which, with the exception of a few unimportant streets, is mostly modern. Besides the buildings already noticed, Edinburgh possesses a large number of important edifices and institutions, chief amongst which are the Royal Institution (accommodating the Royal Society and other bodies), a beautiful Grecian building; the National (Picture) Gallery, another fine building in the Greek style, the two buildings standing on a conspicuous site between East and West Princes Street Gardens; the National Portrait Gallery, a building due to private munificence and accommodating also the National Museum of Antiquities; the Museum of Science and Art; the Episcopal Cathedral of St. Mary's, one of the largest religious edifices of modern times; the university buildings, including those of the medical department, standing apart from the others; the infirmary buildings; the high school, register office, and others. Amongst the more prominent educational institutions are the university, the high school, the academy, the United Free Church New College, the Edinburgh School of Medicine (connected with the Royal

College of Physicians and the Royal College of Surgeons), Medical College for Women, College of Agriculture, the Edinburgh Veterinary College, Fettes College, the Heriot-Watt College, normal schools, technical, commercial, and other institutions, and endowed secondary schools. The Advocates' Library, the largest in Scotland, contains upwards of 550,000 printed volumes and 3000 MSS.; the university library, 200,000; the library of Writers to the Signet, 100,000. There is also a rate-supported public library in a building erected at the expense of the late Andrew Carnegie. Printing, bookbinding, coach-building, type-founding, machine-making, the making of rubber goods, furniture-making, ale-brewing on a very large scale, and distilling are the principal industries. Edinburgh is the headquarters of the book trade in Scotland, and the seat of the chief Government departments. It is a great resort of tourists and other travellers. On account of its picturesque and commanding situation and its literary fame, Edinburgh is often called the 'Modern Athens'. The origin of Edinburgh is uncertain. Its name is by many thought to be derived from Eadwinsburh, the Burgh of Edwin, a powerful Northumbrian king of the early seventh century, who absorbed the Lothians in his rule. The town was made a royal burgh in the time of David I; but it was not till the fifteenth century that it became the recognized capital of Scotland, and from that time it was the scene of many important events in Scottish history. The city is now governed by a council, which elects from its members a Lord Provost, a city treasurer, and seven bailies. It returns five members to Parliament, and within the municipal boundaries are included Portobello, Granton, Liberton, Duddingston, and since 1920 also the port of Leith. Pop. 420,281.—BIBLIOGRAPHY: J. B. Gillies, *Edinburgh, Past and Present*; M. O. Oliphant, *Royal Edinburgh, Her Saints, Kings, Prophets, and Poets*; W. H. O. Smeaton, *Edinburgh and its Story*; H. E. Maxwell, *Edinburgh: a Historical Study*.

Edinburgh, County of, or Midlothian, is bounded north by the Firth of Forth, along which it extends 11 or 12 miles; and by the counties of Linlithgow, Haddington, Berwick, Lanark, Peebles, Selkirk, and Roxburgh; area, 234,926 acres, over half of which is arable or under permanent pasture. The south-south-east and south-west parts of the county are diversified with hills, of which the two principal ranges are the Pentlands and Moorfoots, the former stretching across the county to within 4 miles of

Edinburgh. The principal rivers are the North and South Esks and the Water of Leith, all running into the Forth. The lowlands towards the Forth are the most fertile; the farms are of considerable size, and the most approved methods of agriculture are in use. The hilly parts are chiefly under pasturage and dairy farming. The chief crops are oats, barley, turnips, and potatoes. The manufactures are comparatively limited, but include ale, whisky, gunpowder, paper, and tiles. The fisheries are valuable. The chief towns are: Edinburgh, Dalkeith, and Musselburgh. Midlothian and Peebles return two members to Parliament. Pop. 506,378.

Edinburgh, Duke of, H.R.H. Prince Alfred Ernest Albert, K.G., K.T., K.P., &c., Duke of Saxe-Coburg-Gotha, the second son of Queen Victoria, was born at Windsor Castle, 6th Aug., 1844, died in 1900. At the age of fourteen he joined the navy as naval cadet, and served on various foreign stations. In 1862 he declined the offer of the throne of Greece. On his majority he received £15,000 a year from Parliament, and was created Duke of Edinburgh, Earl of Kent, and Earl of Ulster. In 1867 he was appointed to the command of the frigate *Galatea*, in which he visited Australia, Japan, China, and India. In 1873 he received an additional annuity of £10,000, and next year he married the Grand-Duchess Marie, only daughter of the Emperor of Russia. In 1882 he was made a vice-admiral, and subsequently held important commands. In 1898 he succeeded his uncle as ruler of Saxe-Coburg-Gotha, and resigned £15,000 of his annuity and his other privileges as an English prince, but retained his rank of admiral. He had one son (who predeceased him) and four daughters. He was succeeded as Duke of Saxe-Coburg by his nephew, Leopold Charles, Duke of Albany.

Edinburgh Review, The, a quarterly review established in 1802. It had an immediate and striking success, the brilliancy and vigour of its articles being much above the standard of the periodical literature of that time. In politics it was Whig, and did good service to the party. The *Review* was founded by a knot of young men living in Edinburgh, the more prominent of whom were Brougham, Jeffrey, Sydney Smith, and Francis Horner. It was edited from 1803 to 1829 by Jeffrey, under whom it was very successful. In reply to his criticisms Byron wrote his *English Bards and Scotch Reviewers*. Among the famous contributors to the *Review* were Lord Macaulay, Lord John Russell, and John Stuart Mill.

Edinburgh University, the latest of the Scottish universities, was founded in 1582 by a charter granted by James VI. The number of professors and other teachers is now over 240. The university is a corporation consisting of a chancellor, rector, principal, professors, registered graduates and alumni, and matriculated students. Its government is administered by the University Court, the Senatus Academicus, and the General Council, as in the other Scottish universities, in all of which new ordinances have been introduced under the Universities (Scotland) Act of 1889. The University Court, which is the supreme governing body of the university, consists of the rector, who is president, the principal, the Lord Provost of Edinburgh, and eleven assessors. The Senatus superintends the teaching and discipline of the university, and consists of the principal and professors. The General Council consists of the chancellor, who is president, the members of the University Court and Senatus, and the graduates of the university. It takes cognizance of matters generally affecting the well-being of the university. The chancellor is the official head of the university, and it is through him or his deputy, the vice-chancellor, that degrees are conferred. He is elected for life by the General Council. The principal is the resident head of the university and president of the Senatus, and is appointed for life (at Edinburgh by a body called the 'Curators', elsewhere by the Crown). The lord rector is elected for three years by the matriculated students. There are six faculties in the university, viz. arts, science, divinity, law, medicine, and music. Some of the professors are appointed by the Crown, others by special electors, and a considerable number by the curators, who represent the university court and the town council. The number of students in 1919-20 was over 4300. Candidates for degrees in the different faculties must now pass an entrance examination before attendance upon classes. Women are admitted to all courses and degrees, equally with men, except in the faculty of divinity. Those desirous of taking the degree of Master of Arts (M.A.) must attend classes and pass examinations in at least seven subjects, selected from four departments, viz. language and literature, mental philosophy, science, history and law, the course of study extending over three academic years at least. There is a considerable restriction in choice of subjects, since four of them must be (*a*) Latin or Greek; (*b*) English or a Modern Language; (*c*) Logic or Moral Philosophy; (*d*) Mathematics or Natural Philosophy; and the whole subjects must include both of (*a*) or both of (*c*), or two out of the three—mathematics, natural philosophy, and

chemistry. Four medical degrees are conferred: Bachelor of Medicine (M.B.), Bachelor of Surgery (Ch.B.), Master of Surgery (Ch.M.), and Doctor of Medicine (M.D.). Before any of these degrees can be obtained the candidate must have been engaged in medical study for at least five years. The degrees in law are Bachelor of the Law (B.L.), Bachelor of Laws (LL.B.), and Doctor of Laws (LL.D.), the last being purely honorary. In divinity the degrees are Bachelor and Doctor of Divinity (B.D. and D.D.), the latter being honorary. In science the degrees are likewise Bachelor and Doctor (B.Sc. and D.Sc.), both conferred in the three departments of pure science, engineering, and public health. There is also a B.Sc. in agriculture. The degree of Doctor of Philosophy (D.Phil.) is conferred for proficiency in mental science, and that of Doctor of Letters (D.Litt.) for proficiency in literary, philological, and linguistic studies. The degrees of Bachelor and Doctor of Music (Mus.B. and Mus.D.) are also conferred. There is a joint board of examiners for the four Scottish universities, having the control and supervision of the preliminary examinations. The university has splendid laboratories and museums. The foundation stone of a new science laboratory was laid by King George on 6th July, 1920. The library contains 200,000 volumes. There are bursaries, scholarships, and fellowships, amounting annually to about £12,500. Since 1918 the University of Edinburgh unites with the other Scottish universities in returning three members to Parliament. The constituency consists of the General Council.—BIBLIOGRAPHY: J. Kerr, *Scottish Education, School and University, from Early Times to 1908*; *University Calendar*; Sir Alex. Grant, *The Story of the University of Edinburgh from Early Times to 1908*.

Ed'ison, Thomas Alva, an American inventor, born in Ohio in 1847. He was poorly educated, became a newsboy on the Grand Trunk Railway, and afterwards, having obtained some type, issued a small sheet of his own known as the *Grand Trunk Herald*, printing it in a freight car. He then set himself to learn telegraph work, and in a short time became an expert operator. In 1863, while at Indianapolis, he invented an automatic telegraph repeater. This was the first of a long series of improvements and inventions. He opened an extensive establishment at Newark for the manufacture of electrical, printing, automatic, and other apparatus. In 1876, his health breaking down, he gave up manufacturing and devoted himself to investigation and invention. Amongst his numerous inventions are the

quadruplex and sextuplex telegraph, the carbon telephone transmitter, the 'Edison system' of lighting, the electric fire-alarm, the 'Edison electric railway', the phonograph, and the megaphone. His improvements in the cinematograph made it practicable, though he did not originate the idea of it.

Ed'monton, an urban district and parliamentary borough in England, county of Middlesex, 7½ miles north of London, with an extensive trade in timber, carried on by the Lea River navigation. The 'Bell at Edmonton' has become famous by association with the adventures of Cowper's *John Gilpin*. The borough returns one member to Parliament. Pop. 64,820.

Edmonton, a town of North-Western Canada, on the North Saskatchewan (here navigable). Since 1905 it is the capital of the province of Alberta, and has grown considerably in recent years. It is an important station on the Canadian Pacific, Grand Trunk Pacific, and Canadian Northern railway systems, and is the distributing centre of an immense area, being also the centre of an excellent farming district. Easily-mined coal is worked here. Pop, 61,000.

Ed'mund, St., King of the East Angles, began to reign in 855, died in 870. He was revered by his subjects for his justice and piety. In 870 his kingdom was invaded, and he himself slain, by the Danes. The Church made him a martyr, and a town (Bury St. Edmunds) grew up round the place where he was buried.

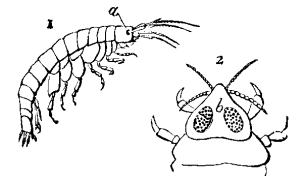
Edmund I, King of England, an able and spirited prince, succeeded his brother Athelstan in 940. He conquered Cumbria, which he bestowed on Malcolm, King of Scotland, on condition of doing homage for it to himself. He was slain at a banquet 26th May, 946.

Edmund II, surnamed *Ironsides*, King of England, the eldest son of Ethelred II, was born in 989. He was chosen king in 1016, Canute having been already elected king by another party. He won several victories over Canute, but was defeated at Assandun in Essex, and forced to surrender the midland and northern counties to Canute. He died after a reign of only seven months.

Edom, in the New Testament *Idumæa*, in ancient times a country lying to the south of Palestine. The Edomites are said in *Genesis* to be the descendants of Esau, who was also called Edom (a word signifying 'red'), and who dwelt in Mount Seir, the mountain range now called *Jebel Shera*, stretching between the Dead Sea and the Gulf of Akabah. Edom is frequently mentioned in the Assyrian inscriptions. The Edomites were subdued by King David, and after the separation of the ten tribes remained subject to the Kingdom of Judah until the reign of Jehoram, when they revolted and secured their independence for a time. They were again subdued about half a century later by Amaziah, and again, in the reign of Ahaz, recovered their independence, which they maintained till the time of the invasion of Judea by Nebuchadnezzar. They fell under the rule of the Persians, and afterwards their fortunes were merged in those of Arabia. The chief city in this region was Petra, which now presents remarkable ruins, as well as several rock-cut temples.

Edred, King of England, son of Edward the Elder, succeeded to the throne on the murder of his brother, Edmund I, in May, 946. He quelled a rebellion of the Northumbrian Danes, and died in 955.

Edriophthal'mata, one of the great divisions of the Crustacea, including all those genera which have their eyes sessile, or embedded in the head, and not fixed on a peduncle or stalk as in the crabs, lobsters, &c. It is divided into two orders. (1) Amphipoda, laterally flattened, as in the marine sandhopper (*Talitrus*), and the fresh-water shrimp (*Gammarus*). (2) Isopoda, flattened from above downwards. Sea-slaters or wood-lice (*Ligia* and *Idothea*); fish parasites (*Cymothoa*); fresh-water wood-lice (*Asellus*); land wood-lice (*Oniscus*, *Porcellio*, *Armadillidium*, which can roll up).



Edriophthalmata
1, Fresh-water shrimp
(*Gammarus pulex*). a,
Single eye. 2, Head of
Cymothoa. b, Clusters of
simple eyes.

Edri'si, Abu-Abdallah Mohammed, a famous Arabian geographer, a descendant of the ancient princely family of the Edrisites, born about A.D. 1100, died about 1180. He studied at the Moorish university of Cordova, after which he travelled through various countries. At the request of King Roger II of Sicily he constructed a globe with a map of the earth, which

represented all the geographical knowledge of the age. He accompanied this with a descriptive treatise completed about 1154, and still extant. The work was published at Rome in Arabic (1592), and in 1619 a Latin translation of it, under the title of *Geographia Nubiensis*, appeared in Paris.

Education is the name applied to the systematic instruction given by each succeeding generation to the young of the race to fit them for the work of life. The word itself is derived from the Latin verb *educare*, which means to rear, to nourish, to bring up, and also to educate. Long before the dawn of civilization men saw that the young had to be prepared for the battle of life; had to learn how to make and how to use the offensive and defensive weapons employed against their enemies; how to form or build shelters to protect themselves against the weather and against their foes; how to make traps or snares for the wild things on which they fed; how, in fact, to use their powers of mind and body in such a way as to secure for themselves the fullest and most satisfactory life possible under the circumstances in which they found themselves.

While education thus understood would be the story of man on the earth, an account of his more or less satisfactory, but always continuous, efforts to perfect the relations between his desires and his environment, it would have to embrace also an account of the conflict between the demands of communities and the rights of individuals. Education, however, as we understand it, is more limited in its scope. It is the instrument employed by the State for the training of its citizens.

The Greeks were the first Europeans to treat education as a science. The results they obtained were good, and have to a certain extent determined the course taken by European education ever since. Plato defined the aim of the education of which he gives us an account in the *Republic*, to be the "development in the body and in the soul of all the perfection which it is possible for them to attain". This was the Greek ideal of what education should aim at; a high ideal indeed; but one that omits an element of immense importance which we find introduced in Milton's definition of the 'end of learning', that is, the aim of education. Milton boldly declares this to be: "To repair the ruin of our first parents by regaining to know God aright, and out of that knowledge to love Him, as we may the nearest by possessing our souls of true virtue, which being united to the heavenly grace of faith

makes up the highest perfection". Perfection is the end sought in both cases, and which seems the nobler it is unnecessary to say. This impression is deepened when he proceeds to declare that as "Our understanding cannot ... arrive so clearly to the knowledge of God and things invisible, as by orderly conning over the visible and inferior creatures, the same method is necessarily to be followed in all discreet teaching".

By Aristotle the order of education was: first, education of the body, the just and proportionate development of its powers. The instrument employed for this purpose was gymnastics; not the gymnastics employed in training professional athletes, but more moderate exercises; for, as the philosopher insists, too strenuous bodily exertion is apt to spoil the child, because body and mind must not be hard worked at the same time. Music, according to him, had various aims: education proper, the training of the affections, and the occupation of leisure. Drawing was taught as a branch of music for the purpose of developing the child's sense of beauty, mathematics were taught to cultivate his intellect, and dialectic (logic and philosophy) to prepare the pupil for a scientific training.

To the idealistic philosopher Plato, the whole life of man, at least the whole of what we may call the active life, was educative. Education was State-controlled, and at the end of the first six years, spent by the child in the seclusion of family life, the State took charge. The aim of the education proposed by Plato was to develop in the child the cardinal virtues—honour to parents, love of fellow-citizens, courage, truthfulness, and self-control. From the seventh to the tenth year the training was mainly in gymnastics; from the tenth to the thirteenth the child learned to read and to write; from the thirteenth to the sixteenth his affections and his sense of the beautiful were cultivated through learning poetry and studying music; from the seventeenth to the twentieth year he applied himself mainly to athletics, so that he might be qualified to take his share in the defence of the State. At twenty men were called upon to choose their occupation; to turn their minds to the study of the sciences; and to shape by practical military and other services to the State that character which it was the aim of education to form. From thirty to thirty-five Plato supposes the citizens of his ideal republic to devote themselves to the study of *Dialectics*, the method of purely intellectual knowledge, by which reason, using hypothesis, arrives at the first principles of things. From thirty-five to fifty the life of the citizen

was to be given up to public service, that is, to the promotion in the position for which he was best fitted of the general well-being.

The training set forth by the Greek philosophers was the training thought necessary to fit a man to be a ruler. As the Greek city states were slave states, and most of the manual work was performed by slaves, that necessary part of the training of the youth of the community is ignored. This fact has had, undoubtedly, an enormous influence on the ideas of education put forward since. The preliminary training demanded by the Greeks included, besides gymnastics, grammar and music. At a later time these were understood to include the seven arts: Grammar, Rhetoric, Dialectic (*Trivium*), and Arithmetic, Music, Geometry, and Astronomy (*Quadrivium*). To the Greeks, myths were the instruments of the earliest education, the aim of which was the development of a character in the citizen which would lead him to give his best and most loyal services to the State.

The aim of Greek education was the formation of the philosophic thinker, the man fitted by nature and training to guide and direct the energies of the man of action. Roman education, on the other hand, directed its efforts mainly to the moulding of the man of action himself. The Romans adopted the form rather than the spirit of Greek education. The aim of Roman education was to make a man who could do things; a practical man, a man full of energy, who was ever ready to sacrifice himself in the interests of the State; a man who knew the laws and who regulated his conduct by them; who revered his father and his country's gods; and found his chief pleasure in the complete overthrow and utter destruction of his country's foes. He could discourse eloquently and not unphilosophically; and he spared neither himself nor others in his effort to maintain the freedom of his country, and to bring destruction on the enemies of Rome. Roman education began in the home, and during the earlier years was largely directed by the mother. Later the preparation of the boy for life was taken over by the father; but it is probable that, from very early times many, if not most, Romans boys were sent to school, where, under the *magister literarius* (elementary teacher), the *grammaticus* (advanced teacher), and the *rhetor* (professor), they acquired the knowledge and accomplishments it was needful for them to obtain.

The Roman schools, elementary and secondary, seem to have been conducted in a verandah, and boys and girls seem to have been taught in the same school. The chief Roman writers on education are Cicero, Seneca, and Quintilian. Quintilian tells us that Cato also wrote a treatise on the subject, but that that work had been lost. The oratorical training of which Quintilian was the expositor seems to have been largely out of connection with real life; and, though he claims that the orator must be a widely cultured, wise, and honourable man, seems to have developed a tendency to the bombastic abuse of ornate and stilted speech. The practical effects, too, of the corruption of family education were far from satisfactory. Moral degradation followed, and humanity seems to have been rescued only by the introduction of a new ideal of life, which substituted for the pagan self-reliance, self-control, moderation, and proportion, self-denial, self-forgetfulness, and humility; which made the last, indeed, the chief virtue, and looked on pride and self-confidence as spiritual sins.

The introduction of Christianity was followed by the inroads into the Roman Empire of barbarous tribes from the north and east. Before these attacks the Western Roman Empire collapsed, and with it to a greater or less extent the educational system of the time.

It must be remembered that between three and four hundred years elapsed between the downfall of the Western Roman Empire and the beginnings of the Holy Roman Empire under Charlemagne. Classical or pagan culture, as profane learning, was at a discount, and the aim of the monasticism which grew out of the introduction of Christianity was mystic absorption in the contemplation of God.

This interval was followed by the efforts of Charlemagne to revive Roman culture, and to establish schools throughout Western Europe. In this he was aided by Alcuin and other scholars from England, where in the comparative quiet that followed the conquest of Britain there had grown up a system of education. Throughout his dominions three classes of schools were established by Charlemagne, the Palace School, the Bishop's School, and the Monastery School. These were intended to take the place of the splendid system of public schools that had grown up under the Roman Empire. The course of studies established in these mediæval schools, following the practice of Greece and Rome, was divided into two parts: the *Trivium*,

including Grammar, Dialectic, Rhetoric; and the *Quadrivium*, which embraced Geometry, Arithmetic, Music, and Astronomy. Education in the palace or castle schools had a different aim. It sought to develop the bodily powers, and to awake in the pupils that respect for the weak which was shown in the worship of women, and that love of justice, and belief in its supremacy, which characterized the *chivalry* of the Middle Ages.

The scholastic education of this time laid special stress on formal logic and metaphysics. Latin was taught, was, indeed, the universal language of the period. Questions about the nature of the unseen and the spiritual occupied much of men's minds; while their time was taken up in discussing the character of universals, the true realities which lay behind the individual manifestations of experience. As a rule, the physical world was ignored, and human intelligence disregarded; but there were notable exceptions, among which the teachings of Bishop Grosseteste (died 1253) and of Roger Bacon (1214 to 1294) take a prominent place.

It was during the period of scholasticism that universities, in imitation of the trade guilds of the time, sprung up in different parts of Europe, particularly in Spain, Italy, France, and England. To the famous schools both in England and on the Continent scholars flocked from all parts, and their instruction presented little difficulty, as Latin, the language in which the instruction was given, was the common language of scholars in Western Europe. The establishment of universities in different countries was a sign rather than a cause or result of that intellectual and spiritual awakening which, after nearly a thousand years of almost complete stagnation, manifested itself among the peoples of Europe.

It is usual to date the Renaissance from 1453, the fall of Constantinople; but it must not be forgotten that owing to the clash between East and West, the struggle between Christianity and Mohammedanism (the Crusades, as these religious wars were called), there had from the end of the eleventh century been a considerable change of outlook among the nations of Western Europe. This was specially the case in Italy, where city states, not unlike those of Greece in their character, had sprung up, and where, as in Greece in the time of Pericles, there had been the great outburst of literary activity which is associated with the names of Boccaccio, Dante, and Petrarch. In Northern and Western Europe the intelligence stimulated by the new

learning was directed towards the improvement of the method of study. All study was linguistic. Latin was the instrument of common intercourse; Greek and Hebrew were sacred as the tongues in which the Scriptures had been conveyed; it was no wonder, therefore, that the humanistic education was almost entirely confined to the study of languages. Sturm (1507 to 1589) drew up a scheme of studies which had long a great influence on the school courses of instruction throughout Europe.

The reaction against authority which marked the Reformation period was specially noted for the reaction against the purely verbal education given to the young, whose education, as we learn from Locke, was calculated to teach them "not to believe, but to dispute", and to fit them "for the university, not for the world". On the Continent Rabelais (1483 to 1533) led this realistic movement, which was continued by Montaigne (1533 to 1592) in France, and under the influence of Bacon by Brinsley and Hoole in England, and Ratke and Comenius on the Continent. Up to this time the chief English writers on the subject of education had been Sir Thomas Elyot in his *Governour*, Roger Ascham in his *Scholemaster*, and Richard Mulcaster in his *Positions*.

The intellectual activity which marked in England the closing decades of the sixteenth and the first part of the seventeenth century saw the issue of Milton's *Tractate*, one of the most famous books on education ever produced. The *Tractate* discusses only the kind of education that should be given to gentlemen's sons between the ages of twelve and twenty-one, so that it is strictly limited in its application, as it does not deal with the education of the people, nor with the education of women. The ideal which Milton put before him as the aim of "a complete and generous education" was "to fit a man to perform justly, skilfully, and magnanimously all the offices both private and public of peace and war". Milton in his *Tractate* discusses studies, exercise, and diet, showing that he clearly understood that education was concerned with the body as well as the mind and spirit.

Towards the close of the seventeenth century Locke, an English physician and philosopher, published (1693) his *Thoughts concerning Education*, a book which influenced immensely the character and direction of future educational studies. As he informs his readers in his letter to Edward Clarke, he counsels everyone "after having well examined and

distinguished what fancy, custom, or reason advises in the case ... to promote everywhere that way of training up youth ... which is the easiest, shortest, and likeliest to produce virtuous, useful, and able men in their distinct callings". He begins his essay with the statement, "A sound mind in a sound body is a short but full description of a happy state in this world", and the suggestions he makes as to the physical, moral, and intellectual training of the young are for the most part sound. He decried a too severe discipline, maintaining that "If the mind be curbed and humbled too much in children, ... they lose all their vigour and industry". On the other hand, he held that if you "Remove hope and fear, there is an end of all discipline"; and he held that, as far as possible, "Childish actions are to be left perfectly free and unrestrained". He applied the science of psychology to the study of child nature, and of the methods to be employed in training it; and so prepared the way for the modern methods of education. "Interest is the secret of Herbart", according to one of his devoted admirers. Locke seems to have anticipated this when he declares that "None of the things they are to learn should ever be made a burden to them, or imposed on them as a task".

Though his attitude towards the universe was utterly opposed to the attitude of Locke, Rousseau drew almost all that was practical in his scheme for the education of the young from the English writer. Rousseau's work, though largely inspired by Locke, was essentially of a revolutionary kind. It held that man is the great corrupter; that "Everything is good as it comes from the hands of the Creator; and that man's handling makes everything worse". In effect he said, leave the child as much as possible alone. An attempt constantly to direct him can only result in stupefying him. It is true we receive our education from nature, from men, and from things; but nature must be our guide in determining the use of the other two. As few restraints as possible must be imposed on the child, and the use of books should be prohibited. For the child there should be "no other book but the world", and "no other instruction but facts". The child's education he divides into four stages, infancy, childhood, boyhood, and youth. The first two stages last till the beginning of the thirteenth year, when the boy is supposed to be fit for instruction. From such instruction the teaching of words must disappear, and the teaching of things must take its place. The subjects most suitable for instruction were, Rousseau declared, measuring, drawing, geometry,

speaking, and singing. Books, he declares, are useless, are, indeed, altogether harmful. The method he advocates is the method of self-teaching and the use of the senses, which Rousseau held would work to the profit of the intelligence. The child's knowledge should rest on his own observation, and not on belief in authority, and each child should be taught a manual trade.

At fifteen, according to Rousseau, real education begins; and it is the duty of the teacher to study the subject he has to act upon, in other words, to discover the nature of the pupil, which must in all cases determine the means and the method employed in his education. Two things must be taught. These are the true relations, racial and individual, that exist among men; and how to direct and control the emotions aroused by the environment so that the best results may arise. Here he finds occasion for the use of moral teaching and for instruction in religion. The facts of history must be placed before him; but he must be left to form his own judgment. He is now to be taught religion as a help to the regulation of the passions; but not the religion of any particular sect. His time is to be given up largely to reading and to the acquirement of taste; to the study of history and eloquence; and to attendance at the theatre.

The revolutionary doctrines preached by Rousseau in his *Émile* and in his other educational works had an immense effect on the Continent, and particularly on the work of one of his most ardent admirers, the Swiss farmer and schoolmaster Pestalozzi, an eccentric, dubbed by his schoolfellows "Harry Oddity of Fools-town". Thinking the education demanded for *Émile* by Rousseau vastly superior to that which he himself received, he very early became an ardent admirer of the system advocated by the French philosopher, and an eager reformer. *Émile* and the *Contrat Social* were condemned by the magistrates of Zurich, and Pestalozzi and some of his fellow-students were imprisoned for the *Memorial* in which they defended these works. Later Pestalozzi determined to be a farmer. He was married at the age of twenty-three, and started growing madder and vegetables on some poor land near Zurich. On the land he built for himself a house, the *Neuhof*.

In the winter of 1774 he hit upon the expedient of taking into his house some twenty poor children of the neighbourhood, whom he treated as his

own. They worked with him in summer in the fields, and in winter in the house. Improved health for the children, increased intelligence, and a manifest devotion to their benefactor were some of the results speedily displayed, and the experiment drew much attention to itself. Urged on by his love for the children, Pestalozzi took in a larger number, and in a very short time found himself bankrupt. In this period of seeming disaster Pestalozzi turned author. The books which he produced were greedily read on the Continent, and aroused the greatest interest. After some work at Stanz and at Burgdorf, Pestalozzi settled to work in the castle of Yverdun on Lake Neuchâtel, which became in the early years of the nineteenth century a place of pilgrimage for European students and lovers of education. Forced to leave Yverdun in 1815, he continued his work at Clindly till 1824.

Friedrich Froebel spent the years 1807 to 1809 at Yverdun, and so fitted himself to carry on the work Pestalozzi had to some extent made popular. His name, however, is specially associated with the schools for very young children to which he gave the name of *Kindergarten*, that is, 'gardens of children', places where young children, like young plants, were properly watched and tended. For the children in these schools their employment was to be play, play from which and by which they acquired clear notions regarding themselves and their environment. "Education", he asserted, "should lead and guide man to clearness concerning himself and in himself, to peace with nature, and to unity with God." He held that powers were developed by exercise; that failure to use any part of the body or mind led to the shrinkage of the part, and sometimes even to its complete loss. He held that if we wish to develop the body we must exercise the body, and that, similarly, if we wish to develop the intellect or the emotions they must be exercised. He insists that teachers must be careful to interfere as little as possible; must remember at all times that the aim of teaching is "to bring ever more and more out of man rather than to put more and more into him". He based his system on action; agreed with Montaigne that "children's games were their most serious occupations"; and with Locke that "All the plays and diversions of children should be directed towards good and useful habits". Froebel was not the founder of infant schools. These were first established on the Continent and in Britain with the object of helping mothers. In Britain their establishment is associated with the names of the educational enthusiasts James Buchanan and Samuel Wilderspin.

Nearly ten years before Froebel's stay with Pestalozzi at Yverdon, Herbart, next to Kant and Hegel the most influential of German philosophers, visited the inspired educationist at Burgdorf, and found him employing methods based on the principles which he himself had worked out in his psychology. To both it was clear that there is a definite order in which subjects should be taught to the children, and that this order is determined, not merely by the relation of the subjects to each other, but by their power of satisfying the growing wants and capacities of the child. Pestalozzi had arrived intuitively at a method, and had practically applied it, which Herbart had scientifically worked out as applicable to the whole educational field. Three years later Herbart published pamphlets on Pestalozzi's best-known book, *How Gertrude teaches her Children*, and on *The A.B.C. of Sense-perception*, and in these showed what weight he attached to observation as an instrument of education. Two years later he published one of his most notable works on education, *The Æsthetic Revelation of the World*, and in 1806 *General Pedagogy*. In 1809 he was appointed professor of philosophy at Königsberg, where he remained till 1833, and where his services to the cause of education, both by his writings and by his establishment of normal schools and experimental schools, cannot be exaggerated. He warns teachers not to educate too much; to be careful not to destroy the individuality of the child, such individuality being that which characterizes individuals of the same class. He lays the greatest stress on the importance to the teacher of child study, maintaining that he will be unable to teach unless he knows the child as he is. For Herbart the aim of education is summed up in morality, "the highest aim of humanity and consequently of education", itself. "I have no conception", he writes, "of education without instruction, just as I do not acknowledge any instruction that does not educate." "Instruction", he says elsewhere, "will form the circle of thought, and education the character; the last is nothing without the first." A great deal, according to Herbart, depends upon the pupil himself, who "grasps rightly what is natural to him", and who must be saved from the tendency to one-sidedness in which following his bent would result, by the cultivation in him of many-sidedness. This cultivation involves the control of the pupil's mental activity, and the instrument for this control is interest, which causes the pupil's complete absorption in its object. For the attainment of this Herbart proposes certain formal steps of instruction. These steps are

usually set forth as (1) Preparation, (2) Presentation, (3) Comparison, (4) Generalization, (5) Application.

The nineteenth century was a period of continuously increasing interest in education, and of a generally growing belief in its utility. It was taken up by the Governments of the different countries, and ordered and regulated almost out of existence. Seven years before the death of Pestalozzi the first public grant for education was made by the British Parliament, and from that time up to the present the Government has continued to extend its power over the education of the country. For a long time the Government in Britain was satisfied to subsidize elementary education; but later it insisted on hard-and-fast lines of instruction. So thoroughly were these regulated in most countries that a French Minister of Education could boast he was able to say what work every child in France was engaged in at that particular moment.

In Britain it was only bit by bit, and with very considerable reluctance, that the Government took upon itself the responsibility for the education of the country. In Scotland a national system of general education, constituted in 1560, remained in force until reconstructed by the *Education Act* of 1872. (See *Scotland*.) Compulsory education was introduced into England in 1870, together with what was described as payment by results; and, for some time, the aim which the teacher had to keep before him was the production at the annual examination of the largest number of pupils who could satisfy the tests in Reading, Writing, and Arithmetic, or, as they were called, the 'three R's', and so earn the Government grant. For between thirty and forty years this unnatural and mechanical system remained in force. From 1864 onwards Commission after Commission sought to reduce English secondary education to order. The most notable of these was The Bryce Commission of Enquiry into Secondary Education, 1894-5, whose recommendations have since been put into force by legislation. One of the results of the increasing interest in education throughout England was the founding, early in the latter half of last century, of great day schools, like the City of London, St. Paul's, and Merchant Taylors, in London and other large cities; and, after the passing of the Education Act of 1902, the establishment everywhere of Council Secondary Schools.

Of the immense number of works on education issued during the last half of the nineteenth century, perhaps the best known are those of Herbert Spencer and of Professor Bain. The former seeks to explain education from the Darwinian standpoint, and the latter to determine from psychology the intellectual value of the various subjects taught in school, and the average age at which they should be taught to children. Of practical English educators during the nineteenth century, the most outstanding names are undoubtedly those of Arnold of Rugby, Thring of Uppingham, and Abbott of the City of London School.

In recent times the advances made in the theoretical and practical studies of the sciences of anthropology, physiology, and psychology have exercised an enormous influence on educational theories and practices. Careful observations of young children by scientific observers like Darwin, Dearborn, and Preyer have added greatly to our knowledge of child-nature; and helped to suggest new methods of studying it and developing it. The result has been the promulgation within the present century of a number of educational methods, some of which, in contrast to the older practices, must seem almost revolutionary. Among these must be remembered the 'Heuristic Method' of teaching science put forward by Professor H. E. Armstrong. The object of the method is to put the student as completely as may be in the position of an original investigator; and it has been classed by writers on education as being, like so many other modern methods, a 'play method'. Froebel in his kindergarten was one of the first to introduce successfully the play method in education, and the 'gifts' by which the plan was carried through were of his own devising; but such cannot be said of Dr. Montessori, whose method of education engrosses so much attention at the present time. The Montessori apparatus was originally devised by Dr. Seguin for the instruction of mental defectives. Dr. Montessori used the apparatus first for the training of young children; but the cardinal feature of the Montessori system is the determined effort to make the child entirely responsible for his own education, and to interfere as little as possible with his development. The apparatus is so contrived that it can only be used in one way if the problem is to be solved; so the child is forced to attend to the differences in size and shape and carefully to compare the different pieces. In addition, the Montessori system attempts to cultivate the social virtues; teaches the children to live and to work and play with others, and so to learn

to be well-mannered. The teacher in this system retires into the background, and the children are left to go their own way, to choose their own tasks, and to be their own critics. Great attention is also given to the physical development of the children.

Experimental education has been attempted both in Germany, where the need for it was first put forward by Kant, and in England; but it is in the United States of America that the chief advances in this direction have been made. There the Binet attempt to measure the intelligence of the child, to fix in fact a metric scale of intelligence, has been elaborated, and the Binet-Simon system of tests devised, and later modified by L. M. Terman. There, too, schools have been established which have tried the working out of what may be described as the non-interference with the pupil principle. Among these may be mentioned the 'George Junior Republic' and the Gary Schools. The latter, we are told by their founder, were "not instituted to turn out good workers for the steel company, but for the educational value of the work they involved". To this must be added the 'Dalton Laboratory Plan', tried lately as an experiment by Miss Helen Parkhurst in a public secondary day school in Dalton. By this plan, the time-table is abolished, the child undertakes to get up a certain amount of work each month in each particular subject, and is left free to distribute his time as he chooses, so that he can devote more time to those subjects in which he is backward. The school is divided into departments (laboratories) each under a specialist who gives the help needed, but leaves the pupil to himself as much as possible.—

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Education Act, the name given to several Acts dealing with education in Great Britain. Among the principal Education Acts are: (1) that of 1870, which introduced compulsory education; (2) that of 1891, which reduced, or in some cases abolished, school fees; (3) that of 1902, which authorized

the levying of an education rate; and (4) that of 1918, which raised the age for leaving school, and made education compulsory up to the age of eighteen by means of continuation schools. Pupils must attend these schools for 320 hours each year.

Edward, known as *the Elder*, King of England, son of Alfred the Great, born about 870, died in 925. He succeeded his father in 901, and his reign was distinguished by successes over the Danes. He fortified many inland towns, acquired dominion over Northumbria and East Anglia, and subdued several of the Welsh tribes.

Edward, surnamed *the Martyr*, King of England, succeeded his father, Edgar, at the age of fifteen, in 975. His reign of four years was chiefly distinguished by ecclesiastical disputes. He was treacherously slain in 979 by a servant of his stepmother, at her residence, Corfe Castle. The pity caused by his innocence and misfortune induced the people to regard him as a martyr.

Edward, King of England, surnamed *the Confessor*, was the son of Ethelred II, and was born at Islip, in Oxfordshire, about 1004. On the death of his maternal brother, Hardicanute the Dane, in 1041, he was called to the throne, and thus renewed the Saxon line. Edward was a weak and superstitious, but well-intentioned prince, who acquired the love of his subjects by his monkish sanctity and care in the administration of justice. His queen was the daughter of Godwin, Earl of Kent. He died in 1066, and was succeeded by Harold, the son of Godwin. Edward caused a body of laws to be compiled from those of Ethelbert, Ina, and Alfred, to which the nation was long fondly attached. He was canonized by Pope Alexander III in 1161.

Edward, Prince of Wales, surnamed *the Black Prince*, born 15th June, 1330, the eldest son of Edward III and Philippa of Hainault. In 1346 he commanded part of the forces at the battle of Crécy, and earned the praise of his warlike father. It was on this occasion that he adopted the motto *Ich dien* (I serve), used by all succeeding Princes of Wales. In 1355 he commanded the army which invaded France from Gascony, and distinguished himself the following year at the great battle of Poitiers. By the Peace of Brétigny the provinces of Poictou, Saintonge, Périgord, and

Limousin were annexed to Guienne and formed into a sovereignty for the prince under the title of the Principality of Aquitaine. A campaign in Castile, on behalf of Pedro the Cruel, and the heavy taxes laid on Aquitaine to meet the expenses, caused a rebellion, and ultimately involved him in a war with the French king. His own health did not allow him to take the field, and having seen his generals defeated he withdrew into England, and after lingering some time died (1376), leaving an only son, afterwards Richard II.

Edward I (of the Norman line), King of England, son of Henry III, was born at Winchester in 1239, died 7th July, 1307. The contests between his father and the barons called him early into active life, and he finally quelled all resistance to the royal authority by the decisive defeat of Leicester at the battle of Evesham, in 1265. He then proceeded to Palestine, where he showed signal proofs of valour, although no conquest of any importance was achieved. His father's death in 1272 gave him the crown. On his return home he showed great vigour as well as a degree of severity in his administration. He commenced a war with Llewellyn, Prince of Wales, which ended in the annexation of that Principality to the English Crown in 1283. Edward's ambition was to gain possession of Scotland, but the death of Margaret, the Maid of Norway, who was to have been married to Edward's son, for a time frustrated the king's designs. But on 26th Dec., 1292, John Baliol was induced to do homage for his crown to Edward at Newcastle. Baliol was forced by the indignation of the Scottish people into war with England. Edward entered Scotland in 1296, devastated it with fire and sword, and placed the administration of the country in the hands of officers of his own. Next summer a new rising took place under William Wallace. Wallace's successes recalled Edward to Scotland with an army of 100,000 men. Wallace was at length betrayed into his hands and executed as a traitor. All Edward's efforts, however, to reduce the country to obedience were unavailing, and with the flight of Robert Bruce, Earl of Carrick, to Scotland, the banner of Scottish independence was again unfurled. Edward assembled another army and marched against Bruce, but only lived to reach Burgh-on-Sands, a village near Carlisle, where he died. Edward I was wise in council and vigorous in action. During his reign great progress was made in the establishment of law and order throughout the land.

Edward II, King of England, born at Carnarvon Castle in 1284, and the first English Prince of Wales, succeeded his father, Edward I, in 1307. He was of an agreeable figure and mild disposition, but indolent and fond of pleasure. After marching as far as Cumnock, in Ayrshire, with the army collected by his father, he returned, dismissed his troops, and abandoned himself entirely to amusements. His weakness for a clever but dissolute young Gascon, Piers Gaveston, on whom he heaped honours without limit, roused the nobles to rebellion. Gaveston was captured in Scarborough Castle, and executed as a public enemy on 19th June, 1312. Two years after this, Edward assembled an immense army to check the progress of Robert Bruce, but was completely defeated at Bannockburn. In 1322 he made another expedition against Scotland, but without achieving anything important. The king's fondness for another favourite, Hugh le Despenser, had made a number of malcontents, and Queen Isabella, making a visit to France, entered into a correspondence with the exiles there, and formed an association of all hostile to the king. Aided by a force from the Count of Hainault, she landed in Suffolk in 1326. Her army was completely successful. The Despensers, father and son, were captured and executed, and the king was taken prisoner and confined in Kenilworth, and ultimately in Berkeley Castle, where he was murdered 21st Sept., 1327.

Edward III, King of England, son of Edward II by Isabella of France, was born in 1312, died 21st June, 1377. On his father's deposition in 1327 he was proclaimed king under a council of regency, while his mother's lover, Mortimer, really possessed the principal power in the State. The pride and oppression of Mortimer led to a general confederacy against him, and to his seizure and execution (10th Oct., 1330). Edward now turned his attention to Scotland, and, having levied a well-appointed army, defeated the regent, Douglas, at Halidon Hill, in July, 1333. This victory produced the restoration of Edward Baliol, who was, however, again expelled, and again restored, until the ambition of the English king was diverted by the prospect of succeeding to the throne of France. Collecting an army and accompanied by the Black Prince, he crossed over to France. The memorable battle of Crécy followed, 25th Aug., 1346, which was succeeded by the siege of Calais. In the meantime David II, having recovered the throne of Scotland, invaded England with a large army, but was defeated and taken prisoner by a much inferior force under Lord Percy. In 1348 a truce was concluded with

France; but on the death of King Philip, in 1350, Edward again invaded France, plundering and devastating. Recalled home by a Scottish inroad, he retaliated by carrying fire and sword from Berwick to Edinburgh. In the meantime the Black Prince had penetrated from Guienne to the heart of France, fought the famous battle of Poitiers, and taken King John prisoner. A truce was then made, at the expiration of which (1359) Edward again crossed over to France and laid waste the provinces of Picardy and Champagne, but at length consented to a peace. This confirmed him in the possession of several provinces and districts of France which were entrusted to the Prince of Wales (the Black Prince), but gradually all the English possessions in France, with the exception of Bordeaux, Bayonne, and Calais, were lost.

Edward IV, King of England, was born in 1442, died in April, 1483. His father, Richard, Duke of York, was grandson of Edmund, Earl of Cambridge and Duke of York, fourth son of Edward III, while the rival line of Lancaster descended from John of Gaunt, the third son. The York line had intermarried with the female descendants of Lionel, the second son, which gave it the preferable right to the Crown. Edward, on the defeat and death of his father at the battle of Wakefield, assumed his title, and, having entered London after his splendid victory over the troops of Henry VI and Queen Margaret at Mortimer's Cross, in Feb. 1461, was declared king by acclamation. The victory of Towton, soon after his accession, confirmed his title, and three years after this, on 4th May, 1464, the battle of Hexham completely overthrew the party of Henry VI. The king now made an imprudent marriage with Elizabeth, widow of Sir John Grey, at the very time when he had dispatched the Earl of Warwick to negotiate a marriage for him with the sister of the French king. He thus alienated powerful friends, and Warwick, passing over to the Lancastrian cause, gathered a large army, and compelled Edward to fly (in Sept. 1470). Henry's title was once more recognized by Parliament. But in 1471 Edward, at the head of a small force given him by the Duke of Burgundy, landed at Ravenspur in Yorkshire, and his army, being quickly increased by partisans, marched swiftly on London and took the unfortunate Henry prisoner. Warwick now advanced with an army to Barnet, where a battle was fought, 4th April, 1471, which ended in the death of Warwick and a decisive victory for Edward. Shortly afterwards Edward also met and defeated a Lancastrian

army, headed by Queen Margaret and her son Edward, at Tewkesbury. The prince was murdered, and the queen was thrown into the Tower, where Henry VI soon after died. Edward was preparing for an expedition against France when he died.

Edward V, King of England, the eldest son of Edward IV, was in his thirteenth year when he succeeded his father in 1483. His uncle, the Duke of Gloucester, soon made himself king as Richard III, and caused the young king and his brother to be sent to the Tower, where he had them smothered by ruffians.

Edward VI, King of England, son of Henry VIII by Jane Seymour, was born in 1537, died in July, 1553. At his father's death he was only nine years of age. His education was entrusted to men of the first character for learning, under whose training he made great progress, and grew up with a rooted zeal for the doctrines of the Reformation. His reign was, on the whole, tumultuous and unsettled. In Oct., 1551, the Protector Somerset, who had hitherto governed the kingdom with energy and ability, was deposed by the intrigues of Dudley, Duke of Northumberland, who became all-powerful. He induced the dying Edward to set aside the succession of his sisters, Mary and Elizabeth, and settle the crown upon Lady Jane Grey, to whom he had married his son Lord Guildford Dudley. Edward VI restored many of the grammar schools suppressed by Henry VIII, and these schools are still known as King Edward's schools.

Edward VII, King of Great Britain and Ireland and Emperor of India, eldest son of Queen Victoria and the Prince Consort, was born at Buckingham Palace on 9th Nov., 1841, died 6th May, 1910. In Dec., 1841, he was created Prince of Wales. He was educated under private tutors and at Edinburgh, Oxford, and Cambridge; visited Canada and the United States in 1860; and underwent military training at the Curragh camp in 1861. Promoted to the rank of general in 1862, he visited Palestine and the East, and next year took his seat in the House of Lords. On 10th March, 1863, he was married in St. George's Chapel, Windsor Castle, to Princess Alexandra, eldest daughter of Christian IX of Denmark, and from this time onwards he discharged many public ceremonial functions. Attacked by typhoid fever in the winter of 1871, his life was for a time despaired of, but he recovered early in 1872, his recovery being made the occasion of a thanksgiving

service in St. Paul's Cathedral. During 1875 and 1876 he visited India. He was a member of the Poor Law Commission of 1893. He promoted the establishment of the Imperial Institute as a memorial of Queen Victoria's jubilee (1887), and he commemorated her diamond jubilee (1897) by founding the Prince of Wales's (now King's) Hospital Fund for the better financial support of the London hospitals. On the death of Queen Victoria on 22nd Jan., 1901, he succeeded to the throne, and was crowned on 9th Aug., 1902. King Edward did much to promote friendly relations with foreign powers, especially with France and the United States. It was through his personal influence that the Entente Cordiale with France was brought about. To him and Queen Alexandra were born: Albert Victor Christian Edward, Duke of Clarence and Avondale, born 1864, died 1892; George Frederick Ernest Albert, who succeeded his father as George V, born 1865, married 1893, to Princess Victoria Mary of Teck; Princess Louise, now Princess Royal, born 1867, married 1889, to the Duke of Fife, who died 29th Jan., 1912; Princess Victoria, born 1868; and Princess Maud, born 1869, married 1896, to Prince Charles of Denmark, now King of Norway as Haakon VII.—BIBLIOGRAPHY: *Life of the King*, by 'One of His Majesty's Servants'; Holt-White, *The People's King*; E. Legge, *King Edward in his true Colours*; J. P. Brodhurst, *The Life and Times of Edward VII*; W. H. Wilkins, *Edward the Peacemaker*.

Edward, Thomas, a Scottish naturalist, born 1814, died 1886. The son of poor parents, he was apprenticed to a shoemaker and worked at his trade till nearly the end of his life, but succeeded in acquiring much knowledge of natural history and some fame as a naturalist. An interesting biography of Edward (*Life of a Scottish Naturalist*), written by Samuel Smiles, appeared in 1876, and a pension of £50 a year was shortly afterwards conferred on him by Queen Victoria.

Edwards, Amelia Blandford, English novelist and Egyptologist, born in London in 1831, died in 1892. She gave early evidence of great literary ability by her contributions to periodicals, and attracted attention by her novel *My Brother's Wife* (1855). Among her best-known novels are: *Hand and Glove* (1859), *Barbara's History* (1864), *Half a Million of Money* (1865), *Debenham's Vow* (1870), and *Lord Brackenbury* (1880). Miss Edwards wrote also ballads and books of travel, and in 1882 founded the

Egypt Exploration Fund and devoted herself to Egyptology, leaving funds to found a chair of Egyptology in University College, London.

Edwards, Bryan, English writer, born in Wiltshire in 1743, died in 1800. He inherited a large fortune from an uncle in Jamaica, where he long resided. His *History, Civil and Commercial, of the British Colonies in the West Indies* appeared in 1793.

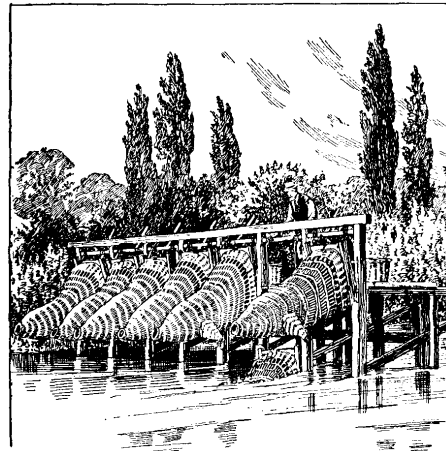
Edwards, John Passmore, British philanthropist and journalist, born at Blackwater, Cornwall, in March, 1823, died on 22nd April, 1911. Trained as a journalist, he became representative of the paper *The Sentinel*, and was opposed to the Corn Laws. In 1862 he bought *The Building News*, and in 1876 the London *Echo*, of which he was director for twenty years. Although somewhat unpopular on account of his opposition to the Boer War, he is remembered as a public benefactor, having founded numerous Passmore Edwards institutions, public libraries, and settlements, and contributed largely to hospitals. He was a delegate to the peace congresses at Brussels, Paris, and Frankfort (1848-50), and twice refused a knighthood.

Edwards, Jonathan, American theologian and metaphysician, born 5th Oct., 1703, died 22nd March, 1758. He entered Yale College in 1716, and studied till 1722, when he received a licence as preacher. In 1723 he was elected a tutor in Yale College, but resigned in 1726 to be ordained as minister at Northampton (Mass.). After more than twenty-three years of zealous service here, he was dismissed by the congregation owing to the severity with which he sought to exercise church discipline. He then went as a missionary among the Indians at Stockbridge, in Massachusetts. Here he composed his famous work on the *Freedom of the Will*, which appeared in 1754. In 1757 he was chosen president of the college at Princeton, New Jersey, but died shortly afterwards.

Edwy, King of England, son of Edmund I, succeeded his uncle Edred in 955. Taking part with the secular clergy against the monks, he incurred the confirmed enmity of the latter. The Papal party, headed by Dunstan, was strong enough to excite a rebellion, by which Edwy was driven from the throne to make way for his brother Edgar. He died in 959, being probably not more than eighteen or nineteen years old.

Eecloo (āk-lō'), a town, Belgium, province of East Flanders, 11 miles north-west of Ghent, the seat of textile manufactures. Pop. 13,536.

Eel, the popular name of fishes belonging to the teleostean sub-order Apodes. The common eel (*Anguilla vulgaris*) is the type of a special family (Anguillidæ) and has a very wide distribution in the fresh waters of the globe. It is snake-shaped, devoid of ventral fins, and the minute scales are embedded in the slimy skin. When five or six years old it migrates to the deep sea for spawning, after which it probably dies. Curious flattened larvæ (*Leptocephalus*) hatch out from the floating eggs, and undergo a metamorphosis to become young eels or elvers, which when a year old ascend rivers in vast numbers as 'eel fare'. Eels are esteemed as an article of food, and even elvers are compressed into a sort of cake. In England river eels are caught in great numbers by means of eel-bucks or eelpots, traps consisting of a kind of basket with a funnel-shaped entrance composed of willow rods converging towards a point, so that the eels can easily force their way in but cannot return. A stocking or tube of coarse cloth hanging from an aperture of a box down into the interior is also used. In England a kind of trident called an *eel-spear* is used also for taking them. A fisherman wades to the shallows, and, as he strikes his spear in the mud in every direction around him, the eels reposing on the bottom are caught between the prongs. They are also taken by hooks and lines and in other ways. See *Conger-eel*; *Muraena*. Electric eels belong to another group. See *Electrical Fishes*.



Eel-bucks on the Thames

Effen'di, a Turkish title which signifies lord or master. It is particularly applied to the civil, as *aga* is to the military officers of the Sultan. Thus the Sultan's first physician is called *Hakim effendi*, and the priest in the seraglio *Imam effendi*.

Efferves'cence, the rapid escape of a gas from a liquid, producing a turbulent motion in it, and causing it to boil up. It is produced by the actual formation of a gas in the liquid, as in fermentation, or by the liberation of a gas which has been forced into it, as in aerated beverages.

Efficiency, in mechanics and engineering, the ratio of the useful energy given out by a machine to the energy supplied to it. Energy cannot be created or destroyed, but it may assume various forms, and, within limits, can be changed from any one of these forms to any other. A machine or engine is an apparatus for converting energy in some given form into energy in another assigned form. In practice it is found impossible to convert the whole of the given energy into the form wanted, there being always a residue which is not of the right kind, and is, therefore, counted as useless. The smaller the residue, the more efficient is the machine. In the machines of elementary mechanics, such as the lever or the screw, the energy supplied is work done by the power or effort, and the energy wanted is work done on the load. If E is the effort, and W the load, then if there were no friction we would have $E = Wr$, where r is the velocity ratio, or ratio of the velocities of the points of application of load and effort. The relation found by experiment, however, is usually of the type $E = Wr + C$, where C is a constant. The efficiency is the fraction Wr/E or $1 - C/E$, so that it increases with the load. In *heat engines*, energy in the form of heat is converted into mechanical energy. Heat is taken in at the source, part of it is changed into mechanical energy, and the remainder is rejected to the condenser. According to the second law of thermodynamics, the efficiency of such an engine has a definite upper limit which it cannot exceed, this being the ratio of the difference of the temperatures of the source and the condenser to the temperature of the source, these temperatures being measured on the absolute scale, that is, from -273°C . reckoned as the zero. The efficiency of a steam-engine is usually compared with that of an ideal engine working between the same temperatures, and going through a definite periodic set of operations called the Rankine cycle. If the thermal efficiency of an actual engine is 27 per cent, and that of an ideal engine working on the Rankine cycle is 30 per cent, obviously the important figure is the ratio of 27 to 30, or 90 per cent.

The performance of a steam-engine depends, not only on its *thermal efficiency*, but also on its *boiler efficiency* and its *mechanical efficiency*. The boiler efficiency is the percentage of the heat obtainable from the fuel consumed which is actually used in the engine; in a good boiler it may be 75 per cent. The mechanical efficiency is the ratio of the work given out at the crank-shaft to the work done on the piston; in other words, it is the ratio

of brake horse-power to indicated horse-power. It may perhaps be 80 per cent. To arrive at the over-all efficiency, the various partial or component efficiencies must be multiplied together. In comparing one type of engine with another, what is important is obviously this over-all efficiency, or ratio of energy output to the theoretical energy value of the fuel employed. Thus, to take the case of marine engines, the Diesel oil-engine is inferior to the turbine and to the reciprocator in point both of thermal and of mechanical efficiency. But when the efficiency of the boilers is taken into account, the Diesel comes out very decidedly ahead of the others. Taking coal at 10,000 British thermal units per pound, and Diesel oil at 18,000 British thermal units per pound, Mr. T. R. Wollaston has given the following figures for the number of British thermal units consumed per brake horse-power hour: steam-engine 19,000; steam turbine 21,000; gas-engine 15,000; Diesel engine 9000. Electrical plant in general reaches a high standard of efficiency. Some figures are: transmission lines 85 to 95 per cent; motors and generators at full load 70 to 80 per cent from 1 to 5 h.p., 80 to 90 per cent from 5 to 50 h.p., and 95 per cent for large sizes. Electrical transformers are the most efficient of all machines. Their efficiency ranges from about 90 per cent in small sizes, up to perhaps 98.5 per cent for large machines at full load. See *Energy*; *Internal-combustion Engines*; *Steam-engines*; *Thermodynamics*.

Efflores'cence, the property which certain hydrated salts have of losing water when exposed to air. Thus washing-soda, $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$, if left in air becomes opaque, loses its crystalline appearance, and finally falls to a powder by loss of water. The term is also applied in botany to the process of flowering.

Effluents, a general term applying to liquids, on being discharged, after undergoing some form of treatment. The term is more particularly applied to the purified liquid discharged into rivers and streams from sewage-works, the crude sewage having been freed of the grosser solids, and rendered clear and innocuous to animal and vegetable life.

Effodien'tia, the name proposed for a new order of mammals to include pangolins and aard-varks. See *Edentata*.

Égalité, Philippe. See *Orleans, Louis Philippe Joseph*.

Egbert, considered the first king of all England, was of the royal family of Wessex. He succeeded Brihtric in 802 as King of Wessex. He reduced the other kingdoms and rendered them dependent on him in 829, thus becoming their overlord. He died in 839.

Egede, Hans (ā'ge-dā), the apostle of Greenland, born in 1686 in Norway, died in 1758. In 1721 Egede set sail for Greenland with the intention of converting the natives to Christianity, and for fifteen years performed the most arduous duties as missionary, winning by his persevering kindness the confidence of the natives. In 1736 he returned to Copenhagen, where he was made a bishop and director of the Greenland Missions.

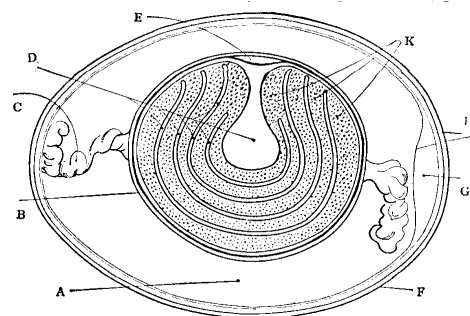
Eger (ā'gër), a town of Bohemia, Czecho-Slovakia, on a rocky eminence above the Eger, 91 miles west of Prague; once an important fortress, though now quite dismantled. It has manufactures of woollens, cottons, leather, and soap. Wallenstein was assassinated there (1634). Pop. 26,620.

Ege'ria, a nymph who received divine honours among the Romans. Numa is said to have received from her the laws which he gave to the Romans.

Egersund (ā'gër-su'nd), a seaport on the south-west coast of Norway, some distance south of Stavanger, and connected with it by railway, has a large pottery-work, fishing and shipping trade. Pop. 3500.

Egerton, Francis. See *Bridgewater, Duke of*.

Egg, (1) in the narrower sense, the female reproductive or germ-cell, which after impregnation or fertilization by a male germ-cell (spermatozoon or sperm) develops into an embryo. (See *Ovum*.) (2) The term is applied, more broadly, to a more complicated reproductive body that consists of an ovum together with supplementary parts. The egg of a bird, for example, includes the fertilized and developing ovum (yolk), nutritive white (albumen), and protective double egg membrane covered by a porous calcareous



Section of Hen's Egg
A, White or albumen. B, Vitelline membrane. C, Chalaza. D, White yolk. E, Germinal disc. F, Shell. G, Air space. H, Shell membrane. K, Yellow yolk.

shell. The eggs of animals lower than the birds have usually only three parts, viz. the germinal spot or dot, the germinal vesicle, and the vitellus or yolk; the first being contained in the vesicle, and that again in the yolk. The common domestic fowl, the turkey, the pea-hen, and the common duck produce the eggs which are commonest in the market. The eggs of the green plover (*Vanellus cristatus*) are esteemed as a delicacy. The hard roes of fishes are the ovaries, containing innumerable eggs (over nine millions in the cod). The salted hard roes of the sturgeon are known as caviare. A hen's egg of good size weighs about 1000 grams, of which the white constitutes 600, the yolk 300, and the shell 100. When the white of an egg is warmed it coagulates to a firm opaque mass. Eggs form an important article in British commerce; the number imported in 1919 amounted to the value of £8,613,000, mainly from Russia, Denmark, Austria, France, and Italy.

Egg, an island of Scotland. See *Eigg*.

Egga, a town of N. Nigeria, on the right bank of the Niger, about 70 miles above the junction of the Benue. Pop. 10,000.

Eggar, or **Egger**, a name given to moths of the family Lasiocampidæ. *Lasiocampa trifolii*, a well-known British moth, is called the grass-egger, and the *L. quercus* the oak-egger, from the food of their caterpillars.

Egg-bird, or **Sooty Tern** (*Sterna fuliginosa*), a bird of considerable commercial importance in the West Indies, as its eggs, in common with those of two other species of tern, form an object of profitable adventure to the crews of numerous small vessels.

Eggleston, Edward, American novelist and miscellaneous writer, born in 1837, died in 1902. He entered the ministry of the Methodist Church, was engaged in pastoral work for some years, afterwards as pastor of an independent church founded by himself. He wrote and edited much, among his books being: *The Hoosier Schoolmaster* (1871), which first appeared in *Hearth and Home*; *The End of the World: A Love Story*; *Roxy*, a highly popular novel (1878); *The Hoosier Schoolboy*; *The Graysons*; *Household History of the United States*; *The Faith Doctor*. His novels are marked by abundance of incident, skilful handling of dialect, and realistic portraiture.

Egg-plant, or **Brinjal** (*Solanum melongēna*), nat. ord. Solanaceæ, an herbaceous plant, from 1 foot to 18 inches high, with large white or purplish flowers. The fruit is about the size of a goose's egg, and generally yellow, white, or violet, and when boiled or stewed is used as an article of food. It is cultivated in India, the United States, &c., and in European hothouses. There are several other species of egg-plants, as *S. indicum* and *S. sodomium*.

Egham, an urban district of England, county of Surrey, on the Thames opposite Staines, about 21 miles from London, with the Royal Holloway College for women, and the Holloway Sanatorium. Near it is Runnymede, where King John signed Magna Charta.

Egil Skallagrim, an Icelandic bard or poet of the tenth century, who distinguished himself by his warlike exploits in predatory invasions of Scotland and Northumberland. Having fallen into the hands of a hostile Norwegian prince, he procured his freedom by the composition and recitation of a poem called *Egil's Ransom*, which is still extant.

Eginhard, or **Einhard**, friend and biographer of Charles the Great (Charlemagne), born in Maingau (East Franconia) about 770, died in 840. He was educated in the monastery at Fulda, and his capacity attracted the attention of Charles, who made him superintendent of public buildings, and of whom he became the constant companion. He also enjoyed the favour of his son Louis the Pious. His later years were passed at Mühlheim-on-the-Main, where he founded a monastery. His *Vita Caroli Magni* is a work of great value, and his letters are also important.

Eg'lantine, one of the names of the sweetbrier (*Rosa rubiginosa*), a kind of wild rose. The name has sometimes been erroneously used for other species of the rose and for the honeysuckle.

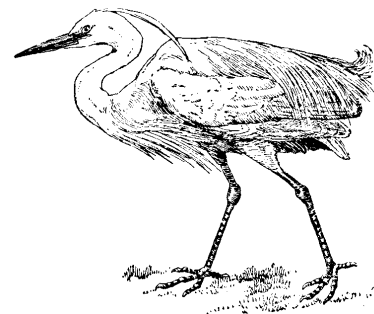
Eg'mont, Lamoral, Count, Prince of Gavre, was born in 1522, of an illustrious family of Holland. He adopted a military career, accompanied Charles V in his African expeditions, and distinguished himself under Philip II in the battles of St. Quentin (1557) and Gravelines (1558). Philip having gone to Spain, Egmont soon became involved in the political and religious disputes which arose between the Netherlands and their Spanish rulers. He tried to adjust the difficulties between both parties, and in 1565 went to

Spain to arrange matters with Philip. He was well received, sent back with honour, but quite deceived as to the king's real intentions. In 1567 the Duke of Alva was sent with an army to the Netherlands to reduce the insurgents. One of his first measures was to seize Count Egmont and Count Horn. After a trial before a tribunal instituted by Alva himself they were executed at Brussels 5th June, 1568. A well-known drama of Goethe's is founded on the story of Egmont.

E'goism, as a philosophical doctrine, the view that the elements of all knowledge and the reality of the things known are dependent on the personal existence of the knower. This theory is also called Subjective Idealism or Solipsism. It maintains that his individual ego is the only being that a man can logically assert to exist. As an ethical theory (practical egoism) it is the opposite of altruism. It maintains that the governing principle of conduct for the individual is his own good on the whole, and that self-interest is the basis of morality. Egoism is to be distinguished from egotism, which denotes the practice of putting forward or dwelling upon oneself, of thinking, talking, or writing about oneself.

Egremont, a town of England, in Cumberland, in the valley of the Ehen, 3 miles from the sea, giving name to a parliamentary division. It has ruins of an ancient (twelfth century) castle associated with a legend that served Wordsworth as the subject of a poem. Iron-ore and limestone are worked. Pop. 6300.

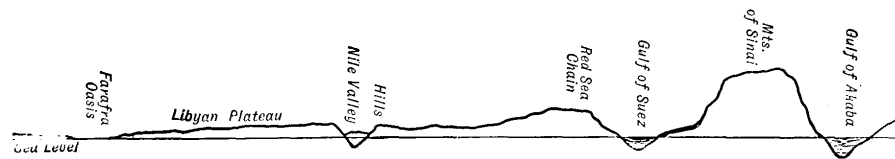
Eg'ret, a name given to those species of white herons which have the feathers of the lower part of the back elongated and their webs disunited, reaching to the tail or beyond it at certain seasons of the year. Their forms are more graceful than those of common herons. The American egret (*Ardëa egretta*) is about 37 inches long to the end of the tail; plumage soft and blended; head not crested; wings moderate; the tail short, of twelve weak feathers. The European egret (*A. alba*) is about 40 inches long, of a pure white plumage; the bill is black or dark brown, yellow at the base and about the nostrils, and the legs are almost black. The little egret (*A. garzetta*) is about 22 inches



Little Egret (*Ardëa garzetta*)

long from bill to end of tail, the plumage is white. The term egret is used in the feather trade for a bunch of the loose plumes, valued as an ornament.

Egypt (from Gr. *Aiguptos*) is, as Herodotus has said, "the gift of the Nile". This



Diagrammatic Section across Egypt from Farafra Oasis to Sinai

great river, about 4000 miles in length, rises as the White Nile, three degrees south of the equator, drawing its waters from the Central African lakes. To the south of Khartoum, and 1350 miles from the sea, it is joined by the Blue Nile, which rises in the mountains of Abyssinia, and about 140 miles farther on it is fed by the Atbara, its last tributary. On the tableland of Nubian sandstone between Khartoum and Elephantine the river forms two great loops, and is intercepted by shallows or cataracts, of which there are six in all. The 'first cataract'—the last on the journey northward—is at Assouan, where a ridge of intercepting granite crops up. At Edfu, about 68 miles farther north, the limestone formation is entered, and the Nile then flows uninterrupted between flanking hills that here and there attain the height of 1000 feet. Egypt proper extends from Assouan to the Mediterranean. At a distance of about 100 miles from the sea the Nile divides into the branches forming the Delta. To the south of Cairo it sends out the Bahr Yusuf, a branch about 200 miles long, which flows into the fertile Fayum. The narrow valley, the average breadth of which is 10 miles, is 'the land of Egypt'. Its cultivable area is not so large as Belgium, being under 10,000 sq. miles in extent. Rain falls to the north of Cairo, but in Upper Egypt there are showers only once in every three or four years. The fertility of the country is due to the Nile. Each year the great river rises in flood when the equatorial lakes are suddenly swollen by heavy tropical rains and the snow melts in the Abyssinian mountains. The mean summer heat is 83° F. in the Delta and 122° F. in the valley. It is a dry heat, not so oppressive as that of India, and malaria is practically unknown. The most trying part of the year is during the period of 'Low Nile'. Before the surplus waters were stored in the Assouan Dam, the river shrank so low that its flow seemed uncertain. For about two months the hot and blistering 'hanseen' (or 'sand-wind') keeps blowing. A new season is ushered in by the cool north

wind—the Etesian wind of the Greeks—which clears the accumulated dust from vegetation. It is lauded in ancient texts by priestly poets and Pharaohs. About the same time the conspicuous star Sirius makes its appearance. It was anciently regarded as a form of the Mother Goddess. On the 'Night of the Drop', in June, a fertilizing tear was supposed to fall from this star, and thereafter the 'new Nile' was born. For about four days (before the Assouan Dam was constructed) the rising river flowed green, the slimy matter on the marshes of Upper Egypt being pushed forward by the 'new water'. This was the 'Green Nile'. Then the Nile turned blood-red with Abyssinian clay. This was the 'Red Nile'. As soon as the fertilizing 'new water' touched the parched sands, Egypt awoke to new life. Countless insects appeared, new grass and flowers sprang up, and trees and shrubs broke into brilliant blossoms that filled the air with sweet perfume. Bursting over its banks, the steadily rising river flooded the valley generously and refreshingly. According to the Coptic Calendar, the inundation season lasted from June till September, the seed-time from October till January, and the harvest began in February.



Part of the Hieroglyphic Legend of
Heru-Behutet and the Winged Disk,
cut on the Walls of the Temple of
Edfû in Upper Egypt

Translation: In the three hundred
and sixty-third year of Rā-Heru-
Khuti, who liveth for ever and for
ever, His Majesty was in TA-
KENS, and his soldiers were with
him; (the enemy) did not conspire
(auu) against their lord, and the
land (is called) UAUATET unto
this day. And Rā set out on an
expedition in his boat, and his

followers were with him, and he arrived at UTHES-HERU, (which lay to) the west of this nome, and to the east of the canal PAKHENNU, which is called (... to this day). And Heru-Behutet was in the boat of Rā, and he said unto his father Rā-Heru-Khuti (i.e. Rā-Harmachis), "I see that the enemies are conspiring against their lord; let thy fiery serpent gain the mastery ... over them."—Reproduced by permission from Vol. XXXII of *Books on Egypt and Chaldaea*, by Sir E. A. Wallis Budge.

Early Religion and Civilization.—In its earliest phases the religion of ancient Egypt reflected the natural phenomena of the Nile Valley in their relation to the needs, experiences, and achievements of mankind. The flood was an annual 'miracle of mercy', and the early people tried to account for it. They concluded it was a gift of the gods. It ensured the food-supply; it brought health and relief from the oppressive heat endured when the sand-wind prevailed and the river was low. The new water was 'the water of life'; it fertilized the parched soil and caused barley and millet (which grew wild in the Delta) to spring up, trees to yield fruit, and curative herbs to appear on the river banks. In the prehistoric period the Nile was identified with Osiris, who, according to the traditions of the Delta people, once reigned as their king, and introduced the agricultural mode of life which made it possible for large and growing communities to dwell in the narrow valley. In the Pyramid Texts (c. 2700 B.C.) Osiris is the controller of the Nile, the principle of life in the Nile, and the Nile itself. In one of his phases the god is the 'Green One'—the Green Nile. A Pyramid Text reads: "Horus comes! He beholds his father in thee, Green One, in thy name of Water of Greenness". The soul-substance (literally 'the seed') of Osiris was the vital principle in the green or new water. Osiris was the serpent-soul in the water, and the serpent (leviathan) of the ocean which 'encircled the netherworld'. The god is addressed in a Pyramid Text: "Thou art great, thou art green in thy name of Great Green" (Mediterranean Sea). Osiris was slain by Set, and his life-blood was the Red Nile, which entered the soil and vegetation. Osiris was not regarded as the Green One because vegetation is green; the ancient Egyptians appear to have attributed the greenness of vegetation to

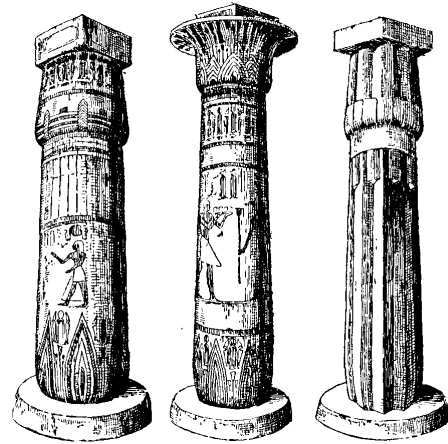
the Green Nile, the soul-substance of Osiris. The sap of shrubs and trees was 'Blood'—the blood of the god. Osiris continued to live after death. On earth he was in barley, fruit, &c., and in the fertilized soil. He was in the other world Judge and King of the Dead. In his underworld Paradise the souls of the dead grew corn and cultivated fruit-trees—the 'food of life'. The Osirian cult had origin in the Delta of Lower Egypt. In Upper Egypt a solar cult exalted Horus, the falcon god, as chief deity. Their heaven was beyond the sky 'to the east'. In the Pyramid Texts there is clear evidence that the solar cult believed the souls of the dead went eastward, while the Osirian cult believed they went westward. Osiris was called 'First of the Westerners'. The 'Easterners' of the south (Upper Egypt) conquered the 'Westerners' of the north (Lower Egypt), and Egypt was united into a single kingdom by the traditional King Mena, with whom begins the dynastic history of Egypt. This conquest appears to have been due to the introduction of copper weapons.

The idea that the Horites were invaders from Arabia or Mesopotamia has been abandoned. Copper was anciently found in the wadis of Upper Egypt and on the shores of the Red Sea. After boat-building and navigation were well advanced copper was mined in Sinai. According to Egyptian evidence, Edfu was the centre of the early copper industry and of the Horus cult. As Egyptian copper is naturally hard, it required no amalgam. Egypt, therefore, never had a Bronze Age, nor had it a Neolithic Age. The copper artifacts were imitations of Palæolithic forms of the Solutrian type. After the conquest there occurred fusions of religious cults. Local pantheons reflected local politics. But although the sun-cult of Heliopolis exalted Ra (or Re) as King of the Gods, the belief that all that existed originated in water persisted till the end. The water-mother was Hathor, who gave birth to Osiris. As the Nile was supposed to come from heaven, she was the sky-goddess; her animal was the primeval cow of a pre-dynastic cult, and she was the shell-spirit of water as well—the Egyptian Aphrodite. The shell, pearl, cow, sky, sun, moon, and stars were connected with Hathor as Nut. Ra, the sun-god, was, like Osiris, regarded as her son. Her attributes were in time absorbed by Isis. At the dawn of the Dynastic Age the religious beliefs of the Egyptian peoples were already well developed, the agricultural mode of life was established in the Nile Valley and in the Delta area, the calendar had been introduced, while copper weapons and implements were in use.



Painted inner wooden coffin of Pen-Amen-Neb-Nest-Taui, a prophet of the God Amen and of the Goddess Bast at Thebes.

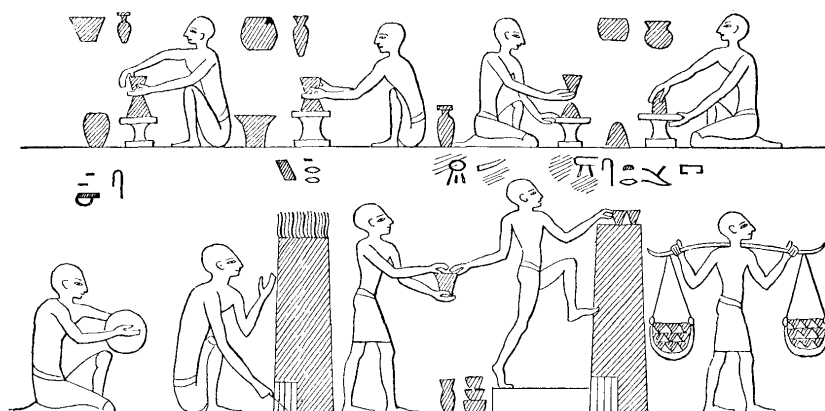
The subsequent history of the official religion has a political aspect. Local cults rose into prominence as a city-state or ruling family achieved political ascendancy. Memphite theology and the Memphite god Ptah (the god of artisans) assumed importance when the city of Memphis became the capital of the united



Types of Columns from Egyptian Temples.

kingdom. Heliopolis ('the city of the sun') was the northern centre of the solar cult, which, during the fourth and fifth dynasties (c. 2900-2625 B.C.), became influential enough to impose its theology on the court. The popular Osirian faith was absorbed. Pharaohs were 'Sons of Ra', the sun-god, and Ra supplanted the southern sun-god Horus. Before the Pyramid Age the Osirian and Horite cults had been blended, and Horus became the son of Osiris. Although the living Pharaoh, however, was the son of Ra, he was also a Horus; after death he became an Osiris. The culture-blending process introduced many complexities. During the twelfth dynasty (2000-1788 B.C.) the name of the Theban god Amon entered into royal names. But the permanent political ascendancy of Amon of Thebes really followed upon the expulsion of the Hyksos military aristocracy about 1580 B.C. By this time the northern sun cult's influence had become sufficiently strong to have Ra blended with the Theban deity who was subsequently known as Amon-Ra. Before the close of the eighteenth dynasty (c. 1350 B.C.) a royal sun cult, promoted by Pharaoh Akhenaton (Amenhotep IV), exalted Aton, the sun-disc, as sole god of Egypt and the rest of the world. The Amon-Ra cult regained its political ascendancy with the rise of the nineteenth dynasty. In later times the chief gods of the reigning families were blended forms of Amon, Ra, Ptah, and Osiris. Not only the gods, but the rival Paradises, were blended. Osiris's

under-world Paradise was transferred to the mythical other world beyond the horizon, and the sun-barque of the sun-god, which carried the soul of the Pharaoh, was supposed to touch at 'the port of Paradise'. It went westward and passed through the under-world, and emerged again next morning at dawn in the east. The contradictions in the Egyptian religious texts are believed to be mainly due to the blending of beliefs regarding the fate of man which were originally fundamentally different. Local deities were embraced in the official theology, but at their centres remained prominent and influential. But these, too, were in time so strongly influenced by the solar and Osirian faiths that they suffered in no small degree loss of identity except in name. The religious beliefs of Egypt as a whole were never completely systematized. There were no heresies because there were no orthodox beliefs. Any religious cult was tolerated, so long as it acknowledged the supremacy of the god or pantheon of the ruling family. In the later period the cult of Serapis (Asar Hapi), the bull form of Osiris, was popular.



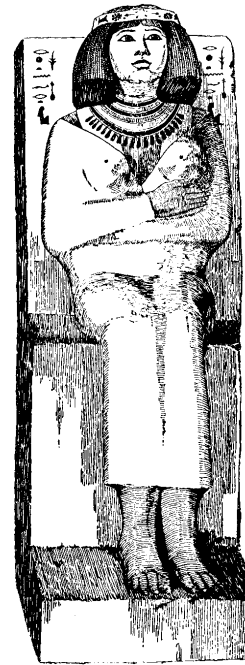
Egyptian Pottery-making
From a wall-painting in the tombs of Beni-Hassan.

Arts and Crafts.—Art developed in ancient Egypt under religious patronage. The earliest use made of Nubian gold was in manufacturing imitation luck-shells worn by the pre-dynastic peoples. Gold thus acquired a religious significance; at an early period it was associated with the sun-deity—the mother-goddess in her solar aspect was called 'Golden Hathor'. The hieroglyph for gold (*nub*) is a collar of beads. Exquisite gold ornaments in symbolic shapes were produced during the early dynasties. No finer gold ornaments have ever been produced anywhere than those of the twelfth

dynasty (c. 2000 B.C.). These include chased gold pectoral ornaments and coronets and crowns inlaid with stones. When copper was first introduced it was used like gold. After implements were made of copper, vases of alabaster, diorite, &c., were worked with increasing skill and taste. The hardest stone was hewn and dressed for building purposes. No people have ever shown greater skill than the Egyptians in their stonework. The sculptors set themselves, when constructing temples, to imitate in stone the lashed palm-sticks, reeds, and papyrus stems used in the earliest shrines to stiffen the mud walls. Massive temple pillars were decorated with lotus petals, rose petals, &c. The early artists, who carved ivory, began to work in stone after copper implements were invented, and produced low reliefs in temples and tomb-chapels. Statuary in limestone, wood, and copper in the early dynastic period was vigorous and realistic. The sculptors were using the hardest material by the time of the Pyramid Age (c. 2700 B.C.). A great tomb-statue of Pharaoh-Khafa, in diorite, preserved in the Cairo Museum, is one of the triumphs of Egyptian sculpture. The Empire-period sculpture reached a high level of excellence. It was to provide 'soul-bodies' for dead Pharaohs that these great works of art were produced. A great advance in the manufacture of pottery was achieved during the Pyramid Age, when the potter's wheel was invented. To Egypt the ancient world owed this notable contrivance. It was introduced in time into Babylonia, Iran, India, China, Crete, Greece, and Western Europe. Shipbuilding is another Egyptian industry which promoted progress. Cretan and Phœnician vessels were of Egyptian design. In all histories of shipping and navigation the ancient Egyptians are credited with being the pioneers of maritime enterprise. The custom of mummification arose in Egypt, and promoted the study of anatomy. Surgery had its origin in mummification, as astronomy had in astrology, and chemistry had in alchemy. Connected with each temple were architects, artists and sculptors, metal-workers and dyers. Ships were constructed to obtain wood for temples and to import pearls, precious stones, herbs, incense-bearing shrubs and trees, &c., for religious purposes. In the history of early civilization the Egyptian priests play a prominent part as patrons of the arts and crafts.

History.—In the hot, dry sands of Upper Egypt, which preserve the dead from decay, have been found the bodies of large numbers of pre-dynastic Egyptians. They were of the type known as the 'Mediterranean race'. The

contents of their stomachs have yielded husks of barley and millet and fragments of mammalian and fish bones. Circumcision was practised, and some men shaved. These people used malachite as an eyelid paint. When they discovered that copper could be extracted from malachite, it was used at first like gold, as has been stated. The production of copper implements and weapons was followed by the conquest of Lower Egypt by the copper-using Upper Egyptians. After the latter moved north, they found that the bodies of their dead decayed, and the practice of mummification was introduced. Before 3000 B.C. the broad-headed, long-bearded Armenoid type began to filter into Lower Egypt. The blending of Armenoids and Arabians in Syria produced 'the hybrid race of Semites'. In Egypt the ethnic fusion was most marked at the commercial capital, Memphis, and especially during the time of the pyramid builders (c. 2900-2750 B.C.). The spread of 'copper culture', and the importation into Egypt of timber from Lebanon, apparently brought the ancient races into close contact. Withal, shipbuilding and the art of navigation had advanced by leaps and bounds. Before the Pyramid Age there were sea-traders on the Mediterranean, and the Egyptians imported copper from Sinai across the Red Sea. The legendary Pharaoh who united Upper and Lower Egypt was Mena or Menes. From his time (c. 3400 B.C.) till the close of the sixth dynasty (c. 2475 B.C.) the capital was Memphis. This period is known as that of the 'Old Kingdom'. Among its outstanding monarchs were Khufu, Khafra, and Menkure of the fourth dynasty, the builders of the largest pyramids. Herodotus refers to them as *Cheops*, *Chephren*, and *Mykerinos*. The 'Middle Kingdom' begins with the rise of Thebes in Upper Egypt as the centre of political power. During this period the nobility became so influential that the Pharaohs had to recognize their rights and privileges. In the period of the famous twelfth dynasty (c. 2000-1788 B.C.) the Theban monarchs established a uniform control of Egypt. The later kings of this dynasty were unable, however, to withstand the inroads of Asiatics, and the Middle Kingdom came to an end with the Hyksos invasion. Of the Hyksos,



Nefert, a royal princess
of the Old Kingdom
period
From a limestone
statue in the Cairo
Museum.

the so-called 'Shepherd Kings', little is known. They were civilized Asiatics, and during their overlordship of Egypt, which embraced the thirteenth till the seventeenth dynasties (c. 1800-1575 B.C.), the horse and chariot were introduced into Egypt. A Theban royal house rose into prominence during the latter part of their sway, and the Hyksos were finally expelled by Pharaoh Aahmes, who founded the eighteenth dynasty. The Empire period was then inaugurated. Egypt's greatest emperor, Thothmes III (1515-1461 B.C.), extended his conquests to the borders of Asia Minor, and received tribute from the Hittites, and even from Cyprus and Crete. During the reign of Akhenaton, the Hittites and their allies, the Amorites, seized the Egyptian sphere of influence in Syria and Northern Palestine.

In the nineteenth dynasty (1350-1205 B.C.) much of the lost territory was recovered. Rameses II (1325-1258 B.C.) fought his Waterloo at Kadesh, but found it necessary about 1300 B.C. to conclude a treaty of peace with the Hittites, the Assyrian Power at the time becoming very powerful and aggressive. Rameses III of the twentieth dynasty was the last great Pharaoh of the Empire period. He successfully resisted the threatened invasions of naval and military peoples from Greece and Anatolia in 1200 B.C. It is believed that the Trojan War (1194-1184 B.C.) was waged by the same confederacy which had attempted to invade the Delta region. No fewer than nine Pharaohs named Rameses ruled in Egypt after Rameses III. Most of these were priest-kings. A Libyan dynasty held sway for about two centuries (950-750 B.C.). One of its Pharaohs-Sheshonk was the 'Shishak' who was an ally of Solomon; after the death of that monarch he invaded Palestine. The Ethiopians of Nubia (Sudan) subsequently overran Egypt. One of its Pharaohs, Shabaka, was the ally of King Hosea of Israel against Assyria; he was defeated at Raphia by Sargon in 720 B.C. The last Ethiopian Pharaoh, Taharka, was in 662 B.C. overcome by the invading army of the Assyrian Emperor, Ashur-banipal. The northern royal family of Sais then came into power, and the twenty-sixth dynasty, which lasted for about 130 years (662-525 B.C.), was inaugurated by Psamtik I. Pharaoh-Necho, referred to in the Bible, was the second ruler. It was during Necho's reign that his Phoenician mariners circumnavigated Africa. Egyptian culture was at the time spreading far and wide along sea and land routes. Trade was flourishing. The greatest world-power at the time, however, was Persia, and in 525 B.C. Egypt was conquered by Cambyses and became a Persian

province, with short interruptions of weak native dynasties (the twenty-eighth to thirtieth), until in 332 B.C. Alexander the Great seized it and founded Alexandria. The Ptolemaic dynasty afterwards held sway for about three centuries. During this period learning and the arts flourished. Alexandria was not only a commercial town, but a centre of culture and the capital of Egypt. Osiris was worshipped there in the form of Serapis. During the latter part of the dynasty the native Egyptians were using Greek and Græcized names, and the whole country was more or less Hellenized. The fifteenth Ptolemy was the younger brother of the famous Cleopatra, the seventh of her name. He vanished, and was succeeded by Cleopatra's son, Cæsarion—Ptolemy XVI—whose father was Julius Cæsar. Both Cleopatra and her son perished when Egypt became a Roman province in 30 B.C. A daughter of Cleopatra and Antony became the wife of Juba, King of Morocco.



Queen Ahmes (wife of Thothmes I)

From a relief on the wall of the temple at Der-el-Bahari. The face is of Mediterranean type. She represents the royal line which soon afterwards fused with a foreign strain, so that the facial type changed.

The Romans drew vast quantities of gold from the mines of Nubia (*nub* means 'gold') and made Egypt their 'granary'. Egyptian religious beliefs and customs were perpetuated by the Roman emperors. Tiberius and Vespasian restored ancient Nilotic temples. The worship



Head of Rameses II
From the mummy

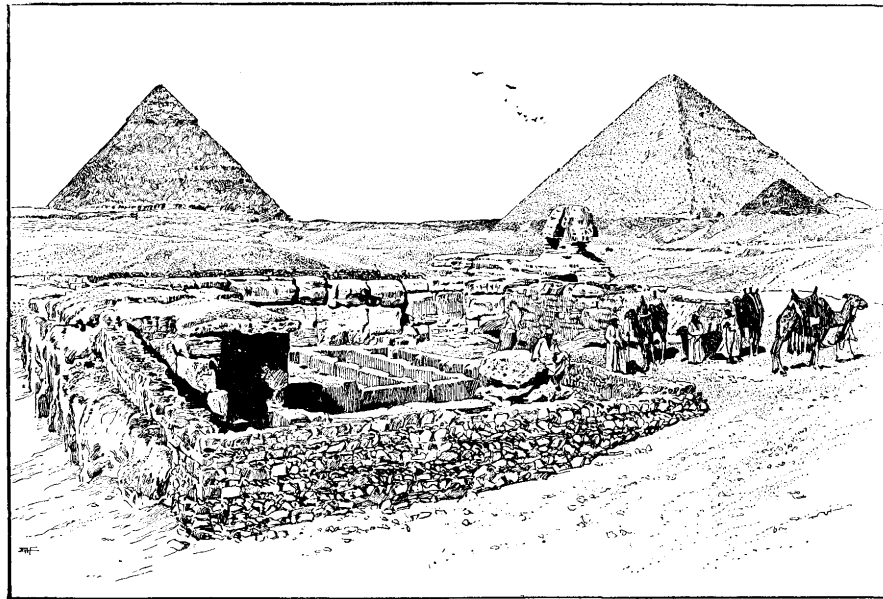
of Isis spread to Rome. Hadrian had to give a decision in a dispute between Memphis and Heliopolis regarding the sacred bull. But Egyptian native learning was decaying, and the knowledge of hieroglyphic writing was dying out. Christianity was introduced during the Roman period, and the Coptic Church established. In A.D. 642 the Romans finally abandoned Egypt, which, till 868, became a province of the successive Mohammedan

caliphates of Medina, of Damascus, and Baghdad. The Turkish soldiery dominated Egypt for a period. The Shia heretics afterwards became

powerful, and the Christians were well treated. In 1250 the Mamelukes (descendants of slaves) came into power. Their pomp-loving sultans and emirs lived in great splendour. They came under Turkish sway early in the sixteenth century, but when Napoleon conquered Egypt in the eighteenth century they were again semi-independent. The British drove the French out of Egypt. Mehemet Ali, an Albanian officer in a Turko-Albanian force, had himself declared Sultan of Egypt, but when he overran Syria and threatened to march to Constantinople, Russia intervened. Britain and France afterwards prevailed on Mehemet Ali to rule Egypt as the viceroy of the Sultan of Turkey. His successor and grandson, Abbas I, built the first railway in Egypt. The next viceroy, Said Pasha, son of Mehemet Ali, granted to a French company the right to construct the Suez Canal. Egypt became bankrupt under his successor, Ismail Pasha, the first Khedive (Prince), during whose reign the Suez Canal was opened. He was deposed when the British and French took over the control of Egyptian finance. During the term of his successor, Tewfik Pasha, the Arabi Pasha rebellion took place. The military occupation of Egypt by British troops was followed by peace and good government. But trouble broke out in the Sudan. Mohammed Ahmed declared himself the Mahdi (Messiah) of the Mohammedans, and conquered a great part of the Sudan. In Nov., 1883, General Hicks ('Hicks Pasha') led an army of 10,000 Egyptians against the false prophet, but while marching across the driest part of the Sudan, misled by spies who acted as guides, his thirst-stricken army was entirely destroyed by the Mahdi's force. This victory gave the false prophet great prestige. In Jan., 1884, General Gordon was sent to Khartoum as Governor-General of the Sudan, but was completely isolated there. Khartoum was captured and the gallant general slain on 26th Jan., 1885, before a relieving force could reach him. The Mahdi died in June, 1885, and was succeeded by Abdullah the Khalifa. After a period of reorganization and preparation in Egypt, the reconquest of the Sudan was begun. Lord (then Sir Herbert) Kitchener was Sirdar, or Commander-in-Chief of the Egyptian army, and his expeditionary force was strengthened by British regiments. In April, 1898, the Khalifa's army was defeated on the banks of the Atbara, and on 2nd Sept. Kitchener won a great victory near Omdurman. The Khalifa escaped, but was rounded up by Sir Reginald Wingate's force, and slain with his emirs at Umme Dubraykat on 24th Nov., 1899. Thereafter the

Sudan came under the control of a British-Egyptian *condominium*, which appointed a Governor-General.

At the time of the outbreak of the Great War, in the autumn of 1914, the Khedive of Egypt was in Constantinople. He sided with the Central Powers. He was consequently deposed by Britain, and Prince Hussein Kamil was declared Sultan of Egypt; the



The Great Pyramids of Giza and the Sphinx
Built by Cheops (Khufu) and Cephron (Khafra) as their future tombs, in order to secure immortality by the preservation of the mummy.

suzerainty of Turkey terminated at the same time. The new ruler of Egypt was the uncle of the deposed Khedive, Abbas Pasha Hilmi (second son of the first Khedive, Ismail Pasha, and brother of Tewfik Pasha, the second Khedive). Hussein Kamil died in 1917 and was succeeded by Ahmed Fuad Pasha. Under the Peace Treaty, Egypt is recognized as an independent kingdom protected by Great Britain. The capital of modern Egypt is Cairo, situated near the site of ancient Memphis. Thebes is represented by Luxor and Karnak.—BIBLIOGRAPHY: (Religion) Breasted, *Development of Religion and Thought in Ancient Egypt*; Renouf, *Book of the Dead*; Budge, *Gods of the Egyptians*; Wiedemann, *Religion of the Ancient Egyptians*; Sayce, *Religion of Ancient Egypt and Babylonia*; G. Elliot Smith, *The Migrations of Early Culture*; (History)—G. Elliot Smith, *The Ancient Egyptians*; Breasted, *A History of Egypt*; Flinders Petrie, *A History of Egypt*; King and Hall, *Egypt and Western Asia in the Light of Recent Discoveries*; H. R. Hall, *The Ancient History of the Near East*; Sir A. Colvin, *The Making of Modern Egypt*; Lord Cromer, *Modern Egypt*.

Egyptian Blue, a brilliant and very permanent pigment used by the Romans in the early centuries of the Christian era. It has been found in ancient frescoes in the Vatican, and also at Pompeii. The chemist Fouqué proved by analysis that it is a double silicate of calcium and copper.

Egyptian Vulture (*Neophron perenoptērus*), a bird that frequents both shores of the Mediterranean, but rarely passes farther north, though it has been found in the British islands. It is one of the smaller vultures, about the size of a raven. The general colour is white, the quill feathers of the wing being dark brown. It frequents the streets of Eastern towns, where it is protected on account of its services as a scavenger. This vulture is sometimes known as Pharaoh's Hen, on account of its frequent representation in Egyptian hieroglyphics. In Spain it is called the *quebranta-huesos* (bone-smasher) in reference to its supposed habit of breaking up bones left by other vultures.

Ehrenberg (ā'rèn-berh), Christian Gottfried, a German scientist, born in 1795, died in 1876. After studying theology, medicine, and natural history, he joined in 1820 an expedition to Palestine, Egypt, and Abyssinia, returning to Berlin in 1825. In 1829 he accompanied Humboldt to the Ural and Altai ranges and to Central Siberia. His great work on Infusoria appeared in 1838, and was at once recognized as the highest authority on the subject. It was followed in 1854 by his *Microgeology*.

Ehrenbreitstein (ā'ren-brīt-stīn), a dismantled Prussian fortress formerly of great strength and situated opposite the confluence of the Moselle with the Rhine, on a precipitous rock 387 feet above the river, and inaccessible on three sides. It is connected with Coblenz on the opposite shore by a bridge of boats. The fortifications, which were erected between 1816 and 1820 at a cost of £1,200,000, could accommodate a garrison of 14,000 men, and possessed room for stores to last an army of 60,000 for a year.

Ehrlich, Paul, German physician, born in Silesia in 1854, died in 1915. Educated at Breslau, Strasburg, and Leipzig, he became *privat-dozent* at the University of Berlin in 1889, and in 1896 was appointed director of the Royal Institute for Serum Research at Steglitz, which was transferred to Frankfurt in 1899, and became the Royal Institute for Experimental Therapeutics. His studies in the histology of blood are very important, but

his claim to fame is based upon his discovery of *salvarsan* (606) and of *neosalvarsan* (614), arsenic compounds which are very efficacious in the treatment of syphilis. He delivered the Croonian lectures in 1900 and the Harben lectures in 1907, received honorary degrees from the universities of Oxford and Chicago, and in 1908 shared the Nobel prize for medicine with Metchnikoff of the Institut Pasteur in Paris. His works include: *Beiträge zu Histologie und Klinik des Blutes*, *Anæmie*, *Abhandlungen über Salvarsan*, &c.

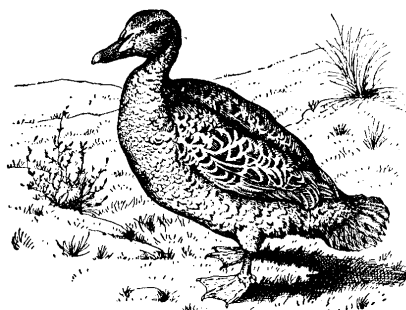
Eibenstock (ī'ben-stok), a town in the south-east of Saxony, with important manufactures of lace. Pop. 9528.

Eichhorn (īh'horn), Johann Gottfried, German Orientalist, historian, &c., born in 1752, died in 1827. He became professor of Oriental languages at Jena, and then at Göttingen. Amongst his works are: *The Hebrew Prophets*, *History of Literature*, *History of the Last Three Centuries*, *Introductions to the Old and New Testaments and to the Apocrypha*.

Eichstätt (īh'stet), an old town, Bavaria, in a deep valley of the Altmühl, 67 miles N.N.W. of Munich. Its principal edifice is a fine Gothic cathedral, founded in 1259. Pop. 8029.

Eider (ī'dër), a river of Schleswig-Holstein, rises 8 miles s. of Kiel, and after a winding course falls into the North Sea at Tönning; length, 112 miles. By means of a canal it long gave communication between the North Sea and Baltic, but the new ship canal here has superseded this route.

Eider Duck (*Somateria mollissima*), a species of duck found from 45° north to the highest latitudes yet visited, both in Europe and America. Its favourite haunts are solitary rocky shores and islands. In Greenland and Iceland they occur in great numbers, and also breed on the western islands of Scotland. The eider duck is about twice the size of the common duck, being about 2 feet 3 inches in length, 3 feet in breadth of wing, and from 6 to 7 lb. in weight. The male is black, head and back white, with a black crown. The female is reddish drab spotted with black, and with two white



Eider Duck (*Somateria mollissima*), female

bands on the wings. They feed largely on shell-fish and crustaceans. Their nests are usually formed of drift grass or dry seaweed, lined with a large quantity of down, which the female plucks from her own breast. In this soft bed she lays five eggs, which she covers over with a layer of down. If this, with the eggs, is removed, the bird repeats the process. One female generally furnishes about ½ lb. of down, but the quantity is reduced by cleaning. This down, from its superior warmth, lightness, and elasticity, is in great demand for beds and coverlets; and the districts in Norway and Iceland where these birds abound are guarded with the greatest vigilance as a most valuable property. As found in commerce this down is in balls of the size of a man's fist, and weighing from 3 to 4 lb. It is so fine and elastic that 5 lb. of the best quality is sufficient for a whole bed. The down from dead birds is little esteemed, having lost its elasticity. The king eider duck (*Somateria spectabilis*) is another species resembling the preceding and inhabiting the same coasts.—Cf. J. G. Millais, *British Diving Ducks*.

Eiffel (ā-fel), Alexandre Gustave, French engineer, born in 1832; attended, from 1852 to 1855, the École Centrale des Arts et Manufactures at Paris, and devoted himself chiefly to the designing of large structures in iron, especially bridges and viaducts, the great bridge over the Douro being one of his works. His name is best known, however, from the lofty iron tower erected by him in connection with the Paris Exhibition of 1889, rising to the height of 985 feet on the Champ de Mars. He was condemned in 1893 to two years' imprisonment and a fine of 20,000 francs for misappropriation of funds belonging to the Panama Canal Company, but the judgment was set aside on technical grounds. In 1913 he published a work entitled *Resistance of the Air*. See next article.

Eiffel Tower, a structure named after the originator, one of the sights of Paris, is by far the loftiest structure in existence, surpassing the Washington Obelisk, the next highest (555 feet), by 430 feet. It cost about £260,000, and was erected partly at the cost of the State, partly by funds provided by Eiffel himself, who formed a company for the purpose. The company derived its profits from the fees which visitors had to pay, but the tower became the property of the State in 1909. The top may be reached by stairs and lifts. The first stage or platform is at the height of 189 feet, and forms a quadrilateral 213 feet square, fitted up as a restaurant. The next platform is at the height of about 380 feet, and is 98 feet square. The third platform is at

the height of 906 feet, and is large enough to accommodate a good number of persons, affording a magnificent view. The lantern higher up is supplied with powerful electric searchlights, and on the very summit is a small area utilized chiefly for scientific observations. The tower has been utilized in experiments connected with the fall of bodies, vibration of the pendulum, and pressure of the air. In recent years the tower has become an important wireless telegraphy station.

Eigg (eg), an island on the west coast of Scotland, county of Inverness, about 10 miles from the mainland, and 5 miles long by about 3 broad. It has bold, rocky shores, and terminates to the south in a lofty promontory called the Scur of Eigg, with a peak of columnar pitchstone porphyry 1339 feet above the sea, and on one side perpendicular as a wall. It is the scene of the massacre, towards the end of the sixteenth century, of 200 Macdonalds by the Macleods of Skye, who suffocated them in a cave where they had taken refuge. Pop. 211.

Eight-hour Day. The eight-hour day was proposed in England as early as 1833, and in 1869 the Trade Union Congress of Birmingham formulated the demand that this ideal working day should be adopted throughout the United Kingdom. The Trade Unions and the Socialists sought to secure the establishment of the eight-hour day through legislation, and it gradually came into force not only in coal-mining, but in various trades and industries. The agitation in favour of an eight-hour day became very strong in Europe towards the end of the nineteenth and at the beginning of the twentieth centuries, and in England it was granted to miners in 1908, and to railway employees in 1919. Since the European War the movement has made great headway, and it now forms part of the programme of the Labour parties in almost all European countries.—BIBLIOGRAPHY: Hedfield and Gibbins, *A Shorter Working Day*; Robertson, *The Eight Hour Question*.

Eighty Club, The, a club formed in 1879 by a number of prominent English Liberals with a view to the promotion of the success of Liberalism at the general election of 1880, whence its name. The members lecture on political subjects and address Liberal associations throughout the country. Women were first admitted to membership in 1920.

Eikon Basilikē (ī'kon ba-sil'ī-kē; Gr., 'the royal image'), the name of a book published shortly after the execution of Charles I in Jan., 1649, and supposed by some to have been written by the king himself. At the Restoration Gauden, afterwards Bishop of Worcester, laid claim to the authorship, and a memorandum in the copy of the Earl of Anglesea, Lord Privy Seal under Charles II, affirms his claim with the authority of Charles II and the Duke of York. The Royalist Clarendon, author of the *History of the Rebellion*, accepted this statement, but others refused to credit Gauden with the authorship. Within a year of its publication, 48,000 copies of the book were sold, and the republicans put forward Milton to answer it, his *Eikonoklastes* (that is 'image-breaker') appearing the same year, by order of Parliament. The *Eikon Basilikē* professes to be a sort of private journal of the king, written in an affectedly dignified strain, and containing numerous assertions of love for his misguided and ungrateful people.—Cf. Almack, *Bibliography of the King's Book, or Eikon Basilikē*.

Eildon Hills (ēl'don), a picturesque hill-mass with three summits, south of Melrose, Roxburghshire, Scotland, reaching a height of nearly 1400 feet, fabled to have been cleft in three by Michael Scott.

Eileithyia (ī-lī-thī'ya), the Greek name of the ancient Egyptian city Nekheb (the modern El-Kab), on the Nile, some distance above Esneh. Important remains have been obtained from rock-tombs in the neighbourhood, and there are several ruined temples.

Eilenburg (ī'lèn-bu'rĥ), a town, Prussian Saxony, 26 miles N.N.E. of Merseburg, on an island of the Mulde. It has manufactures of calico. Pop. 17,400.

Eimbeck (īm'bek), or **Einbeck**, a town of Prussia, province of Hanover, 40 miles south of Hanover, once famous for its beer (*Eimbecker Bier*, whence *Bock*). Pop. 9430.

Einsiedeln (īn'zē-dēln), a village and district, Switzerland, in the canton and 9 miles north by east of Schwyz, 3000 feet above the sea, celebrated for its Benedictine abbey. An image of the Virgin, alleged to possess miraculous powers, annually attracts immense numbers of pilgrims. Pop. 8438.

Einstein, Albert (1879-), physicist, was born at Ulm, Württemberg, Germany, of German-Jewish parents. He was educated at the Gymnasium in Munich, and, on leaving school in his sixteenth year, accompanied his parents to Milan. Six months later, he enrolled at the Technical High School in Zurich, where he studied from 1896 to 1900. He held a post in the Swiss Patent Office from 1902 to 1909, then various professorships in Zurich till 1914, when he received a call to the Prussian Academy of Science, Berlin, as successor to van't Hoff. Einstein has been twice married. He has become famous as the author of the Theory of Relativity (q.v.). The 'special theory', which deals chiefly with electrodynamics and optics, was published in 1905, and the 'general theory' or theory of gravitation, about ten years later. His name became popularly known in 1919, after observations made during the solar eclipse of that year had verified his prediction of the bending of rays of light coming from a star and passing close to the sun. He has made other valuable contributions to Theoretical Physics, among these being a theory of the Brownian movements and various important applications of the modern quantum theory of energy. In 1921 he visited the United States and Britain, and delivered many lectures on Relativity.

Eisenach (ī'zèn-āh), a town of Germany, in the former grand-duchy of Saxe-Weimar, near the mountains of Thuringia, at the junction of the Nesse and Hörsel. It is an attractive town, and contains a palace erected in 1742. It has manufactures of pottery, leather, woollen yarn, &c. Sebastian Bach was born there in 1685. Near it lies the Wartburg, where Luther was kept for safety during 1521 and 1522. Pop. 38,362.

Eisenberg (ī'zèn-berh), a town of Germany, former duchy of Saxe-Altenburg, with a palace and various manufactures. Pop. 10,750.

Eisleben (īs'lā-bèn), a town, Prussian Saxony, 25 miles north-west of Merseburg, celebrated as the place where Luther was born and where he died. There are many memorials of Luther, and also a bronze statue of the reformer erected in 1883. Copper is extensively worked in the neighbourhood. Pop. 24,630.

Eisner, Kurt, Bavarian revolutionary leader, born in 1867 at Berlin, of a Jewish family. He studied at the University of Marburg, and early acquired a vast erudition. Entering journalism, he contributed to the *Frankfurter*

Zeitung, where he published an article attacking the Kaiser. For this he was condemned to nine months' imprisonment. He then wrote for the Socialist press and eventually became editor-in-chief of the *Vorwärts*. In 1907 he published a work entitled *The Fall of the Empire* which attracted much attention, and in 1910 he attacked Prussian ascendancy in the *Munich Post*. Eisner took an active part in the Revolution of 1918, and was appointed Prime Minister of Bavaria. A revolutionary and a Socialist, he was, however, opposed to Bolshevism, which he did not hesitate to criticize violently. But his policy of separation, his aim of liberating the South German States, and his constant attacks upon the Kaiser and the whole military caste of Germany, brought him many enemies. Whilst on his way from his house to the Foreign Office he was shot at and killed by Count Arco Valley on 21st Feb., 1919.

Eisteddfod (ī-steth'vōd; W. *eistedd*, to sit, and *bod*, to be; pl. *eisteddfodau*), an ancient assembly of Welsh bards for the purpose of musical and poetical contests, the judges being originally appointed by commissions from the native princes, and after the conquest from the English kings. There are two kinds of eisteddfodau, the national or general, and the provincial gatherings which take place in many parts of Wales. The last commission was issued by Queen Elizabeth in 1568, but the eisteddfod fell into abeyance during the seventeenth century. In 1798 the ancient custom was revived by the Gwynnedigion Society, and on a more elaborate scale by the Cambrian Society, which grew out of the Gwynnedigion. Eisteddfodau are now held annually in North and South Wales alternately, and are attended by many thousands of people. The festivals of 1919 and 1920 were held at Corwen and at Barry, Glamorgan, respectively.—Cf. Rhys and Brynmor Jones, *The Welsh People*.

Eject'ment, in law, an action wherein the title to lands and tenements may be tried and the possession recovered. It is commenced by a writ addressed to the tenant in possession and all entitled to defend the possession, bearing that the plaintiff lays claim to the property in question, and calling upon all interested to appear within a certain time to defend their rights. In its older form the action was remarkable for the curious fictions on which procedure was based. The names of John Doe, an imaginary plaintiff, and of Richard Roe, an imaginary defendant, were familiar in cases of this kind in the

English courts until 1852, when the Common Law Procedure Act abolished these fictitious suitors.

Ejector, in mechanical engineering, an appliance for ejecting gases, vapours, or liquids from closed spaces by the use of another gas, vapour, or liquid at a higher pressure. For instance, the air may be extracted from a condenser by an ejector. A jet of steam is directed along a short specially-shaped pipe leading from the condenser to the outside atmosphere. The velocity of the steam when it leaves the jet in the pipe is very high, and it blows out into the atmosphere in spite of the atmospheric pressure against it. In blowing out into the atmosphere it sucks the air in the condenser along with it, and after it has been in operation some time practically the whole of the air is sucked out of the condenser. The appliance works on the principle of momentum. The active jet mixes with the material to be ejected and imparts a common momentum to the mixture, which is sufficient to enable it to pass outside the vessel from which the ejection is taking place. The same principle is used in the mercury air-pump (see *Air-pump*).—**BIBLIOGRAPHY:** W. E. Dalby, *Steam Power*; *Modern Mechanical Engineering* (The Gresham Publishing Company).

Ekat'erinburg, a town, Russia, in the government and 170 miles S.E. of Perm, founded in 1723 by Peter the Great. It is the mining and metallurgy centre of the Ural regions; and gem-cutting, the making of machinery, cloth, and candles are industries. Pop. 70,000.

Ekat'erinodar, a town of Russia in the Caucasus, chief town of the Kuban territory, on the River Kuban, a poorly-built place with a considerable trade. Pop. 107,360.

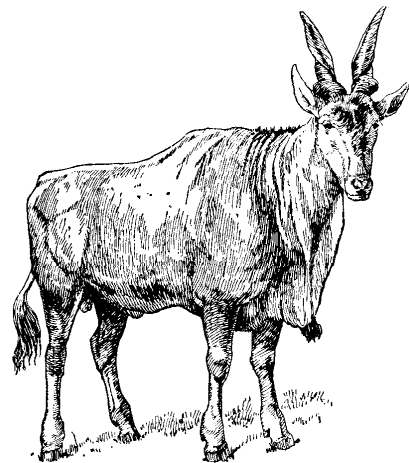
Ekat'erinoslav, a town of the Ukraine, capital of a government of the same name, on the right bank of the Dnieper, 250 miles N.E. of Odessa. Founded in 1787, it is a manufacturing centre, producing iron, machinery, tobacco, and beer. Pop. 220,100.—The government, which is intersected by the Dnieper and reaches the Sea of Azov, has great mineral wealth, especially in coal (Donetz basin), iron, manganese, and rock-salt; and its fertile black-earth soil produces abundant crops of wheat and other grains. Area, 24,478 sq. miles; pop. 3,537,300.

Elæagna´ceæ, the oleaster family of plants, a small nat. ord. of apetalous dicotyledons scattered over the northern regions. The only British member is the sea-buckthorn (*Hippophaë rhamnoides*).

Ela´in, the oily principle of fat obtained by submitting fat to the action of boiling alcohol, allowing the stearin to crystallize, and then evaporating the alcoholic solution. It is not unlike vegetable oil in its appearance and its properties, and forms soaps with alkalies.

E´lam, the ancient name of a country on the eastern border of Babylonia. Its civilization dates back beyond 3000 B.C. Before 2000 B.C. it was strong enough to subdue part of Babylonia. Its power was finally broken by the last Assyrian monarchs. The capital was Susa, which became prominent again after the rise of Cyrus. Its splendour during the Persian period is reflected in the *Book of Esther*, in which it is referred to as 'Shushan'.

E´land, *Oreas (Orias) canna*, a species of antelope inhabiting Africa, the largest of all its kind, being about the size of an ox. Its flesh, especially that of the thighs, which are dried and used in this state, is highly prized. It is now almost extinct south of the Limpopo, but it is plentiful in the Kalahari. The colour is a light or greyish brown, and it possesses a short mane. The horns, which are about 18 inches long and nearly straight, are spirally keeled.



Eland (*Oreas canna*)

El´anus, the name of certain species of raptorial birds of the genus *Elānus*, belonging to the kites. The type species is the black-winged kite (*E. cæruleus*) of Africa and South Asia, which strays to South-West Europe. A very similar form (*E. leucurus*) is native to tropical and subtropical America, and other species (*E. scriptus* and *E. axillaris*) are Australian.

Elaphomyces, a genus of Ascomycetous fungi, section Plectascineæ, with closed, subterranean ascus-fruits resembling those of the genuine truffles (Tuberineæ), but not closely allied to that family. *E. cervinus* (Hart's truffle)

is not infrequent in Britain; it forms 'mycorhiza' with roots of oak, beech, and various conifers.

E'laps, a genus of poisonous American snakes, the type of the family Elapidæ, to which belongs the cobra de capello.

El-Arish, Egyptian city on the Mediterranean, on the Wadi el-Arish, and chief city of the territory bearing the same name. It was taken by the French under Kléber in 1799, but abandoned the same year. Pop. about 5000.

Elasmobranchii (-brang'ki-i), a sub-class of fishes, including sharks, dog-fishes, rays (skates); and also Chimæra (q.v.) and its allies. They are predaceous forms, in which the mouth is a transverse slit on the under side of the head, the numerous simple teeth are in several rows (except in chimæroids), the short intestine possesses a spiral valve and opens into a cloaca. The tail is asymmetrical (heterocercal), and numerous placoid scales (dermal denticles) are embedded in the skin. The skeleton is cartilaginous; the heart possesses a muscular conus arteriosus with numerous rows of pocket-valves; and there are five (sometimes six or seven) pairs of gill-pouches opening by slits to the exterior, these not being covered by an external flap (operculum) except in chimæroids. Fertilization is internal, and the male is provided with a pair of copulatory organs (claspers) projecting backwards from the pelvic fins. The eggs sometimes develop within the body of the mother, but are usually laid in horny pouches (mermaids' purses). The group is of great antiquity, and many extinct fossil types are known.

Elasmothe'rium, an extinct genus of Mammalia, found in the post-Pliocene strata of Europe, comprising animals of great size allied to the rhinoceros, and having probably one large horn and a smaller nasal horn.

Elastic Bitumen, Elaterite, or Mineral Caoutchouc, an elastic mineral bitumen of a blackish-brown colour, and subtranslucent. It has been found at Castleton, in Derbyshire.

Elasticity, the property in virtue of which bodies resist change of volume or of shape, and tend to regain their original bulk or shape when the deforming forces are removed. Solids possess elasticity of volume and of shape. Liquids and gases have elasticity of volume; they resist compression, but

offer only a transient resistance to change of shape (see *Viscosity*). The elasticity of a gas is measured by the pressure to which the gas is subjected, if there is no change of temperature. When a gas is compressed suddenly, it has a greater elasticity on account of the rise of temperature which takes place. Liquids are less compressible than gases; water is compressed by about 1 part in 20,000 when the pressure on it is increased by one atmosphere. A knowledge of the elastic properties of solids is of importance in all branches of applied mechanics. Homogeneous solids offer definite resistance to compression, twisting, stretching, and bending, and this resistance is expressed by a number called a modulus. Let the deforming force be reckoned per unit of area, e.g. a pressure in tons per square inch; this is called the stress. The unital deformation produced by the stress is called the strain, for example, compression per unit of volume. The modulus is obtained by dividing the stress by the strain; if this is done with the above example, the ratio will give the bulk modulus. When the applied forces cause change of shape without change of volume, the ratio of stress to strain is called the shape modulus or the rigidity of the material. This property is brought into play when mechanical power is transmitted by means of shafting. Young's modulus is employed in the cases of stretching and bending. It is given by the ratio stretching force per unit area to stretch per unit length. In 1678 Hooke stated the law that stress is proportional to the strain which it causes. This law is found in practice to be true for metals within a certain range of stress which lies below the elastic limit. If the stress is increased beyond this limit, the material begins to give way, and permanent change of shape or volume takes place. In the processes of riveting and wire-drawing, the material is purposely strained beyond the elastic limit, whilst the correct working of a spring balance requires that the spring should never be overstrained. When metals are subjected to frequently repeated stresses, they undergo a weakening and are said to become fatigued, and are liable to give way under a smaller stress than would otherwise cause fracture. The speed with which sound waves are transmitted through a material depends on the elasticity of the material; such compressional waves in water have been employed by the Roumanian engineer, Constantinescu, to transmit power by means of water-pipes.

Mathematical Theory.—Consider an elastic body at rest and free from strain. Let the body be subjected to forces, fulfilling the ordinary statical

conditions of equilibrium, and therefore not tending to give the body any motion of translation or rotation as a whole. The particles of the body will move very slightly relative to each other; in other words, a system of strain will be set up in the body. To maintain this strain a definite system of stress is necessary. The problem for the mathematical theory is to determine the state of strain and stress at every point of the body when the applied forces are given. These applied forces may either be body forces (of which practically the only example is weight), or surface forces; the latter are pressures or tractions, and are defined by their directions and amounts per unit area. It is first of all necessary to show how strain and stress can be specified mathematically.

Strains.—If x, y, z are the co-ordinates of a point in the unstrained body, and if this point is displaced to $(x + u, y + v, z + w)$ when the straining forces are applied, then u, v, w , which are supposed to be very small, are called the component displacements at (x, y, z) . It is clear that if u, v, w were constant, the body would simply be displaced without strain. The state of strain can in fact be shown to depend on the first derivatives of u, v, w with respect to x, y, z . The strain round any given point consists simply of three stretches parallel to a certain set of three mutually perpendicular directions. These directions vary from point to point, so that this specification of the strain is inconvenient for calculations. A suitable method depends on the fact that the strain is known round a point when we know the values of the six quantities

$$\frac{du}{dx}, \frac{dv}{dy}, \frac{dw}{dz}, \frac{dw}{dy} + \frac{dv}{dz}, \frac{du}{dz} + \frac{dw}{dx}, \frac{dv}{dx} + \frac{du}{dy},$$

at the point. These are called the components of strain at (x, y, z) . The first three are *stretches* parallel to the axes, the other three are *shearing* strains. We may get an idea of the nature of these strains from two simple typical cases. 1. Let $u = ex, v = 0, w = 0$. This makes $du/dx = e$, and the other five strains zero. But we see that the displacement of every particle is perpendicular to the yz plane, and proportional to its distance from that plane. Every line parallel to the axis of x is therefore elongated by a definite fraction of its original length, the value of this fraction being e , which is du/dx . The strains $du/dx, dv/dy, dw/dz$ are therefore *stretches* parallel to the axes. 2. Let $u = 0, v = cz, w = 0$. This gives $dv/dz + du/dy = c$, and the other

five strains zero. The displacement of every particle is parallel to the axis of y , and proportional to its distance from the plane xy . The strain is therefore a slide, or *shear* of planes parallel to xy in the direction of the axis of y .

Stresses.—To specify the stress round a point (x, y, z) , consider a small plane area through the point. The material on one side of this acts on the material on the other side with a certain force whose components parallel to the axes are F, G, H , say, per unit area. If we know F, G, H for every orientation of the small plane area, the state of stress round (x, y, z) is defined. But it is easy to show, as below, that we can find F, G, H for every area if we know them for areas parallel to the co-ordinate planes. We are thus led to the specification of the stress round (x, y, z) by the six *components of stress*, xx, yy, zz, xy, xz, yz ; where xy , for example, means the force per unit area *parallel* to Ox exerted on a plane *perpendicular* to Oy by the material on the positive side of that plane on the material on its negative side. Thus e.g. the components of the force per unit area exerted across the yz plane through (x, y, z) by the material on the positive side of that plane are xx, xy, xz . It is important to note that $xy = yx$. This is easily proved by considering the equilibrium of a small rectangular volume of the material round (x, y, z) as centre, with its edges parallel to the axes; if xy were not equal to yx , there would be a residual couple in the plane xy .

Relations between the Strains and the Stresses.—When the strains are known, the stresses can be found from a generalized Hooke's law, which can be deduced from the principle of energy, combined with consideration of symmetry. If the solid is isotropic, i.e. is symmetrical in its elastic properties in all directions round a point, the relations between stress and strain are of the form

$$\begin{aligned}\overline{xx} &= \lambda \left(\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} \right) + 2\mu \frac{du}{dx}, \\ \overline{yz} &= \mu \left(\frac{dw}{dy} + \frac{dv}{dz} \right); \end{aligned}$$

the values of the other four components of strain can be written down from symmetry. Here λ and μ are constants, each being a *modulus* of elasticity. In particular μ is the *shape modulus* or the *rigidity*, already referred to. The

Young's modulus and the bulk modulus can easily be found in terms of λ and μ .

Equations of Equilibrium in Terms of the Stresses.—A rectangular element dx, dy, dz , of the body is held in equilibrium by the body force, and the tractions on its faces arising from the stress. The tractions per unit area, parallel to the axis of x , on the six faces, are: on the plane x , $-xx$; on the plane $x + dx$, $xx + (d/dx \, xx)dx$; on the plane y , $-xy$; on the plane $y + dy$, $xy + (d/dy \, xy)dy$; and similarly for the plane z . Let the force acting on the mass of the body, such as its weight, be (X, Y, Z) per unit mass, and let ρ be the density. By equating the sum of the x components of all the forces to zero, we get

$$\begin{aligned} & \frac{dxx}{dx} + \frac{dxy}{dy} + \frac{dxz}{dz} + \rho X = 0; \\ \text{Similarly } & \frac{dxy}{dx} + \frac{dyy}{dy} + \frac{dyz}{dz} + \rho Y = 0, \\ \text{and } & \frac{dxz}{dx} + \frac{dyz}{dy} + \frac{dzz}{dz} + \rho Z = 0. \end{aligned}$$

The Surface Traction in Terms of the Stresses.—Draw a small tetrahedron round (x, y, z) with its faces perpendicular to the axes and to the direction (l, m, n) , and consider the equilibrium of this small body. Let F, G, H be the components per unit area of the force on the plane whose direction cosines, *drawn outwards*, are l, m, n . If A be the area of the face perpendicular to (l, m, n) , we get, by resolving parallel to Ox ,

$$F \cdot A = \overline{xx} \cdot lA + \overline{xy} \cdot mA + \overline{xz} \cdot nA.$$

$$\text{Hence } F = \overline{lx} + \overline{mxy} + \overline{nxz},$$

$$\text{and similarly } G = \overline{lxy} + \overline{myy} + \overline{nyz},$$

$$H = \overline{lxz} + \overline{myz} + \overline{nz}.$$

If (x, y, z) is a point at the surface of the body, and l, m, n are the direction cosines of the outward normal at that point, these values of F, G, H are the

component of the force that must be applied from outside to the surface at (x, y, z) to maintain the state of stress.

The Equations connecting the Displacements and the Applied Forces.—By using, in the equations of equilibrium, the values of the stresses in terms of the strains, we find the body equations of equilibrium in terms of displacements,

$$\mu \left(\frac{d^2u}{dx^2} + \frac{d^2u}{dy^2} + \frac{d^2u}{dz^2} \right) + (\lambda + \mu) \frac{d}{dx} \left(\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} \right) + X_Q = 0,$$

with two similar equations.

The surface equations of equilibrium can also be written down at once by substituting the values of stresses in terms of strains in the expressions for F, G, H given above.

The Problem of Equilibrium.—To find the strain under given forces we have to solve the body and surface equations of equilibrium, when X, Y, Z and F, G, H are given. This problem has not been completely solved except in a few cases. It was solved by Lamé and Lord Kelvin for a solid or hollow sphere; it has also been solved for an infinite solid bounded by two parallel planes, or by a circular cylinder. Many particular solutions, however, are known for bodies of other shapes. Some of these solutions are of great practical value, e.g. St. Venant's solutions for the torsion and flexure of prisms. For bodies in which one or two dimensions are small, i.e. for thin plates and shells, and for thin rods, approximate theories have been given, which are partly deduced from the above exact equations, and partly from plausible hypotheses, a complete treatment based on the exact equations being in most cases impracticable.

The Problem of Vibrations.—When a body is vibrating, the mass acceleration parallel to Ox of the particle at (x, y, z) is $\rho \, dx \, dy \, dz \, d^2u/dt^2$. The equations of vibration are therefore found by writing $-d^2u/dt^2$ instead of X , in the first body equation of equilibrium, and similarly with the others. The surface conditions will usually be that F, G, H are zero. The problem has been completely solved by H. Lamb for a solid or hollow sphere. For the elastic solid theory of the luminiferous ether, see *Ether*; for

some practical solutions of the general equations of equilibrium, see *Strength of Materials*.—BIBLIOGRAPHY: A. E. H. Love, *Mathematical Theory of Elasticity*; Lord Kelvin and Tait, *Natural Philosophy*; Todhunter and Pearson, *History of Elasticity and Strength of Materials*.

El'ateridæ, the name of a family of beetles, remarkable for their ability to throw themselves to a considerable height in the air, when placed on their back, by a vigorous muscular movement. Hence their names of springing-beetles, click-beetles, skip-jacks, &c. When alarmed, the elater counterfeits death. Flowers, grass, and decaying wood are the habitations of these animals, which are almost always found singly. The larvæ are often very injurious to vegetation, especially those which devour the roots of herbaceous plants (as in the genus *Agriōtes*), and are known from their slenderness and hardness as wire-worms. The fireflies of America belong to the family. In these a pair of luminous organs is found on the thorax, while there is a third on the under side of the base of the abdomen. The *Pyrophorus noctilucus*, called *cucujos* in Brazil, is used as a personal ornament by ladies. The largest species of the genus *Elater*, the *Elater flabellicornis*, is 2½ inches in length.

Elate'rium, a substance obtained from the fruit of the squirting or wild cucumber (*Ecballium agreste*). The juice of the unripe fruit, when expressed and allowed to stand, deposits elaterium as a green sediment with an acrid taste, a faint odour, and powerful cathartic properties. It is a violent purgative, and is poisonous, but its action is not constant. The active principle in it is called *elaterin*.

Elba (Lat. *Ilva*), a small island in the Mediterranean, in the province of Livorno (Leghorn), Italy, separated from the mainland by the Strait of Piombino, about 6 miles wide. The island is 18 miles long and from 2½ to 10½ miles broad, and is traversed by mountains rising to a height of over 3000 feet. It is rich in iron, marble, granite, salt, &c.; and iron ore is exported. Excellent wine and fruits are produced. It has two seaports—Porto-Ferraio (the capital) and Porto-Longone. The Treaty of Paris in 1814 erected Elba into a sovereignty for Napoleon, who resided in it from 4th May, 1814, to 26th Feb., 1815, when he escaped and landed at Cannes on 1st March. After Napoleon's departure the island was restored to Tuscany, which became part of Italy in 1860. Pop. 30,450.

Elbe (elb; Ger., pronounced el'be; Lat. *Albis*; Bohem. *Labe*), an important river in Central Europe. It rises on the south-west slopes of the Schneekoppe or Snowcap, one of the Riesengebirge, between Bohemia and Silesia. From this point it flows nearly due south into Bohemia for about 50 miles, when it turns to the west, and after about 40 miles takes a general north-north-west direction till it falls into the North Sea, intersecting Saxony and a considerable portion of Prussia. The finest scenery of its valley is in the Saxon Switzerland. Its length is 725 miles; drainage area, 56,865 sq. miles. The principal affluents are: on the right, the Iser, Schwarz-Elster, and Havel; on the left, the Alder, Moldau, Eger, Mulde, and Saale. In the lower part of its course the river divides into several arms, which unite again about 5 miles below Hamburg. It is more or less navigable for about 525 miles, but its estuary is much encumbered with sand-banks. In 1870 its navigation was declared free from Hamburg to Melnik in Bohemia. The North Sea and Baltic ship canal connects its estuary with Kiel Bay, and there are other important connected canals. It is well stocked with fish.

Elberfeld (el'bër-felt), a town of Rhenish Prussia, in the government of and 15 miles east of Düsseldorf, on both sides of the Wupper, enclosed by lofty hills. Taken with Barmen it stretches along the Wupper valley for about 7 miles. The old streets are narrow and irregular, but the newer quarters are well built. It is a great seat of manufacturing industry, among its leading products being cottons, woollens, silks, velvet, mixed textile goods, buttons, ribbons, lace, yarns, thread, carpets, aniline dyes, iron and steel, machinery, pianofortes, and paper. Calico-printing, dyeing, and bleaching are very extensively carried on. It has given its name to a system of poor relief, combining organized voluntary effort and individual treatment. Pop. 170,195.

Elbeuf (el-beuf), a town of France, department of Seine-Inférieure, 11 miles s.s.w. of Rouen, in a valley on the left bank of the Seine, connected by two bridges with St. Aubin on the opposite side of the river. It is an important centre for the production of woollen manufactures, chiefly of lighter cloths and fancy goods, and is also an entrepôt for the finer and heavier cloths of Louviers and Sedan. It communicates by steamers with Paris, Rouen, and Havre. Pop. 19,240.

Elbing, a seaport town of West Prussia, on the Elbing, near its entrance into the Frische-Haff. It was once a flourishing Hanse town, and is still a place of considerable industry and trade, the manufactures including iron goods, machinery, brass and tinplate goods. It has also shipbuilding yards. Pop. 58,636.

Elburz, a lofty mountain range extending over Northern Persia, parallel with and overlooking the Caspian. Highest peak, Mt. Demavend, 19,400 feet; average height, 6000 to 8000 feet.

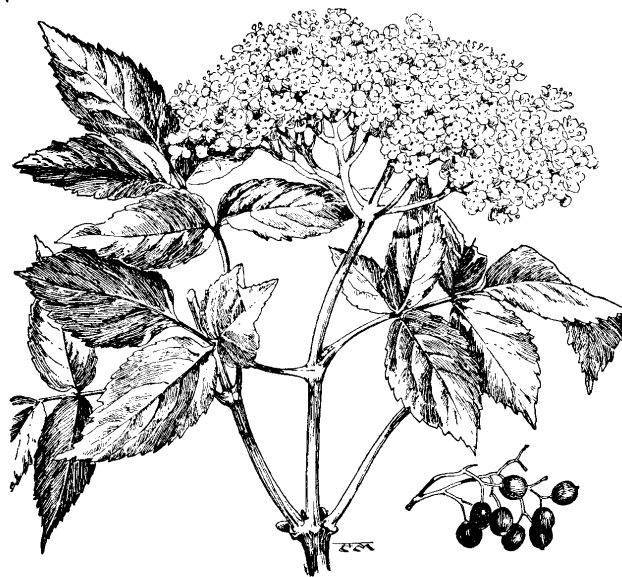
Elcesaites (el-ses'a-īts), a sect of Gnostics which arose in the reign of Trajan about the beginning of the second century. They were a branch of the Essenes, and resembled the Ebionites. A Jew, named Elxai, or Elkesai, is their reputed founder.

Elche (el'chā), a town of Spain, in the province and 14 miles w.s.w. of Alicante, on the left bank of the Vinalopo, surrounded by palm trees. It contains various Roman remains, a fine church, and a town house of the fifteenth century. Chief industry, the culture of dates. Each summer, from the 13th to the 15th of August, an interesting fête is held at Elche, and a fourteenth century liturgical drama (*The Representation of the Assumption of Our Lady St. Mary*) is performed. Pop. 27,620.

Elchingen (el'hing-en), **Ober** and **Unter**, two villages of Bavaria, on the left bank of the Danube, about 3 miles apart and 8 miles north-east of Ulm. In 1805 Marshal Ney defeated the Austrians at Ober Elchingen, and won for himself the title of Duke of Elchingen.

Elder, a name given to different species of the genus *Sambucus*, nat. ord. Caprifoliaceæ. These are small trees or shrubs, with opposite and pinnated leaves, bearing small white flowers in large and conspicuous corymbs, small berries of a black or red colour, and bitter and nauseous leaves possessing purgative and emetic properties. The wood of the young shoots contains a very large proportion of pith. The common elder of Britain (*S. nigra*) is a wild shrub or small tree, distinguishable by its winged leaves, its clusters of small, cream-white flowers, and the small black berries by which these are succeeded, and from which a kind of wine is sometimes made. The dwarf elder or danewort (*S. Ebulus*) is also found in many parts of Britain, and was popularly supposed to have sprung from the blood of the

Danes. Two species inhabit North America: *S. canadensis*, a common plant from the 49th to the 30th parallel of latitude, the berries of which are black and have a sweet taste; and *S. pubescens*, which bears red berries, and inhabits Canada, the northern parts of New England, and the Alleghany Mountains. Elder wood is yellow, and in old trees becomes so hard that it is often substituted for box-wood. Its toughness, also, is such that it is



Common Elder: Foliage, Inflorescence, and Fruit

made into skewers and tops for fishing-rods. The light pith is utilized for balls for electric experiments, and various ointments, drinks, and medicinal decoctions are made from the bark, leaves, flowers, and berries.

Elders, persons who, on account of their age, experience, and wisdom, are selected for office, as, among the Jews, the seventy men associated with Moses in the government of the people. In the modern Presbyterian Churches elders are officers who, with the pastors or ministers, compose the consistories or kirk-sessions, with authority to inspect and regulate matters of religion and discipline in the congregation. As a member of the kirk-session the elder has an equal vote with his minister, and as a member of the higher Church courts, when delegated thereto, he has a right to discuss and vote on all matters under discussion in the same manner as the clergy themselves. In the Mormon Church the elder is an officer whose duty it is "to preach and baptize, to ordain other elders, to bless children, and to take the lead at all meetings". Among the Shakers there are four elders, two men and two women, in each congregation.

Eldon, John Scott, Earl of, Lord Chancellor of England, born in 1751 at Newcastle-on-Tyne, died in London, 13th Jan., 1838. His father was a coal-dealer and public-house keeper of means, and John was educated with his brother William (afterwards Lord Stowell) at Newcastle, and at Oxford, where he obtained a fellowship. He was called to the Bar in 1776, and in

1782 was made King's Counsel. Next year he entered Parliament, supported Pitt, and was made Solicitor-General, and knighted. In 1792 he purchased the estate of Eldon. In 1793 he became Attorney-General, and in 1799 was created Chief Justice of the Court of Common Pleas, and raised to the peerage and the House of Lords by the title of Baron Eldon. On the accession of the Addington ministry he became Lord Chancellor (1801), and retained this post under the subsequent administration of Pitt until the death of the latter in 1806. A year later, however, he resumed the chancellorship under Liverpool, and held it without break for twenty years. In 1821 he was created an earl by George IV. On the accession of the Canning ministry in 1827 he resigned the chancellorship, and never again held office. As a lawyer he was a master of English jurisprudence; as a politician he was opposed to reform, and by no means free from the charge of servility and intrigue.

El Dora'do, a country that Orellana, the lieutenant of Pizarro, pretended he had discovered in South America, between the Orinoco and Amazon Rivers; and which he named thus on account of the immense quantities of gold and precious metals which, he asserted, he had seen in Manoa, the capital of the country. The term El Dorado was first applied to a South American tribal king who was said to cover his body annually with gold-dust. It now designates any place abounding in gold, or offering opportunities for the acquisition of sudden wealth.

Eleanor Crosses (el'i-nor), memorial crosses erected on the spots where the bier of Eleanor, the wife of Edward I, rested on its way from Grantham to Westminster. Twelve were erected, but only three, those of Northampton, Geddington, and Waltham, remain.

Eleat'ic School, a Grecian philosophical sect, so called because it originated in Elea (Lat. *Velia*), a town of Magna Græcia (Southern Italy), of which also three of its most celebrated teachers, Parmenides, Zeno, and Leucippus, were natives. The founder was Xenophanes of Colophon, who came to Elea late in life, bringing with him the physical theories of the Ionian school, to which he added a metaphysic. The two schools soon drifted widely apart, especially in respect of method. In opposition to the physical philosophy of the Ionian school, and also the doctrine of Heraclitus, who taught that everything is flux, the Eleatic philosophers

asserted that change and difference are only empty illusions, and that the only true reality is changeless being. Starting from the observation of external nature, the Ionians endeavoured to discover some elementary principle, as water, air, fire, or a combination of elements, by the action of which the phenomena they observed might be accounted for. The Eleans made the abstract idea of Being or God, deduced from the contemplation of the Universe as a whole, their starting-point. Their reasonings sometimes led them to deny the reality of external phenomena altogether.

Elecampane (el-i-kam-pān'; *Inŭla Helēnium*), a plant of the nat. ord. Compositæ, found in Britain and other parts of Europe, and in Asia. It is 3 or 4 feet high; the radical leaves are often 2 feet and more in length; the flowers are large and yellow; the root, which is perennial, possesses a bitter camphor-like taste. It was formerly much used as a stimulant for all the secreting organs, and in tuberculosis on account of the germicidal action of the bitter principle (helenin) which it contains.

Election, in theology, the doctrine that God has from the beginning elected a portion of mankind to eternal life, passing by the remainder. It is founded on the literal sense of certain passages of Scripture, and has been amplified by the labours of systematic theologians into a complete and logical system. It dates in ecclesiastical history from the time of Augustine; but Calvin has stated it so strongly and clearly in his *Institutes* that it is generally associated with his name.

Election, in politics, the selection by voting of a person or persons to occupy some post or office. The most important elections are those of the members of the legislative assemblies of the different countries, and as to the manner in which these are carried out strict laws are in force. In such elections voting by ballot is now general. The chief forms of election in Britain are parliamentary and municipal elections, in both of which the basis of the suffrage (or right of voting) is the payment of poor rates. Members of Parliament formerly required a property qualification in England and Ireland; but this restriction, which never existed in Scotland, has been abolished. In both parliamentary and municipal elections the ballot has been in operation since 1872. For the prevention of bribery and corrupt practices many Acts have been passed, of which that now in operation came into force in Oct., 1883, and has been annually renewed. By it persons

convicted of treating, bribery, personation, and undue influence are liable to imprisonment with hard labour, and to disqualification in respect of the franchise and public offices. It also imposes many limitations with regard to the number of assistants and committee-rooms, and the use of conveyances. By the Reform Act of 1918, the maximum expenditure for campaign purposes during parliamentary elections is to be sevenpence per elector in county constituencies, and fivepence per elector in boroughs. By this Act the cost of registration is paid half out of local rates, and half by the State. At election times the returning officer's expenses are to be paid by the Treasury. Under the provisions of the Ballot Act the returning officer is required, in the case of a county election, to give notice of an election within two days after that on which he receives the writ; or in the case of a borough election, to give notice on the day on which he receives the writ, or at the latest on the day following. In county or district borough elections the nomination must take place within ten days of the receipt of the writ, at least three clear days, however, being allowed to elapse between the first public notice and the day of nomination. In ordinary borough elections the candidate must be nominated not earlier than the third day after public notice, and not later than the fourth day after that on which the writ is received. A candidate is nominated in writing, with the signatures of a proposer, seconder, and eight other electors, all registered in the constituency to be represented. In the event of there being more candidates than vacancies, the returning officer adjourns the election for the purpose of taking a poll. The polling must take place not less than two or more than six clear days after the day of nomination, if it be a county or district borough election; in the case of an ordinary borough, it must take place not more than three clear days after nomination, Sundays, Christmas Day, &c., not being counted as days. Where the votes for rival candidates are equal, the returning officer, if registered in the constituency, may give the casting-vote. If he decline to do so, a scrutiny is demanded, which usually results in certain deductions on the ground of spoiled papers, disqualified voters, &c., sufficient to give one candidate priority. In elections for the school boards the cumulative system of voting is employed (see *Cumulative Vote*).—Cf. C. Seymour and D. P. Frary, *How the World Votes*.

Elector (Ger. *Kurfürst*, 'electoral prince'), the title of certain princes of the Holy Roman Empire, who had the right of electing the emperors. In the

reign of Conrad I, King of Germany (912-918), the dukes and counts became gradually independent of the sovereign, and assumed the right of choosing future monarchs. In the thirteenth century the number of these electors was seven—the Archbishops of Mainz, Cologne, and Trèves, the King of Bohemia, the Count Palatine, the Duke of Saxony, and the Margrave of Brandenburg. In 1648 an eighth electorate was created to make room for Bavaria, and Hanover was added as a ninth in 1692. The votes of the Palatinate and of Bavaria were merged in one in 1777. In 1802 the two ecclesiastical electors of Cologne and Trèves were set aside, and Baden, Würtemberg, Hesse-Cassel, and Salzburg declared electorates; so that there were ten electors in 1806 when the old German Empire was dissolved.—Cf. Viscount Bryce, *The Holy Roman Empire*.

Electrical Fishes, a name given to fishes possessing the property of communicating an electric shock when touched with the hand or any electric conductor. One of the best known is the electric eel (*Gymnōtus electricus*), a native of South America. It is of nearly equal thickness throughout; head and tail obtuse; ordinary length, 3½ to 4 feet. The seat of the four electrical organs is along the under side of the tail, and they are said to possess the power of knocking down a man, and of painfully numbing the affected limb for several hours after the shock. After a few discharges, however, the faculty of producing a shock is impaired, and an interval of rest is required for a new storage of force. Similar but less-marked powers are possessed by an African cat-fish (*Malapterurus electricus*), in which the electric organ invests the entire body as a sort of jacket under the skin. Still feebler in this respect are the electric rays, of which the best known (species of *Torpedo*) are native to the Mediterranean, Red Sea, Atlantic, and Pacific Oceans. Here the electric organ consists of a large mass on each side of the front part of the body.

Electrical Measuring Instruments, the name given to instruments which measure electric power, energy, voltage, or current. The majority of such instruments are current-operated. Thus, with the exception of electrostatic voltmeters, all voltmeters are really current measuring instruments; but since this current is made to be proportional to the P.D. between the voltmeter terminals, the scale reading is proportional to the voltage being measured. One and the same instrument may be used as an ammeter or as a voltmeter, by providing it with shunts for use as an ammeter, and series

resistances for use as a voltmeter. If the current to be measured is large, the *shunt* will have a very *low* resistance compared with that of the instrument, so that only a small fraction of the total current passes through the instrument. Similarly, when a large P.D. is being measured, the *series resistance* will have a very *high* value, so that the current through the instrument may not exceed that which gives full-scale reading. By using shunts or series resistances of different values, different ranges can be given to the instruments.

In addition to the types already described (see *Ammeter*), there is a class depending on the mutual action of current-carrying conductors placed near one another. This type is largely used in alternating-current work. It is also specially suitable for power measurements, and practically all *wattmeters* work on this principle. The Siemens Dynamometer was the first instrument of this type.

The Kelvin Standard Balance is a special form of dynamometer, in which the mechanical turning-moment due to weights on a beam is balanced by the electrical turning-moment due to currents in fixed coils and in coils attached to the ends of the beam. The electrostatic voltmeter mentioned above is the only instrument which is operated by a P.D. instead of a current. In it a moving vane is attracted into a fixed pair of quadrants; or a set of vanes is attracted into a set of quadrant cells.

The majority of electricity meters are of the motor type, i.e. a disc is driven by motor action at a speed which is proportional to the power passing through the meter. The disc spindle engages with gearing which drives the pointers on a set of dials recording the energy units. There are also meters depending on electrolytic action (Wright meter); or on the difference in period between two pendulums, one of which is controlled by the load current (Aron meter).

Electric Battery, a group of primary or secondary cells, suitably arranged for the purpose of producing an electric current. Primary batteries consisting of a few cells are commonly used for intermittent work where a relatively small current is required, e.g. for electric bells. If a larger current is necessary, especially if it has to be maintained over a considerable period, a battery of secondary cells is used. Such batteries are commonly used for

country house lighting. Very large batteries, used either alone or in conjunction with automatic reversible boosters, are frequently employed in public electric supply systems.

The name *electric battery* was originally given to an arrangement of Leyden jars (see *Leyden Jar*), but is now applied only to cells, the Leyden-jar arrangement being called a Leyden-jar battery.

Electricity, the name given to the ultimate cause of electrical phenomena. The laws governing these phenomena are well known, but the actual nature of electricity has not yet been fully revealed, although much light has been thrown on the subject by recent researches. (See *Electron*.) Although the practical applications of electrical phenomena have all been developed within the last fifty years, the production of an electric charge by friction, as demonstrated by the power of rubbed amber to attract light bodies, was observed by a Greek philosopher as long ago as 600 B.C. The Greek name for amber, ἤλεκτρον (*electron*), is the root from which our word electricity is derived. Friction was the only artificial source of electricity known until Galvani, near the close of the eighteenth century, accidentally obtained it by the contact of two metals with the limbs of a frog; and Volta, developing Galvani's discovery, invented the first galvanic or voltaic battery.

The discovery by Faraday in 1831 of the principle of the production of an electromotive force by the motion of a conductor in a magnetic field, laid the foundation for the development of the electric generator (q.v.), and thus of modern electric power supply.

The study of electrical phenomena is conveniently divided into two branches, one dealing with stationary charges of electricity (*electrostatics*), the other with electric currents (*current electricity*).

Electrostatics.—If a pair of ebonite rods be electrified by friction with flannel, then by suspending the one rod and presenting the other to it, it is easily demonstrated that a mutual mechanical force of repulsion exists between them. If now a glass rod be electrified by friction with silk, it will be found that it attracts the suspended electrified ebonite rod. These experiments reveal the facts that electric charges may be of two opposite kinds, and that like charges repel one another, while unlike charges attract one another.

The charge produced on glass by friction with silk is called *positive*; that produced on ebonite by friction with flannel is called *negative*. The kind of charge produced depends not merely on the material rubbed, but also on the material of the rubber. Thus a warm dry glass rod becomes *negatively* electrified when rubbed with fur. The rubber always becomes electrified with a charge of the *opposite* kind to that produced on the material rubbed, and these two charges are *equal in amount*. All bodies may be electrified by friction, but those which allow a free movement of the charge over them (such bodies are called *conductors*, to distinguish them from *insulators*, which do not allow this free movement) must be held by an insulating handle, or else the charge will be removed as quickly as it is produced.

Coulomb proved that the magnitude of the mutual mechanical force exerted between two charged bodies depends on the amounts of the charges and the distance between them. Faraday called attention to the influence of the medium in which the charges are placed. Thus if two charges of q_1 and q_2 units respectively are placed d centimetres apart in a given medium, the mechanical force f in dynes exerted between them is given by the equation $f = (q_1 q_2) / (K d^2)$, provided the dimensions of the bodies on which the charges are concentrated are small in comparison with d . The coefficient K is called the *dielectric constant* of the medium, and its value is taken as unity for air.

In accordance with this relationship, *unit charge* is defined as that charge which repels an equal and similar charge placed at a distance of 1 centimetre in air, with a force of 1 dyne.

If the medium surrounding a charged body be explored with a unit charge, a mechanical force varying in magnitude and direction from point to point will be found to act on the unit charge. In such a case, an *electric field* is said to exist in the medium.

The *strength of the electric field* at any point is defined as numerically equal to the mechanical force which would act on a unit charge placed in air (or more strictly in a vacuum) at that point. The *direction* of the electric field at any point is defined to be the direction of the mechanical force acting on a unit *positive* charge placed at that point.

It should be noted that the strength of the electric field and the mechanical force are numerically equal only when the dielectric constant of the medium is unity. Thus if F is the field strength, K the dielectric constant, and U the mechanical force acting on a unit charge, $F = KU$.

It is very convenient to represent an electric field by means of what are called *lines of electric force*. If lines are drawn, starting from a positive charge and ending on a negative charge, such that the tangent to the line at any point is the direction of the electric force at that point, these lines are called lines of electric force. They can be drawn in such a way that the strength of the electric field at any point is numerically equal to the number of lines of electric force passing through unit area surrounding that point (and taken at right angles to the direction of the force). The lines of electric force will thus completely represent the electric field.

Further, if the following properties are attributed to the lines of electric force, viz. (a) that a line of electric force tends to shorten itself as far as possible; (b) that lines of electric force mutually repel one another; then all the phenomena due to the presence of an electric field may be interpreted by the behaviour of the lines of electric force.

Figs. 1 and 2 show the lines of electric force in the space surrounding two charged spheres. Fig. 1 shows the case where the charges are opposite, fig. 2 the case where they are similar. In fig. 1 the attraction between the spheres may be thought of as due to the tendency of the lines of force to shorten themselves. Similarly, the mutual repulsion of the spheres in fig. 2 may be regarded as a consequence of the mutual repulsion of the lines of force.

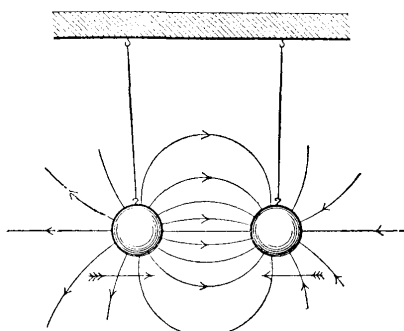
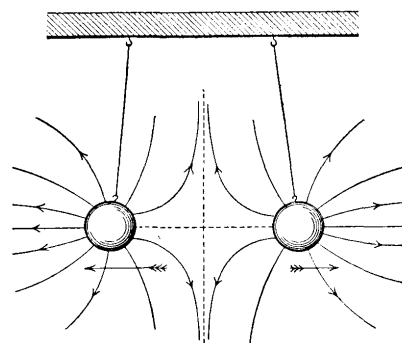


Fig. 1

The distribution of a charge upon an insulated conductor isolated in space depends upon the shape of the conductor. If the conductor is



spherical, the charge is uniformly distributed.

Fig. 2

If the curvature varies from point to point, the quantity of charge per unit area, or the *electric surface density*, will vary from point to point. The sharper the curvature is, the greater the surface density will be. In fig. 3 the distance of the dotted lines from the surface of the conductors is proportional to the surface density. These lines, therefore, give a graphical representation of the distribution of charge. In sharply pointed conductors nearly the whole charge will be concentrated at the pointed end. Owing to the large charge per unit area at the pointed part, particles of dust, water-vapour, &c., will be powerfully attracted, will become charged by conduction, and will then be powerfully repelled. In this way the original charge will be rapidly dissipated. This effect may be shown by keeping a sharply pointed conductor powerfully charged by an electric machine. The streaming of the particles from the point produces a wind which is sufficient to blow out the flame of a candle.

Conductors which are intended to retain their charge for a long period must be smooth and polished, and the maximum curvature must be as small as possible. In lightning-conductors practical advantage is taken of this 'power of points' to dissipate a charge rapidly.

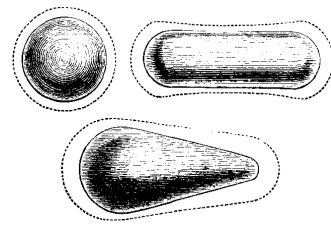


Fig. 3

The distribution of the charge on a conductor is influenced by the presence of other conductors, whether charged or not. This is due to what is called *electrostatic induction*. If an uncharged insulated conductor B is brought near a charged conductor A, a charge of the *opposite* kind is induced on the parts of B nearer to A, and a charge of the *same* kind on the parts farther away from A. Since B was originally uncharged, these induced charges are equal in amount.

If B is now removed to a distance, the induced charges neutralize one another, and B returns to its original uncharged state.

While B is near A, let the induced charge of the *same* kind as the charge on A be neutralized by touching B with an earth-connected conductor, say the finger. On removing B to a distance, it will no longer be uncharged as

before, but will have a charge of the *opposite* kind from that on A. B is now said to have been *charged by induction*.

It is instructive to view these phenomena in the light of the conception of lines of electric force. When B is brought up towards A, some of the lines of force associated with the charge on A, and originally linked to surrounding objects, will now, owing to the tendency of the lines to shorten themselves, be linked to B. At the same time an equal number of lines (of opposite direction relative to B) will link B to the nearest surrounding objects.

Since by definition a line of force starts from a positive charge and ends on a negative charge, the charge on the parts of B nearer to A will be of the *opposite* kind to that on A, but the charge on the part farther from A will be of the *same* kind as that on A. When the earth-connected conductor is brought near B, the lines formerly linking B to surrounding objects will link B to the earth-connected conductor. Finally, when the latter touches B, these lines shorten themselves indefinitely and disappear.

The attraction of light particles to a charged body is explained by electrostatic induction. The charge of opposite kind induced on the particle being nearer than that of the same kind, the particle is attracted. When it touches the charged body, the charge of opposite kind is neutralized, and the charge of like kind now left on the particle causes repulsion to take place. If the electrified body is an insulator, the neutralization of the charges only takes place slowly, and consequently it may be some time before the particle is repelled.

If two charged conductors be connected by a wire, in general it will be found that a flow of electricity from one to the other will take place. This flow is said to be due to a *difference of electric potential* between the two conductors. If no flow takes place, then the difference of potential is zero. Electric potential difference (the contraction P.D. is commonly used) is numerically equal to the work done in carrying a unit charge

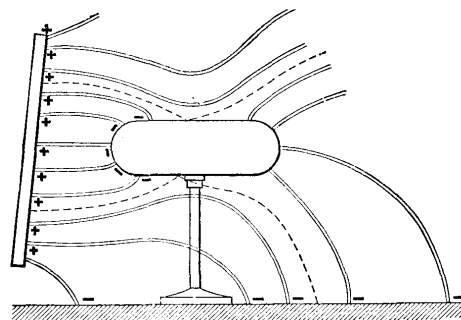


Fig. 4.—Induction, and Lines (or tubes) of Force

from the one conductor to the other. If the work is done *against* the electric forces, in moving a unit positive charge from A to B, then B is said to be at a higher potential than A. Although actually it is with *differences* of potential that we have always to deal, it is convenient in many cases to refer these differences to a zero, and speak of *the potential* at a point. The ideal zero of potential would be the potential at a point infinitely far removed from all electrified bodies. In practice it is convenient to regard the potential of the earth as zero. The potential at a point is then numerically equal to the work done in carrying a unit positive charge from earth to the point. The potential at every point on a conductor is obviously the same, for if it were not so, a flow of charge would take place and equalize the potential. If an insulated uncharged conductor be connected by a wire to a charged conductor, a flow of charge will take place until every point on both conductors is at the same potential. The quantity of charge which each conductor will then have depends on what is called the *capacity* of the conductor.

The *capacity of a conductor* is defined as the quantity of electricity with which it must be charged in order to raise its potential from zero to unity. Thus if Q be the quantity, V the potential, and C the capacity, we have $C = Q/V$. The potential of a conductor is, therefore, directly proportional to the charge upon the conductor, and inversely proportional to the capacity of the conductor.

The capacity of a conductor may be increased by placing close to it another conductor which is kept at zero potential. Such an arrangement is called a condenser. The Leyden jar (see *Leyden Jar*) is a well-known example of a condenser. The capacity depends not merely on the dimensions of the conductors and the distance between them, but also upon the nature of the dielectric separating them. The ratio of the capacity of a condenser with a given dielectric to the capacity it would have with an air dielectric, is called the *specific inductive capacity* of the dielectric. Numerically the specific inductive capacity of a dielectric is equal to the dielectric constant already mentioned.

In the experimental investigation of electrostatic phenomena it is convenient to have appliances which will supply charges as they are required. The simplest appliance of this kind is the electrophorus, which

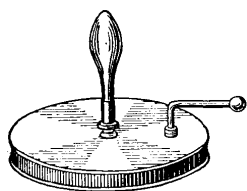


Fig. 5.—
Electrophorus

consists of a disc of ebonite or other suitable material with a metallic base, and a metal disc of slightly smaller diameter having an insulating handle attached at right angles to its surface (see fig. 5). To use the electrophorus, the ebonite is given a negative charge by striking it with fur or flannel. The metal disc is then placed on top of the ebonite plate. Since the ebonite is an insulator, no general neutralization of the positive induced charge on the lower side of the metal disc can take place. The negative charge on the upper surface of the metal disc is then neutralized by touching with the finger. The disc is thus left positively charged. The disc is then lifted by the insulating handle, and the charge utilized as required. Theoretically speaking, this process may be repeated continuously without affecting the original charge on the ebonite plate, but in practice the ebonite has to be re-excited from time to time on account of the loss of charge by leakage. More elaborate appliances of many different forms have been used, but the only one of these *electric machines*, as they are called, which is now commonly employed is the *Wimshurst machine*. This machine consists of two circular plates of glass or ebonite carrying equal even numbers of tinfoil sectors symmetrically placed on their outer surfaces. A pair of brass arms carrying wire brushes, which simultaneously make contact with diametrically opposite sectors on each plate, is so arranged as to lie at an angle of about 45° to the horizontal, and to be at right angles to one another. A pair of combs is placed at each end of the horizontal diameter of the plates, so that the sectors pass close to the teeth of these combs. The combs serve as collectors, and are connected one pair to the positive pole, and the other pair to the negative pole of the machine. The general appearance of the machine is shown in fig. 6. The machine acts on the induction principle, and if kept warm and dry is self-exciting.

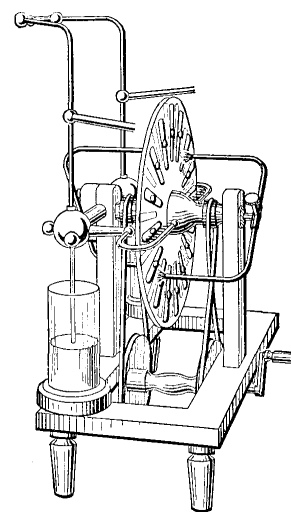


Fig. 6.—Wimshurst
Machine

The *electroscope* is a simple piece of apparatus for detecting the presence of an electric charge, determining its sign (positive or negative), and making a

very rough comparative estimate of its potential. It consists of a pair of strips of gold-leaf attached to a brass rod terminating in a brass cap. The whole is enclosed in a glass case, or a case having glass sides. The base is made of conducting material. The sides of the case are coated internally with tinfoil (or two rods connected to the base project upwards to the level of the gold-leaf strips). The general appearance of one form of electroscope is shown in fig. 7. The gold-leaf strips, the brass rod, and the cap must be carefully insulated. When a charged body is brought near the electroscope the leaves become charged similarly by induction. The repulsion due to the similar charges causes the leaves to diverge.

If the cap be touched with the finger, the charge on the leaves is neutralized, and the leaves collapse. On removing the charged body the leaves diverge again, owing to the spreading of the charge on the cap, which was held by the inducing charge, over the whole conductor, including the leaves. The electroscope is thus charged by induction. It may also be charged by conduction, i.e. by the direct transfer of a charge to the electroscope. When we know the kind of charge, positive or negative, which has been given to the electroscope, an unknown charge can be tested. If the approach of the unknown charge causes a further divergence of the leaves, then it is of the same kind as that with which the electroscope is charged.

When accurate quantitative measurements have to be made, an instrument called an *electrometer* is used. This instrument, the development of which is due chiefly to Lord Kelvin, is capable of making accurate measurements of electrostatic potential differences down to quite low values.

Essentially an electrometer consists of a light suspended conductor which moves within four fixed quadrants. Opposite pairs of these quadrants are connected together, one pair to one terminal, and the other pair to the other terminal of the instrument. The P.D. to be measured is applied at these terminals. The suspended conductor or 'needle' is charged to a definite high potential, and the deflection produced is observed from the movement of a spot of light reflected from a mirror attached to the suspending fibre. In this case the deflection is proportional to the P.D. between the quadrants. For measuring a high P.D., the needle

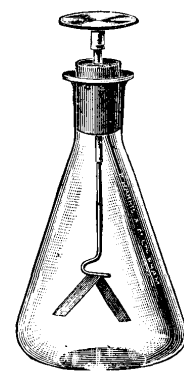


Fig. 7.—
Electroscope

may be connected to one pair of quadrants. With such an arrangement the instrument is less sensitive, and the deflection is proportional to the square of the P.D. between the quadrants.

Current Electricity. The phenomena connected with the flow of electricity through a conductor come under this heading. Such a flow of electricity will take place if by some means the ends of the conductor are maintained at different potentials. An *electric current* is then said to exist in the conductor. The difference of potential may be maintained by chemical action (see *Daniell's Cell*; *Electric Battery*), by electro-dynamic action (see *Generator*), or by heat action (see *Thermo-electricity*). The magnitude of the current which will flow when a steady P.D. is maintained between the ends of the conductor is determined by what is called the electrical *resistance* of the conductor. The resistance R is defined as the ratio of the applied potential difference V to the current I produced, i.e. $R = V/I$. This is a partial expression of Ohm's Law for the Electric Circuit, which in its most general form states that the current which flows at any instant in an electric circuit is equal to the algebraic sum of the electromotive forces existing in the circuit at that instant, divided by the total resistance in the circuit at that instant (see *Electromotive Force*).

For the particular case where the algebraic sum E of the electromotive forces is steady, and the total resistance R is not varying, we have $I = E/R$. This is the form which applies to steady direct currents. If the current is changing (whether alternating or merely varying in value), varying E.M.F.'s, in addition to the applied E.M.F., exist in the circuit, and the above expression no longer holds good.

The resistance of a conductor depends on its material, and varies directly as the length, and inversely as the cross-section of the conductor. Thus $R = \rho(l/A)$, where ρ is the specific resistance of the material, l the length of the conductor, and A the cross-sectional area of the conductor. The *specific resistance* is the resistance between opposite faces of a unit cube of the material at a definite temperature (usually 0°C.). The resistance of a conductor varies to a greater or less extent with variation of temperature.

For pure metals the resistance increases considerably with increase of temperature. With certain alloys the change is so slight as to be negligible.

In some alloys, and in carbon and insulating materials, the resistance falls with increase of temperature.

Measurement of Resistance.—Low resistances can most conveniently be measured by a fall of potential method, based on the relationship $R = V/I$. The current may be read by an ammeter, and the potential difference by a low-reading voltmeter (see *Electrical Measuring Instruments*). Where greater accuracy is required, a constant current is sent through the resistance to be measured, and also through a known standard resistance of about the same value. A sensitive galvanometer (see *Galvanometer*) is used to compare the P.D. across the unknown resistance with that across the standard. Since the current is the same through both, the resistances will be proportional to the galvanometer deflections, and from the known value of the standard resistance the value of the unknown resistance can be calculated. Resistances of moderate value are best measured by a Wheatstone Bridge, or one of its modifications (see *Wheatstone Bridge*).

A substitution method is more suitable for high resistances. A galvanometer is connected in series with a standard high resistance and a steady source of E.M.F. The deflection is noted. The unknown resistance is now substituted for the standard, and the new deflection noted. Provided the resistance of the galvanometer and other parts of the circuit is negligible in comparison with the resistance to be measured, the resistances are inversely as the deflections. The unknown resistance is, therefore, equal to the ratio of the first to the second deflection multiplied by the value of the standard resistance. For insulation tests on installations, direct-reading instruments are frequently used (see *Ohmmeter*).

Effects of an Electric Current.—When a current flows in a conductor, the temperature of the conductor is raised. This is due to the power dissipated on account of the resistance of the conductor. The power dissipated is equal to I^2R watts, and by giving suitable values to I and R any required amount of heat per second can be obtained. This *heating effect* of the current is made use of in electric lighting, electric heating and cooking, in electric furnaces, and in certain electro-medical appliances.

If a magnetic needle is brought near a conductor carrying a current, it will be found to be deflected. This is due to the magnetic field, which is always

associated with an electric current. This *electro-magnetic effect* is of the utmost practical importance (see *Electro-magnetism*; *Generator*; *Electric Motors*).

When a current is passed through a conducting liquid, such as a solution of a metallic salt or a salt in a fused state, chemical action takes place. The behaviour of such a conductor is entirely different from that of a metallic conductor, since a current can flow in it only if chemical dissociation takes place (see *Electrolysis*).

Practical use of electrolysis is made in electroplating, the production of electrotype blocks for printing, the refining of copper, and the production of metallic sodium and potassium. Electrolysis is also used as a means of storing electrical energy in a chemical form (see *Secondary Cell*).

An electric current may be constant in direction (*direct current*), or may alternate in direction with a certain frequency (*alternating current*). Alternating currents have advantages for the transmission of large amounts of power over considerable distances (see *Electric Power Transmission and Distribution*), and may be used for electric lighting and the operation of electro-dynamic machines and apparatus (see *Electric Motors*).

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Electric Light, a light obtained by the conversion of electric energy into light energy. The usual method is to heat some material to incandescence by passing an electric current through it. The material may be carbon (arc lamps), tungsten wire (all modern incandescent lamps), mercury vapour (mercury vapour lamps), or volatilized metallic salts (flame arc lamps). Other materials have been used, such as zirconium, yttrium, and thorium oxides, and osmium and tantalum among the metals, but they have been displaced entirely by the materials mentioned above.

Ordinary arc lamps, and even flame arc lamps, are being displaced by the modern high-candle-power gas-filled tungsten lamp. Flame arc lamps have

a high efficiency, and are still largely used for street lighting, but the cost of the frequent trimming required, even in lamps of the magazine type, gives the gas-filled lamp an advantage over them. Lamps of the mercury vapour class have a high efficiency, and the light has a high actinic value which is valuable for certain photographic processes, but the absence of the red and orange part of the spectrum gives the light a characteristically ghastly effect which limits the use of this type of lamp.

The Carbon Arc.—Although the arc lamp has fallen into disuse, the carbon arc is still extensively employed for projection work, as in cinema projectors and in searchlights. The action of the carbon arc is as follows: If a potential difference of about 50 volts is maintained between a pair of carbon rods, and the tips of the rods are momentarily brought into contact and then separated by a short distance, then the current is maintained by an arc across the gap. The temperature of the positive tip rises to about 4000° C., and the tip itself soon becomes hollowed, forming what is called the *positive crater*.

The illustration below represents the two carbons of the arc light as they appear when cold, the positive carbon being marked + and the negative -. The central figure is a magnified representation such as can be obtained by throwing an image of the burning carbons on a screen by means of a lens. In fig. 1 the upper rod is the positive one, and the hollowed shape of the tip is clearly shown. The negative tip becomes roughly pointed in shape, and its temperature is about half that of the positive crater.

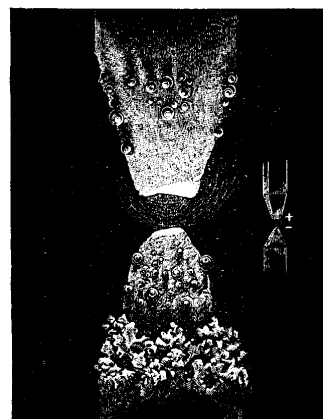


Fig. 1.—Positive and Negative Carbons

The positive crater has an extremely high intrinsic brilliancy, and nearly the whole of the light is emitted from its surface, the negative tip and the arc itself contributing very little. In order to stabilize the arc, a series resistance of a few ohms is necessary. The carbons gradually burn away, the rate of consumption of the positive carbon being about twice that of the negative. It is, therefore, necessary to 'feed' the carbons towards one another. This may be done automatically by the action of a pair of solenoids, one carrying the current which passes through the arc, the other carrying a current proportional to the potential difference across the arc. These solenoids, by means of a suitable mechanism, act in opposition, the current solenoid separating the carbons, and the potential difference solenoid bringing them closer together. The actions balance one another when the arc is of the correct length.

Such an arrangement also serves to strike the arc when the supply is switched on. In order to prevent the arc from wandering round the carbons, the positive carbon is cored, and sometimes the negative carbon also. The core consists of purer softer carbon of lower resistance, and the arc remains centrally placed.

Flame Arc Lamps.—The carbon arc principle is modified in these lamps, so that the arc itself supplies nearly the whole of the light. The arc is made highly luminous by impregnating the carbons with metallic salts, which are volatilized and become incandescent in the arc. Their presence also lowers the resistance of the arc, so that its length can be greatly increased.

The tendency of the arc to wander is also increased, so that cored carbons are essential, and their diameter must be made as small as possible. These thin carbons burn away quickly, so that they must be made proportionately longer

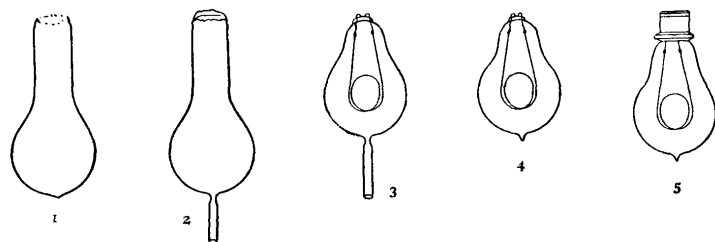
for the same time of burning. In order to reduce their resistance a soft-metal inner core is used. The carbons, instead of being placed one above the other, are inclined at a small angle with the arc between their lower ends. The arc is made as large as possible by the action of a small electromagnet placed just above the gap.

The feeding mechanism is similar in principle to that used for ordinary carbon arcs. For street lighting, lamps of the magazine type are used. In these lamps a number of pairs of carbons is placed in the magazine, and as each carbon is used up, a new one automatically takes its place.

Mercury Vapour Lamps.—In these lamps the light is obtained from incandescent mercury vapour in a tube from which the air has been exhausted. The positive terminal is connected to a small iron electrode at one end of the tube. At the other end there is a small bulb, which contains a little pool of mercury, which is connected to the negative terminal. To start the lamp, the tube has to be tilted, so that a stream of mercury flows along it and makes contact with the iron electrode. The current which then flows vaporizes some of the mercury, and when the tube is tilted back to its original position, the discharge is maintained through the mercury vapour. A small series resistance is required in order to make the operation of the lamp stable. For small lamps a glass tube is used, but owing to the higher temperature reached in lamps consuming considerable power, it is necessary to use a quartz tube for large lamps. Quartz is transparent to ultra-violet light, and to avoid harmful effects the tube is usually enclosed in a larger one of flint glass, which stops the ultra-violet rays.

Incandescent Lamps.—This is the name commonly given to the type of lamp in which the light is produced by an incandescent filament. The filament is enclosed in a glass bulb, which is either exhausted to a high vacuum, or else contains an inert gas under pressure. The filament is heated to incandescence by the current passing through it.

The first lamp of this type to come into general use was the carbon filament lamp. This has now been ousted by the much more efficient tungsten filament lamp. The earlier tungsten



Stages in the Manufacture of an Incandescent Lamp

lamps were very fragile, owing to the brittleness of the filament. Later, a

1, Bulb as received from furnace. 2, Stem attached for exhausting. 3, Filament sealed in. 4, Lamp exhausted of air. 5, Finished lamp.

process was discovered whereby tungsten could be made malleable. The manufacture of drawn-wire filaments thus became possible, and the tungsten filament lamps which are now produced will stand a considerable amount of rough handling. This type of lamp is now in universal use for house lighting.

The limit of temperature at which the filament can be worked is set by the disintegration of the filament, which blackens the bulb and weakens the filament till it breaks. Recent research has revealed that this is due to a double chemical action between traces of water vapour and the incandescent metal. No method of entirely removing water vapour from the bulb has been found, but further research has brought to light the important fact that if the bulb is filled with an inert gas under pressure, the action is reduced to a minimum. This allows the filament to be worked at a much higher temperature, and since the light emitted increases with temperature much more rapidly than the power consumption does, the efficiency of the lamp can be greatly increased. These discoveries have led to the development of the modern *gas-filled lamp*. Owing to the high intrinsic brilliancy of the filament, high candle-power lamps of this type can be made which are not unduly bulky. For this reason, and because of their high efficiency and the absence of the need for any adjustment or attention, gas-filled lamps are coming into extensive use for street lighting and for factory and workshop lighting. Smaller lamps of this type are also being widely adopted for the illumination of shop windows.

Electric Motors, the name given to that division of dynamo-electric machinery in which electrical power is converted into mechanical power.

Electric motors are classified as *direct-current motors* or *alternating-current motors*, according as the electric power taken by the motor is in the form of a direct current or an alternating current. Further subdivisions of each class are made on the basis of differences in the operating characteristics of the various types.

Direct-current Motors.—The motor consists of a fixed magnetic field system with a rotating armature, which carries the conductors through which the supply current is passed. The magnetic field, produced in the air-gap between the poles and the armature, reacts with the current-carrying conductors of the armature and produces the *mechanical turning-moment* or *torque*.

At the same time the motion of the conductors through the magnetic field generates an E.M.F. in the conductors. This E.M.F. is in the opposite direction to the applied E.M.F., and is, therefore, called the *back E.M.F.* of the motor. The current taken by the motor is equal to the difference between the applied and back E.M.F.'s divided by the resistance of the armature winding. Since the armature resistance is always low, and the back E.M.F. is zero at starting, some form of starter is necessary in order to limit the current to a safe value. Essentially the starter consists of a suitable resistance connected in series with the armature. As the motor gains speed this resistance is gradually reduced to zero.

The speed at which a D.C. motor runs varies inversely as the air-gap flux per pole, and very approximately, directly as the applied E.M.F. (directly as the back E.M.F. actually).

The torque produced is proportional to the product of the air-gap flux per pole and the armature current. The torque and speed characteristics of a D.C. motor, therefore, depend on the manner in which the air-gap flux per pole varies with the load current.

Series Motor.—In this type the field magnet windings are connected in series with the armature winding, i.e. the same current flows in both windings. The air-gap flux per pole, therefore, depends on the current taken by the motor. Consequently, at light loads the speed of the motor is very high, and there is a very large fall in speed as the load increases. The torque increases rapidly with load for the same reason. At starting, a large torque is obtained at a low speed. These characteristics are specially suitable for traction purposes, for crane motors, and for the motors for certain machine tools.

Shunt Motor.—In this case the field magnet windings are connected as a shunt to the armature windings, i.e. the current in the field coils depends upon the applied voltage, and is, therefore, constant in normal operation. Apart from the slight effect of the armature magneto-motive force, the air-gap flux per pole, therefore, remains almost constant at all loads. This means that the speed is practically constant at all loads (a very slight fall in speed with load occurs), and the torque, therefore, is almost

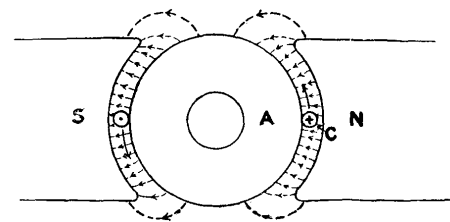


Diagram of a Simple Motor
C, Conductor on surface of iron core
A, which is free to rotate between the
poles N S of an electro-magnet.

directly proportional to the load current. The shunt motor is, therefore, suitable for all cases where an approximately constant speed at all loads is required.

Alternating-current Motors.—There are wide differences between the various types, both in construction and operation. The type most commonly used is the polyphase *induction motor*. In this motor both the field system and the armature consist of a slotted core built up of iron laminations. The field system is called the *stator*, and the armature the *rotor*. Both carry conductors in their slots, and these conductors in each case form a polyphase winding. Current is supplied to the stator winding only. The currents in the rotor winding are *induced* by the action of the rotating magnetic field set up by the stator currents. Hence the name induction motor. For starting, a polyphase resistance completes the circuits of the rotor winding. This resistance is gradually reduced to zero as the motor attains its full speed.

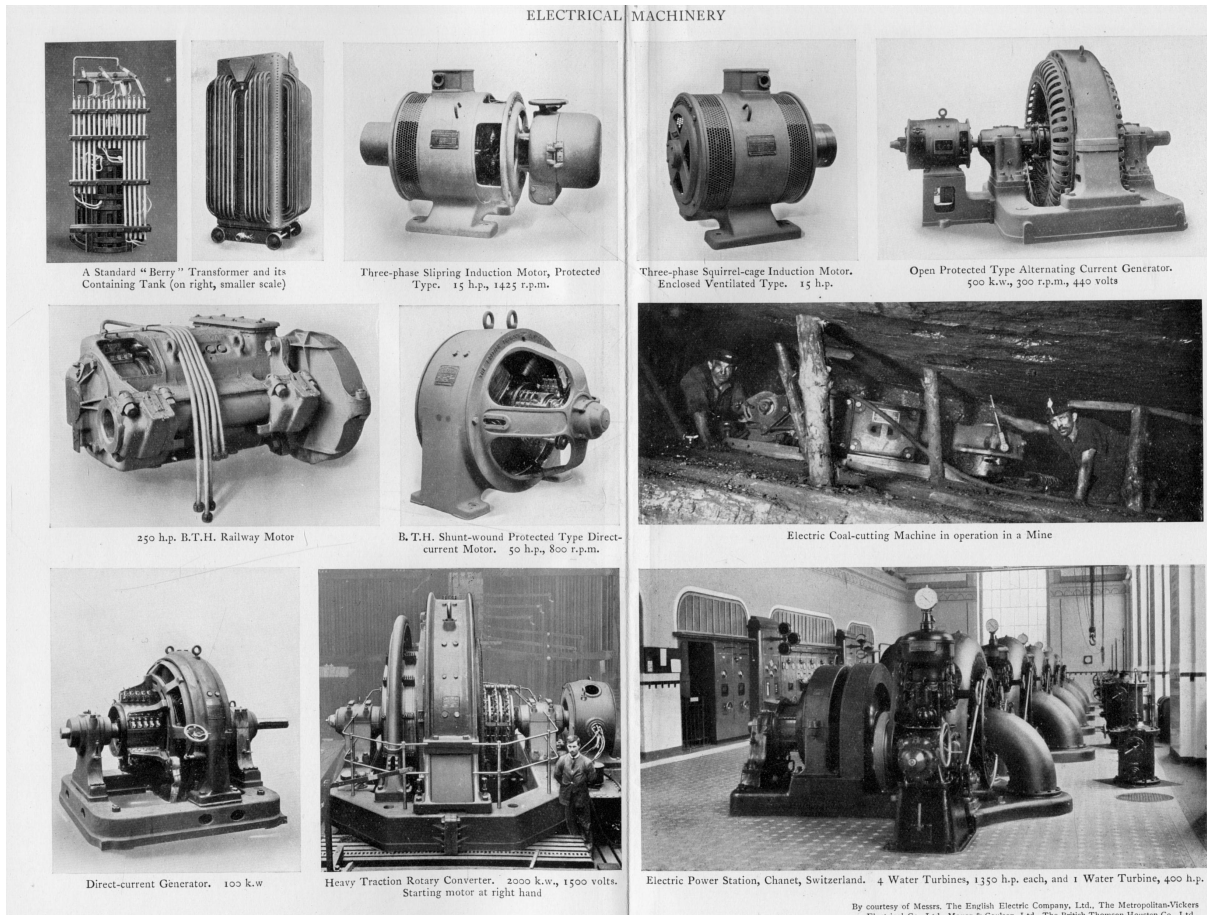
The rotor circuits are, therefore, closed upon themselves in normal operation. In many motors (especially small ones which are started unloaded) the rotor winding consists of a series of copper bars brazed to solid end-rings at each end of the core, thus forming a permanently short-circuited winding. Such a rotor is known as a *squirrel-cage rotor*.

The speed characteristic of the induction motor closely resembles that of the shunt D.C. motor, and induction motors are suitable for similar purposes. The induction motor gives its maximum torque at a speed only slightly below the synchronous speed (corresponding to the number of poles in the stator winding and the frequency of the supply); and the torque decreases very rapidly as the speed rises towards synchronism. The maximum torque has a definite value for a given motor, and if the load demands a greater torque than this, the motor slows down and stops.

Synchronous motors are seldom used except for special purposes. They are exactly similar to the ordinary synchronous generator or alternator in construction, and the field system is almost invariably the rotating part. As their name implies, these motors have the characteristic of running at synchronous speed at all loads. If through overloading, or for any other reason, the motor is unable to maintain its synchronous speed, it immediately falls out of step and stops.

Alternating-current Commutator Motors.—These motors are in general appearance similar to the induction motor, but the rotor is fitted with a

commutator. According to the electrical connections, these motors may be given characteristics similar to direct-current series or shunt motors. Single-phase commutator motors with series characteristics are used on the L.B. & S.C.R. electric trains.



Electric Power Transmission and Distribution. In the public supply of electric power in this country, the usual practice is to use alternating-current generators in the power stations, and to transmit the power at a high voltage to substations. The substation plant reduces the pressure to a value suitable to the consumer, and in many instances also converts the alternating current into direct current. From the substations the power is distributed to the consumers.

For a given amount of power transmitted the cross-section of the cables required varies inversely as the square of the voltage. In order to reduce the outlay on cables, it is important that the transmission voltage should be as high as the circumstances permit. Naturally this becomes more and more important as the distance over which the power has to be transmitted increases. In

America, where large amounts of power are transmitted over very great distances, the pressure used is in some cases 150,000 volts, and the tendency is to raise this till further, as switch gear, insulators, and other apparatus capable of withstanding this high pressure are becoming available. For high-tension underground cables, the pressure now coming into common use is 20,000 volts.

The nature of the low-voltage distribution from the substations, whether alternating current or direct current, depends largely on the requirements of the consumers.

There are certain advantages in the use of direct current, and in this country it is more commonly employed than alternating current, but the substation plant is more costly and requires skilled attendance. If the circumstances are such that these advantages are not important, the lower initial cost and running expenses of an alternating-current distribution would lead to its adoption.

In the Thury system of power transmission high-voltage direct current is used throughout. Only one supply in this country is of this kind, but several are in operation on the Continent. Pressures up to 100,000 volts are used.

Electric Telegraph. See *Telegraph*.

Electric Traction and Electric Tramway. In electric traction the mechanical power required for the propulsion of the vehicle is obtained from electric motors. These motors are usually *series direct-current motors*, but for railway work single-phase and three-phase A.C. motors have also been successfully employed (see *Electric Motors*). Up to the present, electric traction on railways has only been employed for suburban traffic in this country. In one instance (L.B. & S.C.R. electrification) single-phase alternating current is used. In all the others the power supply is direct current (see *Railways, Electrification of*).

In electric tramways, except in some few instances where there are objections to the use of an overhead construction, the current is conveyed to the motors through a trolley pole carrying a wheel running on an overhead bare copper wire. A hand-operated drum controller, directly controlling the driving and electric braking of the motors, is used. A hand-brake, and commonly a separate electro-magnetic brake, are provided.

Except in very small tramway systems, the power is generated as high-tension alternating current, and transformed and converted at substations suitably

placed in the area covered by the tramway (see *Electric Power Transmission and Distribution*). The low-tension D.C. power is distributed from the substations to the trolley wire. The car rails are earthed, and provide a return path for the current. In order to minimize the flow of current to other conductors in the vicinity of the car rails, copper cables returning directly to the substation are connected to the rails at suitable intervals. These earth-return cables are connected in series with special low-voltage dynamos (called *negative boosters*) at the substation. This arrangement automatically keeps the P.D. between the most distant point of the car rails and the substation within a prescribed maximum, and effectively prevents the corrosion of pipes laid near the car rails.

Elec'trode (Gr. *hodos*, a way), a term introduced by Faraday to denote the wires or other terminals by which electricity either enters or leaves a body which is undergoing electrolytic decomposition. He called the electrode at which the current enters the *anode* (*ana*, upwards), and the electrode at which the current leaves the electrolyte the *cathode* (*kata*, downwards). (See *Electrolysis*; *Electro-metallurgy*.) The word is now commonly used in a wider sense to denote the conductor by which contact is made with a medium. In this way electrodes are spoken of in connection with electric furnaces, electric welding appliances, vacuum tubes, and mercury vapour lamps, although the actions are not electrolytic.

Electrolysis (Gr. *lysis*, loosening) is the name given to the decomposition of fused salts or solutions of salts, &c., by means of the electric current, and is thus a branch of electro-chemistry. The substance through which the current is passed is termed the *electrolyte*, and must be either an acid, base, or salt in a fused state or in solution. The current enters the electrolyte by an electrode called the *anode*, or the positive terminal. The electrode by means of which the current leaves the electrolyte is termed the *cathode*, or negative terminal.

During the passage of the current the electrolyte is decomposed, and the products of decomposition are released at the electrodes or terminals. According to the modern theory of electrolysis, all electrolytes contain a greater or smaller number of free *ions*. These ions are chemical radicles carrying a definite electric charge. The kind of charge, positive or negative, depends on the nature of the radicle. The ions exhibit none of the chemical properties of the uncharged radicle.

Thus, for example, in an aqueous solution of sulphuric acid, free ions of hydrogen H_2 carrying a positive charge, and free ions of SO_4 carrying a negative charge, exist. An *uncharged* SO_4 radicle would react with the water present, and sulphuric acid would be formed and oxygen liberated. The *ion* SO_4 , however, is incapable of doing this. Owing to the nature of their charges, the hydrogen ions will move towards the negative electrode, and the SO_4 ions towards the positive electrode. On reaching the electrodes the ions give up their charges, and immediately exhibit their ordinary chemical properties. Hydrogen is given off at the negative electrode, while at the positive electrode the uncharged SO_4 radicle reacts with the water present, and oxygen is released.

This is an example of a secondary chemical reaction. This occurs in many cases, and where it occurs the final product is different from that first produced by the electrolytic action. Fresh ions are formed or *dissociated* in the electrolyte as fast as the original ions give up their charges at the electrodes. If this were not so, the electrolytic action would soon cease, since there would be no ions left to move towards the electrodes. The stream of ions carrying their positive and negative charges constitutes the current flowing through the electrolyte. Since the ions carry definite charges, it follows that the amounts of the initial products of an electrolytic action are in the ratio of their chemical equivalents. Thus, if fused silver chloride be electrolysed, for every 108 grammes of silver deposited at one side of the vessel 35.5 grammes of chlorine are given off at the other side (see *Electrode; Electro-metallurgy*).

The electrolytic action of the current is the same at all parts of the circuit. If the current is made to traverse several vessels, each containing the same substance, all *in series* (that is, the current that leaves the first entering the second, and so on), it will be found that in each of the cells precisely the same amount of decomposition goes on. There will be the same weight of silver deposited at one side, and a corresponding weight of chlorine set free at the other.

The same quantity of electricity decomposes chemically equivalent quantities of different electrolytes. If we pass the current through a series of cells containing different electrolytes, for example, dilute sulphuric acid, chloride of silver, sulphate of copper, and collect the products of decomposition, we find that the quantities of hydrogen, silver, and copper set free are strictly proportional to the chemical equivalents of these bodies.

The quantity of the electrolyte decomposed in a given time is proportional to the strength of the current. This fact is made use of in measuring electric currents for standardization purposes, and the practical unit of current (the ampere) is defined, "with sufficient accuracy for all practical purposes", as being "that steady and unvarying current which deposits silver from a specified solution of silver nitrate at the rate of 0.001118 grammes per second".

The practical applications of electrolysis include the refining of copper, the electro-deposition of metals, electroplating, electrotyping, and the production of metallic sodium and potassium (see *Electro-metallurgy*). Electrolytic action is also made use of in the storage of electric energy in secondary batteries (see *Secondary Cell*).

Electro-magnetism, that branch of science which deals with the mutual relations between electric and magnetic fields (see *Electricity; Magnetism*).

It may readily be shown that when an electric current flows in a conductor, a magnetic field is produced around that conductor, i.e. that a magnetic field is produced by the motion of an electric field. Similarly, if a magnetic field is moved at right angles to a conductor, a potential difference is established between the ends of the conductor, i.e. an electric field is produced by the motion of a magnetic field.

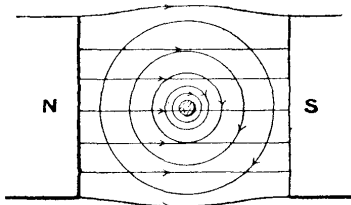


Fig. 1

If a conductor is placed in a magnetic field so that its length is at right angles to the lines of magnetic force (see fig. 1), and a current is passed through the conductor, a mechanical force will act on the conductor, and this force will be at right angles both to the conductor and to the original magnetic field.

From the point of view of lines of magnetic force, the magnetic field produced by the current in the conductor (shown by the concentric circles in fig. 1) will react with the original magnetic field (shown by the horizontal straight lines in fig. 1), and the actual resultant magnetic field will have the form shown in fig. 2. The tendency of lines of force to shorten themselves and repel one another laterally results in a force tending to

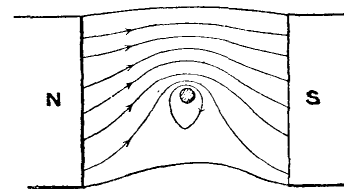


Fig. 2

force the conductor vertically downwards. This force is, of course, mutual, and tends to move the original magnetic field in the opposite direction.

All the phenomena of electro-magnetic action have their basis in these three effects, viz. (1) the production of a magnetic field by an electric current; (2) the production of an E.M.F. or P.D. by the relative motion of a magnetic field and a conductor; and (3) the mutual mechanical action between a current-carrying conductor and a magnetic field system.

The strength of the magnetic field produced by the current may be increased by winding the conductor in the form of a helix or solenoid consisting of a number of turns. The effect can be very greatly increased by providing the solenoid with a soft-iron core. The iron is strongly magnetized as long as the current flows. Such an arrangement is called an *electromagnet*. Electromagnets specially designed to produce a very intense magnetic field are used commercially in handling scrap-iron, pig-iron, &c. The electromagnet takes the place of the crane-hook in an ordinary crane. When the current is switched on, the pieces of iron are attracted and held firmly until the current is switched off again.

Electromagnets are also used for extracting fragments of iron or steel from the eye, and for many laboratory purposes. The most important practical use is the production of the magnetic field required in dynamo-electric machinery (see *Generator*; *Electric Motors*). The magnetic field produced within a coil in which a current flows is made use of to give the deflecting couple in certain types of galvanometers and measuring instruments (see *Galvanometer*; *Electrical Measuring Instruments*).

The absolute C.G.S. unit of current is defined in terms of the magnetic field strength produced by it, viz. "when one absolute C.G.S. unit of current flows in a circular loop of one centimetre radius, the magnetic force produced at the centre of the loop is 2π dynes".

The principle of the electromagnetic generation of an E.M.F. is dealt with under the article *Electro-motive Force*. The mechanical force produced when a current flows in a conductor placed in a magnetic field forms the basis of the action of electric motors, and certain types of galvanometers and measuring instruments. The mechanical force is a mutual one, and tends to move the conductor and the field system in opposite directions. The magnitude of the force varies as the magnetic field strength, the length of the conductor, and the

intensity of the current, and also as the sine of the angle between the field and the conductor. Thus when the direction of the lines of magnetic force is parallel to the conductor, the force is zero; and when their direction is at right angles to the conductor, the force is a maximum. The direction of the force is always at right angles both to the conductor and the direction of the lines of magnetic force. In an electric motor the forces acting on the conductors produce the mechanical output of the machine. In a generator these mechanical forces come into existence as soon as current is taken from the machine. In this case they produce a torque which is opposite in direction to the mechanical torque which is applied to the shaft of the generator in order to drive it.

Electro-medical Apparatus. Electrical apparatus is now widely used in the treatment and diagnosis of disease. The action of the heart may be very accurately observed by means of the electric cardiograph. The cardiograph itself consists of a very sensitive 'string' galvanometer (see *Galvanometer*) and an arrangement whereby the spot of light is focused on a moving photographic plate. In this way a photographic record of the movements of the galvanometer mirror is obtained. The galvanometer terminals are connected to two different parts of the body of the patient (say to a hand and a foot placed in separate brine baths), and the variations of potential differences which occur during a heart-beat cause a movement of the galvanometer mirror.

The X-ray apparatus has recently been adapted for taking instantaneous photographs of the heart. A single powerful discharge from a static transformer takes place through the tube, and a photograph of the position of the heart at that instant is obtained. The X-ray apparatus is very well known from its use in locating fractures, foreign bodies, diseases of the bone, &c.

The X-ray discharge is used as a treatment for certain skin diseases (especially ring-worm), rodent ulcer, and cancer. Very high-frequency alternating currents may be passed through the body without producing the muscular contractions which are a feature of the passage of low-frequency currents through the tissues. Currents of considerable magnitude of very high frequency may thus be passed through the body without inconvenience to the patient. In this way general or local heating of the body may be obtained. This process is known as diathermy. The heating locally may be made sufficiently great to cause coagulation of the tissues, or even actual burning. This method is used in the treatment of tumours and other growths.

Another important electro-medical treatment consists of the local introduction of a drug, into the affected part, by electrolytic action. Thus in the treatment of rodent ulcer, a pad of lint saturated with a 5 per cent solution of zinc sulphate is placed over the ulcer. A zinc electrode is placed on the pad and connected to the positive pole of the supply. The negative pole is connected to a basin of brine in which the patient's hand is placed. The current is made as large as can conveniently be borne (say 30 to 60 milliamperes), and is maintained for about thirty minutes and then gradually reduced to zero. By this means zinc ions are carried into the ulcer. A number of diseases may be treated in this way, the ion used depending on the nature of the case.

Low-frequency intermittent currents from induction coils are frequently used where nerve stimulation or muscular contractions are required. Static electricity is also used for similar purposes. Large Wimshurst machines are used for the treatment of sciatica, and also for neurasthenia. In the latter case a brush discharge is used, and the patient experiences very little physical sensation. The high-frequency apparatus already referred to in connection with diathermy is valuable for the treatment of rheumatism in its earlier stages, and for the stimulation of the scalp in hair treatment. Suitable electrodes are passed backwards and forwards over the affected parts, a bluish brush discharge taking place between the patient and the electrode.

Electro-metallurgy is that branch of metallurgy which uses electrical energy, wholly or in part, for the extraction or treatment of metals. The energy may be converted into heat and used for processes in which high temperatures are necessary, or it may be used for the decomposition of a compound by electrolysis, which may proceed in a fused bath at a comparatively high temperature, or in a solution bath containing a compound of the metal dissolved in a suitable solvent.

The former method of utilizing the energy embraces electrothermal processes, and the latter method, electrolytic processes.

In electrothermal processes, the heat developed by the electric current has been used in a number of industries, including welding, annealing, heat treatment, smelting, refining, &c. Laboratory apparatus, such as tubes, muffles, and crucibles, are also frequently heated by means of an electric current.

For the electric welding of metals there are two systems in use: resistance welding, in which the portions to be welded are pressed together and heated by

the resistance they offer to the passage of a current; and arc welding, in which portions of metal of the same composition as that to be welded are fused on by striking an arc from a suitable electrode. In the electrical annealing of metals, case-hardened steel plates are locally softened where rivet-holes, &c., are required by passing an electric current through copper poles placed 1 or 2 inches apart on the smooth surface. Metallic wire is frequently heated to the annealing temperature between drawing operations, and various types of annealing furnaces are also electrically heated.

In electric smelting, the high temperature of the arc (3600°C.) may be used for the reduction of certain metallic oxides, which at the lower temperature of furnaces heated by coal, coke, gas, &c. (2000°C.), will not give up their oxygen to carbon; other ores are also sometimes smelted by electrical means, especially in localities where current is cheap and fuels are dear. The production of refined steel, special alloy steels, and certain non-ferrous alloys is also carried out in electric furnaces of various types.

The electric arc was first applied to fusion by Siemens in 1879; he fitted, into the bottom of a crucible to receive the charge, a water-cooled copper casing to form the positive pole, and suspended a carbon rod centrally in the crucible to form the negative pole. The current crosses the air-gap between the metal and the negative pole, forms an arc, and rapidly fuses the metal. In 1885 the Cowles Brothers, of Cleveland, Ohio, began to produce aluminium-copper and aluminium-iron alloys by arc smelting, and later produced other metals, difficult to reduce, by the same means. More recently, the development of electric smelting has made rapid strides. Electric furnaces not only yield higher temperature, but have other advantages over furnaces heated by carbon. They develop the heat in a small space, just where it is required for the operation, so that the furnace can be smaller, and less heat is lost by radiation; the charge can be kept free from gaseous products of combustion; the temperature and the whole operation is under better control; and the expense of running the furnace is limited to the time the current is used for doing useful work.

Electric furnaces are now used in the production of pig-iron, steel, ferro-alloys, brass, zinc, &c., and in the heat treatment of various metals. Classifying them according to the manner in which the electrical energy is converted into heat, we have:—

1. Direct resistance furnaces, in which the heat effect is produced within the metal itself by the resistance offered to the passage of the current through it.

This type is used in the refining of steel.

2. Indirect resistance furnaces, to which class belong the various tube and crucible furnaces used in laboratories. The vessels to be heated are wound with wire or ribbon of high resistance, such as platinum, nickel-chrome alloys, &c., and a suitable current passed. Heat-treatment furnaces on a fairly large scale also use this method, a nickel-chrome alloy ribbon being wound on a suitable framework; the heating element in these furnaces, however, generally consists of granular carbon confined in carborundum fire-sand troughs.

3. Induction furnaces, in which a primary coil of copper wire is used, the secondary being formed by the metal charge itself, contained in a suitable annular groove. In this furnace the current passes through the primary and induces a current in the charge, thus melting it. This type of furnace has been largely used in the refining of steel, and to some extent in the melting of non-ferrous metals and alloys.

4. Direct arc-heating furnaces, as exemplified in the Siemens crucible furnace mentioned above.

5. Indirect arc-heating is used in the Stassano furnace, in which the heat is obtained by radiation from the arc, and by reflection from the roof and sides of the furnace. This furnace has been used in the production of steel from scrap, and also direct from ore. There are three electrodes, which nearly meet in the centre of the furnace.

6. Combined resistance and arc furnaces are very largely used for the production of ferrous alloys, such as ferro-silicon, ferro-chrome, and ferro-manganese; for the production of steel from scrap, and for the final refining of steel produced by other processes. In these furnaces the heat is generated largely by the arc, and to a smaller extent by the resistance offered by the whole or a portion of the furnace charge to a powerful electric current. There are several well-known commercial furnaces working on this principle, the best known probably being the Héroult. This furnace is designed for tilting, and is lined with basic material, and large electrodes pass through the roof. An alternating current of 4000 amperes at 110 volts is used for a 3-ton furnace, and the intensity of the current passing through the bath is regulated by raising or lowering the electrodes.

The effect of the European War has been enormous on the development of the electric furnace in this country, for prior to the war in 1914, although the use of

the electric furnace for steel-making was increasing, there were only 5 furnaces in operation in Sheffield, and two or three more in other parts of the country, producing in all about 15,000 tons per annum. Soon after the commencement of the war, it became necessary to deal with the rapidly accumulating quantity of shell turnings, to make substitutes for Swedish iron and steel, which could not be imported, and to make large quantities of special alloy steel for various war purposes. As a result of these demands, within four years the number of electric furnaces increased to over 100, the steel produced being over 200,000 tons per annum. Since 1918 the number of furnaces has further increased, and probably reached 150 of various sizes and makes in 1920. In America a similar development has taken place, the number of furnaces increasing from 7 in 1907 to 363 in 1920, the output of electric steel in 1918 amounting to over 500,000 tons. In France, also, great strides have been made, and owing to the shortage of pig-iron, synthetic processes for its production from iron and steel scrap and ore were developed in open-pit arc-resistance furnaces, yielding 220,000 tons in 1916-8.

Electrolytic Processes.—The application of electrolysis for the production of metals from a fused electrolyte is most important in the case of aluminium. This metal cannot be produced by direct electrolysis in aqueous solution, but is deposited electrolytically from a fused bath of cryolite, containing alumina in solution. As the metallic aluminium is extracted from the molten bath, further quantities of purified oxide are added. The anodes consist of carbon blocks suspended in the molten bath, and the cathode consists of the carbon lining of the furnace. Calcium, cerium, lithium, magnesium, potassium, sodium, and strontium are obtained by the electrolysis of fused chlorides, sodium being also obtained from fused hydroxide and fused nitrate.

Metallic magnesium was obtained by the electrolysis of the fused chloride by Bunsen in 1852, but the application of electrolysis as a means of recovering metals from ores by means of aqueous solutions dates back to 1836, in which year Becquerel obtained copper from sulphide ores by first extracting the copper as sulphate or chloride, and then recovering the copper by the electrolysis of the solutions, using insoluble anodes. The method has since chiefly been applied to the treatment of copper ores and products, but has also been used for the recovery of nickel, gold, zinc, &c. The production of electrolytic zinc from solutions has been encouraged as a result of the shortage of pure zinc for war purposes, and several processes have been developed. In these processes the solution used consists either of zinc sulphate or of zinc

chloride, the anodes consisting of metallic lead or of carbon, and the cathodes of pure zinc sheets.

It is in connection with the refining of metals that electrolytic processes become of prime importance. Elkington, in 1865, was the first to refine impure metallic copper electrolytically and recover the silver contained in it. Pure copper is now commonly obtained from impure copper anodes in an electrolyte of copper sulphate containing free sulphuric acid, a current density of 12 to 15 amperes per square foot being used at 0.34 to 0.44 volt. Gold is also refined by a similar process, the electrolyte used consisting of gold chloride solution containing free hydrochloric acid. In this case a current density of 100 amperes at 1 volt is used. Silver is likewise refined in a silver nitrate bath, iron by the electrolysis of sulphate or chloride solution, and lead in a solution of lead fluosilicate containing free hydrofluoric acid.

In all the above-mentioned processes the anode is cast from the impure metal to be refined, and the cathode consists of a sheet or plate on which the pure metal is deposited.

It will be seen that these refining processes are very similar to electroplating methods.

Electromotive Force, the name given to the force tending to produce a flow of electricity in an electric circuit. The electromotive force, or E.M.F., is measured in terms of the work done in carrying unit quantity of electricity once round the circuit.

Thus unit electromotive force (absolute) is said to exist in a circuit if 1 erg of work is done in carrying 1 coulomb of electricity once round the circuit. The potential difference, or P.D. (in electromagnetic units), between two points in an electric circuit is similarly defined in terms of the work done in carrying 1 coulomb of electricity from the one point to the other.

Production of an Electromotive Force.—There are several sources of E.M.F., e.g. (a) chemical action, as in primary and secondary cells; (b) thermo-electric action, as in the thermopile; (c) electro-magnetic action, as in generators, motors, transformers, and induction coils.

The electromotive force due to chemical action depends on the material of the electrodes and the nature of the electrolyte, and also to a slight extent on the temperature. Thus, for any given pair of materials (say zinc and copper)

immersed in a certain electrolyte of given strength (say dilute sulphuric acid), the E.M.F. produced at a given temperature has a definite value. For a discussion of the electromotive force produced by thermo-electric action, see *Thermo-electricity*.

The principle of the electromagnetic generation of an E.M.F. may be stated in its most general form as follows: If lines of magnetic force are interlinked with an electric circuit, and if by any means the number of interlinkages of the lines of magnetic force with the circuit is made to change, then an E.M.F. will be generated in the circuit, the magnitude of this E.M.F. being proportional to the time rate of change of the interlinkages. Thus, if the interlinkages are changing at the rate of one per second, one absolute unit of E.M.F. will be generated; or if the interlinkages are changing at the rate of a hundred million per second, an E.M.F. of 1 volt will be generated. It is immaterial in what manner the change of interlinkages is brought about.

A permanent magnet may be moved so as to vary the lines of magnetic force linked with an electric circuit, as in magneto-generators; or the circuit may be moved through a magnetic field (see *Generator*; *Electric Motors*); or the magnetic field produced by a current in one coil linked with a second coil may be varied by varying the current in the first coil, as in static transformers and induction coils.

The electromagnetic generation of an E.M.F. is the fundamental principle which has made possible the generation and utilization of electrical energy on a large scale.

Electron, the atom of electricity, more especially of negative electricity. The first light on the question of the structure of electricity came from the laws of electrolysis (q.v.), established by Faraday. These laws are explained very naturally if we make the assumption that electricity, like matter, is atomic, the atom being the charge carried by the hydrogen ion. Clerk Maxwell even proposed to call this charge 'one molecule' of electricity, but added the remark that "it is extremely improbable that when we come to understand the true nature of electrolysis we shall retain in any form the theory of molecular charges, for then we shall have obtained a secure basis on which to form a true theory of electric currents, and so become independent of these provisional hypotheses". To-day, however, so far are we from discarding the hypothesis of the atomic nature of electricity that we find ourselves compelled by the pressure of experimental facts to interpret all electrical phenomena, in metals

as well as in electrolytes, in terms of this very hypothesis. Any statical charge is supposed to be made up of a very great number of electrons, just as a material body is composed of atoms of matter. A metallic conductor is supposed to contain many free electrons, which normally bear much the same relation to the material molecules as a saturated vapour bears to the liquid in equilibrium with it. When an electromotive force is applied, it causes a drift of the electrons in the opposite direction to the force, the charge on the electrons being negative. It is this drift of electrons which constitutes an electric current.

The striking advances that have been made in our knowledge of the nature of electricity since the last years of the nineteenth century have been due chiefly to the study of the electric discharge in gases. Hittorf in 1869 and Crookes in 1879 examined the rays, now called the cathode rays, which stream from cathode to anode in a tube containing gas of very low pressure. The phenomena suggested to Crookes that the rays consist of material particles carrying a negative charge and moving at a high speed; but many physicists rejected this explanation, holding that the rays were due to some form of wave motion in the ether. About 1897 it was conclusively shown by Perrin, Wiechert, and Sir J. J. Thomson that Crookes's view was the correct one. Sir J. J. Thomson measured the velocity of the particles, and also the ratio of the charge e , to the mass m of each. His method was to subject a fine beam to the action of two fields of force, one magnetic, the other electric, and both perpendicular to the line of motion and also to each other. The electric field being X , and the magnetic field H , the forces on a particle were in the same direction, and equal to eX , evH . Either field by itself deflected a fine beam, as was shown by the motion of a spot of light where the beam struck a fluorescent screen. The value of X was adjusted till there was no deflection in the combined fields. Hence $X = vH$, and v was found from the measured values of X and H . The deflections under the two fields acting separately were also observed. Either of these deflections, when v is known, gives the value of the ratio e/m . The values of the velocity v were found to depend on the E.M.F. between the terminals of the discharge-tube. They varied from $1/30$ to $1/3$ of the velocity of light. The fraction e/m , however, had always the same negative value, no matter how the material of the cathode and the nature and pressure of the gas were varied.

Many other ways of obtaining these negatively charged particles, or electrons, are now known. The β -rays from radio-active substances (see *Radio-activity*) are simply electrons moving with great speeds, approaching sometimes within

2 or 3 per cent of the velocity of light. Hot metals give off electrons copiously: this property is used in the construction of the Coolidge X-ray tube and of the thermionic valve (q.v.). A metal plate illuminated by ultra-violet light, from an electric arc or spark, for instance, gives off electrons moving at all velocities below a certain maximum (see *Photo-electric Effect*). From whatever source the electrons are derived, their properties are found to be the same.

The determination of e and m separately is a much more difficult matter than the determination of their ratio. The first attempt to measure e directly was made by Townsend, and published in 1897. Townsend obtained his ions in the hydrogen and oxygen given off when caustic potash is electrolyzed. The charged gases when bubbled through water formed a cloud. This cloud could be completely removed by bubbling through concentrated sulphuric acid, but reappeared when the gas came out again into the atmosphere, owing to the condensation of water-vapour on the ions. Townsend determined the weight of the cloud and its total charge. He also found the average weight of the minute spherical drops forming the cloud by observing their rate of fall under gravity, and calculating their radius from a theoretical formula known as Stokes's law, viz. $v = \frac{2}{9}ga^2\varrho/\eta$, where a is the radius, ϱ the density, v the velocity of the drop, and η is the viscosity of air. The weight of the cloud divided by the weight of a drop gave the number of drops, which was presumably the same as the number of ions. Finally, dividing the total charge by the number of ions, Townsend found e , the average charge carried by an ion. His value came out about three-fifths of the value accepted now.

This pioneer method of Townsend's has been improved and modified in various ways by C. T. R. Wilson, Sir J. J. Thomson, H. A. Wilson, and notably by Millikan, of Chicago. Millikan's charge carriers were minute oil drops, which were given elementary charges by means of ionizing rays from radium. Observations were made of the equilibrium and motion of these charges under the combined influence of gravity and a strong vertical electric field, the intensity of which could be varied at will. A single drop could be kept in view for several minutes at a time, and note was taken of the effect of each new charge as it was picked up by the drop. On calculation, the charge was found in all cases to have very approximately the same value. It so happened, as a consequence of the method of producing the drops, that they carried a small frictional charge, and incidentally Millikan was able to verify that this was always an integral multiple of the electronic charge e . Millikan's result, which

is most probably the best yet found, is that $e = 4.774 \times 10^{-10}$ absolute electrostatic units, or 1.591×10^{-20} absolute electromagnetic units.

An indirect but very interesting method of determining e was devised independently by Regener and by Rutherford and Geiger. The special feature of this method is the actual counting of the number of α -particles (see *Radioactivity*) shot out per second through a given solid angle by a small speck of radium. Each α -particle produces a scintillation on a sensitive screen placed in its path, and these scintillations are counted one by one by the observer. The total quantity of electricity carried by the α -particles emitted in one second is measured independently. The charge on each particle is then found by simple division. This charge is found to be almost exactly twice Millikan's value for e , as it ought to be, as it is practically certain that the α -particle is an atom of helium which has lost two electrons.

The value of e/m , as determined by Thomson's method described above, is 1.76×10^7 e.m.u. per gramme, or 5.29×10^{17} e.s.u. per gramme. Taking this with Millikan's value for e , we find $n = 0.902 \times 10^{-27}$ grammes. The exact determination of e has made it possible to assign precise values to several other important physical constants, which formerly were only known roughly from data depending on the Kinetic Theory of Gases. Thus Avogadro's constant N , or the number of molecules in one gramme-molecule (molecular weight in grammes) of any gas can be connected with e by the exact measurements of electrolysis, which give $Ne = 9650$ e.m.u. It follows that $N = 6.06 \times 10^{23}$, and that the number of gas molecules per cubic centimetre at 0° C and 76 centimetres pressure is 2.70×10^{19} . We find at once also the mass of the hydrogen atom as 1.66×10^{-24} grammes, the density of hydrogen being known to be .0899 grammes per litre. The mass of the electron is therefore about $1/1840$ of the mass of the hydrogen atom, which till the isolation of the electron was the smallest mass known.

It is necessary, however, to scrutinize with some care the meaning of the word mass as applied to an electron. The determination of the mass of the hydrogen atom ultimately depends on weighing, that is, on finding its gravitational inertia. We cannot weigh an electron, but must determine its mass by experiments involving its motion, the word mass here meaning the ratio of the force acting on the electron to the acceleration produced, and the force being calculated from the charge and velocity of the electron on the principles of

electrodynamics. An electron being entirely different in its physical nature from ordinary matter, the question arises whether its mass, as calculated in this way, is actually a definite constant, as it is for a material particle, according to the accepted principles of Newtonian dynamics. It can even be shown, as was first done by Sir J. J. Thomson, that a moving charged body possesses inertia in virtue of the mere fact that it carries a charge. The value of this inertia, or electromagnetic mass, when the velocity is small compared with that of light is, in a vacuum, for a small sphere of radius a , $\frac{2}{3}e^2/a$, where e is the charge. If the velocity is greater than, say, $\frac{1}{10}$ the velocity of light, the formula for the electromagnetic mass is more complicated, and, indeed, cannot be calculated without some assumption as to the internal distribution of charge in the electron itself. Two formulæ for the mass have been given, one by Abraham, the other by H. A. Lorentz. Abraham started from the supposition that the electron is a rigid sphere carrying a uniform surface charge. Lorentz showed that a simpler theory could be obtained by the hypothesis that the electron contracts, in the direction of its motion, by a certain definite amount depending on its velocity. On both theories the value found for the mass depends on the relation between the direction of the force and the direction of the motion. On Lorentz's theory the longitudinal mass, or mass when the force is in the direction of the motion, is $m_0/(1-\beta^2)^{3/2}$; and the transverse mass, or mass when the force is perpendicular to the velocity, is $m_0/(1-\beta^2)^{1/2}$; where m_0 is the mass for very small speeds, and β is v/c , the ratio of the velocity of the electron to the velocity of light. The two theories have been tested by various experimenters, with somewhat conflicting results. On the evidence of experiments by Bucherer, however, Lorentz's theory of the contractile electron is now generally accepted, and it is regarded as highly probable that electrons are devoid of all mass except the electromagnetic mass due to their charge of negative electricity.

No fundamental positive electron has been isolated which at all corresponds to the negative electron, or corpuscle, as it is called by Sir J. J. Thomson. The nearest approach to a positive electron is the nucleus of the hydrogen atom, which carries a positive charge of the same magnitude as the charge on an electron. Practically the whole mass of the atom resides in this nucleus. According to the modern theory of the structure of matter, the neutral atom of any element is built up of a comparatively small number of electrons and an equal number of these positive nuclei. Electrons being present everywhere, and

their action influencing all natural phenomena, their properties will naturally come up for consideration from various points of view in other articles. See *Ionization*; *Isotopes*; *Matter*; *Radio-activity*; *Rays*, *Electric*.—BIBLIOGRAPHY: J. A. Crowther, *Ions, Electrons, and Ionizing Radiations*; R. A. Millikan, *The Electron*; N. R. Campbell, *Modern Electrical Theory*; O. W. Richardson, *The Electron Theory of Matter*; H. A. Lorentz, *Theory of Electrons*.

Electro-plating, the process of depositing a coating of some selected metal on a given surface by means of electrolysis (q.v.). The most important classes of electro-plating commonly carried out are nickel-plating, used very largely for a variety of articles made of iron, steel, &c.; copper-plating, used for facing printing-blocks and as a first coating to non-metallic substances prior to silver- or gold-plating; silver-plating, for imitation silverware and for cutlery, &c.; gold-plating, for ornamental ware, jewellery, &c. Previous to plating it is necessary to remove all grease, dirt, oxide, &c., from the surface, this cleansing of the articles being the first step in the operations necessary. The exact procedure for cleansing varies with the nature of the articles to be plated, but for the removal of grease a strong caustic alkali bath is generally used. To remove oxide and dirt, scratch-brushing is used, also scouring with pumice-stone. Acid-dipping baths are also employed, muriatic acid or sulphuric acid for iron or steel articles, dipping-acid, which is a mixture of sulphuric acid and nitric acid, for brass. For the actual deposition an electrolytic cell is prepared, containing a solution of a suitable salt of the metal to be deposited, with an anode, generally consisting of a plate of the same metal, attached to the positive pole of the battery used, the article to be treated being connected with the negative pole and thus forming the cathode. When a current of electricity is passed through the solution, a thin coating of metal is deposited on the article forming the cathode, and an equivalent portion is carried into solution from the anode. In the case of nickel-plating, the solution used is made from the double chloride or sulphate of nickel and ammonium, to which salt, sal-ammoniac, &c., may be added. The bath is used at a temperature of 100° F., and cast-nickel plates are used as anodes. For copper-plating the bath used generally consists of an acid solution of sulphate or acetate of copper, cyanide of potash also being added; in case the article is made of zinc, an alkaline bath is used. The bath may be used cold, but is sometimes kept at about 120° F. For iron simple dipping is sometimes used, as copper is readily deposited on iron without the use of an electric current. For electroplating of copper, anodes of metallic copper, having a surface equal to that of the articles to be coated, are used. For silver-plating the solution consists of the double cyanide of silver

and potash, and may be used either hot or cold. An article to be silver-plated is often prepared by a preliminary dip in a solution of nitrate of mercury, which causes a slight amalgamation with mercury. After this preliminary treatment it is placed in the bath and a slight deposit of silver obtained, after which it is removed, well brushed, washed, and replaced in the bath. A silver plate is used as an anode. A density of $1\frac{1}{4}$ to $1\frac{1}{2}$ ounces of silver to the square foot gives an excellent plate about the thickness of common writing-paper. In gold-plating baths, a hot solution of the double cyanide of gold and potash is used at 170° F., and for the anode platinum foil is frequently used, the strength of the bath being maintained by the addition of fresh quantities of chloride of gold. After all kinds of plating as described above, the goods are thoroughly washed in water, and dried by means of saw-dust or in a drying-chamber. In ordinary circumstances the deposited metal presents a dead or matted appearance, and if a bright polished effect is desired, it is burnished and buff-polished. Certain chemicals added to the solution will cause the original deposit to have a metallic lustre.

Electrotype. The production of copper facsimiles by the electric current is called *electrotype*, and is the oldest branch of electro-metallurgy. One of its most important applications is the copying of type set up for printing, and of wood blocks for wood-cuts. A mould is first obtained in gutta-percha or some similar material. This, being a non-conductor, is brushed over with plumbago in its interior, so as to give it a conducting surface to receive the deposit. After several hours the deposit is detached from the mould and backed by pouring in melted solder, the surface being first moistened with chloride of zinc to make the solder adhere. In the copying of steel engravings the mould is obtained by electro-deposition of copper on the steel, the surface of which must first be specially prepared to prevent adhesion; and a second electro-deposition of copper, on the mould thus obtained, gives the required copy, from which impressions can be printed.

Elec'trum (Gr. *ēlektron*), in antiquity, a term applied to native gold, which frequently contains notable quantities of silver, copper, and other metals. According to Pliny, the term electron was applied to native gold containing at least 20 per cent of silver. The term was afterwards transferred from this native alloy to the artificial alloy of gold and silver on account of its colour and inferior lustre. The word originally meant 'amber', and was given to impure gold on account of a supposed resemblance. Electrum was used since the eighth or seventh century B.C.

Elec'tuary, or **Confection**, is a pharmacopœial preparation. It is solid, but of soft consistence, and contains sugar or honey, impregnated with some more active body. The best known is the confection of senna.

Ele'git, in English law, a writ by which a creditor who has obtained a judgment against a debtor, and is hence called the *judgment-creditor*, may be put in possession of the lands and tenements of the person against whom the judgment is obtained, called the *judgment-debtor*, until the debt is fully paid. The writ is addressed to the sheriff, who enforces it. The writ of *elegit* was first authorized by the Statute of Westminster the Second, which gave the *judgment-creditor* the right to choose between a writ against the debtor's land, and until 1883 his goods also, and an execution by writ against the latter's person or chattels. The new writ, representing the choice of the creditor, was therefore called an *elegit*, Lat., he has chosen. See *Fieri Facias*.

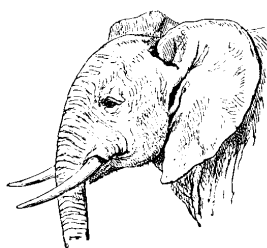
El'egy (Gr. *elegos*, mourning, song), a mournful and plaintive poem or funeral song, or any serious poem of a melancholy contemplative kind. In classic poetry what is known as *elegiac verse* is composed of couplets consisting of alternate hexameter and pentameter lines. In English we generally understand by elegies lyric poems which are laments over the dead, such as Milton's *Lycidas*, or Shelley's *Adonais*.

Elemen'tal Spirits, according to a belief common in the Middle Ages, spirits proper to and partaking of the four so-called elements, viz. salamanders or fire spirits, sylphs or aerial spirits, gnomes or earth spirits, and undines or water spirits.

El'ements, the simplest constituent principles or parts of anything; in a special sense, the ultimate indecomposable constituents of any kind of matter. In ancient philosophies the term was applied to fire, air, earth, and water. The mediæval chemists, however, absorbed in the study of metals and mineral substances, supposed that the metals consisted of an elemental sulphur and an elemental mercury mixed together more or less perfectly and in different proportions. To these were subsequently added salt and some others, so that about the middle of the seventeenth century the first principles amounted to five, divided into two classes; the active, consisting of mercury or spirit, sulphur or oil, and salt; and the passive, consisting of water or phlegm, and earth or the terrestrial part. The names remained, not so much as denoting substances or ultimate principles as gradually coming to denote functions; the first great modification being the expansion of the idea of elemental sulphur

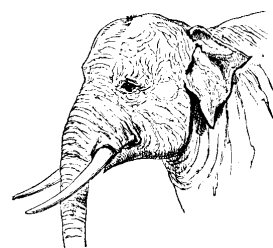
into phlogiston by Stahl, as the result of which the adherents of the phlogistic theory applied the term phlogiston to the gases then discovered, the mineral, vegetable, and animal acids, the alkalies, earths, and metallic calces, oil, alcohol, and water. The substances considered as simple naturally changed with the change of theory introduced by Lavoisier, who considered as elements, oxygen, nitrogen, hydrogen, sulphur, phosphorus, and carbon, the metals and the earths, and, as Boyle had already suggested, practically defined an element as a body not yet decomposed, the definition now commonly adopted. For list of known elements see *Chemistry*.

El'emi, the fragrant resinous exudation from various trees, such as the *Canarium commune*, from which the Eastern or Manila elemi is obtained; the *Icīca Icīcarība*, the source of the American or Brazilian elemi; and the *Elaphrium elemifērum*, from which the Mexican elemi comes. It is a regular constituent of spirit varnishes, and is used in medicine, mixed with simple ointment, as a plaster.



Head of African
Elephant (*Elephas*
africanus)

El'ephant, the popular name of a genus, family, or sub-order of five-toed proboscidian mammals, usually regarded as comprehending two species, the Asiatic (*Elephas indicus*) and the African (*E. africanus*). From a difference in the teeth, however, the two species are sometimes referred to distinct genera



Head of Indian
Elephant (*Elephas*
indicus)

(*Euelephas* and *Loxodon*). The so-called white elephants are merely albinos. The African elephant is distinguished from the Asiatic species by its greater height, its larger ears, its less elevated head and bulging or convex forehead, the closer approximation of the roots of the tusks, and the greater density of the bone. It has also only three external hoofs on the hind-feet, while the Asiatic has four. All elephants are remarkable for their large, heavy, short bodies supported on columnar limbs, a very short neck, a skull with lofty crown and short face-bones, with the exception of the premaxillaries, which are enlarged to form tusk-sockets. To compensate for the short neck, they have the long proboscis, often 4 or 5 feet in length, produced by the union and development of the nose and upper lip. It is made up of muscular and fibrous tissue. The trunk is of great strength and sensibility, and serves alike for

respiration, smell, taste, suction, touch, and prehension. The tusks, which are enormously developed upper incisor teeth, are not visible in young animals, but in a state of maturity they project in some instances 7 or 8 feet. The largest on record (undoubtedly that of an extinct species) weighed 350 lb. Elephants sometimes attain the height of 12 feet or more, but their general height is about 9 or 10 feet. Their weight ranges from 4000 to 9000 lb. The period of gestation is twenty months, and the female seldom produces more than one calf at a birth: this, when first born, is about 3 feet high, and continues to grow till it is sixteen or eighteen years of age. It is said that they live to the age of 150 years. They feed on vegetables, the young shoots of trees, grain, and fruit. They are polygamous, associating in herds of a considerable size under the guidance of a single leader. An elephant leaving or driven from a herd is not allowed to join another, but leads a lonely, morose, and destructive life. Such solitary elephants are known as 'rogues'. Elephants are caught either singly or in herds. In the former case it is necessary to catch adroitly one of the elephant's legs in the noose of a strong rope, which is then quickly attached to a tree; another leg is then caught, until all are securely fastened. His captors then encamp beside him, until under their treatment he becomes tractable. When a herd is to be caught a strong enclosure is constructed, and into this the elephants are gradually driven by fires, noise, &c. With the aid of tame elephants the wild ones are tied to trees and subjected to the taming process. The domesticated elephant requires much care, and a plentiful supply of food, being liable to many ailments. The daily consumption of a working elephant is, according to Sir J. E. Tennent, 2 cwt. of green food, about half a bushel of grain, and about 40 gallons of water. Their enormous strength, docility, and sagacity make them of great value in the East for road-making, building, and transport. They are used by the great on occasions of pomp and show, being often richly caparisoned, and bearing on their back a howdah containing one or more riders, besides the mahout or driver sitting on the animal's neck. Tiger-shooting is often practised from an elephant's back. Several extinct species are known, the most notable being the mammoth (*E. primigenius*), a contemporary of prehistoric man. The allied genus Mastodon was of very wide distribution, and the Tertiary deposits of the Fayum (Egypt) have yielded the remains of types that bridge over the gap between elephants and more typical quadrupeds. See *Mammoth*; *Mastodon*.—BIBLIOGRAPHY: Andersson, *The Lion and the Elephant*; Sir J. E. Tennent, *The Wild Elephant in Ceylon*; Sanderson, *Wild Beasts of India*; R. Lydekker, *The Game Animals of Africa*.

Elephan'ta Isle, or **Gharapuri**, a small island in the Bay of Bombay, between Bombay and the mainland, 6 miles north-east of the former; circumference about 5 miles. It consists of two long hills chiefly overgrown with wood. A city is supposed to have flourished on the island between the third and tenth centuries, but now it has only a few inhabitants, who rear sheep and poultry for the Bombay market. It is celebrated for its rock temples or caves, the chief of which is a cave-temple supposed by Fergusson to belong to the tenth century, 130 feet long, 123 broad, and 18 high. It is supported by pillars cut out of the rock, and containing a colossal figure of the trimurti or Hindu Trinity: Brahma, Vishnu, and Siva. The temple is still used by the Bania caste for the Sawa at certain festivals.

Elephant-fish (*Callorhynchus antarcticus*), a fish of the sub-class Elasmobranchii (rays and sharks), so named from a proboscis-like structure on the nose: called also Southern Chimæra. It inhabits the Antarctic seas, and is palatable eating.

Elephantiasis is a disease characterized by progressive enlargement of a limb, or portion of the body, and occurs most frequently in the legs. The enlargement begins below the knee and gradually involves the entire limb. The onset may be slow and painless, or sudden with fever and rapid swelling. The disease is common in all countries in which the Filariæ prevail. No drug destroys the embryos in the blood, and in infected districts the drinking-water should be boiled or filtered. In rapid cases rest, liquid diet, purgation, and firm bandaging of the legs are indicated. Surgical treatment for removal of adult Filariæ in enlarged glands has met with some success.

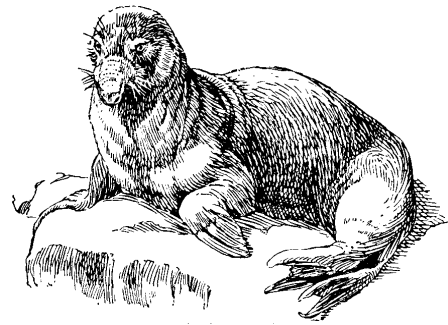
Elephanti'ne, the Greek name of a small island of Egypt, in the Nile, just below the First Cataract and opposite Assouan (Syene). It is partly covered with ruins of various origins—Egyptian, Roman, Saracen, and Arabic, the most important being a gateway of the time of Alexander, a small temple dedicated to Khnum and founded by Amenophis III, and the ancient Nilometer mentioned by Strabo. The latter was restored in 1870 by the Khedive Ismail Pasha. The northern part is low, the southern elevated and rocky.

Elephant Lore. The cult of the elephant is found among many nations in Asia and Africa. It exists in Indo-China, Cambodia, Abyssinia, Siam, and Sumatra. The Aryo-Indian god Indra rides on an elephant. Buddha had a white elephant form. One of the Sanskrit names for the elephant is *Naga*, which connects the animal with the sacred snake, possibly on account of its trunk; another name is

Hastin, 'having a hand'. The Wambuwegs believe the elephant to be the abode of the souls of their ancestors. It is a bad omen, according to the *Talmud*, to dream of an elephant.

Elephant River, a river of Cape Colony, running into the Atlantic after a course of 140 miles,

Elephant-seal, the Proboscis Seal, or Sea-elephant, the largest of the seal family (Phocidæ). There are probably two species, one (*Macrorhinus angustirostris*) found only on the coast of California and Western Mexico, the other (*Macrorhinus leoninus*) found in Patagonia, Kerguelen Island, Heard's Island, and other parts of the Southern Seas. They vary in length from 12 to 30 feet, and in girth at the chest from 8 to 18 feet. The proboscis of the male is about a foot long when the creature is at rest, but elongates under excitement. The females have no proboscis and are considerably smaller than the male. Both species are becoming rare owing to the wholesale slaughter of them which takes place.



Elephant-seal

Elephant's-foot, the popular name of *Testudinaria elephantipes*, a plant of the nat. ord. Dioscoreaceæ (yams, &c.), distinguished by the shape of its rootstock, which forms a nearly hemispherical mass rising a little above the ground, covered with a thick corky bark. It has a slender climbing stem growing to a length of 30 or 40 feet, with small heart-shaped leaves and greenish-yellow flowers. It is known in the Cape Province as Hottentots' Bread.

Eleusi'ne, a genus of grasses, several of which, e.g. *E. coracana*, are cultivated as grain plants in India, Japan, and Tibet.

Eleusinian Mysteries, the sacred rites anciently observed in Greece at the annual festival of Dēmētēr or Ceres, so named from their original seat Eleusis. According to the Homeric hymn to Dēmētēr, the goddess, while wandering in search of Persephone, came to Eleusis, where she was hospitably received by King Celeus. He directed the establishment of a temple in her honour, and showed the use of grain to Triptolemus and other princes. As a preparation for the greater mysteries celebrated at Athens and Eleusis, lesser Eleusinia were

celebrated at Agræ on the Ilissus. The greater Eleusinia were celebrated in the month Boedromion (September-October), beginning on the 15th of the month and lasting nine days. The celebrations, which were varied each day, consisted of processions between Athens and Eleusis, torch-bearing and mystic ceremonies attended with oaths of secrecy. They appear to have symbolized the old conceptions of death and reproduction, and to have been allied to the orgiastic worship of Dionysus (Bacchus). They are supposed to have continued down to the time of Theodosius I.

Eleu'sis, in ancient geography, a small city of Attica, about 14 miles from Athens, near the shore opposite the Island of Salamis. Its temple of Dēmētēr was one of the most beautiful buildings of Greece. The sacred buildings were destroyed by Alaric in A.D. 396. In 1882 the Greek Archæological Society undertook excavations, and numerous remains have been unearthed. There is now a large straggling village here.

Eleu'thera, one of the largest of the Bahama Islands. It is of very irregular shape, its length being about 70 miles, and its breadth in general from 2 to 4 miles, though in one part 10. Pop. 6533.

Elevation. In astronomy, the elevation of an object above the horizon is measured by the arc intercepted between the horizon and the object on the circle which passes through the object and the zenith. In geometry, solids can be represented by means of two projections; one on a horizontal plane, and the other on a plane perpendicular to the horizontal. The former is called the plan, and the latter the elevation.

Elevation of the Host (Lat. *hostia*, a victim), in the ritual of the Mass, is the lifting up of the elements immediately after consecration, to be worshipped by the people. It was introduced into the Latin Church in the eleventh century, in consequence of the denial by Berengarius of the real presence in the sacrament. The Council of Trent ordered that the host should be worshipped with the highest adoration, that of *latria*, which is offered to God only.

El'elevator, (1) a mechanical contrivance consisting of a series of boxes or buckets attached to a belt travelling round two drums, one above and one below, for hoisting grain, meal, coal, coke, &c. In America large buildings which contain such contrivances, and in which grain is stored, receive the same name. (2) An apparatus for raising or lowering persons or goods to or

from different levels in warehouses, hotels, &c., consisting usually of a cage or movable platform worked by hydraulic power: also called a *lift* or *hoist*.

Elf-arrows, Elf-bolts, or Elf-shot, popular names in Europe for stone arrow-heads and axes. They were worn as charms against lightning; cattle and men are said to have been struck and wounded by them. In the Far East they are 'thunder-stones'.

Elgar, Sir Edward, English composer, was born at Broadheath, Worcestershire, 2nd June, 1857. For some time he acted as conductor of the Worcester Instrumental Society, and as organist at St. George's, Worcester, but when later he turned to composition he resigned both these positions. In 1892 he produced *The Black Knight*, and this was followed by several oratorios, cantatas, and other works, including *The Light of Life*, a short oratorio (Worcester Festival, 1896); *King Olaf*, a cantata (North Staffordshire Festival, 1896); *Imperial March* (1897); *Te Deum* (Hereford Festival, 1897); *Caractacus* (Leeds Festival, 1898); and *Orchestral Variations* (1899). In 1900 his famous sacred cantata, *The Dream of Gerontius*, was produced at the Birmingham Festival (repeated at Düsseldorf in 1901 and at the Niederrheinische Musik Fest in 1902), and added immensely to his already considerable reputation. In 1902 the *Coronation Ode* proved extremely popular, and in 1903 the Birmingham Festival introduced *The Apostles*, a fine oratorio, which, like the *Gerontius*, was honoured at the Niederrheinische Musik Fest the following year. In March, 1904, an 'Elgar Festival', lasting three days, was held at Covent Garden, London, at which, in addition to *The Dream of Gerontius*, *The Apostles*, and other compositions by Dr. Elgar, was produced *Allassio*, a new concert overture, the outcome of a visit to Italy. In 1904 Dr. Elgar was knighted. From 1905 to 1908 he was professor of music at Birmingham University. He has received musical and other degrees from Oxford, Cambridge, and Yale.

Elgin, James Bruce, eighth Earl of, and twelfth Earl of Kincardine, Governor-General of India, born in 1811, died in 1863. Educated at Eton and Christ Church, he entered Parliament in 1841 as member for Southampton, and in the same year succeeded to the earldom. He was appointed Governor-General of Jamaica in 1842, and in 1846 Governor-General of Canada. In 1849 he was raised to the British peerage as Baron Elgin of Elgin. In 1857 he went as special ambassador to China, and concluded the Treaty of Tientsin (1858). In 1859 he became Postmaster-General in Palmerston's Cabinet, in 1860 was sent on a special mission to Peking, and in 1861 became Governor-General of India.

—Victor Alexander Bruce, ninth Earl of Elgin, son of the preceding, born 1849, died 1917, was also Governor-General of India (1894-9), and Colonial Secretary in the Campbell-Bannerman Ministry from Dec., 1905, to April, 1908.

Elgin (el'gin), a royal and parliamentary burgh of Scotland, capital of Elgin County, situated on the Lossie, about 5 miles from its influx into the Moray Firth, 70 miles N.W. of Aberdeen. The town largely consists of mansions and villas. The most interesting edifice is the cathedral, now in ruins, which was once the most magnificent in Scotland. It was founded by Bishop Andrew Moray in 1224; plundered and burned in 1390 by the 'Wolf of Badenoch', and again in 1402 by Alexander, third son of the Lord of the Isles; restored 1390 to 1424; and again plundered in 1568. Until 1918 the Elgin Burghs sent one member to the House of Commons. Pop. 8656.—*Elgin*, county of, also called Morayshire, is a maritime county, bounded by the Moray Firth, Banffshire, Inverness-shire, and Nairnshire; area, 340,000 acres. Along the sea-coast, which extends for more than 30 miles, the surface is flat, but inland it rises into hills of moderate elevation, intersected by fine and fertile valleys. The chief rivers are the Spey, Lossie, and Findhorn, the Spey and Findhorn having excellent salmon fishing. Inexhaustible quarries of freestone (rich in fossils) are worked. The climate is noted for its general mildness, dryness, and salubrity. The lower tracts of land are fertile and highly cultivated, the principal crops being wheat, oats, potatoes, and turnips. The great majority of farms are small. A portion of the surface is still covered with native forests. The county unites with Nairnshire in returning one member to the House of Commons, Pop. 43,427.

Elgin, a town of the United States, in Illinois, on Fox River, 36 miles N.W. of Chicago. It has a watch-factory and various flourishing industries. Pop. 25,976.

Elgin Marbles, the splendid collection of antique sculptures brought chiefly from the Parthenon of Athens to England by the seventh Earl of Elgin (1766-1841) in 1814, and afterwards purchased by Parliament for the British Museum at the cost of £35,000. They consist of figures in low and high relief and in the round, representing gods, goddesses, and heroes; the combats of the Centaurs and Lapithæ; the Panathenaic procession, &c. They exhibit Greek sculpture at its highest stage, and were partly the work of Phidias. The historical and artistic value of the Elgin marbles was at first doubted, and Lord

Elgin himself was not spared. His act in removing the marbles was denounced as vandalism.

El Hasa, a fertile district of Eastern Arabia, on the Persian Gulf. It produces dates, wheat, millet, and rice. Pop. estimated at 175,000.

Eli, one of the Hebrew judges, the predecessor of Samuel. He was high-priest and judge for forty years, but was less successful as head of his own household. His two sons having been slain, and the ark taken in battle by the Philistines, the news proved so severe a shock that he fell and broke his neck, at the age of ninety-eight. Little is really known of the history of Eli, since he is only shown to us in the weakness of old age, unable to control his sons Hophni and Phinehas, whose wickedness disgusted and alienated the people.

Eli'jah, the most distinguished of the prophets of Israel, flourished in the ninth century B.C., during the reigns of Ahab and Ahaziah, and until the beginning of the reign of Jehoram, his special function being to denounce vengeance on the kings of Israel for their apostasy. He incurred the anger of Jezebel, wife of Ahab, for slaying the prophets of Baal, but escaped to Horeb, afterwards returning to Samaria to denounce Ahab for the murder of Naboth. Elijah at length ascended to heaven in a chariot of fire, Elisha, his successor, being witness. See *1 Kings*, xvii to xxi, and *2 Kings*, i and ii.

Elimination, in mathematics, the process of treating a given set of equations so as to deduce from them an equation free from a selected letter, or from several selected letters. For instance, if the system of equations

$$a_1x + b_1y + c_1z = 0,$$

$$a_2x + b_2y + c_2z = 0,$$

$$a_3x + b_3y + c_3z = 0,$$

has a solution in which one at least of x, y, z is different from zero, then

$$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix} = 0.$$

(See *Determinant*.)—BIBLIOGRAPHY: Burnside and Panton, *Theory of Equations*; Salmon, *Higher Algebra*.

El'iot, George, the assumed literary name of Mary Ann, or, as she preferred to write the name in later years, Marian Evans, English novelist. She was the daughter of a Warwickshire land-agent and surveyor, was born at Griff, near Nuneaton, on 22nd Nov., 1820, and died on 22nd Dec., 1880. She received at Coventry an excellent education, comprising the classical and modern languages, and shortly after her twenty-first year became a convert to Rationalism. Her first literary undertaking was the completion of Mrs. Hennell's translation of Strauss's *Life of Jesus* (1846). Towards the end of her task she seems, however, to have wearied of it, and when the work appeared she declared herself 'Strauss-sick'. After spending two years abroad, she boarded at the house of John Chapman, editor of the *Westminster Review*, of which she became sub-editor. It was not, however, until January, 1857, that she came prominently into public notice, when the first of a series of tales entitled *Scenes from Clerical Life* appeared in *Blackwood's Magazine*. The series came to an end in Nov., 1857, and in the following year the publication of *Adam Bede* placed her in the first rank of writers of fiction. It was succeeded by *The Mill on the Floss* (1860), *Silas Marner* (1861), *Romola* (1863), *Felix Holt* (1866), *Middlemarch* (1872), and *Daniel Deronda* (1876). In addition to those prose works she published three volumes of poems, *The Spanish Gypsy* (1868), *Agatha* (1869), and *The Legend of Jubal* (1874). Her last work published during her life was the series of essays entitled *The Impressions of Theophrastus Such* (1879), but a volume of mixed essays was issued posthumously. For many years she was happily associated both in life and work with George Henry Lewes, though a legal union was impossible during the lifetime of Mrs. Lewes. In May, 1880, after Lewes's death, she married Mr. John Cross, but did not survive the marriage many months, dying rather suddenly at Chelsea.—BIBLIOGRAPHY: Haton, *George Eliot in Derbyshire*; J. W. Cross (editor), *George Eliot's Life as Related in Her Letters and Journals* (3 vols.); O. Browning, *Life of George Eliot*; Deakin, *The Early Life of George Eliot*; Sir Leslie Stephen, *George Eliot* (in English Men of Letters Series).

Eliot, Sir John, one of the ablest of the popular leaders of Charles I's reign, of an old Cornwall family, born in 1592, died in 1632. He entered Parliament in 1614 as member for St. Germans, winning immediate reputation as an orator. As vice-admiral of Devon he was energetic in suppressing piracy. In the three Parliaments of 1623, 1625, 1626, he made his way to the front of the constitutional party, joined Hampden and the rest in refusing contributions to the forced loan, and took a prominent share in drawing up the Remonstrance and Petition of Right. He was imprisoned in the Tower in 1629, and died in

confinement. During his imprisonment he wrote a work on constitutional monarchy entitled *The Monarchie of Man*. Among his other works are: *An Apology for Socrates*, and *Negotium Posterorum* (an account of the Parliament of 1625).

E'lis, a maritime state of ancient Greece in the west of the Peloponnesus, bordering on Achaia, Arcadia, and Messenia, and watered by the Rivers Alphēus and Penēus. Of its capital Elis (now Kaloskopi) there are few traces. Olympia, where the famous games were held, was near the Alpheus. Since 1899 Elis forms a nomarchy of Greece.

Eli'sha, a Hebrew prophet, the disciple and successor of Elijah. Many miracles of prediction and cure, and even of raising the dead, are ascribed to him, but his figure is less original and heroic than that of his master. He held the office of prophet for fully sixty-five years, from the reign of Ahab to that of Joash (latter half of ninth century B.C.).

Elix'ir, a word of Arabic origin (*al iksir*, the philosopher's stone), applied by the alchemists to a number of solutions employed in attempting the transmutation of metals into gold, and also to a potion, the *elixir vitæ*, or elixir of life, supposed to confer immortality. It is still used for various popular remedies, for the most part composed of various aromatic and stimulative substances held in solution by alcohol.

Elizabeth (*Carmen Sylva*), Dowager Queen of Roumania, born at Neuwied, principality of Wied, in 1843, died at Bucharest, 2nd March, 1916. In 1869 she was married to Prince Charles of Hohenzollern, who became King of Roumania in 1881. Queen Elizabeth, or, as she was generally known, Carmen Sylva (her pen-name), was not only a patron of Roumanian writers and artists, but herself a distinguished author. Among her works, which were all, with the exception of one, written in German, are: *The Bard of the Dimbovitza*, *Pilgrim Sorrow*, *A Real Queen's Fairy Tales*, and *From Memory's Shrine*. In 1914 she was made an honorary fellow of the Royal Society of Literature of Great Britain.

Elizabeth, Queen of England, daughter of Henry VIII and of Anne Boleyn, was born at Greenwich, 7th Sept., 1533, and almost immediately declared heiress to the crown. After her mother had been beheaded (1536) both she and her sister Mary were declared bastards, and she was finally placed after Prince Edward and the Lady Mary in the order of succession. On the accession of

Edward VI Elizabeth was committed to the care of the Queen-Dowager Catherine; and after the death of Catherine and execution of her consort Thomas Seymour she was closely watched at Hatfield, where she received a classical education under William Grindal and Roger Ascham. At the death of Edward Elizabeth vigorously supported the title of Mary against the pretensions of Lady Jane Grey, but continued throughout the whole reign an object of suspicion and surveillance. In self-defence she made every demonstration of zealous adherence to the Roman Catholic faith, but her inclinations were well known. On 17th Nov., 1558, Mary died, and Elizabeth was immediately recognized queen by Parliament. The accuracy of her judgment showed itself in her choice of advisers, Parker, a moderate divine (Archbishop of Canterbury 1559), aiding her in ecclesiastical policy; while William Cecil, Lord Burleigh, assisted her in foreign affairs.

The first great object of her reign was the settlement of religion, to effect which a Parliament was called on 25th Jan., and dissolved on the 8th May, its object having been accomplished. The nation was prepared for a return to the Reformed faith, and the Parliament was at the bidding of the Court. The ecclesiastical system devised in her father's reign was re-established, the royal supremacy asserted, and the revised Prayer Book enforced by the Act of Uniformity. While, however, the formal establishment of the reformed religion was easily completed, the security and defence of the settlement was the main object of the policy and the chief source of all the struggles and contentions of her reign. Freed from the tyranny of Mary's reign, the Puritans began to claim predominance for their own dogmas, while the supporters of the Established Church were unwilling to grant them even liberty of worship. The Puritans, therefore, like the Catholics, became irreconcilable enemies of the existing order, and increasingly stringent measures were adopted against them. But the struggle against the Catholics was the more severe, chiefly because they were supported by foreign powers; so that while their religion was wholly prohibited, even exile was forbidden them, in order to prevent their intrigues abroad. Many Catholics, particularly priests, suffered death during this reign; but simple nonconformity, from whatever cause, was pursued with the severest penalties, and many more clergymen were driven out of the Church, by differences about the position of altars, the wearing of caps, and such like matters, than were forced to resign by the change from Rome to Reformation.

Elizabeth's first Parliament approached her on a subject which, next to religion, was the chief trouble of her reign, the succession to the Crown. They

requested her to marry, but she declared her intention to live and die a virgin; and she consistently declined in the course of her life such suitors as the Duc d'Alençon, Prince Erik of Sweden, the Archduke Charles of Austria, and Philip of Spain. While, however, she felt that she could best maintain her power by remaining unmarried, she knew how to temporize with suitors for political ends, and showed the greatest jealousy of all pretenders to the English succession. With the unfortunate Mary, Queen of Scots, were connected many of the political events of Elizabeth's reign. On her accession the country was at war with France. Peace was easily concluded (1559); but the assumption by Francis and Mary of the royal arms and titles of England led to an immediate interference on the part of Elizabeth in the affairs of Scotland. She entered into a league with the Lords of the Congregation, or leaders of the Reformed party; and throughout her reign this party was frequently serviceable in furthering her policy. She also gave early support to the Huguenot party in France, and to the Protestants in the Netherlands, so that throughout Europe she was looked on as the head of the Protestant party. This policy roused the implacable resentment of Philip, who strove in turn to excite the Catholics against her both in her own dominions and in Scotland. The detention of Mary in England (1568-87), whither she fled to the protection of Elizabeth, led to a series of conspiracies, beginning with that under the Earls of Northumberland and Westmorland, and ending with the plot of Babington, which finally determined Elizabeth to make away with her captive. The execution of Queen Mary (1587), though it has stained her name to posterity, tended to confirm her power among her contemporaries. The state of France consequent on the accession of Henry IV, who was assisted by Elizabeth, obviated any danger from the indignation which the deed had caused in that country; and the awe in which King James stood of Elizabeth and his dread of interfering with his own right of succession to England made him powerless. But Philip of Spain was not to be so appeased, the execution of Mary lending edge to other grievances. The fleets of Elizabeth had galled him in the West Indies, her arms and subsidies had helped to deprive him of the Netherlands; the Armada was already in preparation. Accordingly he called the Queen of England a murderess, and refused to be satisfied even with the sacrifice she seemed prepared to make of her Dutch allies. The Armada sailed on 29th May, 1588. The war with Spain dragged on till the close of Elizabeth's long reign.

During her reign the splendour of her government at home and abroad was sustained by such men as Burleigh, Bacon, Walsingham, and Throgmorton; but she had personal favourites of less merit who were often more brilliantly

rewarded. Chief of these were Dudley, whom she created Earl of Leicester, and whom she was disposed to marry, and Essex, whose violent passions brought about his ruin. He was beheaded in 1601, but Elizabeth never forgave herself his death. Her own health soon after gave way, and she died on 24th March, 1603, naming James VI of Scotland as her successor.—BIBLIOGRAPHY: M. A. S. Hume (editor), *Calendar of State Papers* (Spanish Series); J. Bruce (editor), *Letters of Elizabeth and James VI*; W. Camden, *History of Queen Elizabeth*; J. A. Froude, *History of England*; M. Creighton, *Queen Elizabeth*; E. S. Beesley, *Queen Elizabeth*.

Elizabeth, a city of New Jersey, United States, 14 miles s.w. of New York, with which it has ample communication by railway and steamer. It is a favourite residence of New York business men. The Singer Sewing-machine Company has a large factory here, and there are also foundries and oil-cloth factories. Pop. 73,409.

Elizabeth, St., of Thuringia, daughter of Andreas II, King of Hungary, was born at Pressburg 1207, and in 1221 married to Louis IV, land-grave of Thuringia. She erected hospitals, fed a multitude of poor from her own table, and wandered about in a humble dress, relieving the wretched. Louis died on a crusade, and her own life terminated 19th Nov., 1231, in a hospital which she had herself established. The church over her tomb at Marburg is one of the most splendid Gothic edifices in Germany.



Elizabethan Architecture. Moreton Old Hall, Cheshire

Elizabethan Architecture, a style of architecture which prevailed in England during the reigns of Elizabeth and James I. It succeeded to the Tudor style, properly so called, with which it is sometimes confounded. The Elizabethan is a mixture of inferior Gothic and debased Italian, producing a singular heterogeneousness in detail, with, however, wonderful picturesqueness in general effect, and domestic accommodation more in accordance with the wants of an advancing civilization than was afforded by the styles which preceded it. The chief characteristics of Elizabethan architecture are: windows of great size both in the plane of the wall and deeply embayed, ceilings very richly decorated in relief, galleries of great length, very tall and highly-decorated chimneys, as well as a profuse use of ornamental strapwork in the parapets, window-heads, &c. The Elizabethan style is the last stage of the Tudor or Perpendicular, and from its corresponding in point of period with the Renaissance of the Continent has sometimes been called the English Renaissance. The epithet Jacobean has sometimes been given to the very latest stage of the Elizabethan, differing from the Elizabethan proper in showing a greater admixture of debased Italian forms. The princely houses which arose during the reign of Elizabeth are numerous, and many even yet remain to attest the splendour of the time. Of these may be mentioned Burghley House, Hardwick Hall, and Bramhall Hall.—Cf. Gotch and Brown, *Architecture of the Renaissance in England*.



Elizabethan Architecture: an Interior Reconstruction in the Victoria and Albert Museum, London.

Elizabeth Farnese (fa'r-nā'zā), Queen of Spain, daughter of Edward II, Prince of Parma, born 1692, died in 1776. On becoming the second wife of Philip V she surprised those who had counselled the marriage by assuming the practical headship of the kingdom, and her ambition and that of her minister Alberoni disturbed the whole of Europe. Carlyle calls her a "termagant tenacious woman".

Elizabethgrad, a town of the Ukraine, on the Ingul, with an imperial palace, a theatre, manufactures of soap and candles, and several great fairs. Pop. 75,800.

Elizabeth Islands, a group of sixteen American islands south of Cape Cod, with a permanent population of about 150.

Elizabeth of Valois, or **Isabella**, Queen of Spain, was born in 1545, died in 1568. She was the daughter of Henry II of France and Catherine de' Medici. By the Treaty of Cateau-Cambrésis she was destined to be the wife of the Infante, Don Carlos, but his father, Philip II, being left a widower, became fascinated and married her himself. The stories of a romantic relationship existing between Elizabeth and Don Carlos are entirely groundless, but have furnished tragic subjects to Otway, Campistron, Chénier, Schiller, and Alfieri.

Elizabeth Petrovna, Empress of Russia, daughter of Peter the Great and Catherine, born in 1709 or 1710, died in 1762. She ascended the throne on 7th Dec., 1741, as the result of a conspiracy, in which Ivan VI, a minor, was deposed. Elizabeth is said to have rivalled her mother in beauty, and to have surpassed her in her love of pleasure, and her government was largely conducted by favourites. She was a patron of literature, founded the University of Moscow, and corresponded with Voltaire. A war with Sweden, in 1743, was advantageously concluded by the peace of Åbo. In 1748 she sent an army to assist Maria Theresa in the War of the Succession, and joined in the Seven Years' War against Prussia. She died before this war was concluded.—

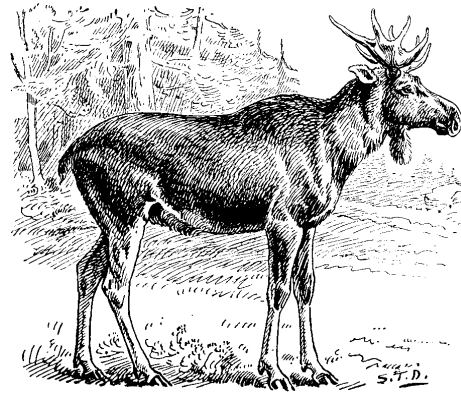
BIBLIOGRAPHY: Nisbet Bain. *The Daughter of Peter the Great*; A. S. Rappoport, *The Fair Ladies of the Winter Palace*.

Elizabethpol, a town of Russia, in the Caucasus, capital of the government of same name, covering a great space of ground from the gardens and open areas it contains, but very unhealthy. Pop. 18,505.—The government has an area of 17,000 sq. miles, a pop. of 636,310. It is partly mountainous, partly steppes, and produces grain, cotton, tobacco, and wine.

Elizabeth Stuart, Queen of Bohemia, daughter of James I of England and VI of Scotland, born in Falkland Palace, Fifeshire, 1596, died on 13th Feb., 1662. Her marriage with the Palatine Frederick was celebrated at Whitehall in 1613. Her husband, then at the head of the Protestant interest in Germany, accepted in 1619 the Crown of Bohemia offered to him by the revolted Protestants of that country. After his defeat, however, by the imperialists at the battle of Prague in 1620, he and his wife were obliged to flee, first to Breslau and

Berlin, and then to the Hague. Elizabeth returned to England at the Restoration with her nephew Charles II, but mingled very little in society. Elizabeth had thirteen children, of whom Charles Louis, the eldest surviving, was reinstated in the Palatinate by the Treaty of Westphalia in 1648. By her daughters, Elizabeth Charlotte and Sophia, she was the ancestress of Louis Philippe and of George I, and her sons, Rupert and Maurice, became famous Cavalier leaders.

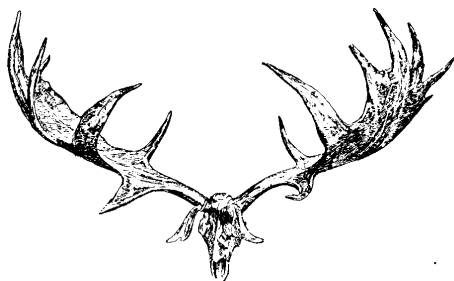
Elk, Moose, or Moose Deer (*Alces Machlis*), the largest of the deer family, a native of Northern Europe, Asia, and America. The American form (to which the name moose is usually given) is sometimes separated from the European as *Alces americanus*, but most naturalists find no specific difference between them. The elk or moose has a short compact body, standing about 6 feet in height at the shoulders, a thick neck, large clumsy head, and horns which flatten out almost from the base into a



Elk (*Alces Machlis*)

broad palmate form with numerous snags. In colour the elk is greyish brown, the limbs, sides of head, and coarse mane being, however, of a lighter hue. Its flesh resembles beef rather than venison. For the most part elks are inoffensive, and so exceedingly wary that they are approached only with difficulty. In America the Indians and half-breeds are the most skilful moose-hunters. By trampling down a restricted area of ground (moose-yard) and browsing on the edge of this, the moose is able to protect itself efficiently against the attacks of wolves. The moose has a wide range in Canada, extending from the Arctic Ocean and British Columbia to New Brunswick and Nova Scotia; and it is found also in Maine. It feeds largely on the shoots of trees or shrubs, such as the willow and maple, and on bark, &c. In Sweden its destruction is illegal, and in Norway there are many restrictions upon the hunting of it.

Elk, Irish (*Megaceros hibernicus*, or *Cervus giganteus*), a large deer found in the Pleistocene strata, and distinguished by its enormous antlers, the tips of which are sometimes 11 feet apart. Though a true deer, its antlers differ from those of living species in that the beam is flattened into a palm. To sustain the great weight, unusually large and strong limbs and neck vertebræ were



Antlers and Skull of Irish Elk

required. Its remains are found not only in Ireland but in Scotland and England, and on the Continent, where they occur in bogs, lacustrine deposits, brick-clay, and ossiferous caves.

El Khargeh. See *Khargeh*.

Elk'hart, a town of Indiana, United States, on Elkhart River, with railroad works and paper-mills. Pop. 19,282.

Ell (Lat. *ulna*, Gr. *ōlenē*, forearm), an old measure whereby cloths, stuffs, &c., are sometimes measured. The ell English is 5 quarters (45 inches), the ell Flemish 3 quarters (27 inches). In Scotland an ell contained 37.2 inches English.

Ell'and, a town of England, W. Riding of Yorkshire, between Halifax and Huddersfield, with an old church and town-hall, manufactures of cottons and woollens, and quarries. It gives its name to a parliamentary division. Pop. 10,676.

Ellenborough, Edward Law, Lord, English lawyer, Lord Chief Justice of the King's Bench, born in 1750 at Great Salkeld, Cumberland, died in 1818. He was educated at the Charterhouse and at Peterhouse, Cambridge, and called to the Bar in 1780. Not long afterwards he took silk, and at the trial of Warren Hastings, in 1785, acted as leading counsel. The defence did not come on until the fifth year of the trial, but after eight years Hastings was acquitted and Law's success assured. In 1801 he was made Attorney-General, and in 1802 became Lord Chief Justice of the King's Bench, and was created baron. He held the office of Chief Justice for fifteen years, resigning in 1818.

Ellenborough, Edward Law, first Earl of, son of Lord Chief Justice Ellenborough (see above), born in 1790, died in 1871. He was educated at Eton and St. John's College, Cambridge, and in 1818, having succeeded his father as second baron, he entered the House of Lords. In 1818 he took office as Lord Privy Seal, and was President of the Board of Control from 1828-30, and again in 1834. In 1841 he accepted the governor-generalship of India, and arrived in Calcutta in 1842, in time to bring the Afghan War to a successful issue. The annexation of Seinde in 1843 was followed by the conquest of Gwalior, but the conduct of the Governor-General gave dissatisfaction at

home, and he was recalled early in 1844. On his return, however, he was defended by Wellington, and received the thanks of Parliament, an earldom, and the Grand Cross of the Bath. He then held the post of First Lord of the Admiralty (1845-6), and was President of the Board of Control from Feb. to June, 1858. His dispatch censuring the policy of Lord Canning as Governor-General of India led to his resignation, and he never resumed office.

Ell'ice Islands, or **Lagoon Islands**, a group of coral islands annexed to Britain in 1892, lying north of Fiji, and extending for 360 miles north-west to south-east. The islands were discovered by Maurelle in 1781. The inhabitants are of Samoan race and language, have long been Christians, and support themselves chiefly by the coco-nut. Pop. 3084.

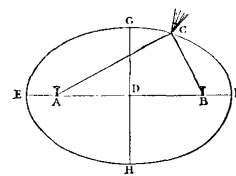
Ellichpur (el-ich-pör'), a town of India, in Ellichpur district, Berar, once a large and prosperous town. There is a military cantonment within two miles. Pop. 27,500.

El'licott, Right Rev. Charles John, English divine, born 1819, died in 1905. Educated at Cambridge, he was professor of divinity in King's College, London, Hulsean lecturer and Hulsean professor of divinity at Cambridge, and Dean of Exeter, and in 1863 was appointed Bishop of Gloucester and Bristol. He was for eleven years chairman of the scholars engaged on the revision of the New Testament translation, and published commentaries on the Old and the New Testaments, as well as sermons, addresses, and lectures.

Elliott, Ebenezer, English poet, known as the 'Corn-law Rhymer', born in 1781 near Rotherham, Yorkshire, died in 1849. At the age of seventeen he published his first poem, *The Vernal Walk*, which was soon followed by others. In 1829 *The Village Patriarch*, the best of Elliott's longer pieces, was published. From 1831 to 1837 he carried on business as an iron merchant in Sheffield. His *Corn-law Rhymes*, periodically contributed to a local paper devoted to the repeal of these laws, attracted attention, and were afterwards collected and published with a longer poem entitled *The Ranter*. Commercial losses compelled him in 1837 to contract his business, and in 1841 he retired from it altogether. In 1850 two posthumous volumes appeared, entitled *More Prose and Verse by the Corn-law Rhymer*.

Ellipse', one of the conic sections. The curve generated by a point which moves so that its distance from a fixed point bears a constant ratio (less than unity) to its distance from a fixed straight line. Kepler discovered that the paths

described by the planets in their revolutions round the sun are ellipses, the sun being placed in one of the foci. To describe an ellipse: At a given distance on the surface on which the ellipse is to be described fix two pins, A and B, and pass a looped string round them. Keep the string stretched by a pencil, C, and move the pencil round, keeping the string at the same tension, then the ellipse EGFH will be described. A and B are the *foci*, D the centre, EF the major axis, GH the minor axis, and the fraction DA/DE the *eccentricity* of the ellipse. A line drawn from any point in the curve perpendicularly to the axis is an ordinate to the axis. Any straight line drawn through the centre and terminated both ways by the curve is called a diameter.



Ellipsoid, a surface bearing the same sort of relation to a spherical surface as an ellipse bears to a circle. The name is also given to the solid bounded by such a surface.

The equation of an ellipsoid, referred to its principal axes, is

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1.$$

Here a , b , c , are the lengths of the principal semi-axes. A plane section is an ellipse, but there are two particular directions of the section for which the ellipse reduces to a circle.

The ellipsoid has important applications in dynamics, as a means of interpreting algebraic formulæ for physical quantities; examples are the ellipsoids of strain and of gyration, and Poinsot's momental ellipsoid.

Two ellipsoids in which the principal sections lie in the same planes, and have the same foci, are called *confocal*.

Ellipsoidal Harmonics are mathematical functions by means of which certain physical problems in heat and electricity relating to ellipsoidal surfaces can be solved. For ellipsoids of revolution, see *Spheroid*.

Elliptic Functions are generalizations of the circular functions *sine*, *cosine*, &c. If

$$u = \int_0^x \frac{dx}{\sqrt{(1-x^2)}} = \sin^{-1}x,$$

we have $x = \sin u$. Similarly, if

$$u = \int_0^x \frac{dx}{\sqrt{(1-x^2)(1-k^2x^2)}},$$

we may write $x = \operatorname{sn} u$, $\sqrt{(1-x^2)} = \operatorname{cn} u$, $\sqrt{(1-k^2x^2)} = \operatorname{dn} u$. These are Jacobi's elliptic functions. They obviously reduce to $\sin u$, $\cos u$, 1, when k is 0. The circular functions have the period 2π ; the elliptic functions are *doubly* periodic, having both a real and a pure imaginary period when k^2 is real and less than 1. Like the functions *sine* and *cosine*, the elliptic functions have *addition theorems*, e.g.

$$\operatorname{sn}(u+v) = \frac{\operatorname{sn} u \operatorname{cn} v \operatorname{dn} v + \operatorname{sn} v \operatorname{cn} u \operatorname{dn} u}{1 - k^2 \operatorname{sn}^2 u \operatorname{sn}^2 v}.$$

Another method and notation has been introduced by Weierstrass, and is now much used. The functions are needed for the solution of many physical problems, such as those of the motion of a top and of a pendulum.—
BIBLIOGRAPHY: A. G. Greenhill, *Elliptic Functions*; Appell and Lacour, *Fonctions Elliptiques*; Whittaker and Watson, *Modern Analysis*.

Ellis, Alexander John, English philologist, born 1814 (name originally Sharpe), died in 1890. He was a distinguished graduate of Trinity College, Cambridge, was elected to the Royal Society in 1864, and was long a prominent member of the Philological Society, being more than once its president. Though phonetics was the subject in which he most highly distinguished himself, he was equally at home in mathematical and musical subjects. His chief published work is *Early English Pronunciation* (in five parts), between 1869 and 1889; but his publications in the form of books, pamphlets, papers, and articles on phonetics, music, and mathematics are numerous.

Ellis, George, English man of letters, born in 1753, died in 1815. Educated at Westminster School and Trinity College, Cambridge, he became one of the

junta of wits concerned in the well-known political satire, *The Rolliad*, and contributed to the *Anti-Jacobin*. He also wrote a preface, notes, and appendix to Way's translation of Le Grand's *Fabliaux*, and published *Specimens of the Early English Poets, with an Historical Sketch* (1790), and *Specimens of Early English Metrical Romances* (1805). He was an intimate friend of Sir Walter Scott.

Ellis, William, English missionary, born 1794, died 1872. He was sent out to the South Sea Islands in 1816 by the London Missionary Society, and returned in 1825, one result of his labours being *Polynesian Researches* (1829). From 1830 to 1844 he was secretary to the society, and afterwards on its behalf made several visits to Madagascar, the longest being from 1861 to 1865. These visits led him to publish *Three Visits to Madagascar* (1858), *Madagascar Revisited* (1867), and the *Martyr Church of Madagascar* (1870).

Ellis Island, a small island in the upper New York Bay. Sold by the New York State to the United States, in 1808, it was for a long time used as a powder magazine, but in 1891 was made an immigrant station.

Ello'ra, or **Elo'ra**, a ruined village, Hindustan, Deccan, Nizam's Dominions, 13 miles north-west of Aurangabad, famous for its rock and cave temples excavated in the crescent-shaped scarp of a large plateau. They run from north to south for about a mile and a quarter, and consist of five Jain caves towards the north, seventeen Brahmanical caves at the centre, and towards the south twelve Buddhistic caves. Of the temples some are cut down through the rock, and left open above like isolated buildings, others are excavated under the hill in the manner of caves properly so called. The interior walls are often richly carved with mythological designs. The most magnificent of the whole is the Hindu temple called Kailasa or Cailasa, the central portion of which forms an isolated excavated mass or immense block 500 feet in circumference and 100 feet high. It is surrounded by galleries or colonnades at the distance of 150 feet, in which the whole Hindu pantheon is cut in the perpendicular rock. Another fine temple, much smaller, but cut under the hill, is the Buddhist cave of Visvakarma, the only one excavated with a curved roof. The date of the caves is not certainly known, but they were probably the work of the reigning families at the neighbouring Deoghir, now Daulatabad, which, prior to the Mohammedan conquest, A.D. 1293, was the capital of a powerful Hindu principality.—Cf. Fergusson and Burgess, *The Cave Temples of India*.

Ellore, a town of India, Godavari district, Madras presidency, once the capital of the Northern Circars. Pop. 29,500.

Ellwood, Thomas, an early writer among the Quakers, born in 1639, died in 1713. About 1660 he was induced to join the Society of Friends, and soon after published *An Alarm to the Priests*. He was imprisoned on account of his religion, but subsequently became reader to Milton, and upon reading the MS. of *Paradise Lost* is said to have suggested to the poet the idea of writing the *Paradise Regained*. In 1705 and 1709 he published the two parts of his *Sacred History*. His works include a poetical life of King David, the *Davideis*, *Forgery no Christianity*, and an autobiography, *The History of the Life of Thomas Ellwood: written by his own hand*.

Elm, a genus of trees (Ulmus; nat. ord., Ulmaceæ), consisting of eighteen species, natives of the northern temperate zone and mountains of Tropical Asia. They have bisexual flowers with a campanulate calyx, as many stamens as there are divisions in the limb of the calyx, and two styles. Two species are common



Common Elm (*Ulmus campestris*)
Fruit, flowers, and leaves.

in Britain, *Ulmus campestris* and *Ulmus montāna*, with many varieties. The *Ulmus campestris*, or common elm, is a fine tree, of rapid and erect growth, and yielding a tall stem, remarkable for the uniformity of its diameter throughout. It is very common as a timber tree in England; but as it rarely produces seed it is questionable whether it is indigenous. It is a native of the south and middle of Europe, and the west of Asia. The average height of a mature tree is 70 or 80 feet, but some reach a height of 150 feet. The wood is brown, hard, of fine grain, not apt to crack, and is used for many purposes. The tree generally attains maturity in seventy or eighty years. *Ulmus montāna* (the

mountain or wych elm), a native of Scotland, grows to a less height than the English elm, is of slower growth, and yields a much shorter bole, but it is far bolder in its ramification and more hardy. It usually attains to the height of about 50 feet. It does not produce suckers, like the English elm, but yields seed freely. The timber is strong and elastic, and the tree often yields large protuberances of gnarled wood, finely knotted and veined, and much esteemed for veneering. *Ulmus glabra*, the smooth-leaved elm, is a variety common in some parts of Britain. It first appeared about the middle of the eighteenth century. The most ornamental tree of the genus is *Ulmus montāna*, variety *pendūla*, the weeping elm. The American or white elm (*Ulmus americāna*) is abundant in the Western States, attaining its loftiest stature between lat. 42° and 46°; here it reaches the height of 100 feet, with a trunk 4 or 5 feet in diameter, rising sometimes 60 or 70 feet before it separates into a few primary limbs. Its wood is not much esteemed. The red or slippery elm (*Ulmus fulva*) is found throughout a great extent of country in Canada, Missouri, and as far south as lat. 31°; it attains the height of 50 or 60 feet, with a trunk 15 or 20 inches in diameter; the wood is of better quality than that of the white elm. The leaves and bark yield an abundant mucilage. The wahoo (*Ulmus alāta*), inhabiting from lat. 37° to Florida, Louisiana, and Arkansas, is a small tree, 30 feet high. The branches are furnished on two opposite sides with wings of cork 2 or 3 lines wide; the wood is fine-grained and heavy.

Elmi'na, a British town and seaport on the west coast of Africa, 8 miles west of Cape Coast Castle. It was acquired by Britain in 1872 with the other Dutch possessions on the Gold Coast, when it was claimed by the King of Ashanti, the result being the Ashanti Wars of 1873-4. Pop. 12,500.

Elmi'ra, a town of the United States, N. York, on the Chemung River; with a college for women, founded in 1855, the State reformatory, and a fine courthouse. Its industrial establishments comprise rolling-mill, blast-furnace, foundries, and machine-works. Pop. 37,176.

Elmo's Fire, St., a meteoric appearance often seen playing about the masts and rigging of ships. If two flames are visible (Castor and Pollux) the sailors consider it a good omen; if only one (Helena), they regard it as a bad one. The name is derived from St. Elmo, or St. Erasmus, who was broken on the wheel A.D. 304.

Elmshorn, a town in Schleswig-Holstein, 20 miles north-west of Hamburg, on the Krückau, a navigable stream. Pop. 14,790.

Elmsley, Peter, D.D., English scholar, born in 1773, died in 1825. Educated at Oxford, he was one of the original contributors to the *Edinburgh Review*, and wrote occasionally, at a subsequent period, in the *Quarterly*. He finally settled at Oxford, on obtaining the headship of St. Alban's Hall and the Camden professorship of ancient history in 1823. He published editions of the *Ædipus Tyrannus* (1811), *Heraclidæ* (1815), *Medea* (1818), *Bacchæ* (1821), and *Ædipus Coloneus* (1823).

El Obeid. See *Obeid*.

Elodea, a genus of submerged water-plants, nat. ord. Hydrocharitaceæ. *E. canadensis*, the Canadian water-weed, was accidentally introduced into Britain about 1840, and spread throughout Europe with extraordinary rapidity, and entirely by vegetative reproduction, as only the ♀ plant exists on this side of the Atlantic. The plant is much used for physiological experiments, e.g. for showing the movements of protoplasm.

Elo'him (plural of *Eloah*), one of the Hebrew names for God, of frequent occurrence in the Bible. Elohim is used in speaking both of the true God and of false gods, while Jehovah is confined to the true God. The plural form of Elohim has caused a good deal of controversy, some considering it as containing an allusion to the doctrine of the Trinity, others regarding it as the plural of excellence, others holding it as establishing the fact of a primitive polytheism. The Elohist passages in the *Pentateuch*, or, in other words, the passages in which the Almighty is always spoken of as Elohim, are supposed to have been written at an earlier period than those in which he is spoken of as Jehovah. The Elohist passages are simpler and more primitive in character than the Jehovistic; thus *Gen. i*, 27 is Elohist; *Gen. ii*, 21-4 is Jehovistic.

El Paso ('the pass' or crossing), a town of the United States, in Texas, at an important ford or crossing of the Rio Grande del Norte, where there is now a railway bridge, with extensive railway connections and large trade with Mexico, the smaller Mexican town of same name being on the opposite bank of the river. Pop. (including suburbs), 39,280.

Elphinstone. Hon. Mountstuart, Indian administrator, son of the eleventh Lord Elphinstone, born in Scotland in 1778, died in 1859. He joined the Bengal Civil Service in 1795, was Ambassador to the Afghan Court in 1808, Resident at the Court of Poonah from 1810 to 1817, and British commissioner to that province from 1817 to 1819, when he became Governor of Bombay. During a

government of seven years he established a code of laws, lightened taxes, and paid great attention to schools and public institutions. He resigned in 1827. A college established by the natives was called after him Elphinstone College. He was the author of an *Account of the Kingdom of Cabul and its Dependencies* (1815), and a *History of India* (1841). He was offered the governor-generalship of India in 1835, and afterwards that of Canada, both of which he declined.

Elphinstone, William, a Scottish prelate, founder of King's College and University, Aberdeen, born at Glasgow in 1431, died in 1514. He was educated at Glasgow College, and served four years as priest of St. Michael's in that city. He then went to France and became professor of law, first at Paris and subsequently at Orleans, but before 1474 he returned home at the request of Muirhead, Bishop of Glasgow, who made him commissary of the diocese. In 1478 he was made commissary of the Lothians, and in 1479 Archdeacon of Argyle. Soon after he was made Bishop of Ross; and in 1483 was transferred to the see of Aberdeen. In 1484 and 1486 he was commissioned to negotiate truces with England, and in 1488 was Lord High-Chancellor of the kingdom for several months. He was next sent on a mission to Germany, and after his return held the office of Lord Privy Seal till his death in 1514. In 1494 he obtained a papal bull for the erection of the university of King's College at Aberdeen.

Elsinore (Dan. *Helsingör*), a seaport of Denmark, in the Island of Seeland, at the narrowest part of the Sound, here only 3½ miles broad, 24 miles north by east of Copenhagen, opposite Helsingborg in Sweden, and connected with it by train-ferry. Near Elsinore is the castle of Kronberg, built by Frederick II of Denmark about 1580, and commanding the Sound. The castle, now chiefly used as barracks, is associated with Shakespeare's *Hamlet*. Before the abolition of the Sound dues in 1857 all merchant ships passing through were bound to pay toll here. Pop. 13,990.

Elster two German rivers, the White or Great Elster, a tributary of the Saale; the Black Elster, a tributary of the Elbe.

Elswick (els'ik), a suburb of Newcastle, England, containing the great ordnance-works of Armstrong, Mitchell, & Co. Pop. 58,352.

Elton, Charles Isaac, English jurist and archæologist, born 1839, died 1900. He was educated at Cheltenham and Oxford, became a barrister and a member

of Parliament, and wrote various works on legal and other subjects, the most important being *Origins of English History*. In this work he traces the development of England and its inhabitants, from the earliest times regarding which we have any knowledge, to the acceptance of Christianity by the Anglo-Saxons, the investigation of the evidence furnished by Greek and Roman writers, and the discussion of prehistoric ethnology and archæology being especially thorough. Other works are: *Commons and Waste Lands*, and *W. Shakespeare: His Family and Friends*.

Elu'triation (Lat. *elutriare*, to wash out), the process of separating the finer particles of a clay, earth, or similar mass, from the coarser, consisting in stirring up the substance in water, letting the coarser particles subside, running off the liquid containing the finer particles, and then waiting till they subside.

Elvas, a fortified city of Portugal, province of Alemtejo, near the Spanish frontier, 12 miles north-west of Badajoz, on a height flanked by two others, each crowned by a castle. It has a cathedral, partly Moorish and partly Gothic, and a Moorish aqueduct, a magnificent work which brings water from a distance of 15 miles. Pop. 10,645.

Ely (ē'li), an episcopal city of England, in the county of Cambridge, on an eminence on the left bank of the Ouse. The ecclesiastical structures comprise the cathedral, one of the largest in England, and the churches of St. Mary, and the Holy Trinity, the last belonging to the time of Edward II, and one of the most perfect buildings of that age. The superb cathedral occupies the site of a monastery founded about the year 673 by Etheldreda, daughter of the King of East Anglia. Its entire length, east to west, is 517 feet, and its west tower is 270 feet high. The whole structure comprises an almost unbroken series of the various styles of architecture which prevailed in England from the Conquest to the Reformation, yet with no loss of impressiveness as a whole. It was begun in 1083, completed in 1534, and since 1847 has undergone extensive additions and restoration. A fine gateway, built in the reign of Richard II, forms the principal entrance to the cathedral precincts. There are a few manufactures, but most of the inhabitants are engaged in agricultural labour. Pop. 7917.

Ely, Isle of, a portion of the county of Cambridge, separated by the Ouse from the rest of the county, and forming itself a sort of county. It is about 28 miles long by 25 miles broad; area, 239,259 acres. The name is also given to a smaller tract, about 7 miles long by 4 miles broad. The soil is very fertile. Pop. 69,752.

Elymus, a genus of grasses, natives chiefly of the north temperate zone. The British species, *E. arenarius* (lyme grass) is a good sand-binder.

Elys'ium, or **Elysian Fields**, among the Greeks and Romans the regions inhabited by the blessed after death. They are placed by Homer at the extremities of the earth, by Plato at the antipodes, and by others in the Fortunate Islands (the Canaries). They were at last supposed to be in the interior of the earth, where Virgil described them as being. The happiness of the blessed consisted in a life of tranquil enjoyment in a perfect summer land, where the heroes, freed from all care and infirmities, renewed their favourite sports.

Ely'tra, the horny cases into which the front wings of beetles are modified, and which meet in a straight line down the middle of the back. The membranous hind-wings are here the organs of flight, and when not in use are folded longitudinally and transversely, and tucked away under the elytra.

Elze (el'tse), Karl, German writer, distinguished for his studies in English literature, born 1821, died 1889. He studied in Leipzig and Berlin, was long a teacher in the gymnasium of his birth-place, Dessau, and in 1875 was appointed to the chair of English language and literature at Halle. Among his writings were valuable biographies of Sir Walter Scott and Lord Byron (the latter translated into English), and a biographical and critical work on Shakespeare, also translated into English (1888).

El'zevir, or **Elzevier**, the name of a family of publishers and printers, residing at Amsterdam and Leyden, celebrated for the beauty of the editions of various works published by them, principally between 1595 and 1680. Louis, the founder of the family (born 1540, died 1617), settled in Leyden, and between 1583 and his death produced about 150 works. Five of his seven sons followed his business:—Matthæus at Leyden; Louis (II) at the Hague; Gilles at the Hague and afterwards at Leyden; Joost in Utrecht; and Bonaventure, who in 1626 associated himself with Abraham, the son of Matthæus. From the press of Abraham and Bonaventure issued the exquisite editions of the classics which have made the name of Elzevir famous. Of these the *Livy* and *Tacitus* of 1634, the *Pliny* of 1635, the *Virgil* of 1636, and the *Cicero* of 1642 are perhaps the most beautiful. The Elzevir books are distinguished by the types and the choice of the paper rather than by the critical preparation of their texts.

Emanation, in a specific sense, an idea at the centre of many philosophic systems which seek to explain the universe as an eternal efflux or emanation from the Supreme Being, comparable with the efflux of light from the sun. The idea of emanation came from the East, and traces of the doctrine are found in the system of Zoroaster. It had a powerful influence on the ancient Egyptian philosophy, as also on that of the Greeks, as may be seen in Pythagoras. It was subsequently developed by Plotinus, the Gnostics, Manicheans, Pantheists, and other sects.

Eman'uel the Great, King of Portugal, born in 1469, died in 1521. He ascended the throne in 1495, and during his reign were performed the voyages of discovery of Vasco da Gama, of Cabral, of Americus Vespucius, and the heroic exploits of Albuquerque, by whose exertions a passage was found to the East Indies, the Portuguese dominion in Goa was established, and the Brazils and Moluccas were discovered. The commerce of Portugal, under Emanuel, was more prosperous than at any former period. The treasures of America flowed into Lisbon, and the reign of Emanuel was justly called 'the golden age of Portugal'. He died at the age of fifty-two, deeply lamented by his subjects, but hated by the Moors and the Jews, whom he had expelled from the country. He was a patron of learned men, and himself left memoirs on the Indies. He married three times: in 1497 Isabella, daughter of Ferdinand and Isabella, heiress of Castile; in 1500 her sister Maria; and in 1519 Eleonora of Austria, sister of Charles V.

Embalming (em-bām'ing; Gr. *balsamon*, balm), the process of so treating dead bodies with aromatic and antiseptic substances as to preserve them from corruption and decomposition. The ancient Egyptians employed this art on a great scale, embalming not only human corpses, but also the bodies of cats, ibises, crocodiles, and other animals held sacred. The mummy of King Mer-en-rē, who lived about 2500 years before our era, found in 1880, was in an excellent state of preservation. Other peoples, such as the Assyrians and Persians, also followed the practice, though hardly equalling Egyptian methods. The abdomen was emptied through an incision, and the brains drawn through the nostrils by means of a special instrument. The ancient Peruvians appear to have injected and washed the corpses with a fluid that flows from imperfectly burned wood, in which pyroligneous acid, creosote, and other antiseptics are present. Pliny alludes to the use of a similar fluid by the Egyptians. In more recent times bodies have been preserved for centuries by embalming, especially when they have remained at a low and uniform

temperature and have been protected from the air. The corpse of Edward I, buried in Westminster Abbey in 1307, was found entire in 1770. Canute died in 1036, and his body was discovered very fresh in Winchester Cathedral in 1776. The bodies of William the Conqueror and of his wife Matilda were found entire at Caen in the sixteenth century. Of the various modern artificial means of preserving bodies, impregnation with corrosive sublimate appears to be one of the most effective, next to immersion in spirits. An injection of sulphate of zinc into the blood-vessels is also stated to be satisfactory; while natron, various spices, and other aromatic compounds are sometimes employed. The original reason for embalming was most probably the preservation of the body to await a resurrection and a future life.—BIBLIOGRAPHY: W. Budge, *The Mummy*; G. Elliot Smith, *A Contribution to the Study of Mummification in Egypt*; Myers, *Textbook of Embalming*.

Embank'ment, a mound of earth, &c., thrown up either for the purpose of forming a roadway at a level different from that of the natural surface of the ground, or for keeping a large body of water within certain limits. When constructed wholly of earth or clay, it is triangular in cross-section, with the apex cut off parallel to the base line, the angle of the sloping sides varying with the nature of the material used. Thus the slope of loose rubble, chalk, stone, loamy sand, or gravel requires about 1½ base to 1 vertical; dry, loose, and ordinary clay, 2 horizontal to 1 vertical, while some clays require a much wider base. To prevent subsidence on marshy or peaty soils, either the weight of the heart of the embankment is diminished, as in Holland, by introducing layers of reeds or fascines, or artificial foundations are prepared. The embankment may be prevented from slipping laterally by forming steps in the earth of the subsoil, or by cutting deep trenches at the feet of the slopes. In cases where embankments are raised for the storage of water, a 'puddle-dike', that is, a water-tight wall, must be inserted through the whole depth of the bank down to the impermeable strata beneath. To resist the action of wind and rain, or of the waters of a slow-flowing stream, the banks should in all possible cases be covered with turf. Among the largest embankments hitherto executed are those on the banks of the Po, the Meuse, the Scheldt; on the shores of the Netherlands; the Oberhäuser embankment on the Augsburg and Lindau Railway, the Gadelbach cutting on the Ulm and Augsburg line, and the Tring cutting on the London and North-Western Railway.

Embar'go, in commerce, an arrest on ships or merchandise by public authority; or a prohibition of State, commonly on foreign ships, in time of war,

to prevent their going out of or coming into port. A breach of embargo, under knowledge of the insured, discharges the underwriters of all liability.

Em'bassy, in its strict sense, signifies a mission presided over by an ambassador, as distinguished from a legation or mission entrusted to an envoy. An ambassador, as the representative of the person of his sovereign, can demand a private audience of the sovereign to whom he is accredited, while an envoy must communicate with the Minister for Foreign Affairs.

Ember-days, in the Anglican and Roman Catholic Churches, fast-days occurring at the times in the year appointed for ordinations. As now observed they are the Wednesday, Friday, and Saturday after the first Sunday in Lent, after the feast of Pentecost or Whitsunday, after the festival of the Holy Cross (14th Sept.), and after the festival of St. Lucia (13th Dec.). The weeks in which these days fall are called *Ember-weeks*.

Ember-goose (*Colymbus septentrionalis*), an aquatic bird, known also as the great northern diver and loon. The latter name, however, is also applied to the great crested grebe.

Emberizi'dæ, a family of small perching birds, typical genus *Emberiza*. It includes the buntings, the snow-flake, the yellow-hammer, and reed sparrow. The ortolan belongs to this family. By some naturalists it is classified as a sub-family of the finches.

Embez'zlement is the appropriation, by a clerk or servant, to himself, of money or property put into his hands in trust. In English law it is a felony punishable by penal servitude for not more than fourteen years, or by imprisonment; and in the case of a male under the age of sixteen, by whipping in addition to the imprisonment.

Em'blements (Fr. *emblaver*, to sow with grain), in law, the crops actually growing at any time upon land. They are considered in law as personal property, and pass as such to the executor or administrator of the occupier, if the latter die before he has actually cut, or reaped, or gathered the same.

Em'bolism is the obstruction of a blood-vessel by an embolus, the name given to a blood-clot or other body carried by the blood-stream, and obstructing the circulation at the point of lodgment. An embolism in a vital organ gives rise to serious symptoms which may cause death in a short time, or more remotely by the production of gangrene or pyæmia.

Embos'sing, the art of producing raised figures upon plane surfaces, such as on leather for bookbinding; on paper for envelopes; on wood or bronze, in architecture or sculpture. Embossing in needlework is effected by embroidery over figures padded with wool felt.

Embra'cery, an attempt to corrupt or influence a jury by money, promises, letters, entertainments, persuasions, or the like.

Embra'sure, in fortification, an opening in the breastwork or parapet of a battery or fortress, to admit of a gun being fired through it.

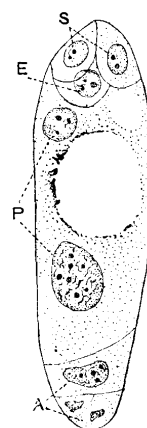
Embroid'ery (O. Fr. *embroder*, from *bord*, border), figured work in gold, or silver, or silk thread, wrought by the needle, upon cloths, stuffs, or muslins. In embroidering stuffs a kind of stretching-frame is used, because the more the piece is stretched the easier it is worked. The art was common in the East in very ancient times. The Jews appear to have acquired it from the Egyptians; Homer makes frequent allusion to it; and Phrygia was celebrated for its embroidery, which was in great demand at Rome. The Nineveh mural reliefs in the British Museum show Assyrian robes with floral ornaments, and a relief (now in the Louvre, Paris) from the palace of Darius I shows Persian robes with embroidery. The Anglo-Saxons had a Continental reputation, and from the eleventh to the sixteenth century the art of pictorial needlework was of the highest importance both as a recreation and as an industry. Embroidery is commonly divided into two classes: white embroidery applied to dress and furniture, in which the French and the Swiss excel; and embroidery in silk, gold, and silver, chiefly in demand for ecclesiastical vestments. The Chinese, Hindus, Persians, and Turks excel in such work.—Cf. Christie, *Embroidery and Tapestry Weaving*.

Embrun (a'n-bru'n), a picturesque walled town, France, department Hautes-Alpes, on a rocky eminence on the Durance. It was sacked successively by Vandals, Huns, Saxons, and Moors, by the Protestants in 1573, and by the Duke of Savoy in 1692. It has a fine cathedral. Pop. 3556.

Em'bry, an immature organism, especially in the earlier stages of development from the fertilized ovum onwards. The embryo of a mammal (except in the egg-laying duck-bill and spiny ant-eater), which develops internally, is known as a *fœtus*. The dormant plantlet in a seed is also known as an embryo.

Embryology, the branch of biology concerned with the fertilization of the ovum and its development into the adult. Aristotle and Galen made some observations on the subject, as regards animals, while Harvey and his successors considerably advanced our knowledge, but as a distinct and important subject embryology only dates from the nineteenth century. In the course of its development an organism repeats the evolution of its group in an abbreviated fashion, thus furnishing a clue to its actual affinities. The subject also throws light on the problems of heredity.

Embryo-sac, the name given to the megaspore of seed-plants. In Angiosperms the ripe embryo-sac is typically a large ovoid sac enclosed in a thin membrane and lined by cytoplasm; it contains seven or sometimes eight nuclei with associated masses of cytoplasm, distributed in a characteristic manner. At the apical end, next the micropyle, is the egg-apparatus, comprising the egg-cell or ovum flanked by the two synergidæ or helping-cells, while the basal or chalazal end is occupied by the three antipodal 'cells'. The cavity of the sac is filled with cell-sap traversed by stout protoplasmic strands, suspended in which, near the centre, are two polar nuclei, or a single fusion-nucleus formed by the union of these. A characteristic feature of Angiosperms is the process of 'double fertilization'. The pollen-tube contains two male gametes, both functional; one fertilizes the egg-cell, the resulting zygote or oospore giving rise by cell-division and growth to the embryo; the other unites with the fusion-nucleus (or the two polar nuclei), and the product is the origin of the special nutritive tissue or endosperm, which is used up by the embryo, either during ripening of the seed (exalbuminous seeds), or at germination (albuminous seeds). See *Gymnosperms*; *Ovule*.



Almost Ripe
Embryo-sac
of *Lilium*
Martagon
A,
Antipodals.
P, Polar
nuclei. E,
Egg-cell. S,
Synergidæ.

Em'den, a town of Prussia, province of Hanover, near the mouth of the Ems, occupying a low flat intersected by numerous canals. It was raised to the rank of a free Imperial city in 1595, was made a free port in 1751, was incorporated with the kingdom of Hanover in 1815, and in 1866 was united to Prussia. The principal building is the great church, built in 1455. The harbours admit large vessels, and several canals run inland. It exports grain, dairy produce, and gin, and has shipbuilding yards, and manufactures hosiery and leather. Pop. 24,000.

Em'erald, a variety of beryl, a well-known gem of pure green colour, somewhat harder than quartz; specific gravity, 2.67 to 2.73. It is a silicate of aluminium and the rare element glucinum or beryllium, which was detected in it by Vauquelin after it had been discovered by the same chemist in the beryl. Its colour is due to the presence of chromium, of which there may be 0.2 to 0.3 per cent present. Its natural form is either rounded or that of a

short six-sided prism. It is one of the softest of the precious stones, but is not acted on by acids. Emeralds of large size and at the same time free from flaws are rare and more valuable than diamonds or rubies; the largest on record is said to have been possessed by the inhabitants of the valley of Manta in Peru when the Spaniards first arrived there. It was as big as an ostrich egg, and was worshipped as *the mother of emeralds*. The ancients, who valued them, especially for engraving, are said to have procured them from Ethiopia and Egypt. The finest are now obtained from Colombia. The Oriental emerald is a variety of the ruby, of a green colour, and is an extremely rare gem.

Emerald Green, a vivid light-green pigment, an aceto-arsenite of copper, used both in oil and water-colour painting. It is extremely poisonous. Hydrated chromium sesquioxide is another mineral emerald green. There is also an aniline dye of this name.

Emerald Lore The emerald as a sacred stone was anciently believed to blind a serpent which gazed at it, but to strengthen human eyes, and was, according to Theophrastus, worn as a ring-stone on account of this property. It was confused with 'false emerald', a kind of malachite. This fact explains the reference to ancient kings presenting blocks of emerald 1 or 2 cubits long to temples. The Babylonian name was *barraktu*, the Sanskrit *marakata*, the Hebrew *bareket* or *barkat*, the Greek *maragdos* or *smaragdos*.

Emergences, in botany. See *Hairs of Plants*.

Em'erson, Ralph Waldo, an American poet and prose writer, born at Boston, 25th May, 1803, died 27th April, 1882. He graduated at Harvard in 1821, for five years taught in a school, and in 1829 became minister of a Unitarian Church in Boston, but in 1832 resigned his charge. He spent the greater part of 1833 in Europe, and on his return began his career as a lecturer on various subjects, in which capacity he acted for a long series of years. In 1835 he took up his permanent residence at Concord, Mass., and in 1836 published a small volume called *Nature*. He was one of the original editors of *The Dial*, a transcendental magazine begun in 1840. Two volumes of his essays were published, in 1841 and 1844, and his poems in 1846. His miscellaneous addresses had been published in England in 1844, and on

visiting Great Britain in 1847 he was welcomed by a large circle of admirers. In 1850 he published *Representative Men*; in 1856, *English Traits*; in 1860, *The Conduct of Life*; in 1869, *May Day and Other Poems*, and *Society and Solitude*; in 1871, *Parnassus*, a collection of poems; in 1876, *Letters and Social Aims*. Emerson showed certain similarities with Carlyle, of whom he was a friend and correspondent. Their correspondence appeared in 1883. He was not only one of the most original and influential writers that the United States have produced, but also one of the most helpful and influential ethical teachers of the nineteenth century. His gospel of self-reliance, his insistence on the duty of self-respect, and the obligation to listen to the voice of one's own soul, have exerted a wide influence which has grown steadily.—BIBLIOGRAPHY: J. E. Cabot, *Emerson's Complete Works* (11 vols.); G. W. Cooke, *Ralph Waldo Emerson: his Life, Writings and Philosophy*; J. Elliott Cabot, *A Memoir of Ralph Waldo Emerson*; R. Garnett, *Life of Ralph Waldo Emerson*; G. S. Woodberry, *Ralph Waldo Emerson*; J. A. Hill, *Emerson and his Philosophy*.

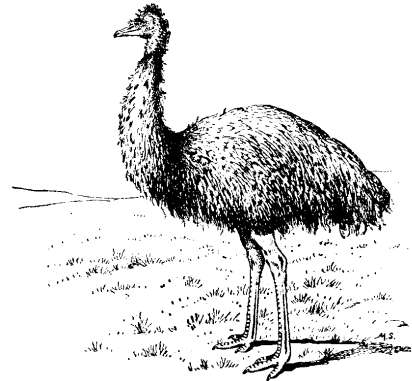
Em'ery (formerly *emeril*, from O. Fr. *emeril*; Gr. *smiris*, emery), an impure variety of corundum, of blackish or bluish-grey colour, chiefly found in shapeless masses and mixed with other minerals. It contains about 82 per cent of alumina, and a small portion of iron; is very hard; is practically infusible, and is not attacked by acids. The best emery is brought from the Levant, chiefly from the Island of Naxos. It is employed in cutting and polishing precious stones; in smoothing the surface of the finer kinds of lenses preparatory to their being polished; in the polishing of marble; by cutlers, locksmiths, glaziers, and other artisans. For all these purposes it is pulverized in large iron mortars or in steel mills, and the powder, which is rough and sharp, is carefully washed and sifted into eight or ten different degrees of fineness. Emery-paper and emery-cloth are made by laying a thin coat of glue upon the fabric, and dusting the emery from a sieve of the required size.

Emet'ic is a substance given to produce vomiting, either acting directly on the nerves of the stomach, or indirectly through the bloodstream on the vomiting centre in the brain. In the first group are common salt, mustard, ipecacuanha, and sulphate of zinc; and apomorphine, which is given hypodermically, is an example of the second. Emetics are not now so

widely used, as in many cases the stomach can be more effectively emptied and then washed out by the passage of the stomach-tube.

Emetine is an alkaloid present in ipecacuanha. It is a powerful emetic, and whether given by the mouth or hypodermically produces vomiting with nausea and depression. It acts chiefly as a local irritant to the lining of the stomach. In minute doses it stimulates expectoration from the lungs.

Emeu, or **Emu**, a large flightless running bird (*Dromæus novæ-hollandiæ*, and *D. irroratus*), formerly dispersed over the whole Australian continent, but now almost extinct in many districts. It is allied to the cassowary, but is distinguished by the absence of a 'helmet' on the top of the head. It nearly equals the ostrich in bulk, being thicker in the body, though its legs and neck are shorter. Its feet are three-toed (the ostrich has two toes), and its feathers, which are double, are of a dull sooty-brown colour, those about the neck and head being of a hairy texture. The wings are small and useless for flight, but the bird can run with great speed. The flesh of the young emeu is by some considered a delicacy. The emeu is a bird of the plain, the cassowary of the forest. It is easily tamed, and may be kept out of doors in temperate climates. It feeds on vegetable matter, fruits, and roots.



Emeu or Emu (*Dromæus novæ-hollandiæ*)

Emeu Wren (*Stipitūrus malachūrus*), a small Australian bird allied to the warblers, somewhat similar to a wren, but having the tail-feathers long, soft, and thinly barbed, similar to emeu feathers.

Emigration, the movement of individuals or groups from one state or country to a colony or another country, to be distinguished from *migration*, which describes the movement of peoples or races from one geographical area to another, and from *colonization*, which implies the foundation of a new state or extension of the sway of the colonists' state of origin. Thus the term does not strictly apply to the migrations of prehistoric times; nor to the movements of the Indo-European races (to which reference occurs in the Old Testament) which took place before the state as a territorial conception

had developed; nor does it describe the great barbarian invasions of the early Christian era. There was comparatively little emigration among the Greeks and Romans, movement among the former being usually for the foundation of colonies or new states, and among the latter as a means of consolidating conquests. In Europe up to the seventeenth century, emigration was sporadic, notable instances being the movement from Flanders to England in the fourteenth century, and of Protestants from France to England in the sixteenth and seventeenth centuries. In the seventeenth century, with the growth of European colonies in America and the East, there was much emigration to those places, notably from Spain, Portugal, and Great Britain to America, and from the Netherlands to the East. In the eighteenth century the movement slackened, but in the nineteenth century, largely as the result of the industrial revolution and the decay of agriculture, the great era of emigration began, especially from the United Kingdom. During the nineteenth century the main stream has flowed westward into America from Europe. Particularly important have been the emigration of Irish to the United States, and of Germans to South America. There has also been considerable movement from Russia into the United Kingdom, in many cases as a half-way house to the United States. In the East, emigration from China and Japan to the United States and Australia, and from India to British tropical colonies, has been important. It is noticeable that the Latin and Yellow races as a rule emigrate with the idea of returning ultimately to their native country; with the Anglo-Saxon, Teutonic, and Slav races the aim of a permanent domicile is predominant.

The most important causes of emigration are love of adventure, political or religious difficulties, and economic pressure. Forced emigration, in the shape of transportation, was formerly of some importance, especially in the case of America and Australia, but is now negligible; and before the European War, emigration from Russia was chiefly for political or religious reasons. To-day economic forces are the most powerful. The direction of the flow of emigration is partly determined by its causes. When these are political or religious, emigrants go where they expect to find freedom, as with the Huguenots in the seventeenth century. When economic forces are at work, emigration takes place towards newer and less developed countries, where pressure on the means of subsistence is less marked than elsewhere. Assistance given to emigrants, such as grants of land, loans of

capital, and passages at reduced rates also has an influence, likewise the regulations of the countries concerned regarding emigration and immigration. In Australia and the United States, regulations forbidding the entrance of Yellow races have checked the movement of Chinese and Japanese to those countries; and the Government of India discourages emigration save under adequate safeguard for proper pay and treatment.

The results of emigration vary with the economic and other circumstances of the countries concerned. The country from which the movement takes place loses intellectual and physical labour power which the other country gains; but may benefit by relief given to a congested labour market. This was the case with the Netherlands in the seventeenth century, and the United Kingdom in the early nineteenth century. The general tendency is for emigration to benefit the world as a whole by enabling labour to go where it can be most productively employed. This increases world production, opens up new markets, and so indirectly benefits the older countries. Sometimes, however, emigration may cause an industry merely to be transferred from one country to another, as in the case of the fourteenth-century Flemish emigration to England. The importance of these results of emigration in any particular case depends on the class of people who emigrate, and on the volume of emigration. Deportation of criminals obviously benefited only the deporting country. Emigration on political or religious grounds has frequently deprived one country of, and given to another, a vigorous and industrious stock, as in the case of the French Huguenots driven from France to England in the late seventeenth century by the revocation of the Edict of Nantes. Economic pressure tends to send abroad agricultural and other unskilled labour. The majority of emigrants from Great Britain in the nineteenth century belonged to this class. Youth and adaptability, however, are more important qualities for an emigrant than a high level of skill in any trade; and it is probable, therefore, that on the whole emigration has relieved Europe of labour whose supply was in excess of the demand for it, and has never given newer countries the material they require. The political consequences of emigration may also be important. Some writers claim that it has assisted the spread of democracy. Whether this is an advantage is a matter for individual judgment. But emigration may certainly have much influence in creating and maintaining friendly relations between States; or, as shown by Irish influence in the United States, it may embitter the feeling

between them.—BIBLIOGRAPHY: Mayo-Smith, *Emigration and Immigration*; S. C. Johnson, *History of Emigration from the United Kingdom to North America, 1763-1912*.

Émigrés (ā-mi-grās), a name given more particularly to those persons who left France during the Revolution of 1789. At the head of these emigrants stood the royal princes of Condé, Provence, and Artois, the first of whom collected a part of the fugitives to co-operate with the allied armies in Germany for the restoration of the monarchy. At Coblenz a particular court of justice was established to settle causes relating to the French *émigrés*. The corps of Condé was finally taken into the Russian service, and was disbanded in the Russian-Austrian campaign of 1799. When Napoleon became emperor he granted permission to all but a few of the emigrants to return to their country; but many declined to return until after his downfall. By the Charter of 1814 they were shut out from the recovery of their estates and privileges; and though, by a law of 27th April, 1825, some compensation was decreed to them, the grant was withdrawn again after the July revolution.

Emilian Provinces, a term applied to certain Italian provinces annexed to the kingdom of Sardinia in 1860. They comprised the northern part of the States of the Church (Romagna) and the Duchies of Modena and Parma.

Em'inance, an honorary title formerly applied to the Emperor and higher officials of the Empire, but restricted in 1630 by Pope Urban VIII to cardinals. Up to that time they had been called *illustrissimi* and *reverendissimi*.

Emir (em'ēr), the title given by Mohammedans to independent chiefs or princes, *Amir* or *Ameer* being the same word (the *Amir* of Afghanistan). When associated with other words it may designate various dignitaries. Thus the caliphs styled themselves *Emir-al-Mumenin*, Prince of the Faithful; *Emir-al-Omrah*, Prince of Princes, was the title of governors of certain provinces. The title is also given in Turkey to all the real or supposed descendants of Mohammed, through his daughter Fatimah.

Emmerich (em'e-rih), a town, Rhenish Prussia, on the right bank of the Rhine, 5 miles N.E. of Cleves. It joined the Hanseatic League in 1407. It carries on an active trade chiefly with Holland. Pop. 13,418.

Em'met, Robert, an Irish rebel, born at Cork in 1778. He was expelled from Trinity College, Dublin, in 1798, on the ground of exciting disaffection and rebellion, and having become an object of suspicion to the Government, quitted Ireland. He returned there on the repeal of the suspension of the Habeas Corpus Act, and became a member of the Society of United Irishmen for the establishment of the independence of Ireland. In July, 1803, he was the ringleader in the foolish rebellion in which Lord Kilwarden and others perished. He was arrested a few days afterwards, tried, and executed. His fate excited special interest from his attachment to Sarah Curran, daughter of the celebrated barrister. Their sad fates were commemorated by his college friend, Moore, in *Oh, Breathe Not his Name*, and *She is Far from the Land where her Young Hero Sleeps*.

Emotion, a term variously used by psychologists; sometimes as one of the divisions of feeling, the other being sensation; sometimes as opposed to feeling when the latter is identified with sensation, and sometimes as distinct from both sensation and feeling, when the last term is rigidly confined to the sense of pleasure or pain. In any of these uses, however, emotions are distinguished from sensations in that sensations are primary forms of consciousness arising by external excitation, are comparatively simple and immediately presentative phenomena, and are definite in character and capable of localization; while emotions are secondary or derived forms of consciousness, are complex and representative, and are vague and diffused. Sensations are said to be 'peripherally initiated', while emotions are centrally initiated. When, in addition to its being distinguished from sensation, it is also distinguished from feeling, emotion is applied to the whole physical condition accompanying the sense of pleasure or pain (feeling). The muscles of the body and the organic functions of the system are often considerably influenced by emotion, which naturally seeks an outward expression unless held in check by what Darwin has called serviceable associated habits.—BIBLIOGRAPHY: A. Bain, *The Emotions and the Will*; J. M'Cosh, *The Emotions*.

Emped'ocles (-klēz), a Greek philosopher of Agrigentum, in Sicily, born about 490 B.C. He is said to have introduced the democratic form of government into his native city, and the Agrigentines regarded him with the highest veneration as public benefactor, poet, orator, physician, prophet, and magician. Aristotle states that he died in obscurity, at the age of sixty years,

in the Peloponnesus; but he is also said to have thrown himself into the crater of Mount Etna, in order to make it be believed, by his sudden disappearance, that he was of divine origin, and had been translated to heaven alive (cf. Matthew Arnold's *Empedocles on Etna*). According to Lucian, however, his sandals were thrown out from the volcano, and the manner of his death revealed. Empedocles held earth, water, fire, air, as the four fundamental and indestructible elements from whose union and separation everything that exists is formed. To these material elements are added the two moving or operative principles of love and hatred, or attraction and repulsion. He wrote his philosophy in verse; of his chief work, *On Nature*, about 400 lines out of the original 5000 are preserved.

Em'peror (from the Lat. *imperātor*; in Ger. *Kaiser*, from *Cæsar*), the title of the highest rank of sovereigns. The word *imperator*, from *imperāre*, to command, in its most general sense signified the commander of an army. After the overthrow of the Roman republic *imperator* became the title of the rulers or emperors, and indicated their supreme power. Victorious generals were still, however, sometimes saluted with the title *imperator*, in its original sense. With the fall of Rome the title was lost in the West, but was kept up in the Eastern or Byzantine Empire for nearly ten centuries. In 800 it was renewed in the West when Charlemagne was crowned, by Leo III, as 'Carolus Augustus, the God-sent, pious, and great emperor of Rome'. It was, however, for many centuries considered necessary to be crowned at Rome, in order to be formally invested with the title of *emperor*. The imperial dignity became extinct in the East after the conquest of Constantinople in 1453, but the title was adopted by Peter I of Russia in 1721. Napoleon I adopted the old idea of an empire as a general union of states under the protection, or at least political preponderance, of one powerful state; and he was followed in this by his nephew, Napoleon III. In 1806 the first German Empire, 1000 years old, became extinct, and the German Emperor, Francis II, adopted the title of Francis I, Emperor of Austria. In Dec., 1870, the second German Empire was formed, King William of Prussia having accepted the imperial office and title offered him at Versailles. This empire came to an end in Nov. 1918. Britain is considered as an empire, the crown as imperial, and the Parliament is styled the *Imperial Parliament of Great Britain and Ireland*. Queen Victoria assumed the title of *Empress of India* in 1876, but the British sovereign has

not the imperial title in reference to the home dominions. The sovereigns of Japan and Morocco are often, though with little propriety, called *emperors*. —Cf. Articles *Imperator* and *Princeps* in Smith's *Dictionary of Greek and Roman Antiquities*.

Emperor Moth (*Saturnia pavonia*) a British moth belonging to a family Saturniidæ, of which some Indian species produce tussore silk. The colour is greyish-brown, with a faint purple tinge. The wings are about 3 inches in expanse, and in the centre of each is a large eye-like spot. The larva is of a bright-green colour, and studded with large rose-coloured or yellow tubercles.

Empetra'ceæ, a small nat. ord. of heath-like Dicotyledons, of which the type is the crow-berry.

Em'phasis, in rhetoric, a special stress or force given to some syllable, word, or words in speaking, in order to impress the hearers in some desired manner, thus differing from *accent*, the position of which is fixed.

Emphyse'ma is a distention of the tissues with air or other gases. Several forms are recognized: *pulmonary emphysema*, due to dilatation of the minute air-passages with loss of elasticity of the lung tissues; *surgical emphysema*, due to distention of the subcutaneous tissues by air, seen in certain wounds and injuries; *atrophic emphysema*, due to a senile condition of the lung tissues.

Empire Day, a British imperial celebration which is held annually on the 24th of May, the birthday of Queen Victoria. The celebration was officially held for the first time in 1904, and has since gained wide recognition, mainly owing to the unremitting efforts of the twelfth Earl of Meath.

Empir'ic (Gr. *empeiria*, experience) was used in medical history to denote one of a sect of physicians who held that observation and experience were the basis of medicine. The modern use of the term, medically, is restricted to one who practises medicine without any professional education or training.

Empiricism (Gr. *empeiria*, experience), the philosophical theory according to which sense-experience is the source of all knowledge, i.e. that we can investigate the world only through the experience of our senses. It denies

the existence of any *a priori* possibility of knowledge, and maintains that the mind is at first a *tabula rasa*, a clean slate, upon which all the characters are inscribed by experience. The term empiricism is, however, now applied to any philosophical system which finds all its material in experience. The philosophy of empiricism has been particularly developed by English writers of the seventeenth, eighteenth, and nineteenth centuries, such as Locke, Hume, and J. S. Mill. John Locke was the first to express the view in a systematic form. Among more modern empiricists are William James and John Dewey.—BIBLIOGRAPHY: Green, *Prolegomena to Ethics*; James, *Essays in Radical Empiricism*.

Employers' Liability Act, a British Act of Parliament passed in 1880, by which, within certain limits, an injured workman or, in event of his death, his relatives or representatives may claim from the employer compensation for injuries received in his service. The law on this subject was improved by the Workmen's Compensation Act (1897) and its amending Act (1900). These applied to those employed on, in, or about railways, factories, mines, quarries, engineering works, buildings, and to agricultural labourers. An Act of 1906 added other classes of workers, including domestic servants. The maximum compensation on death is three years' earnings or £150, whichever is larger, but not more than £300. Contracting-out is carefully safeguarded. The maximum weekly benefit was raised from £1 to £1, 5s. in 1917, and £1, 15s. in 1920, in cases of total incapacity. Recommendations by the Board of Trade Departmental Committee were made public in July, 1920. These suggest greater powers of Government control, compulsory insurance, and greatly increased compensation in cases of death and total incapacity.

Employment Bureaus were first established on a considerable scale in the United Kingdom by the Labour Exchanges Act, 1909. They were to some extent based upon the German public labour exchanges, which came into being after 1893 in most large towns, and were either municipal or maintained by voluntary associations and supported by the municipality. Their chief object was to put employers and work-people into touch with a view to employment. Before 1909 a few public employment bureaus had been established in Great Britain. An Act of 1905 established distress committees in boroughs and urban districts, which were given power to establish labour exchanges. These powers were in some cases exercised,

either by taking over existing bureaus or establishing new ones. Only in London was the system of importance. The 1909 Act gave the Board of Trade power to establish labour exchanges; and, by regulations under the Act, the United Kingdom has been divided into divisions in each of which are a number of exchanges of different grades. The system is industrial and not eleemosynary, aiming solely at providing a recognized market-place for labour. No fees are charged, and use of the exchanges is voluntary. Work-people may register at an exchange between certain hours, and, when a suitable vacancy occurs, the applicant is sent to the employer. Applications for work-people are generally received by telephone, and are recorded if no suitable applicant is available. An important part of the work of the labour exchange is in connection with Unemployed Insurance, under Part II, National Insurance Act, 1911. This provided for payment of unemployed benefit in a limited number of occupations. Subsequent Acts (notably that of 1920) have extended the system to cover the majority of occupations. The scheme is contributory, but the State shares the cost with employers and work-people.—BIBLIOGRAPHY: W. H. Beveridge, *Unemployment*; F. A. Keller, *Out of Work: a study of unemployment*.

Em'poli, a town in North Italy, on the left bank of the Arno, 16 miles W.S.W. of Florence; it has an old collegiate church with good paintings, and manufactures of straw-bonnets. Pop. 21,500.

Empo'ria, a town of the United States, in Kansas, on the Neosho River, with a normal school, and a good trade in grain and cattle. Pop. 9050.

Empyreu'ma, the smell arising from organic matter when subjected to the action of fire, but not enough to carbonize it entirely. The products of imperfect combustion, as from wood heated in heaps or distilled in close vessels, are frequently distinguished as empyreumatic.

Ems, or **Bad Ems**, a beautiful watering-place in the Prussian province of Hesse-Nassau, on the River Lahn, not far from its confluence with the Rhine. Its mineral waters are warm—from 70° to 118° F.,—contain large quantities of carbonic acid gas, and are used in chronic catarrhs, pulmonary complaints, diseases of the stomach, gout, and some diseases of the urinary vessels. There are about 8000 visitors each season. Pop. 6850.

Ems, a river of North-West Germany, which flows north-west through Rhenish Prussia and Hanover, and falls into the Dollart Estuary near Emden; length 230 miles.

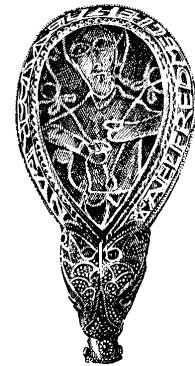
Emu. See *Emeu*.

Emul'sine, or **Synaptase**, originally the name given to the mixture of enzymes in bitter and sweet almonds. Emulsine has the property of being able to hydrolyse the glucoside amygdalin to glucose, benzaldehyde, and hydrocyanic acid.

E'mys, a genus of water-tortoises native to Europe and North America, and belonging to the family Testudinidæ, which includes most reptiles of the tortoise kind.

Enaliosau'rians ('sea-lizards'), a group of gigantic Mesozoic reptiles of which the ichthyosaurus and plesiosaurus were the chief.

Enam'el, a vitreous glaze coloured with metallic oxides, and, when first introduced, made to adhere by fusion on metals, &c. The ancient Babylonians enamelled bricks. No finer enamelling on bronze was done than that done in early Britain. The ancient Britons achieved great skill in decorating bronze shields, armlets, chariot pieces, helmets, &c., with red, blue, and white enamels during the Late Celtic (Early Iron Age) period and later. Indeed it is believed that the *champlevé* process of excavating hollows for enamel on metal in various flowing and artistic designs of symbolic character was developed in pre-Roman Britain. Philostratus, a third-century classical writer, referring to the enamelled trappings of horses, remarks that "the barbarians who reside in Ocean pour these colours on heated bronze, so that they adhere and become hard as stone". Beautiful specimens of enamelled bronze found in England, Scotland, and Ireland, preserved in the British Museum, include the Battersea and Witham shields, bridle-bits from Dumfries, and Rise, near Hull, and an enamelled 'terret' from the Fayum, Egypt, whither, archæologists believed, it was taken by some Roman soldier. Enamelling on bronze and iron was



Alfred's Jewel
A jewel of blue enamel enclosed in a setting of gold, with the words round it: "Ælfred had me wrought", found at Athelney, Somersetshire, in the seventeenth century.

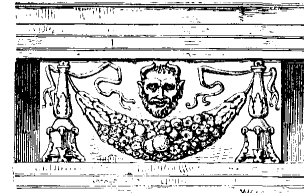
practised in Central Europe and at Koban in the Caucasus at an earlier date than in Italy and Egypt. Byzantine enamels on gold date from the tenth century. M. Salomon Reinach was the first to point out that red enamels were used as substitutes for coral, which, by the way, had a religious value as a 'life giver' and 'protector'. The later blue enamel may have been a substitute for lapis-lazuli, and other enamels, white, violet, green, and yellow, for other sacred stones. The ancient enamels are more or less opaque. Transparent enamels were favoured in the thirteenth century by Italian goldsmiths. A favourite method of applying enamel is known as *cloisonné*, which means inlaid between partitions. The design is outlined in bent-wire fillets, which are fastened to the plate by means of silver solder or the enamel itself. In *champlevé* work the plate itself is scooped out into channels for the enamel. The distinction between *cloisonné* and *champlevé* work, therefore, is something like the distinction between a breastwork and a trench. Enamelled glass is really deeply coloured glass. Bicycle enamel is made of asphalt or resin dissolved in oil, each coat being hardened by heat. Enamel paint is made by mixing copal varnish, &c., with metallic oxides. A special preparation is applied to leather which is afterwards heated—this is 'patent leather'. Enamel painting dates back to the sixteenth century and is used nowadays chiefly for street signs and advertisements. The term 'enamel' is applied to the hard protective coating of teeth.—BIBLIOGRAPHY: E. Molinier, *Dictionnaire des émailleurs*; H. Cunynghame, *Art of Enamelling*; A. Fisher, *The Art of Enamelling upon Metal*; H. M. Chapin, *How to Enamel*.

Ena'ra, a lake in the north of Finland, about 50 miles long by 30 miles broad. It is studded by innumerable islets, receives several streams, and is connected by the Patsjoki with the Arctic Ocean. At its south-west extremity is a small fishing-town of the same name, with an annual fair.

Enare'a, a region belonging to the country of the Gallas, south of Abyssinia. Sakha is the principal town. Coffee and ivory are the chief exports. The inhabitants are the most civilized of the Gallas.

Encar'pus, in architecture, a sculptured ornament in imitation of a garland of fruits, leaves, or flowers, suspended between two points. The garland is widest in the middle, and diminishes gradually to the points of suspension, from which the ends generally hang down. The encarpus is sometimes

composed of an imitation of drapery similarly disposed, and sometimes of an assemblage of musical instruments, implements of war or of the chase.



Encarpus, from Palazzo
Niccolini, Rome

Encaustic Painting, a kind of painting practised by the ancients, for the perfecting of which heating or burning-in was required. Pliny distinguishes three species, in all of which wax was used with colours, and applied either with bronze instruments (cauteria), a sharp-pointed tool (cestrum), or brushes. The art has been revived in modern times, but has not been greatly employed. As the chief aim in encaustic painting was the securing of permanence and durability by the application of heat, the word *encaustic* has been applied to other and widely different processes. Thus it has been used for painting on earthen vessels, for painting on porcelain and work in enamel; and in the same way it was given to the painting on glass of the Middle Ages.—Cf. A. P. Laurie, *Greek and Roman Methods of Painting*.

Encaustic Tiles, ornamental paving-tiles of baked pottery, much used during the Middle Ages in the pavements of churches and other ecclesiastical buildings. The encaustic tile, strictly so-called, was decorated with patterns formed by different coloured clays inlaid in the tile and fired with it. The art appears to have originated in the latter part of the twelfth century, to have attained its highest perfection during the thirteenth, and to have sunk into disuse in the fifteenth. During the whole of this period it was principally carried on in England and Normandy. After a long lapse the art was revived in England in 1830 by Wright, a Shelton potter. In modern manufacture two methods are employed, the 'plastic' and the 'semi-dry' or 'dust' method. The first is, in all essentials, that used in the Middle Ages, except, perhaps, in the perfection of modern moulding appliances; the second consists in ramming pulverized clay with a minimum of moisture into metal dies, the subsequent firing of tiles thus consolidated being attended with less risk from shrinkage.

Ence'nia, festivals anciently commemorative of the founding of a city or the dedication of a church; and in later times periodical ceremonies, as at Oxford, in commemoration of founders and benefactors.

Encephalartos, a genus of Cycads, natives of Africa. Meal (Kaffir-bread) is made from the pith by the natives.

Enchanter's Nightshade, a name common to plants of the genus *Circæa*, nat. ord. Onagraceæ, of which there are two British species, *C. lutetiāna* and *C. alpīna*. The former is about a foot and a half high, and has delicate ovate leaves, small white flowers tinged with pink, and small roundish fruits covered with hooked bristles. It abounds in shady woods. *C. alpīna*, which is similar, but smaller and more delicate, is found in Scotland and north of England. They have no affinity with the nightshades.

Enchorial (en-kō'ri-al) **Writing**, the form of writing used by the old Egyptians for the common purposes of life, as distinct from the hieroglyphic and hieratic (used by the priests). It is also called *Demotic*.

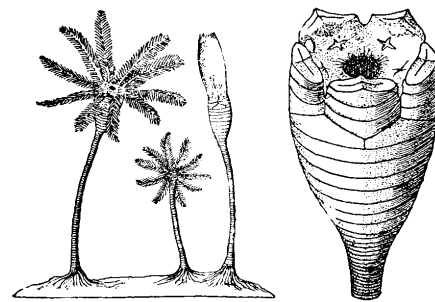
Encke (en'ke), Johann Franz, German astronomer, born at Hamburg in 1791, died in 1865. He studied under the astronomer Gauss at Göttingen. During the War of Liberation (1813-5) he served as artillerist in the German army, and after the peace became assistant in the observatory of Seeberg, near Gotha. Here he calculated the orbit of the comet observed by Mechain, Miss Herschel, and Pons, predicted its return, and detected a gradual acceleration of movement, ascribed by him to the presence of a resisting medium. The comet is now known as Encke's comet. The fame of his works *Die Entfernung der Sonne* (The Distance of the Sun) and *Der Venusdurchgang von 1769* (Transit of Venus of 1769) led to his appointment as director of the Berlin Observatory (1825), a position which he held till his death. From 1830 he edited the *Berliner Astronomisches Jahrbuch*.

Encke's Comet. This object was seen in 1786, and at some subsequent returns, before it was discovered by Encke in 1819 to be a periodic comet. It has since been observed at numerous returns. It revolves round the sun in about three and one-third years, having the shortest period of any comet known. It has exhibited very prominently the feature, shown by many comets, of a contraction of the head or coma on approaching the sun. Encke's comet long manifested the most remarkable feature of a shortening of its period by about two and a half hours in each revolution. The suggestion was made that this was due to resistance by a rare medium

generally diffused in the solar system, which had the effect of reducing its aphelion distance and diminishing its orbit. This, however, is improbable, as other comets show no similar effect. The cause remains undiscovered, and a further extraordinary fact is that the shortening of period is found since 1868 to have been only half of its previous amount.

Enclave (a'n-klāv), a term used in German and French to denote a place or country which is entirely surrounded by the territories of another power.

En'crinite, or **Crinoidea** (Gr. *krinon*, lily, and *eidos*, form), a name often applied to all the marine animals of the class Crinoidea or stone-lilies, phylum Echinodermata, except feather-stars; but more specifically restricted to the genera having rounded, smooth stems attached to the bottom, and supporting the body of the animal, which has numerous jointed arms radiating from a central disc, in which the mouth is situated. Encrinites were exceedingly numerous in past ages of the world's history; of those still existing our knowledge has been greatly increased of recent years through deep-sea dredging. Some of these forms are very graceful and interesting. See *Crinoidea*; *Echinodermata*.



Fossil Encrinites
Group of Pear-encrinites, much reduced, on left, and part of a Pear-encrinite, reduced, on right.

Ency'clical, a sort of circular letter or manifesto issued by a pope, and directed to the Roman Catholic clergy generally or to those of a certain country or area, giving instructions as to conduct to be observed at certain conjunctures, condemning erroneous doctrines, &c. The encyclical, which is a somewhat less formal document than a bull, was especially favoured by Pope Pius IX and Leo XIII. Pope Pius IX issued one in 1864, wherein he condemned eighty alleged errors in modern ideas of religion and civilization, and Pius X issued another in 1907, wherein he condemned modernism. A number of encyclicals was issued by Pope Leo XIII on Bible Study, Socialism, Capital and Labour.

Encyclopedia (Gr. *en*, in, *kyklos*, a circle, and *paideia*, instruction), a systematic view of the whole extent of human knowledge or of particular

departments of it, with the subjects arranged generally in alphabetic order. Varro and Pliny the elder, among the Romans, attempted works of an encyclopedic nature, the latter in his well-known *Historia Naturalis*, or *Natural History*. Other ancient encyclopedic works were those of Stobæus and Suidas, and especially of Marcianus Capella. In the thirteenth century a work on a regular plan was compiled by the Dominican Vincent of Beauvais (died 1264), in which was exhibited the whole sum of the knowledge of the Middle Ages. His work was entitled *Speculum Historiale, Naturale, Doctrinale*, to which an anonymous author added, some years later, a *Speculum Morale*. Roger Bacon's *Opus Majus* also belonged to the encyclopedic class. An exceedingly popular work was the *De Proprietatibus Rerum* of Bartholomeus de Glanvilla, an English Franciscan friar, which maintained its reputation from 1360 to the middle of the sixteenth century. In the seventeenth century various encyclopedic works were compiled, such as the Latin one of Johann Heinrich Alsted (in 7 vols., Herborn, 1620). In 1674 appeared the first edition of Moreri's *Le Grand Dictionnaire Historique*; in 1677 Johann Jacob Hoffmann published at Basel his *Lexicon Universale*; and in 1697 appeared Bayle's famous *Dictionnaire Historique et Critique*, which is still of great value. The first English alphabetical encyclopædia was the *Lexicon Technicum*, published in 1704. Among the chief English works of this kind are: 1. Ephraim Chambers's *Cyclopædia, or A Universal Dictionary of Arts and Sciences*, published in 1728 in 2 vols. folio. 2. *The Encyclopædia Britannica*, published in Edinburgh, in nine editions—the first in 1788, the ninth in 1875-88 (24 vols. 4to, with supplement, 11 vols., 1902-3). The tenth edition was published in 1902, and the eleventh issued in 1910-11 by the University Press, Cambridge. 3. Rees' *Cyclopædia*, 39 vols. 4to, illustrated, 1802-20. 4. *Edinburgh Encyclopædia*, 1810-30, 18 vols. 4to, conducted by Sir David (then Dr.) Brewster. 5. *Encyclopædia Metropolitana*, London, 29 vols. 4to, and containing some valuable complete treatises. 6. *The London Encyclopædia*, by Thomas Curtis, 22 vols. 4to; London, 1829. 7. *The Penny Cyclopædia*, in 28 vols. small folio, 1833-43; since recast under the name of the *English Cyclopædia*. 8. *Chambers's Encyclopædia*, in 10 vols. 9. *The Popular Encyclopædia*, issued in 14 vols. 10. Harmsworth's *Universal Encyclopedia*. 11. Nelson's *The New Age Encyclopædia*. 12. *The New Gresham Encyclopedia*, 12 vols. (one being index). The chief American encyclopædias are the *Encyclopædia Americana*, in 13 vols.; the *New*

American Cyclopædia, in 16 vols.; *Johnson's Universal Cyclopedia*, 8 vols.; *The New International Encyclopædia*, 25 vols. Of the French cyclopædias the most famous is the great *Dictionnaire Encyclopédique*, by Diderot and D'Alembert (see next article); the *Encyclopédie Méthodique, ou par Ordre des Matières*, Paris, 1781-1832, in 201 vols. 4to, of which 47 are plates; the *Encyclopédie Moderne*, 1824-32, 26 vols.; the *Encyclopédie des Gens du Monde*, 1835-44, 22 vols.; the *Dictionnaire de la Conversation et de la Lecture*, 1851-58; the excellent *Grande Encyclopédie*, 31 vols.; and the large and valuable *Grand Dictionnaire Universel du XIX^e Siècle*, published by Larousse, 16 vols. folio (with supplementary vols.); *The Nouveau Larousse Illustré*, 7 vols. Numerous works of this kind have been published in Germany, the most popular being the *Conversations-Lexikon* of Brockhaus; Meyer's *Konversations-Lexikon*; Pierer's *Konversations-Lexikon*; and that issued by Spamer. The most comprehensive is the *Allgemeine Encyklopädie*, originally edited by Professors Ersch and Gruber, begun in 1818, and not yet completed. *The Rousskiy Entsiklopeditsheskiy Slovarj*, the best Russian encyclopedia, in 43 vols, was published between 1905 and 1908.

Encyclopédie (a' n-sik-lo-pā-dē), **The French**, one of the most important literary enterprises of the eighteenth century, originated in a French translation of Ephraim Chambers's *Cyclopædia*. Diderot was appointed to edit it, and enlisted the ablest men of the time as contributors. D'Alembert (who wrote the famous *Discours préliminaire*) edited the mathematics; Rousseau wrote the musical articles; Daubenton, those connected with natural history; the Abbé Yvon, those on logic, metaphysics, and ethics; Toussaint, those on jurisprudence; Buffon contributed the article *Nature*; and Montesquieu, Voltaire, Euler, Marmontel, D'Holbach, Turgot, Grimm, and Condorcet took some share in the great work. Diderot himself was a prolific contributor on a wide variety of topics. The prospectus appeared in Nov., 1750, and the first volume in 1751, the whole being completed, despite fierce opposition, in 1765. The contributors to the *Encyclopédie*, the majority of whom held unorthodox views on religious, political, and social subjects, are known as the *Encyclopédistes*.

Endem'ic (Gr. *en* and *demos*, people) is a term applied to diseases peculiar to people of a particular district or of a nation or country. The cause of this may be due to the physical characters of the place, or to the mode of living,

habits, &c., of the people. Diseases endemic in one region may appear elsewhere when similar influences arise.

En'derby Land, an island in the Antarctic Ocean, long. 50° E., crossed by the Antarctic Circle. It was discovered by John Biscoe in 1831.

En'dive. See *Chicory*.

Endless Screw, a mechanical contrivance, consisting of a screw the thread of which gears into a wheel with skew teeth, the obliquity corresponding to the angle of pitch of the screw. It is generally employed as a means of producing slow motion in the adjustments of machines, rather than as transmitter of any great amount of power.

Endlicher (end'li-hér), Stephen Ladislaus, Hungarian botanist, born at Presburg in 1804. He was successively court-librarian at Vienna, and keeper of the natural history museum; and in 1840 was appointed professor of botany in the University of Vienna, and director of the botanic garden, which he immediately began to reorganize. He took part on the popular side in the German revolution of 1848, and died by his own hand in 1849. Among his chief botanical works are his *Genera Plantarum*, a systematic treatise on botany; and his *Enchiridion Botanicum*, or *Manual of Botany*.

Endocardi'tis, is inflammation of the endocardium, which is the lining membrane of the internal surface of the heart.

Endodermis, the innermost layer of the cortex. It acts as a 'physiological barrier' between the vascular tissues and the cortex, its structure being such as to compel all interchange of water and other materials between the two to pass through the living protoplasm of the endodermal cells. See *Tissues of Plants*.

Endog'amy (Gr. *endon*, within, *gamos*, marriage), a custom among some savage peoples of marrying only within their own tribe: opposite to *exogamy*.

Endogenous Plants, old name for monocotyledons (q.v.).

Endogenous Structures, in botany, are those which arise in the interior of the parent organ. Lateral roots furnish the best example. Opposed to

exogenous structures (see also *Branching* and *Root*).

En'domorph, a term applied to crystals of minerals enclosed in those of other minerals.

En'doparasite (Gr. *endon*, within), a parasite living within, and at the expense of, another organism, as opposed to an *ectoparasite*, which attacks its host from the exterior.

En'doskeleton, in anatomy, a term applied to the internal bony structure of man and other animals (Gr. *endon*, within), in contradistinction to *exoskeleton*, which is the outer and hardened covering of such animals as the crab and lobster.

En'dosmose, or **Endosmo'sis**, the transmission of liquids or gases through porous septa or partitions from the exterior to the interior of a vessel. When two different liquids or gases are separated by a porous vessel, the two fluids pass through the walls of the vessel at different rates, causing a change of volume and of pressure inside and outside the vessel. Endosmose is the name applied to the flow towards the fluid which is increasing in volume. When the transfer of liquid across the porous partition takes place in a cell through which an electric current is flowing the effect is called electrical endosmose.

En'dosperm, the tissue surrounding the embryo in many seeds and contained with it within the testa. It forms a supply of food for the germinating embryo, and is also called albumen.

Endym'ion, in Greek mythology, a huntsman, a shepherd, or a king of Elis, who is said to have asked of Zeus, or to have received as a punishment, eternal sleep. Others relate that Selēnē or Diana (the moon) conveyed him to Mount Latmos in Caria, and threw him into a perpetual sleep in order that she might enjoy his society whenever she pleased. Endymion is also supposed to be a personification of the sun, or of the plunge of the setting sun into the sea.—Cf. Keats, *Endymion*.

Energy, Physical, is the capacity which a body or system of bodies has for doing work. Work is done when a force is overcome, and it is measured by the product of the force and the distance through which it is overcome. A quantity of energy is therefore expressed in terms of the same units as work,

e.g. the foot-pound and the erg. Energy exists in two forms. Potential energy is that which a body possesses in virtue of its position. For instance, by winding up a clock weight it is given a certain amount of potential energy, which it slowly expends in driving the clock; a bent spring and a mass of compressed air also possess energy in the potential form. This kind may also be noted in the voltaic cell and the charged condenser, and in a chemical form in coal and gunpowder. Kinetic energy is possessed by bodies in virtue of their motion. Thus a moving bullet and a falling hammer contain kinetic energy; bodies which are in a state of vibration are also sources of this form of energy, which is diffused from the body through the surrounding medium in the form of waves, whether of sound, heat, light, or the ether waves of radio-telegraphy. Energy may thus exist in any of the following forms: mechanical (potential, kinetic), sound, heat, light, magnetic, electrostatic, electromagnetic, chemical.

Energy may be transformed from one kind into another. When a pendulum is vibrating, there is a continual transformation of potential into kinetic energy, and vice versa. By rubbing the hands together we convert mechanical energy into heat. In an electric tramway system we may note a whole series of transformations. The chemical energy of the fuel is turned into heat in the furnace and boiler; this, again, into kinetic energy of the turbine and dynamo; the latter gives out electric current, the energy of which, after suffering slight losses as heat in the overhead wire, and as light and sound in the spark at the trolley, passes into the motor, to reappear as kinetic energy of the car.

The transformation of energy takes place according to a definite law. The principle of the conservation of energy states that the total amount of energy in a self-contained finite system is constant. This implies that energy cannot be destroyed, and that when a certain amount of energy disappears, an equal amount appears in another form. This principle is apparently contradicted in many cases of transformation, since it is impossible to transform energy by natural process, or by the use of mechanism, without doing work in overcoming frictional or resisting forces. In all such cases the energy spent is converted into heat, which is less available as useful energy. The experiments of Rumford, Davy, and Joule were instrumental in establishing the equivalence of mechanical energy and heat. Rumford showed that water could be boiled by means of the heat produced by rotating a blunt boring-

tool within a cannon, and pointed out that the heat liberated was, in another form, the energy spent in driving the blunt drill. Davy caused two pieces of ice to be rubbed together within a vacuum at a temperature below zero, and melted the ice, thus showing that, since ice has to absorb heat in order to melt, the supply of heat could not have come from the ice itself, but must have resulted from the work done in rubbing. It has to be remembered that, in the time of Rumford and Davy, the belief was prevalent that heat or caloric was a material substance, and not a form of motion.

A further and most important step was made by Dr. J. P. Joule, of Manchester, who measured the amount of mechanical work which is spent in producing one unit of heat. This is known as the mechanical equivalent of heat, or Joule's equivalent. Two hanging weights were geared to a set of paddles which could rotate within a cylindrical copper vessel filled with water, and supplied with fixed vanes. The weights were released, and in descending a measured distance caused the paddles to churn the water in the vessel, and thus the water was slightly warmed. This operation was repeated several times, and the rise of temperature of the water was measured by means of a delicate thermometer. When corrections for friction, cooling, and other losses had been applied, Joule calculated that 772 foot-pounds of work were expended in raising 1 lb. of water 1° F. The experiment has been repeated in various forms, and the value now accepted for Joule's equivalent is 777.

Although energy cannot be destroyed, nor, it may be added, created, it may be rendered less available for use. The various forms of energy may be classified according to their availability, and in this respect mechanical energy is one of the most available, and low-temperature heat is one of the least available. The latter is therefore classed as a lower form of energy, and when energy is converted from a more available to a less available form, it is said to be dissipated or degraded. Now, during any transformation of energy, a part of the energy is spent in overcoming friction forces, and is thus degraded.

The problem of economizing our stores of energy is one which is now attracting more attention than it did formerly. With the greater scarcity of coal, and the future prospect of its complete absence, other natural sources of energy are being investigated. Oil has been discovered in this country,

but not in large quantities. Waterfalls have long been employed for driving mills wherever this type of power could be obtained cheaply and conveniently; the resources of the Highlands in this respect have not been utilized to any great extent. At Kinlochleven, where the valley has been dammed across to obtain sufficient water-power, an aluminium industry has sprung up. There is a scheme on foot at the present time to make use of the tidal energy of the Severn. Here and there windmills may be seen which drive water-pumps employed for draining purposes. On the Severn, near Ironbridge, a ferry is in use which employs the force of the river current to propel the ferryboat across the river. In warmer countries batteries of mirrors have been employed to concentrate the sun's heat for use in the absence of fuel. In large towns the presence of unconsumed carbon (soot) in the atmosphere raises the question not only of fuel economy but also of public health.—BIBLIOGRAPHY: Kelvin and Tait, *Natural Philosophy*; Balfour Stewart, *Conservation of Energy*; Deschanel, *Heat, Light, &c.*; E. Buckingham, *Thermodynamics*.

Enfantin (a'n'-fa'n'-tan'), Barthélemy Prosper, one of the chief founders of St. Simonism; born at Paris 1796, died in 1864. In 1825 he became acquainted with St. Simon, who in dying confided to him the task of continuing the work. This he did with success until after the Revolution of 1830, when, as the representative of the social and religious theories of the school, he quarrelled with Bazard, the representative of its political ideas. Enfantin organized model communities, which quickly fell to pieces; the new organ of the sect, *Le Globe*, was a failure; their convent at Ménilmontant, of which Enfantin was 'supreme father', was broken up by the Government (1832). He himself was imprisoned as an offender against public morality (being an advocate of free love), and on his release attempted to found a model colony in Egypt, which was broken up in the second year. He then retired to Tain (Drôme), where he lived for some time as a farmer. In 1841 he was sent as member of a commission to explore the industrial resources of Algiers, and on his return published a work on the *Colonization of Algiers* (1848). On the Revolution of 1848 he started a new journal, *Le Crédit Public*, but after two years withdrew from public notice. He afterwards held a post on the Lyons and Mediterranean Railway until his death. Among his works are: *Doctrine de St. Simon*, *La Religion St. Simonienne*.

En'field, a town, England, county Middlesex, 9 miles N. by E. London. It is the seat of the Government manufactory of rifles and small-arms. It gives its name to the British rifle (Lee-Enfield), which helped to win the European War. Pop. 56,338.

Enfilade Fire, fire directed down the length of a trench or a line of troops from a point at right angles to their front. Its moral effect is very great, as it usually comes from an unexpected direction, and the target presented to it is generally more vulnerable. Trenches give much less protection against oblique or enfilade fire than they do against frontal fire, although the main purpose of 'bays' is to lessen the effect of enfilading.

En'gadine, a beautiful valley in Switzerland, in the Grisons, on the banks of the Inn, bordering on the Tyrol, about 50 miles long, but in some parts very narrow, divided into Upper and Lower. The pop. of the whole valley amounts to about 12,000. The language generally spoken is the Ladin, a branch of the Romanic tongue. The cold, dry climate and mineral springs have made the valley a favourite resort for invalids.

Engaged Column, in architecture, a column attached to a wall so that part of it (usually less than half) is concealed.

Engels, Friedrich, German Socialist, born at Barmen in 1820, died 1895. He was the son of a rich cotton-spinner, and although destined for a commercial career, he began to collaborate on the *Deutsch-Französische Jahrbücher* issued in Paris by Karl Marx and Arnold Ruge. He helped Marx to organize the Communist League in 1846, and took part in the Revolution of 1848 at Baden. From 1850 to 1869 he lived at Manchester as manufacturer. An intimate friend of Marx, he helped the latter to spread social democratic ideas, and was part author, of the *Communist Manifesto*. After the death of Marx he edited the second and third volumes of *Das Kapital*. Engel's own works include: *The Condition of the Working Classes in England in 1844*; *The Origin of the Family*; *Private Property and the State*; and *Socialism, Utopian and Scientific*.—Cf. Karl Kautsky, *Friedrich Engels: his Life, his Work, and his Writings*.

Enghien (a'n'-gi-a'n'), or *Enguien*, a town in Hainault, Belgium, between Brussels and Tournai. It has a superb castle, and gave the title of duke to a

prince of the house of Bourbon Condé in memory of the victory gained here by the great Condé. Pop. 4540.

Enghien (a'n'-gi-a'n'), Louis Antoine Henri de Bourbon, Duke of, born at Chantilly in 1772; son of Louis Henry Joseph Condé, Duke of Bourbon. On the outbreak of the Revolution he quitted France, travelled through various parts of Europe, and went in 1792 to Flanders to join his grandfather, the Prince of Condé, in the campaign against France. From 1796 to 1799 he commanded with distinguished merit the vanguard of Condé's army, which was disbanded at the Peace of Lunéville (1801). He then took up residence as a private citizen at Ettenheim in Baden, where he married the Princess Charlotte de Rohan Rochefort. He was generally looked upon as the leader of the *émigrés* (q.v.), and was suspected by the Bonapartists of complicity in the attempt of Cadoudal to assassinate the first consul. An armed force was sent to seize him in Baden in violation of all territorial rights, and he was brought to Vincennes on the 20th March, 1804. A trial, which was a mere form, was held the same night; and on the following morning he was shot in the ditch outside the walls. It was this event which drew from Fouché the comment, since become proverbial: "C'est plus qu'un crime, c'est une faute" ("It is worse than a crime, it is a blunder").

En'gine. See *Internal Combustion Engines*; *Steam-engines*.

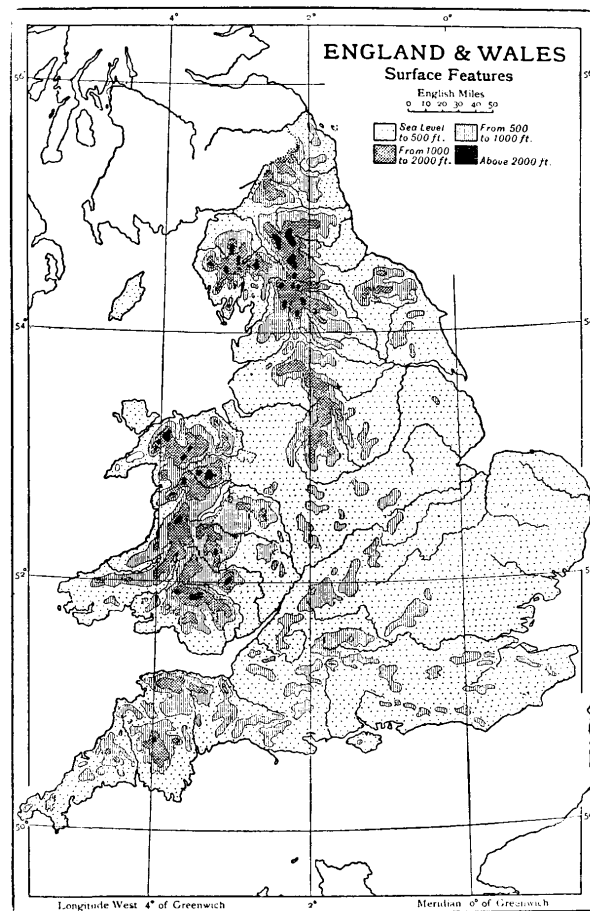
Engineering, the profession concerned in applying the forces of nature to the service of man. It is divided into two groups, civil engineering and military engineering. This grouping of the profession of engineering is adopted in the Charter of the Institution of Civil Engineers. Army engineers are organized as Royal Engineers. Candidates intending to become Royal Engineer officers have to pass the Army Entrance Examination to gain admission to Woolwich. At Woolwich they receive a course of technical instruction, and then proceed to military engineering duties in the Royal Engineers. Naval engineers enter the service as naval cadets. The education of all naval cadets is the same, no matter in what branch of the service they may ultimately specialize, up to the rank of sub-lieutenant, when specialization begins. The engineering lieutenants undergo a special course of engineering training at the Royal Naval College, Greenwich, and then go to sea. Naval engineers are called upon to undergo a severe medical examination, as the conditions of service call for robust men.

In the ordinary way the term *civil engineering* is not used in the technical sense explained above, but is the name given to one of the sections into which the whole group is divided. The 'civil' engineer undertakes the design and erection of constructional works, such as harbours, docks, railways, buildings, bridges, &c. A person entering the profession of civil engineering usually receives a technical education at a technical school, or at a university, and then enters the office of a practising civil engineer. He will spend a part of his time at the drawing-board, learning the details of design, and a part of his time actually in the field or on works, assisting in the supervision of the work. The other departments of the group of 'civil engineers'—as distinct from military engineers—are mechanical engineers, electrical engineers, motor engineers, telegraph engineers, radio engineers, mining engineers, aeronautical engineers, &c. With the exception of mining, the courses of training in these sections are very much the same, and consist of a technical course in a college or a university, followed by a practical training as a pupil in a works. The prior technical education is now being insisted upon by most of the large engineering firms, and, in many of the best works, special courses of instruction are given to apprentices as part of their training by the most experienced engineers of the company. In mining, the orthodox training consists of a technical course in one of the mining schools, followed by practical work in a mine. In this country every mining engineer who intends to take a position of responsibility must qualify by passing a Board of Trade examination. Sea-going marine engineering officers have, in addition to undergoing the usual training, to pass the sea-going engineers' examination of the Board of Trade. It will be seen from the above remarks that the courses of training for engineers depend entirely upon the particular branch of engineering which is to be entered. As this point is often not finally settled till fairly late in a young man's career, it is possibly unwise for him to take his initial training in too narrow a groove. A sound, general technical education, combined with three or four years' experience in a general engineering works, will fit him for specializing in very many sections of engineering, whereas if he intends to enter the mining or the civil engineering professions, a sound technical course, followed by a few years' experience in civil or mining engineering work abroad will usually fit him for a specialized post later on.

Engineers, Royal. Military engineers in one form or another, and under various names, have existed in England since the eleventh century. In those early days men of some education—often monks—were appointed as *Ingeniatores Regis* to undertake the manufacture of the king's engines of war, and to build his castles. In later years they became known as *Attilators*, and when, with the gradual introduction of gunpowder for military purposes, a combined train was formed, are considered to have given their name to what we now call artillery. In the early seventeenth century this train, composed of engineers and artillery, was merely a temporary corps raised for a particular war and disbanded on its conclusion; but in 1698, when the expediency of maintaining a standing army had been to some extent recognized, the first permanent train was raised. In 1716 a separate body of engineers was formed, but without military rank, and it was not till 1782 that military titles were conferred on the officers of engineers. In 1787 the Corps of Engineers became by Royal Warrant the Corps of Royal Engineers, with the mottoes *Ubique* and *Quo fas et gloria ducunt*, which are also borne by the Royal Regiment of Artillery. For a considerable period the rank and file of the corps were known as the 'Royal Sappers and Pioneers', and the term 'Sapper' is still used to denote a private of the corps. Among the present-day peace-time duties of the Royal Engineers are the construction and maintenance of barracks and military works generally, while for war purposes the corps is organized into mobile units known as field squadrons and companies for general field-work, and into more highly specialized units for mining, heavy bridging, and railway work. The corps is recruited almost entirely from among artisans and tradesmen, and a field company of a total strength of 184 all ranks has representatives of no fewer than nineteen trades in it.

England, including *Wales*, the southern and larger portion of the Island of Great Britain, is situated between 50° and 55° 46' N. lat., and 1° 46' E. and 5° 42' W. long. On the north it is bounded by Scotland; on all other sides it is washed by the sea: on the east by the North Sea; on the south by the English Channel; and on the west by St. George's Channel and the Irish Sea. Its figure is, roughly speaking, triangular, but with many windings and indentations, the coast-line measuring not less than 2765 miles. The length of the country, measured on a meridian from Berwick nearly to St. Alban's Head, is 365 miles. Its breadth, measured on a parallel of latitude, attains its

maximum between St. David's Head, in South Wales, and the Naze, in Essex, where it amounts to 280 miles. The area is 37,340,388 acres or 58,310 sq. miles, of which 32,559,868 acres or 50,874 sq. miles are in England, and 4,780,470 acres or 7466 sq. miles in Wales. This is exclusive of the Channel Islands and the Isle of Man, which together would add 193,647 acres or 302 sq. miles more to the area. The subdivision of England into shires or counties does not appear to have assumed a definite form till the time of Alfred. The existing division was first completed under Henry VIII. There are now 'administrative counties' and 'registration counties', differing in area from the old counties; London being now a county. The figures in the table (p. 241) refer to the old counties.



The capital of England and of the British Empire is London. The cities next in size (in order of population) are: Liverpool, Manchester and Salford, Birmingham, Leeds, Sheffield, Bristol, Bradford, Nottingham, and Hull.

Physical Features.—The chief indentations are: on the east, the Humber, the Wash, and the Thames estuary: on the west, the Solway Firth, Morecambe Bay, Cardigan Bay, and the Bristol Channel; those on the south are less prominent, though including some useful harbours. The greater part of the coast consists of cliffs, in some places clayey, in others rocky, and sometimes jutting out, as at Whitby and Flamborough Head on the east, Beachy Head, the Isle of Portland, the Lizard and Land's End on the south and south-west, St. David's Head and St. Bees Head on the west, into bold, lofty, and precipitous headlands. The most extensive stretches of flat coast

these in loftiness and extent, but has its great nucleus much farther to the west, where it covers the greater part of Wales, deriving from this its name, the Cambrian range. Its principal ridge stretches through Carnarvonshire from N.N.E to S.S.W., with Snowdon (3571 feet) as the culminating point of South Britain. Across the Bristol Channel from Wales is the Devonian range. It may be considered as commencing in the Mendip Hills of Somerset, and then pursuing a south-westerly direction through that county and the counties of Devon and Cornwall to the Land's End, the wild and desolate tract of Dartmoor forming one of its most remarkable features (highest summit, Yes Tor, 2050 feet). Other ranges are the Cotswold Hills proceeding in a north-easterly direction from near the Mendip Hills; the Chiltern Hills taking a similar direction farther to the east; and the North and South Downs running eastward, the latter reaching the south coast near Beachy Head, the former reaching the south-east coast at Folkestone.

	Area in Statute Acres, 1921 (Land and Inland Water). Counties, including County Boroughs,	<i>Census Population.</i> Counties, including County Boroughs, 1911.	<i>Census Population.</i> Counties, including County Boroughs, 1921.
ENGLAND.			
Bedfordshire	302,942	194,588	206,478
Berkshire	463,830	280,794	294,807
Buckinghamshire	479,360	219,551	236,209
Cambridgeshire	315,168	128,322	129,594
Isle of Ely	238,073	69,752	73,778
Cheshire	657,950	954,779	1,025,423
Cornwall	868,167	328,098	320,559
Cumberland	973,086	265,746	273,037
Derbyshire	650,369	683,423	714,539
Devonshire	1,671,364	699,703	709,488
Dorsetshire	625,612	223,266	228,258

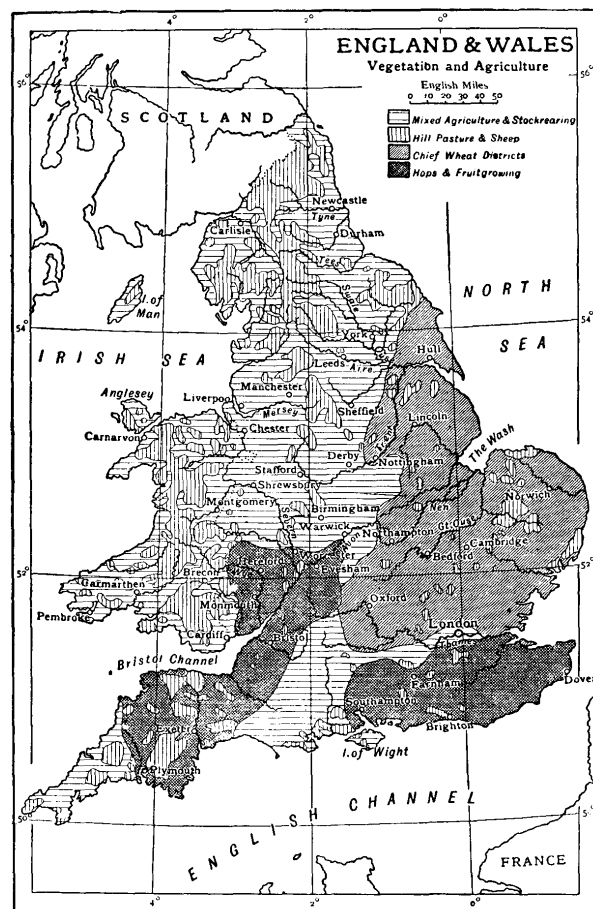
Durham	649,244	1,369,860	1,478,506
Essex	979,532	1,350,881	1,468,341
Gloucestershire	805,842	736,097	757,668
Herefordshire	538,924	114,269	113,118
Hertfordshire	404,523	311,284	333,236
Huntingdonshire	233,985	55,577	54,748
Kent	975,965	1,045,591	1,141,867
Lancashire	1,194,555	4,767,832	4,928,359
Leicestershire	532,779	476,553	494,522
Lincolnshire			
The parts of Holland	263,355	82,849	85,225
The parts of Kesteven	469,142	111,324	108,237
The parts of Lindsey	972,796	369,787	408,643
London	74,850	4,521,685	4,483,249
Middlesex	148,692	1,126,465	1,253,164
Monmouthshire	349,552	395,719	450,700
Norfolk	1,315,064	499,116	504,277
Northamptonshire	585,148	303,797	302,430
Soke of Peterborough	53,464	44,718	46,954
Northumberland	1,291,515	696,893	746,138
Nottinghamshire	540,123	604,098	641,134
Oxfordshire	479,220	189,484	189,558
Rutlandshire	97,273	20,346	18,368
Shropshire	861,800	246,307	242,959
Somersetshire	1,037,594	458,025	465,682
Southampton	958,896	862,393	910,333
Isle of Wight	94,146	88,186	94,697
Staffordshire	741,318	1,279,649	1,349,225
Suffolk, East	557,353	277,155	291,006
Suffolk, West	390,916	116,905	108,982

Surrey	461,833	845,578	930,377
Sussex, East	530,555	487,070	532,206
Sussex, West	401,916	176,308	195,795
Warwickshire	605,275	1,247,418	1,390,092
Westmoreland	504,917	63,575	65,740
Wiltshire	864,101	286,822	292,213
Worcestershire	458,352	387,688	405,876
Yorkshire, East Riding	750,115	432,759	460,717
" North Riding	1,362,058	419,546	456,312
" West Riding	1,773,529	3,045,377	3,181,654
Totals	32,559,868	34,045,290	35,678,530
WALES.			
Anglesey	176,630	50,928	51,695
Brecknockshire	469,281	59,287	61,257
Cardiganshire	443,189	59,879	61,292
Carmarthenshire	588,472	160,406	175,069
Carnarvonshire	366,005	125,043	131,034
Denbighshire	426,080	144,783	154,847
Flintshire	163,707	92,705	106,466
Glamorganshire	520,456	1,120,910	1,252,701
Merionethshire	422,372	45,565	45,450
Montgomeryshire	510,110	53,146	51,317
Pembrokeshire	393,003	89,960	92,056
Radnorshire	301,165	22,590	23,528
Totals, Wales (12 counties)	4,780,470	2,025,202	2,206,712
Totals, England and Wales	37,340,338	36,070,492	37,885,242



A large part of the surface of England consists of wide valleys and plains. Beginning in the north, the first valleys on the east side are those of the Coquet, Tyne, and Tees; on the west the beautiful valley of the Eden, which, at first hemmed in between the Cumbrian range and Pennine chain, gradually widens out into a plain of about 470 sq. miles, with the town of Carlisle in its centre. The most important of the northern plains is the Vale of York, which has an area of nearly 1000 sq. miles. Properly speaking it is still the same plain which stretches, with scarcely a single interruption, across the counties of Lincoln, Suffolk, and Essex, to the mouth of the Thames, and to a considerable distance inland, comprising the Central Plain and the region of the Fens. On the west side of the island, in South Lancashire and Cheshire, is the fertile Cheshire Plain. In Wales there are no extensive plains, the valleys generally having a narrow rugged form favourable to romantic beauty, but not compatible with great fertility. Wales, however, by giving rise to the Severn, can justly claim part in the vale, or series of almost unrivalled vales, along which it pursues its romantic course through the counties of Montgomery, Salop, Worcester, and

Gloucester. South-east of the Cotswold Hills is Salisbury Plain, but it is only in name that it can be classed with the other plains and level lands of England, being a large elevated plateau, of an oval shape, with a thin chalky soil only suitable for pasture. In the south-west the only vales deserving of notice are those of Taunton in Somerset and Exeter in Devon. A large portion of the south-east may be regarded as a continuous plain, consisting of what are called the Wealds of Sussex, Surrey, and Kent, between the North and South Downs, and containing an area of about 1000 sq. miles. The south-east angle of this district is occupied by the Romney Marsh, an extensive level tract composed for the most part of a rich marine deposit. Extensive tracts of a similar nature are situated on the east coast, in Yorkshire and Lincoln, where they are washed by the Humber; and in the counties which either border the Wash, or, like Northampton, Bedford, Huntingdon, and Cambridge, send their drainage into it by the Nene and the Ouse. Many of these lands are naturally the richest in the kingdom, but have been utilized only by means of drainage.



England is well supplied with rivers, many of them of great importance to industry and commerce. Most of them carry their waters to the North Sea. If we consider the drainage as a whole, four principal river basins may be distinguished, those of the Thames, Wash, and Humber belonging to the North Sea; and the Severn belonging to the Atlantic. The basin of the Thames has its greatest length from east to west, 130 miles, and its average breadth about 50 miles, area 6160 sq. miles. The river itself, which is the chief of English rivers, has a length of 215 miles. The basin of the Wash

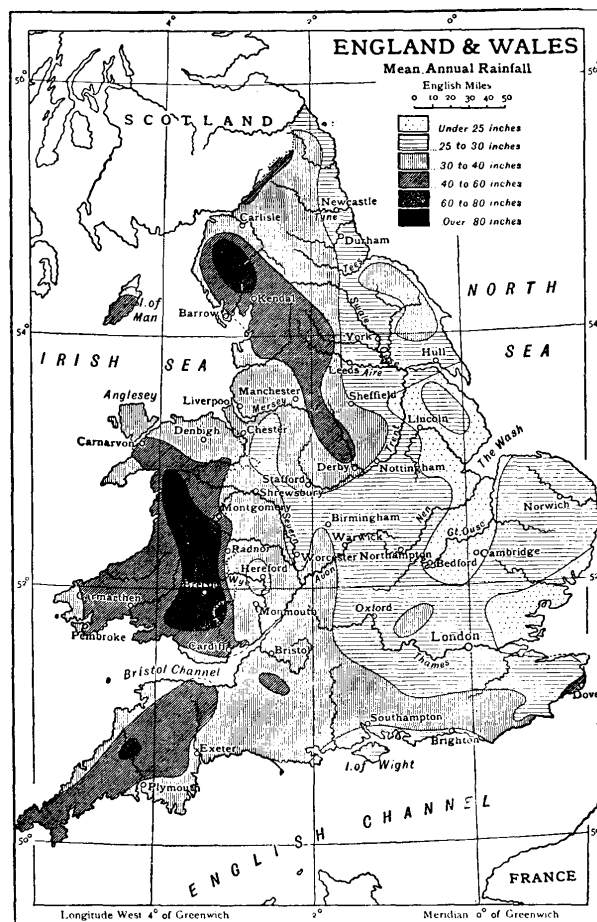
consists of the subordinate basins of the Great Ouse, Nene, Welland, and Witham, which all empty themselves into that estuary, and has an area computed at 5850 sq. miles. The basin of the Severn consists of two distinct portions, that on the right bank, of an irregularly oval shape, and having for its principal tributaries the Teme and the Wye; and that on the left, of which the Upper Avon is the principal tributary stream. The area of the whole basin is 8580 sq. miles. The next basin, that of the Humber, the largest of all, consists of the three basins of the Humber proper, the Ouse, and the Trent, and its area is 9550 sq. miles, being about one-sixth of the whole area of England and Wales. Other rivers unconnected with these systems are the Tyne, Wear, and Tees in the north-east; the Eden, Ribble, Mersey, and Dee in the north-west. The south-coast streams are very unimportant except for their estuaries.

For the minerals, climate, agriculture, manufactures, &c., of England, see the article *Britain*.

Civil History.—The history of England proper begins when it ceased to be a Roman possession. (See *Britain*.) On the withdrawal of the Roman forces, about the beginning of the fifth century A.D., the South Britons, or inhabitants of what is now called England, were no longer able to withstand the attacks of their ferocious northern neighbours, the Scots and Picts. They applied for assistance to Aëtius, but the Roman general was too much occupied in the struggle with Attila to attend to their petition. In their distress they appear to have sought the aid of the Saxons; and according to the Anglo-Saxon narratives three ships, containing 1600 men, were dispatched to their help under the command of the brothers Hengist and Horsa. Vortigern, a duke or prince of the Britons, assigned them the Isle of Thanet for habitation, and, marching against the northern foe, they obtained a complete victory. The date assigned to these events by the later Anglo-Saxon chronicles is A.D. 449, the narratives asserting further that the Saxons, finding the land desirable, turned their arms against the Britons, and, reinforced by new bands, conquered first Kent and ultimately the larger part of the island. Whatever the credibility of the story of Vortigern, it is certain that in the middle of the fifth century the occasional Teutonic incursions gave place to persistent invasion with a view to settlement. These Teutonic invaders were Low German tribes from the country about the mouths of the Elbe and the Weser, the three most prominent being the Angles, the Saxons,

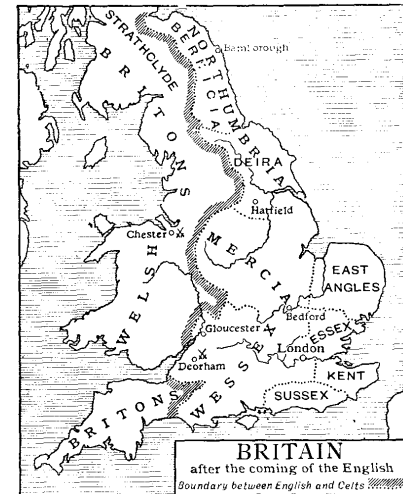
and the Jutes. Of these the Jutes were the first to form a settlement, taking possession of part of Kent and the Isle of Wight; but the larger conquests of the Saxons in the south and the Angles in the north gave to these tribes the leading place in the kingdom. The struggle continued 150 years, and at the end of that period the whole southern part of Britain, with the exception of Strathclyde, Wales, and West Wales (Cornwall), was in the hands of the Teutonic tribes. This conquered territory was divided among a number of small states or petty chieftaincies, seven of the most conspicuous of which are often spoken of as the *Heptarchy*. These were: 1. The kingdom of Kent; founded by Hengist in 455;

ended in 823. 2. Kingdom of South Saxons, containing Sussex and Surrey; founded by Ella in 477; ended in 689. 3. Kingdom of East Angles, containing Norfolk, Suffolk, Cambridge, Ely (Isle of); founded by Uffa in 571 or 575; ended in 792. 4. Kingdom of West Saxons, containing Devon, Dorset, Somerset, Wilts, Hants, Berks, and part of Cornwall; founded by Cerdic 519; swallowed up the rest in 827. 5. Kingdom of Northumbria, containing York, Durham, Cumberland, Westmorland, Northumberland, and the east coast of Scotland to the Firth of Forth; founded by Ida 547; absorbed by Wessex in 827. 6. Kingdom of East Saxons, containing Essex, Middlesex, Hertford (part); founded by Erchew in 527: ended in 823. 7. Kingdom of Mercia, containing Gloucester, Hereford, Worcester, Warwick, Leicester, Rutland, Northampton, Lincoln, Huntingdon, Bedford, Buckingham, Oxford, Stafford, Derby, Salop, Nottingham, Chester, Hertford (part); founded by Crida about 584; absorbed by Wessex in 827.



Each state was, in its turn, annexed to more powerful neighbours; and at length, in 827, Egbert, by his valour and superior capacity, united in his own person the sovereignty of what had formerly been seven kingdoms, and the whole came to be called England, that is Angle-land.

While this work of conquest and of intertribal strife had been in progress towards the establishment of a united kingdom, certain important changes had occurred. The conquest had been the slow expulsion of a Christian race by a purely heathen race, and the country had returned to something of its old isolation with regard to the rest of Europe. But before the close of the sixth century Christianity had secured a footing in the south-east of the island. Ethelberht, King of Kent and suzerain over the kingdoms south of the Humber, married a Christian wife, Bertha, daughter of Charibert of Soissons, and this event indirectly led to the coming of St. Augustine. The conversion of Kent, Essex, and East Anglia was followed by that of Northumberland and then by that of Mercia, of Wessex, of Sussex, and lastly of Wight, the contest between the two religions being at its height in the seventh century. The legal and political changes immediately consequent upon the adoption of Christianity were not great, but there resulted a more intimate relation with Europe and the older civilizations, the introduction of new learning and culture, the formation of a written literature, and the fusion of the tribes and petty kingdoms into a closer and more lasting unity than that which could have been otherwise secured.



The kingdom, however, was still kept in a state of disturbance by the attacks of the Danes, who had made repeated incursions during the whole of the Saxon period, and about half a century after the unification of the kingdom became for the moment masters of nearly the whole of England. But the genius of Alfred the Great, who had ascended the throne in 871, speedily reversed matters by the defeat of the Danes at Ethandune (878). Guthrum, their king, embraced Christianity, became the vassal of the Saxon king, and retired to a strip of land on the east coast including Northumbria and called

the Danelagh. The two immediate successors of Alfred, Edward (901-925) and Athelstan (925-940), the son and the grandson of Alfred, both vigorous and able rulers, had each in turn to direct his arms against these settlers of the Danelagh. The reigns of the next five kings, Edmund, Edred, Edwy, Edgar, and Edward the Martyr, are chiefly remarkable on account of the conspicuous place occupied in them by Dunstan, who was counsellor to Edmund, minister of Edred, treasurer under Edwy, and supreme during the reigns of Edgar and his successor. It was possibly due to his policy that from the time of Athelstan till after the death of Edward the Martyr (978 or 979) the country had comparative rest from the Danes. During the tenth century many changes had taken place in the Teutonic constitution. Feudalism was already taking root; the king's authority had increased; the folkland was being taken over as the king's personal property; the nobles by birth, or ealdormen, were becoming of less importance in administration than the nobility of thegns, the officers of the king's court. Ethelred (978-1016), who succeeded Edward, was a minor, the government was feebly conducted, and no united action being taken against the Danes, their incursions became more frequent and destructive. Animosities between the English and the Danes who had settled among them became daily more violent, and a general massacre of the latter took place in 1002. The following year Sweyn invaded the kingdom with a powerful army and assumed the crown of England. Ethelred was compelled to take refuge in Normandy; and though he afterwards returned, he found in Canute an adversary no less formidable than Sweyn. Ethelred left his kingdom in 1016 to his son Edmund, who displayed great valour, but was compelled to divide his kingdom with Canute; and when he was assassinated in 1017 the Danes succeeded the sovereignty of the whole.

Canute (Knut), who espoused the widow of Ethelred, that he might reconcile his new subjects, obtained the name of Great, not only on account of his personal qualities, but from the extent of his dominions, being master of Denmark and Norway as well as England. In 1035 he died, and was followed in England by two other Danish kings, Harold and Hardicanute, whose joint reigns lasted till 1042, after which the English line was again restored in the person of Edward the Confessor. Edward was a weak prince, and in the latter years of his reign had far less real power than his brother-in-law Harold, son of the great Earl Godwin. On Edward's death in 1066

Harold accordingly obtained the crown. He found, however, a formidable opponent in the second-cousin of Edward, William of Normandy, who instigated the Danes to invade the northern counties, while he, with 60,000 men, landed in the south. Harold vanquished the Danes, and hastening southwards met the Normans near Hastings, at Senlac, afterwards called Battle. Harold and his two brothers fell (14th Oct., 1066), and William (1066-87) immediately claimed the government as lawful King of England, being subsequently known as William I, the Conqueror. For some time he conducted the government with great moderation; but being obliged to reward those who had assisted him, he bestowed the chief offices of government upon Normans, and divided among them a great part of the country. The revolts of the native English which followed were quickly crushed, Continental feudalism in a modified form was established, and the English Church reorganized under Lanfranc as Archbishop of Canterbury.



At his death, in 1087, William II, commonly known by the name of Rufus, the Conqueror's second son, obtained the crown, Robert, the eldest son, receiving the duchy of Normandy. In 1100, when William II was accidentally killed in the New Forest, Robert was again cheated of his throne by his younger brother Henry (Henry I), who in 1106 even wrested from him the duchy of Normandy. Henry's power being secured, he entered into a dispute with Anselm the Primate, and with the Pope, concerning the right of granting investiture to the clergy. He supported his quarrel with

firmness, and brought it to a not unfavourable issue. His reign was also marked by the suppression of the greater Norman nobles in England, whose power (like that of many Continental feudatories) threatened to overshadow that of the king, and by the substitution of a class of lesser nobles. In 1135 he died in Normandy, leaving behind him only a daughter, Matilda.

By the will of Henry I his daughter Maud or Matilda, wife of Geoffrey Plantagenet, Count of Anjou, and frequently styled the Empress Matilda, because she had first been married to Henry V, Emperor of Germany, was declared his successor. But Stephen, son of the Count of Blois, and of Adela, daughter of William the Conqueror, raised an army in Normandy, landed in England, and declared himself king. After years of civil war and bloodshed an amicable arrangement was brought about, by which it was agreed that Stephen should continue to reign during the remainder of his life, but that he should be succeeded by Henry, son of Matilda and the Count of Anjou. Stephen died in 1154, and Henry Plantagenet ascended the throne with the title of Henry II, being the first of the Plantagenet or Angevin kings. A larger dominion was united under his sway than had been held by any previous sovereign of England, for at the time when he became King of England he was already in the possession of Anjou, Normandy, and Aquitaine.

Henry II found far less difficulty in restraining the licence of his barons than in abridging the exorbitant privileges of the clergy, who claimed exemption not only from the taxes of the State, but also from its penal enactments, and who were supported in their demands by the Primate Becket. The king's wishes were formulated in the Constitutions of Clarendon (1164), which were at first accepted and then repudiated by the Primate. The assassination of Becket, however, placed the king at a disadvantage in the struggle, and after his conquest of Ireland (1171) he submitted to the Church, and did penance at Becket's tomb. Henry was the first who placed the common people of England in a situation which led to their having a share in the Government. The system of frank-pledge was revived, trial by jury was instituted by the Assize of Clarendon, and the Eyre courts were made permanent by the Assize of Nottingham. To curb the power of the nobles he granted charters to towns, freeing them from all subjection to any but himself, thus laying the foundation of a new order in society.

Richard I, called Cœur de Lion, who in 1189 succeeded to his father, Henry II, spent most of his reign away from England. Having gone to Palestine to join in the third crusade, he proved himself an intrepid soldier. Returning homewards in disguise through Germany, he was made prisoner by Leopold, Duke of Austria, but was ransomed by his subjects. In the meantime John, his brother, had aspired to the crown, and hoped, by the assistance of the French, to exclude Richard from his right. Richard's presence for a time restored matters to some appearance of order; but having undertaken an expedition against France, he received a mortal wound at the siege of Châlons, in 1199.

John was at once recognized as King of England, and secured possession of Normandy; but Anjou, Maine, and Touraine acknowledged the claim of Arthur, son of Geoffrey, second son of Henry II. On the death of Arthur, while in John's power, these four French provinces were at once lost to England. John's opposition to the Pope in electing a successor to the see of Canterbury in 1205 led to the kingdom being placed under an *Interdict*; and, the nation being in a disturbed condition, he was at last compelled to receive Stephen Langton as archbishop, and to accept his kingdom as a fief of the papacy (1213). His exactions and misgovernment had equally embroiled him with the nobles. In 1213 they refused to follow him to France, and, on his return defeated, they at once took measures to secure their own privileges and abridge the prerogatives of the Crown. King and barons met at Runnymede, and on 15th June, 1215, the Great Charter (Magna Charta) was signed. It was speedily declared null and void by the Pope and war broke out between John and the barons, who were aided by the French king. In 1216, however, John died, and his turbulent reign was succeeded by the almost equally turbulent reign of his son Henry III.

During the first years of the reign of Henry III the abilities of the Earl of Pembroke, who was regent until 1219, retained the kingdom in tranquillity; but when, in 1227, Henry assumed the reins of government he showed himself incapable of managing them. The Charter was three times reissued in a modified form, and new privileges were added to it, but the king took no pains to observe its provisions. The struggle, long maintained in the Great Council (henceforward called Parliament) over money grants and other grievances, reached an acute stage in 1263, when civil war broke out. Simon de Montfort, who had laid the foundations of the House of

Commons by summoning representatives of the shire communities to the Mad Parliament of 1258, had by this time engrossed the sole power. He defeated the king and his son Edward at Lewes in 1264, and in his famous Parliament of 1265 still further widened the privileges of the people by summoning to it burgesses as well as knights of the shire. The escape of Prince Edward, however, was followed by the battle of Evesham (1265), at which Earl Simon was defeated and slain, and the rest of the reign was undisturbed.

On the death of Henry III, in 1272, Edward I succeeded without opposition. From 1276 to 1284 he was largely occupied in the conquest and annexation of Wales, which had become practically independent during the barons' wars. In 1292 Baliol, whom Edward had decided to be rightful heir to the Scottish throne, did homage for the fief to the English king; but when, in 1294, war broke out with France, Scotland also declared war. The Scots were defeated at Dunbar (1296), and the country placed under an English regent; but the revolt under Wallace (1297) was followed by that of Bruce (1306), and the Scots remained unsubdued. The reign of Edward was distinguished by many legal and legislative reforms, such as the separation of the old king's court into the Court of Exchequer, Court of King's Bench, and Court of Common Pleas, and the passage of the Statute of Mortmain. In 1295 the first perfect Parliament was summoned, the clergy and barons by special writ, the commons by writ to the sheriffs directing the election of two knights from each shire, two citizens from each city, two burghers from each borough. Two years later the imposition of taxation without consent of Parliament was forbidden by a special Act (*De Tallagio non Concedendo*). The great aim of Edward, however, to include England, Scotland, and Wales in one kingdom proved a failure, and he died in 1307 marching against Robert Bruce.

The reign of his son Edward II was unfortunate to himself and to his kingdom. He made a feeble attempt to carry out his father's last and earnest request to prosecute the war with Scotland, but the English were almost constantly unfortunate; and at length, at Bannockburn (1314), they were defeated by Robert Bruce, which ensured the independence of Scotland. The king soon proved incapable of regulating the lawless conduct of his barons; and his wife, a woman of a bold, intriguing disposition, joined in

the confederacy against him, which resulted in his imprisonment and death in 1327.

The reign of Edward III was as brilliant as that of his father had been the reverse. The main projects of the third Edward were directed against France, the crown of which he claimed in 1328 in virtue of his mother, the daughter of King Philip. The victory won by the Black Prince at Crécy (1346), the capture of Calais (1347), and the victory of Poitiers (1356), ultimately led to the Peace of Brétigny in 1360, by which Edward III received all the west of France on condition of renouncing his claim to the French throne. (See *Brétigny*.) Before the close of his reign, however, these advantages were all lost again, save a few principal towns on the coast.

Edward III was succeeded in 1377 by his grandson Richard II, son of Edward the Black Prince. The people of England now began to show, though in a turbulent manner, that they had acquired just notions of government. In 1380 an unjust and oppressive poll-tax brought their grievances to a head, and 100,000 men, under Wat Tyler, marched towards London (1381). Wat Tyler was killed while conferring with the king, and the prudence and courage of Richard appeased the insurgents. Despite his conduct on this occasion, Richard was deficient in the vigour necessary to curb the lawlessness of the nobles. In 1398 he banished his cousin, Henry Bolingbroke; and on the death of the latter's father, the Duke of Lancaster, unjustly appropriated his cousin's patrimony. To avenge the injustice Bolingbroke landed in England during the king's absence in Ireland, and at the head of 60,000 malcontents compelled Richard to surrender. He was confined in the Tower, and despite the superior claims of Edmund Mortimer, Earl of March, Henry was appointed king (1399), the first of the House of Lancaster. Richard was, in all probability, murdered early in 1400.

The manner in which the Duke of Lancaster, now Henry IV, acquired the crown rendered his reign extremely turbulent, but the vigour of his administration quelled every insurrection. The most important—that of the Percies of Northumberland, Owen Glendower, and Douglas of Scotland—was crushed by the battle of Shrewsbury (1403). During the reign of Henry IV the clergy of England first began the practice of burning heretics under the Act *de haeretico comburendo*, passed in the second year of his reign. The Act was chiefly directed against the Lollards, as the followers of

Wycliffe now came to be called. Henry died in 1413, leaving his crown to his son, Henry V, who revived the claim of Edward III to the throne of France in 1415, and invaded that country at the head of 30,000 men. The disjointed councils of the French rendered their country an easy prey; the victory of Agincourt was gained in 1415; and after a second campaign a peace was concluded at Troyes in 1420, by which Henry received the hand of Katherine, daughter of Charles VI, was appointed regent of France during the reign of his father-in-law, and declared heir to the throne on his death. The two kings, however, died within a few weeks of each other in 1422, and the infant son of Henry thus became King of England (as Henry VI) and France at the age of nine months.

England, during the reign of Henry VI, was subjected, in the first place, to all the confusion incident to a long minority, and afterwards to all the misery of a civil war. Henry allowed himself to be managed by anyone who had the courage to assume the conduct of his affairs, and the influence of his wife, Margaret of Anjou, a woman of uncommon capacity, was of no advantage either to himself or the realm. In France (1422-53) the English forces lost ground, and were finally expelled by the celebrated Joan of Arc, Calais alone being retained. The rebellion of Jack Cade in 1450 was suppressed, only to be succeeded by more serious trouble. In that year Richard, Duke of York, the father of Edward, afterwards Edward IV, began to advance his pretensions to the throne, which had been so long usurped by the House of Lancaster. His claim was founded on his descent from the third son of Edward III, Lionel, Duke of Clarence, who was his great-great-grandfather on the mother's side, while Henry was the great-grandson on the father's side of John of Gaunt, Duke of Lancaster, the fourth son of Edward III. Richard of York was also grandson on the father's side of Edmund, fifth son of Edward III. The wars which resulted, called the Wars of the Roses, from the fact that a red rose was the badge of the House of Lancaster and a white one that of the House of York, lasted for thirty years, from the first battle of St. Albans, 22nd May, 1455, to the battle of Bosworth, 22nd Aug., 1485. Henry VI was twice driven from the throne (in 1461 and 1471) by Edward of York, whose father had previously been killed in battle in 1460. Edward of York reigned as Edward IV from 1461 till his death in 1483, with a brief interval in 1471; and was succeeded by two other sovereigns of the House of York, first his son Edward V, who

reigned for eleven weeks in 1483; and then by his brother Richard III, who reigned from 1483 till 1485, when he was defeated and slain on Bosworth field by Henry Tudor, of the House of Lancaster, who then became Henry VII.

Henry VII was at this time the representative of the House of Lancaster, and in order at once to strengthen his own title, and to put an end to the rivalry between the Houses of York and Lancaster, he married, in 1486, Elizabeth, the sister of Edward V and heiress of the House of York. His reign was disturbed by insurrections attending the impostures of Lambert Simnel (1487), who pretended to be a son of the Duke of Clarence, brother of Edward IV, and of Perkin Warbeck (1488), who affirmed that he was the Duke of York, younger brother of Edward V; but neither of these attained any magnitude. The king's worst fault was the avarice which led him to employ in schemes of extortion such instruments as Empson and Dudley. His administration throughout did much to increase the royal power and to establish order and prosperity. He died in 1509.

The authority of the English Crown, which had been so much extended by Henry VII, was by his son Henry VIII exerted in a tyrannical and capricious manner. The most important event of the reign was undoubtedly the Reformation; though it had its origin rather in Henry's caprice and in the casual situation of his private affairs than in his conviction of the necessity of a reformation in religion, or in the solidity of reasoning employed by the reformers. Henry had been espoused to Catherine of Spain, who was first married to his elder brother Arthur, a prince who died young. Henry became disgusted with his queen, and enamoured of one of her maids of honour, Anne Boleyn. He had recourse, therefore, to the Pope to dissolve a marriage which had at first been rendered legal only by a dispensation from the Pontiff; but, failing in his desires, he broke away entirely from the Holy See, and in 1534 got himself recognized by Act of Parliament as the head of the English Church. He died in 1547. He was married six times, and left three children, each of whom reigned in turn. These were: Mary, by his first wife, Catherine of Aragon; Elizabeth, by his second wife, Anne Boleyn; and Edward, by his third wife, Jane Seymour.

Edward, who reigned first, with the title of Edward VI, was nine years of age at the time of his succession, and died in 1553, when he was only

sixteen. His short reign, or rather the reign of the Earl of Hertford, afterwards Duke of Somerset, who was appointed regent, was distinguished chiefly by the success which attended the measures of the reformers, who acquired great part of the power formerly engrossed by the Catholics. The intrigues of Dudley, Duke of Northumberland, during the reign of Edward, caused Lady Jane Grey to be declared his successor; but her reign, if it could be called such, lasted only a few days. Mary, daughter of Henry VIII, was placed upon the throne, and Lady Jane Grey and her husband were both executed. Mary, a bigoted Catholic, seems to have wished for the crown only for the purpose of re-establishing the Roman Catholic faith. Political motives had induced Philip of Spain to accept of her as a spouse; but she could never prevail on her subjects to allow him any share of power. She died in 1558.

Elizabeth, who succeeded her sister Mary, was attached to the Protestant faith, and found little difficulty in establishing it in England. Having concluded peace with France (1559), Elizabeth set herself to promote the confusion which prevailed in Scotland, to which her cousin Mary had returned from France as queen in 1561. In this she was so far successful that Mary placed herself in her power (1568), and after many years imprisonment was sent to the scaffold (1587). As the most powerful Protestant nation, and as a rival to Spain in the New World, it was natural that England should become involved in difficulties with that country. The dispersion of the Armada by the English fleet under Howard, Drake, and Hawkins was the most brilliant event of a struggle which abounded in minor feats of valour. In Elizabeth's reign London became the centre of the world's trade, the extension of British commercial enterprise being coincident with the ruin of Antwerp in 1585. The Parliament was increased by the creation of sixty-two new boroughs, and its members were exempted from arrest. In literature not less than in politics and in commerce the same full life displayed itself, and England began definitely to assume the characteristics which distinguish her from the other European nations of to-day.

To Elizabeth succeeded (in 1603) James VI of Scotland and I of England, son of Mary Queen of Scots and Darnley. His accession to the crown of England in addition to that of Scotland did much to unite the two nations, though a certain smouldering animosity still lingered. His dissimulation,

however, ended in his satisfying neither of the contending ecclesiastical parties—the Puritans or the Catholics; and his absurd insistence on his divine right made his reign a continuous struggle between the prerogative of the Crown and the freedom of the people. His extravagance kept him in constant disputes with the Parliament, who would not grant him the sums he demanded, and compelled him to resort to monopolies, loans, benevolences, and other illegal methods. The nation at large, however, continued to prosper through the whole of his reign. His son Charles I, who succeeded him in 1625, inherited the same exalted ideas of royal prerogative, and his marriage with a Catholic, his arbitrary rule, and illegal methods of raising money provoked bitter hostility. Under the guidance of Laud and Strafford things went from bad to worse. Civil war broke out in 1642 between the king's party and that of the Parliament, and the latter proving victorious, in 1649 the king was beheaded.

A Commonwealth or republican government was now established, in which the most prominent figure was Oliver Cromwell. Mutinies in the army among Fifth-monarchists and Levellers were subdued by Cromwell and Fairfax, and Cromwell, in a series of masterly movements, subjugated Ireland and gained the important victories of Dunbar and Worcester. At sea Blake had destroyed the Royalist fleet under Rupert, and was engaged in an honourable struggle with the Dutch under van Tromp. But within the governing body matters had come to a deadlock. A dissolution was necessary, yet Parliament shrank from dissolving itself, and in the meantime the reform of the law, a settlement with regard to the Church, and other important matters remained untouched. In April, 1653, Cromwell cut the knot by forcibly ejecting the members and putting the keys of the House in his pocket. From this time he was practically head of the Government, which was vested in a council of thirteen. A Parliament—the Little or Barebones Parliament—was summoned, and in the December of the same year Cromwell was installed Lord Protector of the Commonwealth of England, Scotland, and Ireland. With more than the power of a king, he succeeded in dominating the confusion at home, and made the country feared throughout the whole of Europe. Cromwell died in 1658, and the brief and feeble protectorate of his son Richard followed.

There was now a widespread feeling that the country would be better under the old form of government, and Charles II, son of Charles I, was called to

the throne by the Restoration of 1660. He took complete advantage of the popular reaction from the narrowness and intolerance of Puritanism, and even endeavoured to carry it to the extreme of establishing the Catholic religion. The promises of religious freedom made by him before the Restoration in the Declaration Breda were broken by the Test and Corporation Acts, and by the Act of Uniformity, which drove two thousand clergymen from the Church and created the great dissenting movement of modern times. The Conventicle and Five-mile Acts followed, and the 'Drunken Parliament' restored Episcopacy in Scotland. At one time even civil war seemed again imminent. The abolition of the censorship of the press (1679) and the reaffirmation of the Habeas Corpus principle are the most praiseworthy incidents of the reign.

As Charles II left no legitimate issue, his brother the Duke of York succeeded him as James II (1685-8). An invasion by an illegitimate son of Charles, the Duke of Monmouth who claimed the throne, was suppressed, and the king's arbitrary rule was supported by the wholesale butcheries of such instruments as Kirke and Jeffreys. The king's zealous countenance of Roman Catholicism and his attempts to force the Church and the universities to submission provoked a storm of opposition. Seven prelates were brought to trial for seditious libel, but were acquitted amidst general rejoicings. The whole nation was prepared to welcome any deliverance, and in 1688 William

of Orange, husband of James's daughter Mary, landed in Torbay. James fled to France, and a convention summoned by William settled the crown upon



him, he thus becoming William III. Annexed to this settlement was a Declaration of Rights circumscribing the royal prerogative by depriving him of the right to exercise dispensing power, or to exact money, or maintain an army without the assent of Parliament. This placed henceforward the right of the British sovereign to the throne upon a purely statutory basis. The Toleration Act, passed in 1689, released dissent from many penalties. An armed opposition to William lasted for a short time in Scotland, but ceased with the fall of Viscount Dundee, the leader of James's adherents; and though the struggle was prolonged in Ireland, it was brought to a close before the end of 1691. The following year saw the origination of the national debt, the exchequer having been drained by the heavy military expenditure. A Bill for triennial Parliaments was passed in 1694, the year in which Queen Mary died. For a moment after her death William's popularity was in danger, but his successes at Namur and elsewhere, and the obvious exhaustion of France, once more confirmed his power. The Treaty of Ryswick followed in 1697, and the death of James II in exile in 1701 removed a not unimportant source of danger. Early in the following year William also died, and by the Act of Settlement Anne succeeded him.

The closing act of William's reign had been the formation of the grand alliance between England, Holland, and the German Empire, and the new queen's rule opened with the brilliant successes of Marlborough at Blenheim (1704) and Ramilies (1706). Throughout the earlier part of her reign the Marlboroughs practically ruled the kingdom, the duke's wife, Sarah Jennings, being the queen's most intimate friend and adviser. In 1707 the history of England becomes the history of Britain, the Act of Union passed in that year binding the Parliaments and Realms of England and Scotland into a single and more powerful whole. See *Britain*.

Ecclesiastical History.—The first religion of the Celts of England was Druidism. It has been conjectured that Christianity may have reached Britain by way of France (Gaul) before the conclusion of the first, or not long after the commencement of the second century, but the period and manner of its introduction are uncertain. It had, however, made considerable progress in the island previous to the time of Constantine the Great (306-337). Several bishops from Britain sat in the Councils of Nice (325), Sardica (347), and Ariminum, in Italy (359); and in 519 an ecclesiastical

synod of all the British clergy was held by St. David, Archbishop of Caerleon, for extirpating the remains of the Pelagian heresy.

A period of almost total eclipse followed the inroad of the pagan Saxons, and it was not till A.D. 570 that signs of change showed themselves in the new nationality. On the coming of Austin, or St. Augustine, sent over in 596 by Gregory the Great, a residence at Canterbury was assigned to him, and Ethelberht, King of Kent, and most of his subjects, adopted Christianity. Other missionaries followed; East Saxons were soon after converted by Mellitus; and a bishop's see was established at London, their capital, early in the seventh century. The Northumbrians were next converted, an event accelerated by the marriage of their king, Edwin, with a daughter of Ethelberht, and by the labours of the missionary Paulinus. The influence of Edwin and Paulinus also secured the conversion of Carpwald, King of the East Angles; and, as a reward to Paulinus, Edwin erected a see at York, and obtained an archbishop's pall for him from Pope Honorius I, who sent one at the same time to Canterbury. The conversion of the other kingdoms followed in the course of the seventh century.

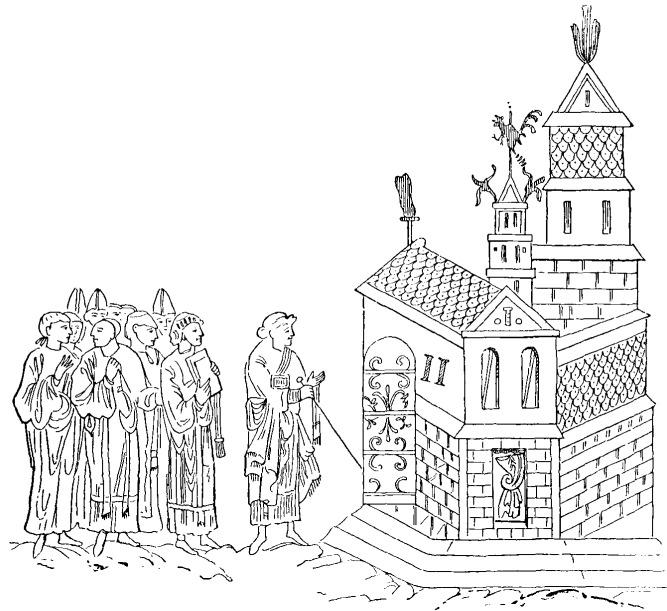
As Kent and Wessex received Christianity from Roman and Frankish missionaries, and Mercia and Northumberland through the Scottish St. Aidan (for Northumbria had apostatized after the death of its first Christian king, and received Christianity anew from a Scottish source), there were certain differences between the Churches, especially concerning the time of keeping Easter. To promote the union of the Churches thus founded in England with the Church of Rome, a grand council was summoned by Theodore of Tarsus, Archbishop of Canterbury, at Hertford, A.D. 673, when uniformity was secured among all the English Churches, and the see of Canterbury made supreme.

The clergy in course of time attained, particularly after the Norman Conquest, to such a height of domination as to form an *imperium in imperio*. Under Anselm (1093-1109) the Church was practically emancipated from the control of the State, and the power of the Pope became supreme. The result was a considerable increase of monasticism in England, and the prevalence of the greatest abuses under the cloak of Church privilege. Several monarchs showed themselves restive under the Papal control, but without shaking off the yoke; and though Henry II

succeeded in abating some evils, yet the severity of the penance exacted from him for the murder of Becket is a striking proof of the power that the Church then had in punishing offences committed against itself. The reaction set in during the reign of Henry III, when the vigorous independence of Robert Grosseteste did much to stimulate the individual life of the English Church. With the reign of Edward I the new system of Parliaments came as an effective rival of the Church Synods, and various Acts restrained the power of the clergy. In the fourteenth century the teaching of Wycliffe promised to produce a thorough revolt from Rome; but the difficulties of the House of Lancaster—which drove its members to propitiate the Church—and the Wars of the Roses, prevented matters coming to a head.

A steady decay of vital power set in, however, and when Henry VIII resolved to recast the English Church there was no effective protest. In 1531 the convocation of the clergy addressed a petition to Henry VIII as the chief protector and only and supreme lord of the English Church. Not very long after, the Parliament abolished appeals to the see of Rome, dispensations, licences, bulls of institution for bishoprics and archbishoprics, the payment of Peter's-pence, and the annates. In 1534 the Papal authority was set aside by Act of Parliament, and by another Act of Parliament, passed in 1535, Henry assumed the title of supreme head of the Church of England. These Acts, although they severed the connection between the English Church and the Holy See, did not alter the religious faith of the Church. But under Edward VI the Duke of Somerset, the protector of the realm during the minority of the king, caused a more thorough reform of the doctrines and ceremonies of the Church to be made. At his instigation Parliament in 1547 repealed the statute of the six articles promulgated by Henry VIII, and in 1551 a new confession of faith was embodied in forty-two articles, denying the infallibility of councils, keeping only two sacraments, baptism and the Lord's Supper, and rejecting the real presence, the invocation of saints, prayer for the dead, purgatory, and the celibacy of the clergy. At the same time a new liturgy was composed, in which English was substituted for Latin.

With the reign of Mary the old religion was re-established; and it was not till that of Elizabeth that the Church of England was finally instituted in its present form. The doctrines of the Church were again modified, and the Forty-two Articles were reduced to thirty-nine by the convocation of the clergy in 1563. As no change was made in the episcopal form of government, and some rites and ceremonies were retained which many of the reformed considered as superstitious, this



Consecration of a Saxon Church
From an ancient manuscript of Cædmon's poems.

circumstance gave rise to many future dissensions. In 1559, before the close of the first year of Elizabeth's reign, the Acts of Supremacy and Uniformity were passed with the object of bringing about the entire subjection of the Church and the people in religious matters to the royal authority.

From James I some relief was anticipated by Puritans and Nonconformists, but they were disappointed. Under Charles I the attempt was made, through the instrumentality of Laud, to place all the Churches of Great Britain under the jurisdiction of bishops. But after the death of Laud the Parliament abolished the episcopal government, and condemned everything contrary to the doctrine, worship, and discipline of the Church of Geneva. As soon as Charles II was restored, the ancient forms of ecclesiastical government and public worship were re-established, and three severe measures were passed against nonconformity, namely, the Corporation Act of 1661, the Act of Uniformity, passed in 1662, and the Test Act, passed in 1673 (see *Act of Uniformity, Corporation and Test Acts*). In the reign of William III, and particularly in 1689, the divisions among the friends of Episcopacy gave rise to the two parties called the *high-churchmen* or *non-jurors*, and *low-churchmen*. The former maintained the doctrine of passive obedience to the sovereign; that the hereditary succession to the throne is of divine institution; and that the Church is subject to the jurisdiction of God alone. The gradual progress of civil and

religious liberty since that time has settled practically all such controversies. The measures of relief granted to those outside the Established Church include the repeal of the Corporation and Test Acts (1828), Catholic emancipation (1829), and the opening of the old universities to Dissenters (1871).

The Established Church of England has always adhered to Episcopacy. Under the sovereign as supreme head, the Church is governed by three archbishops and forty bishops, of Canterbury, York, and Wales. The Archbishop of Canterbury is styled the *Primate of all England*, and to him belongs the privilege of crowning the kings and queens of England. The province of Canterbury comprehends 30 bishoprics; in the province of the Archbishop of York, who is styled *Primate of England*, there are 12 bishoprics, the province comprising Cheshire, Lancashire, Yorkshire, and the other northern counties. Wales has now been formed into a separate archbishopric. An Act was passed in 1914 disestablishing and disendowing the Church in Wales and Monmouthshire. The Act, suspended during the European War, came into force on 31st March, 1920. Archbishops and bishops are appointed by the sovereign by what is called *acongé d'élire* or leave to elect, naming the person to be chosen and sent to the Dean and Chapter. The National Assembly of the Church of England (Powers) Act of 1919 instituted a National Assembly in England consisting of the House of Bishops, a House of Clergy, and a House of Laymen, which has power to legislate in Church matters. The archbishops and bishops, to the number of 24, have seats in the House of Lords, and are styled Lords Spiritual. The following are the bishops' sees: London, Winchester, Bangor, Bath and Wells, Birmingham, Bradford, Bristol, Chelmsford, Chichester, Coventry, Ely, Exeter, Gloucester, Hereford, Ipswich, Lichfield, Lincoln, Llandaff, Norwich, Oxford, Peterborough, Rochester, St. Albans, St. Asaph, St. David's, Salisbury, Southwark, Southwell, Truro, Worcester, Durham, Carlisle, Chester, Liverpool, Manchester, Newcastle, Ripon, Sheffield, Wakefield, Sodor and Man. To every cathedral belong several prebendaries and a dean; these together, spoken of as 'the Dean and Chapter', form the council of the bishop. The bishops are aided in their work by 36 suffragan and assistant bishops in England and Wales. The ordinary clergy are the *priests*, whether curates, vicars, or rectors. A *parson* is a priest in full possession of all the rights of a parish church; if the great tithes are *impropriated*, the priest is called a vicar; if not, a rector; a *curate* (in popular speech) is one who exercises the spiritual office under a rector or vicar. The *deacons* form the third order of ordained clergy. The doctrines of the Church are contained in the Thirty-nine Articles; the form of worship is directed by the

Book of Common Prayer. The revenue of the Church from endowments is over £6,000,000 annually. The clergy number about 27,000.—BIBLIOGRAPHY: Wakeman, *Introduction to the History of the Church of England*; Newbolt and Stone, *Church of England*.

English Art.—As regards *architecture* little can be said with regard to the style prevalent between the invasion of the Anglo-Saxons and the Norman Conquest, from the fact that the remains of buildings erected in England before the Conquest are few and insignificant. The Norman style was introduced in the reign of Edward the Confessor, though the workmen, both then and after the Conquest, being English, the earlier work preserved many native characteristics. The Norman period proper extends from about 1090 to 1150, some of the best examples being parts of the cathedrals of Rochester, Winchester, Durham, and Canterbury. In the brief period 1160 to 1195 a marked change took place in the adoption of the pointed arch and what is known as the *Early English style*. Improved methods of construction led to the use of lighter walls and pillars instead of the heavy masses employed in the Norman style. Narrow lancet-shaped windows took the place of the round arch; bold projecting buttresses were introduced; and the roofs and spires became more lofty and more pointed, while in the interiors pointed arches rested on lofty clustered pillars. The best Early English type is Salisbury Cathedral. The Early English style has been regarded as lasting from 1190 to 1270, when the *Decorated style* of Gothic began to prevail. The transition to the Decorated style was gradual, but it may be considered as lasting to 1377. Exeter Cathedral is an excellent example of the earliest Decorated style. Between 1360 and 1399 the Decorated style gave place to the *Perpendicular*, which prevailed from 1377 to 1547, and was an exclusively English style. Gothic architecture, though it lingered on in many districts, practically came to an end in England in the reign of Henry VIII. The *Elizabethan* and *Jacobean styles*, which followed, were transitions from the Gothic to the Italian, with which these styles were more or less freely mixed. Many palatial mansions were built in these styles. In the reign of Charles I Inigo Jones designed, among other buildings, Whitehall Palace and Greenwich Hospital in a purely classic style. After the great fire in London (1666) Sir Christopher Wren designed an immense number of churches and other buildings in Classic style, particularly St. Paul's Cathedral, the Sheldonian Theatre of Oxford, and Chelsea Hospital. Various phases of Classic or Renaissance continued to prevail during the eighteenth and earlier part of the nineteenth century. About 1836 the Gothic revival commenced, and that style has been employed with

considerable success in the churches erected in recent times. The Houses of Parliament, erected between 1840 and 1860 in the Tudor style, the Law Courts of Salford, St. Pancras railway station, and the Law Courts of London (opened 1882) in the Gothic served to sustain an impetus that had been given to the use of that style. At the present day Gothic is much employed for ecclesiastical and collegiate buildings, and a modified type of Renaissance for civil buildings. Of late years a style that has received the name of 'Queen Anne' is much in vogue for private residences. It is very mixed, but withal highly picturesque. The most striking novelties in the nineteenth century have been induced by the extensive use of iron and glass, as exemplified in the Exhibition building of 1851, the Crystal Palace, Sydenham, and the great railway stations.

Very little is known of the state of the art of *painting* among the Anglo-Saxons; but in the ninth century Alfred the Great caused numerous MSS. to be adorned with miniatures, and about the end of the tenth century Archbishop Dunstan won reputation as a miniature painter. Under William the Conqueror and his two sons the painting of large pictures began to be studied, and Lanfranc, Archbishop of Canterbury, adorned the vault of his church with paintings. Numerous miniatures of the thirteenth and fourteenth centuries have come down to us, rude in execution, but not without originality. From this period down to the eighteenth century a succession of foreign painters resided in England, of whom the chief were Mabuse, Hans Holbein, Federigo Zuccherro, Cornelius Jansen, Van Dyck, Lely, and Kneller. Of native artists few are of importance prior to that original genius William Hogarth (1697-1764). Throughout the eighteenth century English artists attained higher eminence in portrait painting than in other departments, and it culminated in Sir Joshua Reynolds (1723-92), Thomas Gainsborough (1727-88), and Romney (1734-1802). These were followed by Raeburn (1756-1823) and Lawrence (1769-1830). Barry (1741-1806), West (1738-1820), and Copley (1737-1815) gained distinction in historical compositions, especially in pictures of battles. Landscape painting was represented by Richard Wilson (1714-82), who painted classical scenes with figures from heathen mythology, and by Gainsborough, already mentioned, who painted scenes of English nature and humble life. The Royal Academy of Arts, of which Reynolds was the first president, was established in London in 1769. Sir David Wilkie (1785-1841), in what is known abroad as genre painting, gained a European reputation that is unsurpassed. In the same class of art C. R. Leslie (1794-1859), Newton (1795-1835), Collins (1788-1847), and Mulready (1786-1863) gained great distinction. In landscape the reputation of Turner (1775-1857) stands alone.

Other distinguished landscape painters are Clarkson Stanfield (1798-1867); David Roberts (1796-1864), who greatly excelled in picturesque architecture; Wm. Müller (1812-45); and John Constable (1776-1837), whose works exercised great influence in France; and Calcott (1799-1844). In historical painting Hilton (1786-1839), Eastlake (1793-1865), Etty (1787-1849), E. M. Ward (1816-79), C. W. Cope (1811-90), and D. Maclise (1811-70) attained celebrity. John Philip (1817-67) greatly distinguished himself by his scenes from Spanish life and by his mastery in colour. Landseer (1802-73) stands by himself as a painter of animals.

In 1824 the nucleus of the National Gallery was formed by the purchase of the Angerstein collection, and in 1832 the vote was passed for the erection of the National Gallery building. The competitions held in Westminster Hall in 1843, 1844, and 1847, with a view to the decoration of the Houses of Parliament, exercised great influence on art. Up to this time English pictures were rather distinguished for colour and effect of light and shade than for carefulness of modelling and exactness of drawing. In aiding to bring about a more accurate and careful style of work, the Pre-Raphaelites (1840-60), while seeking to restore in their practice an early phase of Italian art, exercised a beneficial influence, while they themselves ultimately abandoned the style to which at the first they had been devoted.

The modern group of British painters may be held to date from about 1850. Prominent among these the following may be named: In historical painting Leighton, Alma-Tadema, Watts, Poynter, Long, Goodall, Holman Hunt, Noel Paton, Burne-Jones, and Madox Brown, as also W. P. Frith, whose *Derby Day* and *Railway Station*, so descriptive of modern life, may well be classed as historical. In figure painting or genre T. Faed, Erskine Nicol, Fildes, Orchardson, Herkomer, Millais, and Pettie. In portraiture Millais, Frank Holl, Oules, and Richmond. In landscape Linnell, Hook, W. J. Müller, Peter Graham, John Brett, Vicat Cole, H. Moore, Keeley Halswelle. In water-colours the most eminent artists have been Girtin (1773-1802), Cotman (1782-1842), Liverseege (1803-32), Stothard (1755-1834), Turner, David Cox (1788-1859), De Wint (1784-1849), Copley Fielding (1787-1855), Samuel Prout (1783-1852), W. H. Hunt (1790-1864), Louis Haghe (1806-85), W. L. Leitch (1804-83), Sam Bough (1822-78), John Gilbert (1817-97).—BIBLIOGRAPHY: R. Muther, *History of Modern Painting*; S. Reinach, *Apollo*.

English *sculpture* was long merely an accessory to architecture, and few English sculptors are known by name till comparatively modern times. During

the Renaissance period Torregiano came from Italy and executed two masterpieces in England, the tomb of the mother of Henry VII, and that of Henry himself at Westminster. The troubles of the reign of Charles I and the Commonwealth produced a stagnation in the art, and were the cause of the destruction of many valuable works. After the Restoration two sculptors of some note appeared, Grinling Gibbons, a wood-carver, and Caius Gabriel Cibber. During the eighteenth century there was no English sculptor of great eminence till John Flaxman (1755-1826). He had for rival and successor Sir Francis Chantrey (1781-1841), who acquired renown by the busts and statues which he made of many of the eminent men of his time. John Carew, Sir Richard Westmacott (1775-1856), E. H. Baily (1788-1867), John Gibson (1790-1866), P. MacDowell (1799-1870), H. Weekes (1807-77), J. H. Foley (1818-74), J. Edgar Boehm (1834-90), and Thomas Woolner (1825-92) are a few of the eminent sculptors of the nineteenth century. W. H. Thorneycroft, E. Onslow Ford, C. B. Birch, Alfred Gilbert, G. F. Watts, Henry H. Armstead, G. Simons, Sir Thomas Brock, Harry Bates, and Sir George Frampton are among the foremost sculptors of the present time. The sculptures of the English school in general are characterized by a sort of romantic grace which is their distinguishing mark, and by extraordinary delicacy and finish in detail; but they frequently exhibit weakness in their treatment of the nude.—BIBLIOGRAPHY: Wilhelm Lübke, *History of Sculpture*; E. H. Short, *History of Sculpture*.

English Language.—The language spoken in England from the settlement of the Anglo-Saxons to the Norman Conquest (say 500-1066) is popularly known as Anglo-Saxon, though simply the earliest form of English. (See *Anglo-Saxons*.) It was a highly inflected and purely Teutonic tongue presenting several dialects. The Conquest introduced the Norman-French, and from 1066 to about 1250 two languages were spoken, the native English speaking their own language, the intruders speaking French. During this period the grammatical structure of the native language was greatly broken up, inflexions fell away, or were assimilated to each other; and towards the end of the period we find a few words written in a language resembling the English of our own day in grammar, but differing from it by being purely Saxon or Teutonic in vocabulary. Finally, the two languages began to mingle, and form one intelligible to the whole population, Normans as well as English, this change being marked by a great infusion of Norman-French words, and English proper being the result. English is thus, in its vocabulary, a composite language, deriving part of its stock of words from a Teutonic source and part from a

Latin source, Norman-French being in the main merely a modified form of Latin. In its grammatical structure and general character, however, English is entirely Teutonic, and is classed with Dutch and Gothic among the Low German tongues. If we divide the history of the English language into periods, we shall find three most distinctly marked: first, the Old English or Anglo-Saxon, extending down to about 1100; second, the Middle English, 1100-1400 (to this period belong Chaucer, Wycliffe, Langland); third, Modern English. A more detailed subdivision would give transition periods connecting the main ones. The chief change which the language has experienced during the modern period consists in its absorbing new words from all quarters in obedience to the requirements of advancing science, more complicated social relations, and increased subtlety of thought. At the present time the rapid growth of the sciences already existing, and the creation of new ones, have caused whole groups of words to be introduced, chiefly from the Greek, though unfortunately not a few are hybrid words, coined by some scientist who had small Latin and less Greek.—Cf. H. Sweet, *New English Grammar, Logical and Historical*.

English Literature.—Before any English literature, in the strict sense of the term, existed, four literatures had arisen in England—the Celtic, Latin, Anglo-Saxon, and Anglo-Norman. The first includes such names as those of Taliesin, Llywarch Hen, Aneurin, and Merlin or Merddhin. The Latin literature prior to the Conquest presents those of Aldhelm, Bede, Alcuin, Asser, Ethelwerd, and Nennius. For Anglo-Saxon literature, see the article *Anglo-Saxons*. With the coming of the Normans, although the *Anglo-Saxon Chronicle* was continued until 1154, the native language practically ceased for a time to be employed in literature, Latin being used in law, history, and philosophy, French in the lighter forms of literature. The Norman *trouvère* displaced the Saxon *scop*, or gleeman, introducing the *Fabliau* and the Romance. By the *Fabliau* the literature was not greatly influenced until the time of Chaucer; but the Romance attained an early and striking development in the Arthurian cycle, founded upon the legends of Geoffrey of Monmouth's Latin *History of the Britons* (1147), by Geoffrey Gaimar, Wace, Walter Map, and other writers of the twelfth century. The Latin literature included important contributions to the Scholastic philosophy by Alexander Hales (died 1245), Duns Scotus (died 1308) and William of Occam (died 1347); the philosophic works of Roger Bacon (1214-92); the Goliard poems of Walter Map; and a long list of chronicles or histories, either in prose or verse, by Eadmer (died 1124); Ordericus Vitalis (died 1142), William of Malmesbury (died 1143), Geoffrey

of Monmouth (died 1154), Henry of Huntingdon (died after 1154), Joseph of Exeter (died 1195), Gervase of Tilbury (twelfth century), Roger of Wendover (died 1237), Roger de Hoveden (twelfth and thirteenth centuries), Giraldus Cambrensis (died 1222), Joscelin de Brakelonde (twelfth and thirteenth centuries), and Matthew Paris (died 1259).

Apart from a few brief fragments, the first English writings after the Conquest are the *Brut* of Layamon (about 1200), based on the *Brut* of Wace; and the *Ormulum*, a collection of metrical homilies attributed to Orm or Ormin, an Augustine monk. Next in importance come the rhyming chroniclers Robert of Gloucester (time of Henry III, Edward I) and Robert of Brunne or Mannyng (died 1340), other writers being Dan Michel of Northgate (*Ayenbite of Inwyt*, 1340); Richard Rolle of Hampole (*Pricke of Conscience*, 1340); Laurence Minot (author of eleven military ballads; died 1352); and several works of uncertain authorship, including the *Ancren Riwe* (? Richard Poor, died 1237), *The Owl and the Nightingale* (? Nicholas of Guildford), *The Land of Cockayne* (? Michael of Kildare), the song against the King of Almaine, and a dialogue between the Body and the Soul. To this pre-Chaucerian period belong also several English translations of French romances—*Horn*, *Tristrem*, *Alisaunder*, *Havelok*, and others. Between the beginning and middle of the fourteenth century the English speech had entered upon a new phase of development in the absorption of Norman-French words. A rapid expansion of the literature followed, having as the foremost figure that of Chaucer (1340-1400), who, writing at first under French influences, and then under Italian, became in the end the most representative English writer of the time. Contemporary with him was the satirist William Langland or Langley (1332-1400), the indefatigable John Gower (1325-1408), and the Scot John Barbour (1316-95). In prose the name of John Wycliffe (1324-84) is pre-eminent, the English version of Mandeville's *Travels* being apparently of later date.

The period from the time of Chaucer to the appearance of Spenser, that is, from the end of the fourteenth to near the end of the sixteenth century, is a very barren one in English literature, in part probably owing to foreign and domestic wars, the struggle of the people towards political power, and the religious controversies preceding and attending the Reformation. The immediate successors of Chaucer, Occleve (1370-1454) and Lydgate (died 1460), were neither men of genius, and the centre of poetic creation was for the time transferred to Scotland, where James I (1394-1437) headed the list which comprises Andrew de Wyntoun (fifteenth century), Henry the Minstrel

or Blind Harry (died after 1492), Robert Henryson (died before 1508), William Dunbar (1460-1520), Gavin Douglas (1474-1522), and Sir David Lyndsay (1490-1557). In England the literature was chiefly polemical, the only noteworthy prose prior to that of More being that of Reginald Pecock (1390-1460); Sir John Fortescue (1395-1485); the *Paston Letters* (1422-1505), which are, however, much more interesting for their subject matter than their style; and Malory's *Morte d'Arthur* (completed 1469-70); the only noteworthy verse, that of John Skelton (1460-1529).

It was now that several events of European importance combined to stimulate life and enlarge the mental horizon—the invention of printing, or rather of movable types, the promulgation of the Copernican system of astronomy, the discovery of America, the Renaissance, and the Reformation. The Renaissance spread from Florence to England by means of such men as Colet, Linacre, Erasmus, and Sir Thomas More (1480-1535), the last noteworthy as at the head of a new race of historians. Important contributions to the prose of the time were the Tyndale *New Testament*, printed in 1525, and the Coverdale *Bible* (1535). The first signs of an artistic advance in poetic literature are to be found in Wyatt (1503-42) and Surrey (1516-47), who nationalized the sonnet; Surrey was also a pioneer in the use of blank verse. The drama, too, had by this time reached a fairly high stage of development. The mystery and miracle plays, after the adoption of the vernacular in the fourteenth century, passed from the hands of the clergy into those of the laity, and both stage and drama underwent a rapid secularization. The morality began to embody matters of religious and political controversy, historical characters mingled with the personification of abstract qualities, real characters from contemporary life were introduced, and at length farces on the French model were constructed, the *Interludes* of John Heywood (died 1565) being the most important examples. To Nicholas Udall (1504-56) the first genuine comedy, *Ralph Roister Doister*, was due, this being shortly afterwards followed by John Still's *Gammer Gurton's Needle* (1566). The first tragedy, the *Ferrex and Porrex*, or *Gorboduc* of Sackville (died 1608) and Norton (died 1600), was performed in 1561, and the first prose play, the *Supposes* of Gascoigne (died 1577) in 1566. Gascoigne and Sackville were noteworthy amongst the earlier Elizabethans apart from their plays; but the figures which bulk most largely are those of Sidney (1554-86) and Spenser (1552-99). In drama Lyly, Peele, Greene, Nash, and Marlowe (1564-93) are the chief immediate precursors of Shakespeare (1564-1616), Marlowe alone, however, being at all comparable with the great master. Contemporary and later dramatic writers were Ben Jonson (1573-

1637), the second great Elizabethan dramatist, Middleton (died 1627), Marston (better known as a satirist), Chapman (1557-1634), Thomas Heywood, Dekker (died 1639), Webster (seventeenth century), Ford (1586-1639), Beaumont (1586-1616) and Fletcher (1576-1625), and Massinger (1584-1640). The minor poets include Michael Drayton (1563-1631), Samuel Daniel (1562-1619), John Davies (1570-1626), John Donne (1573-1631), Giles Fletcher (1580-1623), and Phineas Fletcher (1584-1650), Drummond of Hawthornden (1585-1649). In Elizabethan prose the prominent names are those of Roger Ascham (1515-68), John Lyly (1553-1606), Hooker (1554-1600), Raleigh (1552-1618), Bacon (1561-1626), the founder in some regards of modern scientific method, Burton (1576-1640), Herbert of Cherbury (1581-1648), and Selden (1584-1654), with Overbury, Knolles, Holinshed, Stowe, Camden, Florio, and North. The issue of the Authorized Version of the Bible in 1611 may be said to close the prose list of the period, as it represents the finest flower of English prose.

After the death of James I the course of literature breaks up into three stages, the first from 1625 to 1640, in which the survivals from the Elizabethan Age slowly die away. The 'metaphysical poets', Cowley, Wither, Herbert, Crashaw, Habbington, and Quarles, and the cavalier poets, Suckling, Carew, Denham, all published poems before the close of this period, in which also Milton's early poems were composed, and the *Comus* and *Lycidas* published. The second stage (1640-60) was almost wholly given up to controversial prose, the Puritan revolution checking the production of pure literature. In this controversial prose of the time Milton was easily chief. With the Restoration a third stage was begun. Milton turned his new leisure to the composition of his great poems; the drama was revived, and Davenant and Dryden, with Otway, Southerne, Etherege, Wycherley, Congreve, Vanbrugh, and Farquhar in their first plays, and minor playwrights, are the most representative writers of the period. Butler established a genre in satire, and Marvell as a satirist in some respects anticipated Swift; Roscommon, Rochester, and Dorset contributed to the little poetry; while in prose we have Hobbes, Clarendon, Fuller, Sir Thomas Browne, Walton, Cotton, Pepys and Evelyn, John Bunyan, Locke, Sir William Temple, Owen Feltham, Sir Henry Wotton, James Harrington, and a crowd of theological writers, of whom the best known are Jeremy Taylor, Richard Baxter, Robert Barclay, William Penn, George Fox, Isaac Barrow, John Tillotson, Stillingfleet, Bishop Pearson, Sherlock, South, Sprat, Cudworth, and Burnet. Other features of the last part of the seventeenth

century were the immense advance in physical science under Boyle, Isaac Newton, Harvey, and others, and the rise of the newspaper press.

Dryden's death in 1700 marks the commencement of the so-called Augustan Age in English literature. During it, however, no greater poet appeared than Pope (1688-1744), in whom sagacity, wit, and fancy take the place of the highest poetic faculty, but who was a supreme artist within the formal limits of his conception of the art of poetry. Against these formal limits signs of reaction are apparent in the verse of Thomson (1700-48), Gray (1716-71), Collins (1720-59), Goldsmith (1728-74), and in the productions of Macpherson and Chatterton. The poets Prior (1664-1721), Gay (1688-1732), and Ambrose Phillips (1671-1749) inherit from the later seventeenth century, Gay being memorable in connection with English opera; and there are many minor poets—Garth, John Philips, Blackmore, Parnell, Dyer, Somerville, Green, Shenstone, Blair, Akenside, Falconer, Anstey, Beattie, Allan Ramsay, and Robert Fergusson. It is in prose that the chief development of the eighteenth century is to be found. Defoe (1661-1731) and Swift (1667-1745) led the way in fiction and prose satire; Steele (1672-1729) and Addison (1672-1719), working on a suggestion of Defoe, established the periodical essay; Richardson (1689-1761), Fielding (1707-54), Smollett (1721-71), and Sterne raised the novel to sudden perfection. Goldsmith also falls into the fictional group as well as into that of the poets and of the essayists. Johnson (1709-84) exercised during the latter part of his life the power of a literary dictator, with Boswell (1740-95) as his 'Secretary of State'. The other chief prose writers were Bishop Berkeley (1685-1753), Arbuthnot (1675-1735), Shaftesbury (1671-1713), Bolingbroke (1678-1751), Burke, the historians David Hume (1711-76), William Robertson (1721-93), Edward Gibbon (1737-94); the political writers Wilkes and 'Junius', the economist and moral philosopher Adam Smith (1723-90); the philosophical writers Hume, Bentham (1749-1832), and Dugald Stewart (1753-1828); the scholars Bentley (1662-1742), Sir William Jones (1746-94), and Richard Porson (1759-1808); the theologians Atterbury, Butler (1692-1752), Warburton, and Paley; and some playwrights, of whom the most important was Sheridan, but who also included Rowe, John Home, Colley Cibber, Colman the elder, and Foote.

With the French Revolution, or a few years earlier, the modern movement in literature may be said to have commenced. The departure from the old traditions, traceable in Gray and Collins, was more clearly exhibited in the last years of the century in Cowper (1731-1800) and Burns (1759-96), and was

developed and perfected in the hands of Blake (1757-1828), Bowles (1762-1850), and the 'Lake poets' Wordsworth (1770-1850), Coleridge (1772-1834), and Southey (1774-1843); but there were at first many survivals from the poetic manner of the seventeenth century, such as Erasmus Darwin (1731-1802), Dr. John Wolcot (1738-1819), and Samuel Rogers (1763-1855). Amongst the earlier poets of the nineteenth century, also, were George Crabbe (1754-1832), Sir Walter Scott (1771-1832), Hogg (1772-1835), Campbell (1777-1844), James Montgomery, Mrs. Hemans, Bryan Waller Procter ('Barry Cornwall'), Joanna Baillie, Robert Montgomery. A more important group was that of Byron (1788-1824), Shelley (1792-1822), and Keats (1796-1821), with which may be associated the names of Leigh Hunt (1784-1859), Thomas Moore (1779-1852), and Landor (1775-1864). Among the earlier writers of fiction there were several women of note, such as Maria Edgeworth (1767-1849) and Jane Austen (1775-1817). The greatest name in fiction is unquestionably that of Scott. Other prose writers were Malthus, Hallam, James Mill, Southey, Hannah More, Cobbett, William Hazlitt, Sydney Smith, Francis Jeffrey, Lord Brougham. In the literature since 1830 poetry has included as its chief names those of Praed, Hood, Sidney Dobell, Gerald Massey, Charles Mackay, Philip James Bailey, William Allingham, Elizabeth Barrett Browning, Coventry Patmore, the second Lord Lytton ('Owen Meredith'), Arthur Hugh Clough, Matthew Arnold, Dante G. Rossetti, Robert Buchanan, Wm. Morris, Lewis Morris, Jean Ingelow, Swinburne, and last and greatest, Tennyson and Browning. Among more modern English poets are Stephen Phillips (1868-1915), Francis Thompson (1860-1907), Sir William Watson (born 1858), John Davidson (1857-1909), and R. Kipling (born 1865). A brilliant list of nineteenth-century novelists includes Marryat, Michael Scott, the first Lord Lytton, Ainsworth, Benjamin Disraeli (Earl of Beaconsfield), Dickens, Thackeray, Charles Kingsley, Charlotte Brontë, Lover, Lever, Wilkie Collins, Mayne Reid, Charles Reade, George Eliot, Anthony Trollope, William Black, Thomas Hardy, R. D. Blackmore, George Meredith, R. L. Stevenson, Miss Braddon, Mrs. Craik (Miss Mulock), Mrs. Oliphant, Miss Yonge, and others. Towards the end of the nineteenth and at the beginning of the twentieth century there was a deepening interest in the drama, and the list of brilliant dramatists includes the names of Barrie, H. A. Jones, G. B. Shaw, Pinero, Granville Barker, and others. The tendency in the fiction of the twentieth century is a concrete and imaginative presentation of the social, ethical, and sentimental problems of the day. This tendency is clearly seen in the novels of John Galsworthy and H. G. Wells. To the historical and biographical list of the nineteenth century belong Macaulay, Buckle, Carlyle, Thirwall, Grote,

Milman, Froude, Lecky, S. R. Gardiner, Kinglake, John Richard Green, E. A. Freeman, Stubbs, Dean Stanley, John Morley, Leslie Stephen. In science and philosophy among the chief writers of the nineteenth century have been Whewell, Sir W. Hamilton, Mansel, John Stuart Mill, Alexander Bain, Hugh Miller, Charles Darwin, Huxley, Tyndall, Max Müller, Herbert Spencer, T. H. Green.—BIBLIOGRAPHY: *Cambridge History of English Literature*; Taine, *History of English Literature*; Saintsbury, *Short History of English Literature*; Chambers, *Cyclopædia of English Literature*.

English Architecture, Art, Church, Language, Literature, &c. See *England*.

English Channel (Fr. *La Manche*, the sleeve), the arm of the sea which separates England from France, extending, on the English side, from Dover to Land's End; and on the French, from Calais to the Island of Ushant. On the east it communicates with the North Sea by the Straits of Dover, 21 miles wide; and on the west it opens into the Atlantic by an entrance about 100 miles wide. At its greatest breadth it is about 150 miles. The pilchard and mackerel fisheries are very important. The advantages of a railway tunnel under the Channel at or near its narrowest part have been frequently urged; and an English company, formed in 1887 for constructing a tunnel from Dover, to meet a similar tunnel starting from near Calais, has pushed an excavation under the sea for over 2000 yards. The plan, opposed by the British Government for military reasons in 1907, has now been approved of. Plans have also been put forward for a railway bridge across the Straits of Dover.

Engraving, the art of drawing or writing on metal, wood, precious stones, &c., by means of incisions made with instruments variously adapted to the substances operated upon and the description of work intended. The term is also applied to the work so performed, and to impressions taken on paper or similar material from the engraved work. Impressions from metal plates are called engravings, prints, or plates; those printed from wood being termed indifferently wood engravings or wood-cuts. While, however, these impressions are not altogether dissimilar in appearance, the processes are distinct. As a rule, in prints from metal the lines intended to print are incised, and in order to take an impression the plate is daubed over with a thick ink which fills all the lines. The surface is then wiped perfectly clean, leaving only the incised lines filled with ink. A piece of damp paper is then laid on the face of the plate, and both are passed through the press, which causes the ink to pass from the plate to the paper. This operation needs to be repeated for every impression. In the wood block, on the contrary, the spaces between the lines of

the drawing are cut out, leaving the lines standing up like type, the printing being from the inked surface of the raised lines, and effected much more rapidly than plate printing. This process has also been used to a certain extent with metal.

Engraving on wood, intended for printing or impressing from, long preceded engraving on metals. The art is of Eastern origin, and at least as early as the tenth century engraving and printing from wood blocks was common in China. We first hear of wood engraving being cultivated in Europe by the Italians and Germans for impressing patterns on textiles, but no paper impressions earlier than the fourteenth century are known. For a hundred years there is small indication of the practice of the art, which was at first confined to the production of block-books, playing-cards, and religious prints. According to Vasari, the art of printing from engraved plates was discovered in Florence by Maso Finiguerra about 1460, but engravings of earlier date are known to exist. Engraving had long been used as a means of decorating armour, metal vessels, &c., the engravers generally securing duplicates of their works before laying in the niello (a species of metallic enamel) by taking casts of them in sulphur, and rubbing the lines with black. The discovery of the practicability of taking impressions upon paper helped the development of engraving upon copper plates for the purpose of printing from. The date of the earliest known niello proof upon paper is 1452. The work of the Florentine engravers, however, was almost at once surpassed in Venice and elsewhere in North Italy by Andrea Mantegna (1431-1506), Girolamo Mocetto, Jacopo de' Barbari, and others. In Marc Antonio Raimondi (1475-1534), who wrought under the guidance of Raphael, and reproduced many of his works, the art reached its highest point of the earlier period, and Rome became the centre of a new school, which included Marco da Ravenna (died 1527), Giulio Bonasone (1531-72), and Agostino de Musis (flourished 1536). In the meantime, in Germany the progress of the art had been not less rapid. Of the oldest school the most important engraver is Martin Schongauer (1420-88). He was, however, surpassed a generation later by Albert Dürer (1471-1528), who excelled both in copper and wood engraving, especially in the latter, and also etched a few plates. Among his most famous contemporaries and successors were Burgkmair and Lucas Cranach. The Dutch and Flemish schools, of which Dürer's contemporary Lucas van Leyden was the head, did much to enlarge the scope of the art, either by paying increased attention to the rendering of light and shade, and the expression of tone and surface quality, as in the case of Cornelius Cort and Bloemart; or by developing freedom and expression of

line, as in the case of Goltzius and his pupils. Rubens (1577-1640) influenced engraving through the two Bolswerts, Vorstermann, Pontius, and P. de Jode, who engraved many of his works on a large size. Towards the end of the seventeenth century etching, which had before been rarely used, became more common, and was practised with supreme mastery by Rembrandt (1607-69) and other painters of that period. In France, Noel Garnier founded a school of engraving about the middle of the sixteenth century; but it produced no work of any high distinction until the reign of Louis XIV, when Robert Nanteuil, his follower Gerard Edelinck, and Antoine Masson produced many fine portraits, and Gerard Audran engraved works by Nicolas Poussin and Le Brun. Jacques Callot also produced some admirable etchings. These were followed about the middle of the eighteenth century by Wille (1717-1807), a German resident in Paris, who gave new vitality to a waning art, and by the school of French illustrators. Before the middle of the seventeenth century England produced little noteworthy work, availing herself principally of the work of foreign engravers such as Wenzel Hollar, of whom many took up temporary and even permanent residence. The first English engraver of marked importance was William Hogarth (1697-1764), whose works are distinguished for a power of vivid characterization. Vivares (1712-82), a Frenchman by birth, laid the foundation of the English school of landscape engraving, which was still further developed by William Woollet (1735-85), who was also an excellent engraver of the human figure. In historical engraving a not less remarkable advance was made by Sir Robert Strange (1721-92); and Richard Earlom (1743-1822), Valentine Green, and J. R. Smith produced some admirable works in mezzotint. In succession to these came William Sharp (1746-1824), James Bazire (1730-1802), Bartolozzi (1727-1815), who practised stipple engraving, James Heath, Bromley, Raimbach, and others. The substitution of steel for copper plates (1820-30) gave the power of producing a much larger number of fine impressions, and opened new possibilities for highly finished work. During the closing years of the eighteenth century, line engraving attained a depth of colour and fullness of tone in which earlier works are often deficient, and during the following century it reached a perfectness of finish which it had not previously attained. A picture, whether figure or landscape, came to be translated by line engraving with all its depth of colour, delicacy of tone, and effect of light and shade; the various textures, whether of naked flesh, silk, satin, woollen, or velvet, were all successfully rendered by ingenious modes of laying the lines and combinations of lines of varying strength, width, and depth. At the same time, original work by engravers declined in quality. Among engravers who have produced historical works of

large size and in the line manner the names of Raphael Morghen (1758-1833), Longhi (1766-1831), Anderloni (1784-1849), Garavaglia (1790-1835), and Toschi, in Italy; of Forster (1790-1872), Henriquel-Dupont (born 1797), Bridoux (born 1812), and Blanchard (born 1819), in France; of John Burnet (1784-1868), J. H. Robinson (1796-1871), Geo. T. Doo (1800-86), J. H. Watt (1799-1867), and Lumb Stocks (1812-92), in England, stand pre-eminent. Among historical and portrait engravers in the stipple or dotted manner the names of H. T. Ryall, Henry Robinson, William Holl (1807-71), and Francis Holl may be mentioned. In the period 1820-60 landscape engraving attained a perfection in Great Britain which it had not attained in any other country, or at any other time. In fact, most of the work was done by etching, details being sharpened by the graver. Among landscape engravers the names of Geo. Cooke (1781-1834), William Miller (1796-1882), E. Goodall (1795-1870), J. Cousen (1804-80), R. Brandard (1805-62), and Wm. Forrest (born 1805) hold the foremost places. Most of these were associated with the reproduction of Turner's pictures, and owed much to his control and direction. In mezzotint engraving Samuel Cousins (1801-87) and David Lucas, who was associated with John Constable in the 'English Landscape' series, achieved considerable success. In the period 1830-45 various publications called *Annals*, composed of light literature in prose and verse, and illustrated by highly finished engravings in steel, were very popular. The engravings were necessarily of small size, and are generally of great excellence. A number of them, both figure and landscape, are executed with such finish and completeness as to be esteemed perfect works. The illustrations of Rogers's *Poems* and Rogers's *Italy* after Turner and Stothard belong to this period. Many of the originals of the engravings in the *Annals* were finished pictures of large size. A great part of the difficulty in engraving on a small scale from a large picture consists in determining what details can be left out, and still preserve the full effect and character of the original. The most noted engravers for work of this kind are Charles Heath, Charles Rolls, W. Finden, E. Finden, E. Portbury, J. Goodyear, F. Engleheart, Henry le Keux, E. Goodall, and W. Miller. Since 1870 many reproductions of paintings have been produced by means of etching, a comparatively cheap and rapid process. Such works have been fashionable and very popular with collectors. But while some of them have been excellent of their kind, the process is of limited resource, and the best works in this manner do not compare with the masterpieces of line engraving. In original work, however, etching and dry-point (q.v.) have produced some excellent work, notably in the hands of Charles Meryon, J. M. Whistler, Sir Seymour Haden, and Anders Zorn. A revival of mezzotint owes much to Sir Frank Short.

Through lack of encouragement, change of fashion, and the adoption of other methods of reproduction, line engraving on metal has become almost a lost art in Great Britain, though a revival in wood engraving has taken place of recent years.

Line Engraving, as implied by the term, is executed entirely in lines. The tools are few and simple. They consist of the graver or *burin*, the scraper, to remove the burr left by the graver, and the burnisher; an oil-stone or hone, dividers, a parallel square, a magnifying lens; a bridge on which to rest the hand; a blind or shade of tissue paper, to make the light fall equally on the plate, callipers for levelling important erasures, a small steel anvil, a small pointed hammer, and punches. In etching, the following articles are required: a resinous mixture called etching-ground, capable, when spread very thinly over the plate, of resisting the action of the acids used; a dabber for laying the ground equally; an etching needle; a hand-vice; some brushes of different sizes; and bordering wax, made of burgundy-pitch, bees'-wax, and a little oil.

In *etching*, the plate, which is highly polished and must be free from all scratches, is first prepared by spreading over it a thin layer of *ground*. The surface is then smoked, and the outline of the picture transferred to it by pressure from the paper on which it has been drawn in fine outlines by a black-lead pencil. The picture is then drawn on the ground with the etching-needle, which removes the ground in every form produced by it, and leaves the bright metal exposed. Sometimes, however, the drawing is made direct, without the use of tracing. A bank of wax is then put round the plate and diluted acid poured on it, which eats out the metal from the lines from which the ground has been removed, but leaves the rest of the plate untouched. (See also *Dry-point*.) In landscape engraving, as practised in England in the early nineteenth century, the plate is then gone over with the graver, the etched lines clearly defined, broken lines connected, new lines added, &c. Sometimes the plate is *rebitten* more than once, those parts which are sufficiently bitten in the first treatment being *stopped* with varnish, and only the selected parts exposed to after-biting. Finally the burnisher is brought into play alternately with the graver and point to give perfectness and finish. In engraving proper, the lines are first drawn on the metal with a fine point and then cut in by the graver, first making a fine line, and afterwards entering and re-entering till the desired width and depth of lines is attained. Much of the excellence of such engravings depends on the mode in which the lines are laid, their relative thickness, and the manner in which they cross each other. In this method of engraving etching

is but little used, if at all, and then only for accessories and the less important parts.

Soft-ground Etching.—The ground, made by mixing lard with common etching-ground, is laid on the plate and smoked as before, but its extreme softness renders it very liable to injury. The outline of the subject is drawn on a piece of paper larger than the plate. The paper is then dampened, and laid gently over the ground, face upwards, and the margins folded over and pasted down on the back of the plate. When the paper is dry and tightly stretched, a bridge is laid across, and with a hardish pencil and firm pressure the drawing is completed in the usual manner. The pressure makes the ground adhere to the back of the paper at all parts touched by the pencil, and on the paper being lifted carefully off, these parts of the ground are lifted with it, and the corresponding parts of the plate thus left bare are exposed to the subsequent action of the acid. The granulated surface of the paper, causing similar granulations in the touches on the ground, gives the character of a chalk drawing. The biting-in is effected in the same manner as already described, and the subject may be finished by rebiting and dotting with the graver. See *Etching*.

Stipple, or Chalk Engraving, in its pure state, is exclusively composed of dots, made with a special form of graver, varying in size and form as the nature of the subject demands, but few stipple plates are now produced without a large admixture of line in all parts, flesh excepted. Etching is often used to put in the more important lines and tone masses.

The processes of *Aquatint* and *Mezzotint* will be found under their respective heads, the latter differing from all other styles of engraving in that the lights and gradations are scraped or burnished out of a plate prepared so that it would print quite dark all over, instead of the forms being corroded or cut into a plain surface.

The *Mixed Style* is based on mezzotint, which, still forming the great mass of shading, is in this method combined with etching in the darker, and stipple in the more delicate parts. By this combination a plate will produce a larger number of good impressions than it would if it were done entirely in mezzotint.

Engraving on Wood.—The wood best adapted for engraving is box. It is cut across the grain in thickness equal to the height of type, these slices being

subjected to a lengthened process of seasoning, and then smoothed for use. Every wood engraving is the representative of a finished drawing previously made on the block, the unshaded parts being cut away, and the lines giving form, shading, texture, &c., left standing in relief by excavations of varied size and character, made between them by gravers of different forms. Drawings on wood are made either with black-lead pencil alone or with pencil and indian ink, the latter being employed for the broader and darker masses. It is now much the practice to photograph drawings made in black and white upon the wood instead of making the drawing on the wood block. When the drawing is put on the wood by washes or by photography, instead of being entirely done by pencil lines, the engraver has to devise the width and style of lines to be employed instead of cutting in facsimile, as is the case when the drawing is made entirely in lines. The tools required for wood engraving are similar but more numerous than those of the engraver on copper or steel. See also *Die-sinking; Gems.*—BIBLIOGRAPHY: W. Y. Ottley, *Early History of Engraving*; G. Duplessis, *History of Engraving in France*; P. G. Hamerton, *Graphic Arts*; F. Wedmore, *Fine Prints*; A. M. Hind, *A Short History of Engraving and Etching*; J. H. Slater, *Engravings and their Value*; H. C. Levis, *Engraving and Collecting of Prints: Bibliography*.

Engrossing, Forestalling, and Regrating, terms formerly in use for the purchase of corn or other commodities in order to sell again at a higher price, or in order to raise the market price of the same. The modern equivalent is 'making a corner'. These practices were once regarded as criminal, and positive statutes against them were passed in England in 1266-7, in 1350-2, in 1552, in 1562, and in 1570. The offence of *engrossing* was described by the statute of Edward III as the "getting into one's possession, or buying up, large quantities of corn, or other dead victuals, with intent to sell them again"; *forestalling*, as the "buying or contracting for any cattle, merchandise, or victual, coming in the way to the market, or dissuading persons from bringing their goods or provisions there, or persuading them to enhance the price when there"; and *regrating*, "the buying of corn or other dead victual in any market and selling it again in the same market, or within 4 miles of the place". By the statute of Edward VI the engrossing of corn, which included the buying of it in one market to sell it in another, was made punishable by imprisonment and pillory; and no one could carry corn from one part of the kingdom to another without a licence. All the positive statutes against these offences were repealed in 1772, but they were still found to be punishable by common law, and it was not till 1844 that they entirely ceased to rank among offences.

Enharmon'ic, in music, is an epithet applied to intervals smaller than the regular divisions of the scale, i.e. less than semitones. Enharmonic intervals can be produced on stringed instruments, or on specially constructed fixed-tone instruments having more than twelve divisions in the octave.

Enkhuizen (engk'hoi-zn), a seaport of Holland, on a projection in the Zuider Zee, 29 miles north-east of Amsterdam. It had formerly a pop. of 40,000, but the silting up of the harbour has caused its decay, and its inhabitants number now about 7110.

Enlist'ment, the act of engaging oneself or another to perform any service. In general, the use of the word is confined to engagements for the public service, and more especially in the armed forces of the Crown. In earlier days enlistment of soldiers was either for an indefinite period, as, for instance, for a particular war or campaign, or for life. Up to the middle of the seventeenth century enlistments were made to serve the officer raising the force under a contract from the Crown; after this period all enlistments were to serve the king. In both cases they were for a particular regiment only. For the next hundred years troops continued to be raised both in peace and war on the contract system, which by now implied that the officer accepting the contract, in addition to having a considerable say in the matter of allotting commissions to his friends, received a lump sum to cover all expenses of recruiting, pay, and clothing, out of which he and his officers made what they could. The objections to such a system are palpable, and it was abolished in 1783, after which year all duties with regard to the enlistment of troops were placed in the hands of a Director of Recruiting and Organization. The contract system was last used in war as late as the fifties of the last century during the Crimean War. For some eighty years prior to 1847 the term of enlistment was ordinarily for life, but from that year onward to 1870 various systems of limited enlistment were in force. In 1870, with the idea of forming a reserve, the principle of short service was introduced by the Army Enlistment Act, and this principle has been continued by all succeeding legislation. The existing law as to enlistment is to be found in Part II of the Army Act, Sections 78 to 101; more detailed instructions are in the Recruiting Regulations. The Army Act, brought into force annually by the Army (Annual) Act, specifies the term of original enlistment to be twelve years, which may be either entirely in army (colour) service, or partly in colour service and partly in the reserve. In practice the normal terms are seven years' colour service and five years' reserve service for the infantry, with certain modifications in the case of other arms. Enlistment

may be made for general service or for a particular corps, and in the latter case the recruit will be posted to that corps only, and will ordinarily spend his whole service in it. A man desiring to enlist should present himself at a recruiting office, where he will be given a notice setting forth the terms of service. If, after reading the conditions, he still desires to enlist, he will be directed to appear before a justice of the peace (a recruiting officer is *ex officio* a justice of the peace for this purpose) for attestation. Attestation consists in giving signed answers to certain questions contained in the Form of Attestation, and in taking the oath of allegiance. The completed form is then signed by the justice, and the man becomes a properly enlisted and attested soldier. The former practice of giving a shilling to every prospective recruit, and thereafter considering him for some purposes a soldier, is no longer recognized, and, at any time before signing the attestation paper, the man may decline to complete his bargain without rendering himself liable to any penalty. Should he, however, make a false answer to certain of the questions contained in his attestation paper, he is liable to punishment on conviction by court-martial.

Ennis, a town (formerly a parliamentary borough) in Ireland, County Clare, on the Fergus, 19 miles north-west of Limerick. It is irregularly built, the streets being narrow and crooked. There are remains of a Franciscan abbey founded in 1240. Some linen and flannel are manufactured, and there is a trade in agricultural produce. Pop. 5472.

Enniscor'thy, a town in Ireland, County Wexford, on the River Slaney, 77 miles south of Dublin. An old castle erected by one of the early Norman conquerors is in the centre of the town. Vinegar Hill in the immediate vicinity was the scene of a skirmish in 1798, when the town was stormed and burned by the rebels. Pop. 5495.

Enniskil'len, a town (formerly a parliamentary borough), Ireland, County Fermanagh, 34 miles north-east of Sligo, on an island in the river which connects the upper and lower sections of Lough Erne, with suburbs on both sides of the adjoining mainland, with which it communicates by two bridges; a well-built, clean, thriving town. Pop. 4847.

En'nus, Quintus, the father of Latin poetry, was born at Rudiaë, in Calabria, in 239 B.C., and died in 170 B.C. Like our own early poet Gower, he was trilingual, speaking Greek, Oscan, and Latin. He was of good family, and claimed descent from the legendary kings of Calabria. Little is known of his life; he served in the Second Punic War, and held the rank of centurion in 204 B.C.; at a

later date he went to Rome, supported himself by teaching, and was friendly with the greatest of his contemporaries. He died of gout in his seventieth year. Ennius was a man of great versatility. He held perhaps the foremost place among writers of tragedies at Rome. He wrote good comedies. He wrote satires, and prepared the way for Lucilius. He wrote didactic poetry, and prepared the way for Lucretius. Most important of all, he wrote epic poetry—the *Annales*—and prepared the way for Virgil. He was the first to transplant the hexameter into Italy. His predecessors wrote in a rough kind of verse scanned by accent rather than quantity, and known as 'Saturnian verse'. Ennius contemptuously called this "the verse of fauns and soothsayers", and introduced the strong-winged music of Homer into his verse. He also brought in the elegiac couplet, which was to attain perfection at the hands of Propertius and Ovid. He left a permanent impress on the language. He made a systematic study of orthography, and invented a system of shorthand. He was fond of philosophical speculations, and made the Romans acquainted with the rationalism of Euripides and Euhemerus. He was, therefore, a remarkably versatile and prolific writer. His translations from the Greek tragedians were of the greatest importance in the history of Roman drama. His chief fame, however, rests upon his *Annales*, a great epic in eighteen books. Like all of the works of Ennius, it only survives in fragments quoted by later writers. It was a great national epic, recording the history of the Roman state from the landing of Æneas down to the poet's own time. The city itself—*urbs quam dicunt Romam*—may be said to have been the central figure of his poem, a nobler figure than the pious Æneas. The verse of Ennius is sometimes crude and harsh, but it contains many fine lines and grand passages. Some of these lines are world-famous, like those on Fabius Maximus beginning with

Unus homo nobis cunctando restituit rem,

or the great line

Moribus antiquis res stat Romana virisque,

which sums up some of the qualities which placed Rome at the head of the civilized world. In a famous simile Quintilian (*Inst. Or.* x, 1, 88) compares Ennius to a sacred grove of ancient oaks, whose massive immemorial trunks are awe-inspiring rather than beautiful. In his own epitaph Ennius boasted that he still lived as he passed to and fro through the mouths of men (*volito vivu' per ora virum*). Though his works are lost, this is still true, for he inspired

Virgil and influenced all Latin literature.—BIBLIOGRAPHY: W. Y. Sellar, *Roman Poets of the Republic*; L. Müller, *Quintus Ennius*; J. W. Duff, *A Literary History of Rome*.

Enns, a river in Austria, which rises in the Alps of Salzburg, flows N., then E.N.E., then N.N.W., entering Upper Austria (Ober der Enns), which for 15 miles it separates from Lower Austria (Unter der Enns), and finally enters the Danube a little below the town of Enns (4438 inhabitants). Total course about 150 miles.

Enoch (ē'nok), (1) the eldest son of Cain, who called the city which he built after his name (*Gen.* iv, 17). (2) One of the patriarchs, the father of Methuselah. He "walked with God; and he was not; for God took him" (*Gen.* v, 24) at the age of 365 years. The words quoted are generally understood to mean that Enoch did not die a natural death, but was removed as Elijah was.

Enoch, Book of, an apocryphal book of an assumedly prophetic character, to which considerable importance has been attached, particularly on account of St. Jude quoting it in the 14th and 15th verses of his *Epistle*. It is referred to by many of the early Fathers; is of unknown authorship, but was probably written by a Palestinian Jew in Hebrew or Aramaic, was translated into Greek, and from the Greek the existing Ethiopic version was made in the first or second century B.C. Till the end of the eighteenth century it was known in Europe only by the references of early writers. On his return, Bruce, the African traveller, brought with him from Abyssinia two manuscripts containing the Ethiopic translation of it. In 1821 Archbishop Laurence published a translation of the work, and in 1838 the Ethiopic text followed. *The Book of Enoch* has since been repeatedly published, translated, and criticized.

E'nos, a seaport in Thrace, 38 miles N.W. of Gallipoli, on the Ægean Sea, in the Gulf of Enos. Pop. 6940.—The Gulf of Enos is 14 miles in length by about 5 miles in breadth.

Enschede (ens'he-dā), a town of Holland, province of Overijssel, near the Prussian frontier, the chief seat of cotton manufacture in Holland. It has increased rapidly in recent years. Pop. 41,600.

Ensena'da (in Sp., a creek or natural harbour), a seaport of the Argentine Republic, province of Buenos Ayres, the port of the town of La Plata, with which it is connected by rail and tramway, with recently constructed harbour works.—Another place of the same name is a rising port of Mexico, in the

northern part of the peninsula of California on the Pacific, in the Bay of Todos los Santos, with gold- and copper-mines adjacent.

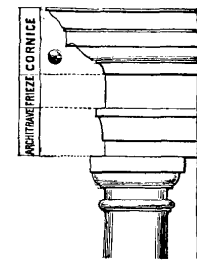
En'sign, formerly, in the British army, the officer who carried the flag or colours of an infantry regiment; for this title, second lieutenant has been substituted since 1871. In naval language the ensign is the flag over the poop or stern which distinguishes the ships of different nations. In the Royal Navy of Britain it is a flag with a white field divided into quarters by the red cross of St. George, and having the union (or Union Jack, as it is commonly called) in the upper corner next the staff. A similar ensign with a red field is flown by the merchant service.

En'silage, in agriculture, a mode of storing green fodder or vegetables in receptacles called 'silos'. These are usually pits of quadrangular form, lined with wood, brick, concrete, or stone. The fodder is cut and mixed, placed in the silo, pressed down, and kept compressed by heavy weights placed on a movable wooden covering. It undergoes a slight fermentation, and attains a slightly acid taste and smell, which is particularly grateful to cattle. The modern system of ensilage dates from about 1875, but the practice was known to the ancient Romans, and the system has been common in Mexico for centuries. Such advantages are claimed for it, as that in a wet season grass can be made into ensilage instead of hay, and that there is little loss of nutritive elements, while it has great feeding powers. Successful experiments have shown that green fodder may be converted into ensilage without a pit by simply piling up and consolidating by pressure.

Entab'lature (Lat. *in*, and *tabula*, a tablet), in architecture, the horizontal, continuous work which rests upon a row of columns, and belongs especially to classical architecture. It consists of three principal divisions—the *architrave* immediately above the abacus of the column, next the *frieze*, and then the *cornice*. In large buildings projections similar to and known also as entablatures are often carried round the whole edifice, or along one front of it.

Enta'da, a genus of leguminous plants, subord. Mimoseæ, containing about a dozen species of climbing tropical shrubs, remarkable for the great size of their pods. *E. scandens* has pods which measure from 6 to 8 feet in length. They are sometimes carried from America to the coasts of Europe by the Gulf Stream. The seeds have a hard, woody, and beautifully polished shell, and are often made into snuff-boxes, scent-bottles, and other small articles.

Entail', in law, the settlement of an estate by which a freehold is limited to a person and the heirs of his body, with such particular restrictions as the donor may specify. Entailed estates are divided into *general* and *special*, the former when the estate is given to the donee and the heirs of his body without exception, the latter when the estate is limited to certain heirs to the exclusion of others. By a Bill introduced into Parliament in 1920 it is proposed that a tenant in tail should have power of disposal by will.



Entablature of
Tuscan Column

En'tasis, in architecture, the delicate and almost imperceptible swelling of the lower part of the shaft of a column, to be found in almost all the Grecian examples, adopted to give a more pleasing effect to the eye.

Entel'lus, an East Indian species of monkey, of the genus *Semnopithēcus* (*S. entellus*). It has yellowish fur, with a face of a violet tinge, and a long and powerful tail, which, however, is not prehensile. It receives divine honours from the natives of India, by whom it is termed *Hanuman*. Costly temples are dedicated to these animals; hospitals are built for their reception, and large fortunes are bequeathed for their support. The entellus abounds in India; enters the houses and gardens of the natives, plunders them of fruit and eatables, and the visit is even considered an honour.

Entente Cordiale, a term applied in international politics to friendly relations existing between different countries and statesmen. It is not a formal alliance, but denotes the existing community of interests and friendly sentiments between two countries. The term has been especially applied to the friendly relations which existed between France and England ever since the reign of Edward VII down to the formal alliance concluded at the outbreak of the European War.

Enteric Fever, or **Typhoid Fever**, is an acute infectious fever, characterized by much general disturbance, and giving rise to ulceration in the small intestine. The distinction between this fever and typhus fever was only established in the middle of last century. It is due to a bacillus, difficult to detect, but during an attack found in many of the internal organs as well as in the stools, urine, and blood of the affected person. Enteric fever occurs in all parts of the world, and in most countries it is endemic, with occasional outbursts of epidemic prevalence. In Great Britain it is most common in the autumn, but epidemics may appear at any season. The great majority of cases

occur between ten and twenty-five years of age; less common in middle life, it is rare after sixty. The most common source of infection is from the fæces and urine of infected persons, hence the channels of infection are contaminated water, milk, and food-stuffs. Much public interest has been roused by the infection, through contaminated sewage-water, of watercress, celery, oysters, and other shell-fish, and various outbreaks have arisen through these agents. A further danger is the 'enteric carrier', a person who has once had enteric fever, and who is harbouring the bacillus for many years in his gall-bladder or elsewhere, and whose stools and urine may be infectious for an indefinite period.

The incubation period is very variable, ranging from one to three weeks, while the onset of the disease itself is usually insidious. The patient complains of feeling out of sorts and of headache, soon followed by the signs of chill, due to the rising temperature, and associated with sleeplessness, occasionally severe head symptoms, and much digestive disturbance.

Attacks vary much in intensity, but during the first three weeks so-called mild cases may suddenly develop more severe symptoms. Convalescence is slow and protracted, as in severe cases emaciation and debility are marked. The chief complications during the acute stage of the illness are perforation of an ulcer through the bowel, demanding immediate surgical interference, and intestinal bleeding resulting from hæmorrhage from an ulcer. During convalescence relapses are frequent, brought on by indiscretions of diet, chill, and undue exposure, or some unknown cause. The most common *sequelæ* arising from the disease are thrombosis of a vein, usually in the thigh; bronchitis; one-sided parotitis; outbreaks of boils and superficial abscesses; and more occasionally heart weakness and disease of bone.

In its early stages enteric fever is difficult to diagnose, and confusion may arise between it and lobar- and broncho-pneumonia, influenza, diarrhœa associated with septic infection, typhus fever, appendicitis, or septicæmia.

In treatment, good nursing is of first importance. The patient must have suitable nourishment and stimulation, and requires to have the greatest care, whatever special form of treatment is being carried out, while constant watch must be kept for the appearance of any complication. Great differences in the treatment are observed in different countries and by different schools of medicine.

Enteri'tis (Gr. *enteron*, intestine) is inflammation of the intestines. It varies from a mild intestinal catarrh, causing slight symptoms, and yielding to treatment in a few days, to cases of severe vomiting and diarrhœa with extreme prostration. These severe forms are most frequently seen in infants and young children during the summer months, and frequently prove fatal. Removal of the cause of irritation and complete rest to the intestines are to be aimed at, as far as possible, in the treatment of the condition.

Enteromorpha, a genus of Green Algæ, similar to *Ulva*, but with a tubular thallus. *E. intestinalis* is common in fresh and brackish waters.

Entertainments Tax, first imposed by the Finance (New Duties) Act, 1916, is an *ad valorem* duty on payments for admission of persons as spectators or members of an audience to any entertainment. Entertainment is defined as including any exhibition, performance, amusement, game, or sport to which persons are admitted for payment. The tax is collected by means of stamped tickets of admission, or (in respect of places of regular entertainment, and in other cases on special cause shown) on the basis of returns furnished to the Board of Customs and Excise by arrangement previously made with the Board. Admission by complimentary ticket is not taxable if no indirect payment is a condition of such admission.

Exemption from the tax may be claimed in respect of any entertainment (1) where the gross receipts are entirely devoted to philanthropic or charitable purposes; or (2) where the purpose is the amusement of children, and the charge for admission does not exceed one penny per head; or (3) which is provided by or on behalf of a school or other educational institution for the furtherance of an object connected therewith, and at which the performers are children under sixteen years of age who have been or are in attendance thereat; or (4) which is wholly educational, or, being partly educational and partly scientific, is conducted by an association not established or carried on for profit, or, having for its aim the revival of national pastimes, is provided by such an association founded for that purpose.

Repayment of the tax may be claimed when the net proceeds of an entertainment are devoted to philanthropic or charitable purposes, and the total expenses met from the receipts do not exceed one-fifth of the receipts.

When admission to an entertainment is dependent upon payment of a contribution or subscription to a club, society, or association, tax is payable

thereon, and where such payment carries with it the right of admission, the tax is due whether the right is exercised or not. If, however, the payment confers the right to other privileges besides admission to an entertainment, e.g. to the use of library, reading-room, &c., only such proportion thereof as the Board determines to represent the right of admission is taxable.

The amount yielded by the tax for the fiscal year 1916-7 was over £3,000,000, for 1917-8 nearly £5,000,000, while for 1919-20 it was approximately £10,485,000.

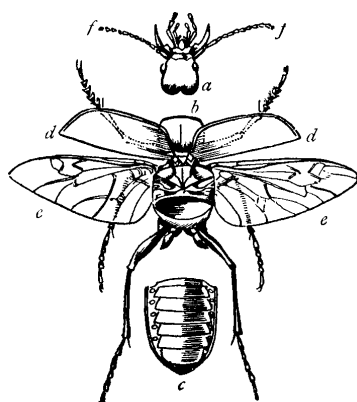
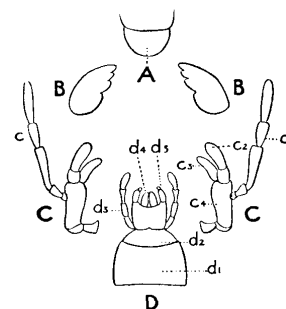


Diagram showing the Parts of Insects

a, Head. *b*, Thorax. *c*, Abdomen. *dd*, Front wings. *ee*, Hind wings. *ff*, Antennæ.

Entomol'ogy, the branch of zoology which treats of insects, the name being from Gr. *entōma*, animals 'cut in', the transverse division or segmentation of the body being their most conspicuous feature. The true insects are those animals of the phylum Arthropoda distinguished from the other classes of the phylum by the fact that the three divisions of the body—the head, thorax, and

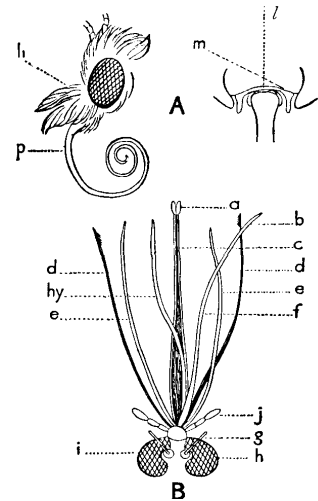
abdomen—are always distinct from one another. There are never more than three pairs of legs in the perfect insect, and these are all borne upon the thorax. Each leg consists of from six to nine joints. The first of these is called the 'coxa', and is succeeded by a short joint called the 'trochanter'. This is followed by a joint, often of large size, called the 'femur', succeeded by the 'tibia', and this has articulated to it the 'tarsus', which may be composed of from one to five joints. Normally two pairs of wings are present, but one or other, or both, may be wanting. The wings are expansions of the sides of the second and third sections of the thorax, and are strengthened by narrow thickenings called 'nervures'. In the beetles the anterior pair of wings becomes hardened so as to form protective cases for the posterior membranous wings, and are called in this condition 'elytra' or 'wing-cases'. The fore-wings are similarly transformed in the Orthoptera, while in many of the Hemiptera they are horny except at the



Biting Mouth Parts of an Insect

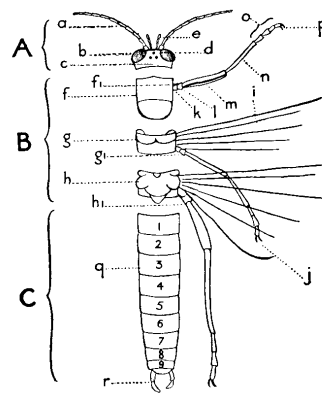
A, Upper lip. *B*, Mandibles. *C*, Maxillæ: *c*₁, palp; *c*₂, galea; *c*₃, lacinia; *c*₄, stipes. *D*, Lower lip: *d*₁, submentum; *d*₂, mentum; *d*₃, labial palp; *d*₄, glossa; *d*₅, paraglossa.

tip. Respiration is effected by means of air-tubes or tracheæ, which open on the surface of the body by lateral apertures called 'stigmata' or 'spiracles', and ramify through every part of the body. The head is composed of several segments amalgamated together, and carries a pair of feelers or 'antennæ', a pair of eyes, usually compound (and often simple eyes in addition), and the appendages of the mouth. These last include an upper lip (labrum), and three pairs of jaws (mandibles, first maxillæ, second maxillæ), the third pair being more or less fused into a lower lip (labium). The thorax is composed of three segments, also amalgamated but generally pretty easily recognized. The abdominal segments are usually more or less freely movable upon one another, and never carry locomotive limbs; but the extremity is frequently furnished with appendages connected with generation, which in some cases serve as offensive and defensive weapons (stings). The organs of the mouth take collectively two typical forms, the masticatory and the suctorial, the former exemplified by the beetles, the latter by the butterflies, in which the mouth is purely for suction. The alimentary canal consists of the œsophagus or gullet, a crop, a gizzard, a stomach, and an intestine, terminating in a cloaca. There is no regular system of blood-vessels; the most important organ of the circulation is a contractile vessel situated dorsally and called the 'dorsal vessel'. The nervous system consists of a pair of cerebral ganglia (brain) in the head, these being the thickened upper part of a nerve-ring which encircles the gullet and passes below into a double ventral nerve-cord dilated into ganglia at intervals. The sexes are in different individuals, and most insects are oviparous. Reproduction is generally sexual, but non-sexual reproduction also occurs. (See *Parthenogenesis*.) Generally the young are very different from the full-grown insect, and pass through a 'metamorphosis' before attaining the mature stage. When this metamorphosis is complete, it exhibits three stages—that of the larva, caterpillar, or grub, that of the pupa or chrysalis, and that of the imago or perfect winged insect. Insects have been divided into three sections—Ametaböla, Hemimetaböla, and Holometaböla, according as they undergo no metamorphosis, an incomplete one, or a complete one. The young of the Ametaböla differ from the adult only in size. They are all destitute of wings;



A, Sucking mouth of a Butterfly: *p*, proboscis; *l*, labium; *l*₁, labial palps; *m*, mandibles. B, Piercing mouth of a Mosquito: *a*, labial palps; *b*, labium epipharynx; *c*, labium; *d* and *e*, maxillæ; *f*, labrum; *g*, antennæ; *h* and *i*, ocelli; *hy*, hypopharynx; *j*, labial palp.

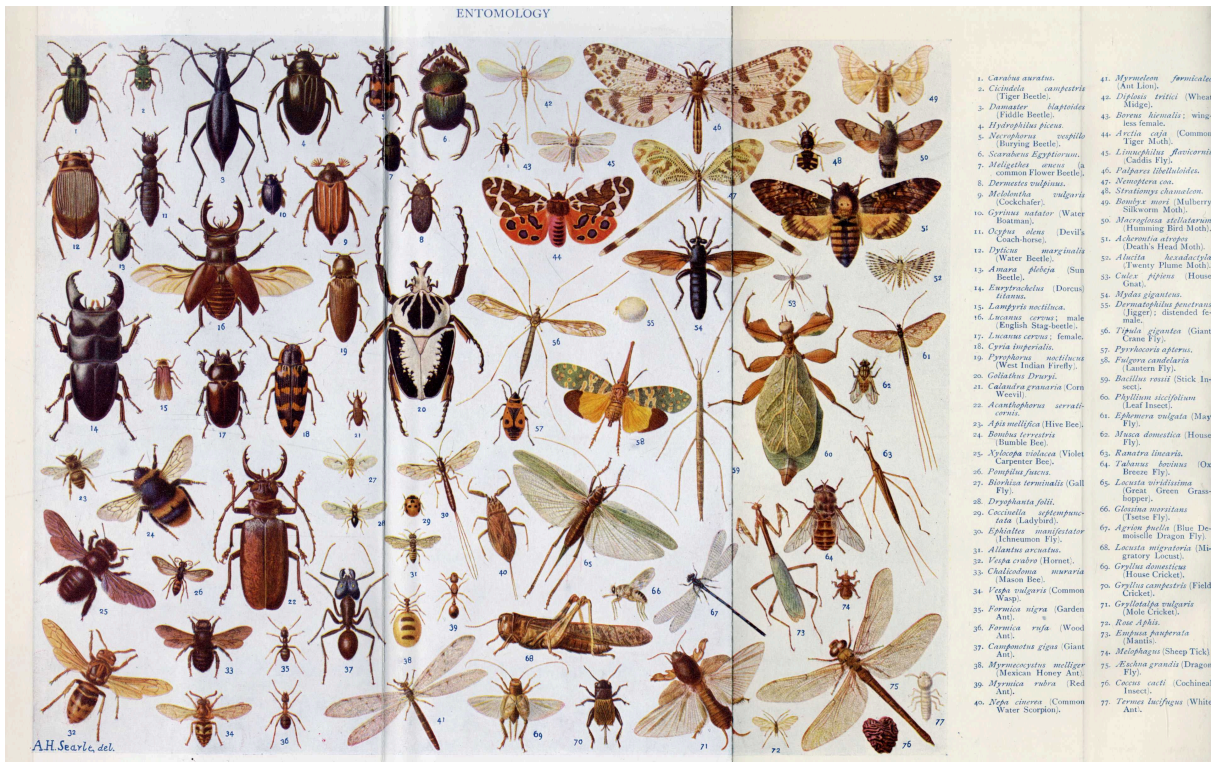
the eyes are simple and sometimes wanting. The Hemimetaböla undergo an incomplete metamorphosis, the larva differing from the imago chiefly in the absence of wings and in size. The pupa, here termed a nymph, is usually active, or, if quiescent, capable of movement. In the Holometaböla the metamorphosis is complete, the larva, pupa, and imago differing greatly from one another in external appearance and habits. The larva is worm-like and the pupa quiescent. The section Ametaböla includes the order Aptëra (tassel-tails and spring-tails). The section Hemimetaböla comprises the orders Hemiptëra (cicadas, bugs, plant-lice, &c.), Orthoptëra (cockroaches, crickets, grasshoppers, locusts, earwigs, &c.), and Neuroptëra (dragon-flies, may-flies, white-ants, &c.). The Holometaböla comprises the orders Diptëra (gnats, bot-flies, gad-flies, mosquitoes, house-flies, fleas, &c.), Lepidoptëra (butterflies and moths), Hymenoptëra (bees, wasps, and ants), and Coleoptëra (lady-birds, glow-worms, cockchafers, weevils, and all of the beetle tribe). A division is sometimes made into Mandibulate and Haustellate groups, the oral apparatus of the former being adapted for mastication, the latter for imbibition of liquid food. Both types are, however, sometimes modified, and occasionally combined.



Structure of a Hexapod

A, Head: *a*, antennæ; *b*, compound eyes; *c*, occiput; *d*, ocelli; *e*, palpi. B, Thorax: *f*, pronotum; *f*₁, prothoracic legs; *g*, mesonotum; *g*₁, mesonotal leg; *h*, metathorax; *h*₁, metathoracic leg; *i*, mesothoracic, and *j*, metathoracic, wings; *k*, coxa of leg; *l*, trochanter; *m*, femur; *n*, tibia; *o*, tarsus;

p, ungues. *C*, Abdomen: *q*, body segments; *r*, genitalia.

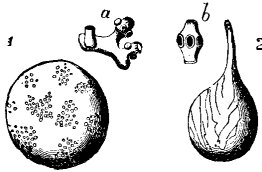


Entomoph'aga ('insect eaters'), a term applied to (1) a group of hymenopterous insects whose larvæ feed upon living insects; (2) a tribe of marsupials, as the opossums, bandicoots, &c., which are insectivorous, though not exclusively so; (3) a section of the edentates, as the ant-eater and pangolin.

Entomophthorineæ, a curious family of Fungi, group Zygomycetes, all parasites on insects. The best known is *Empusa Muscæ*, which attacks the common house-fly. After thoroughly permeating and finally killing the infected fly, the fungus sends numerous hyphæ to the surface, from the ends of which conidia are shot forth by an 'explosive' process, to spread the infection if they alight on living flies. In autumn, flies killed by this parasite may often be found adhering to window-panes, surrounded by a halo of ejected conidia. It has been proposed to utilize this fungus in combating the fly nuisance.

Entomos'traca, a sub-class of crustacea, including forms which are mostly small, and comprising four orders: (1) Branchiopoda, brine-shrimps and water-fleas; (2) Copepoda, including the freshwater Cyclops, and numerous marine species contributing to the floating surface population (plankton); (3)

Cirripedia, barnacles; (4) Ostracoda, types such as Cypris enclosed in a bivalve shell.

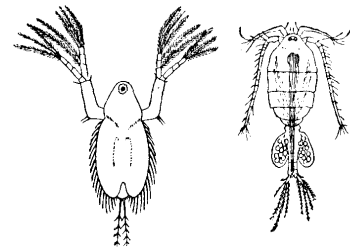


Entozoa magnified
1, *Cænurus cerebrālis*
(producing the staggers
in sheep). *a*, Heads
(shown on the surface)
separately.
2, *Cysticercus*
cellulosæ (causing the
measles in pigs). *b*,
Head.

Entozo'a, a general name for the various parasitic worms that infest the bodies of other animals. Some are found in the intestines, others in the liver, brain, muscles, and other tissues.

They pass through different stages in their development, and at each stage may occupy a different organ (or tissue), and usually a different animal. Thus the cystic or bladder-worm, whose presence in the brain of sheep causes staggers, is the immature form of a tapeworm of the dog, &c. The

number of species is being reduced as the relations of the different forms are studied. They belong to the two phyla Platyhelminthes (flat-worms) and Nematelminthes (thread-worms, &c.). The former embraces flukes (Trematoda) and tapeworms (Cestoda); while the latter includes thread-worms and round-worms (Nematoda), and spiny-headed worms (Acanthocephala).



Entomostraca
Spiny-tailed water-flea
(*Daphnia*) on left; *Cyclops* on
right. Both enlarged.

Entrenchments. The employment of entrenchments, or earthworks, in connection with military operations dates from the earliest times. Entrenched camps, made by the Romans, are still to be seen in many parts of the country. The primary object, in early designs, was to offer a material obstacle to the assaulting enemy; the defenders manned a high parapet overlooking a formidable ditch, and a hand-to-hand conflict decided the issue. The development of fire-arms, and especially of artillery, depreciated the value of entrenchments as affording material obstacles, but gave them a gradually increasing value as a means of protecting the defenders from missiles. The provision of cover, that is to say, concealment from view or protection from fire, ultimately became the dominant factor in the design of earthworks. Obstacles were still necessary, but they had to be provided by other means. Successive improvements in firearms altered the nature of the cover which it was necessary and practicable to provide. A bullet-proof parapet has always been an essential feature, but whereas a few inches of earth sufficed to stop a musket-ball, the modern rifle-bullet will penetrate a thickness of nearly four feet. The introduction, during last century, of shrapnel shell, the bullets from

which descend at a steep angle, was followed by the adoption of overhead cover as a standard feature in trench design. This persisted for several years, until the great increase in the power of high-explosive shell made it impossible to construct any form of roof which would withstand bombardment, even by the lighter artillery accompanying an army in the field, and still permit of the defenders using their rifles from below it. Modern fire-positions are made open, i.e. without overhead cover.

All past wars have proved that victory can only be won as the result of offensive action. Nevertheless, in any campaign it will not be possible to attack at all times and in all places. The provision of the strongest possible force at the vital point necessitates a defensive attitude on other parts of the front. Although entrenchments presuppose a defensive attitude locally, they play an important part in offensive operations. The ultimate aim is that, by a skilful use of entrenchments, a commander may be able to reduce to a minimum the strength of his force in actual combat with the enemy, and thus to retain at his disposal a reserve of troops for offensive action.

Entrenchments may be either hasty or deliberate. Hasty entrenchments are those made on the actual field of battle: by the attackers, to secure the ground won prior to another bound forward; by the defenders, to hold up the attack pending fresh dispositions of troops in rear. The amount of digging that can be done is necessarily small; existing cover must be utilized to the utmost. This may consist of ditches, hedges, sunken roads, railway embankments and cuttings, buildings, woods, shell-holes, &c. All of these are readily convertible into strong defences. The test of battle has proved, over and over again, that troops well trained in adapting natural cover to defence are very difficult to dislodge, once they have dug themselves in. Deliberate entrenchments are employed in the gradual building up of a trench system when once the opportunity of manœuvre has ceased to exist; or in the preparation of a defensive position somewhat remote from the scene of active operations.

The following are the salient features in the design of modern entrenchments: (1) A parapet 18 inches high, and upwards of 5 feet thick, in front of every fire-trench. (2) Longitudinal division of every trench, either by projecting buttresses of earth or by bends, so that no straight portion exceeds 10 yards in length. The effect of this is to give protection against flanking or enfilade rifle-fire, and to localize the burst of shell. (3) A parapet on the rear side (parados), to shield the defenders from the back-blast of shell which burst beyond the trench. (4) Wide trenches (6 feet at the top), to minimize the risk of men

getting buried during bombardment. (5) Accommodation, in dug-outs and other refuges, for a proportion of the troops.

Arms of precision have, during the past twenty years, compelled careful attention to the concealment of entrenchments. Although systems of trenches cannot now be hidden from the eye of the aeroplane-camera, yet the enemy can be kept in doubt, by correct design and careful siting of trenches, as to the strength in which the various portions of a position are held. It is for this reason that the deep fire-trench, with a low parapet in front, has been universally adopted, despite the obvious objection that minor undulations restrict the field of fire because the rifle is brought nearer to the ground. Earthworks on a sky-line, or those seen by the enemy against a distant background, violate the first principles of siting.

Modern entrenchments are arranged in depth. The 'lines' of Wellington's time have given place to a broad belt of mutually supporting defences, organized in three zones. These merge imperceptibly into one another, and each zone extends upwards of a mile from front to rear. The foremost fringe of the outpost zone is in contact with the enemy; it is the high-water mark on which the troops advancing during the last action have come to a standstill and dug themselves in. Very lightly manned, as befits an area where heavy shelling is rife, this zone, nevertheless, plays an important rôle. It harbours the forward artillery observation posts, which control and direct the fire of the guns in rear. It furnishes a 'jumping-off' place for attacks. It takes the first shock of a hostile attack, and, although not strong enough to repulse a serious offensive, contributes to the enemy's ultimate defeat by depriving his onslaught of momentum. The battle zone is more elaborately organized, and capable of being very heavily manned. Within this area the defence intend to bring to a standstill the most determined offensive. It lies sufficiently far back from the fringe of the outpost zone to be reasonably immune from destructive bombardment. Lying still farther back is the third zone, which serves for the accommodation of reserves of troops, and is also prepared for defence, as a last resort, in case the enemy should penetrate the battle zone.

Entrepôt (a' n' -tr-pō; Fr.), a port where foreign merchandise which cannot enter the interior of a country is deposited in magazines under the surveillance of the custom-house officers till it is re-exported; also, any place where goods are sent to be distributed wherever customers are found.

Entre Rios (en'tre rē'os; 'between rivers'), a province of the Argentine Republic, lying between the Uruguay and the Paraná; area estimated at 29,240 sq. miles; pop. 425,370. The province is largely pastoral. Capital, Paraná, with a pop. of 25,000

Entropion is the inversion or turning in of the eyelid. It may be congenital, or arise as the result of some inflammatory process or burn of the conjunctiva. Entropion affecting the lower lid appears also as the result of extreme photophobia (intolerance to light).

Entropy, a term introduced into physics by Clausius as the name of one of the two important thermodynamical properties of a substance which depend on its 'state'. Suppose we have 1 lb. of water at atmospheric pressure and 212° F., say, and suppose we apply heat to the water and change it into 1 lb. of steam at 212° F. The temperature does not change during this process, while the heat which must be added is the latent heat of the steam, namely, about 960 British Thermal Units. The increase of entropy from the first state to the second state is got by dividing the heat given to the substance, namely, 960 B.Th.U., by the absolute temperature at which that heat was given to the substance, namely, 461 + 212 = 673 degrees absolute, i.e. the increase of entropy is $960/673 = 1.43$ units. If the temperature changes with the addition of heat, as it would usually do, we have to imagine the heat to be supplied in small quantities, and to take the average temperature of the body at which these tiny quantities of heat are supplied. The quotient heat ÷ temperature is taken for each small quantity of heat, and the results are added together. The summation is defined as the increase in entropy between the initial and the final states.

In mathematical language the increase in entropy between state A and state B is given by $(\varphi_B - \varphi_A) = \int_A^B \frac{dQ}{T}$, where φ stands for the entropy, Q for the heat received by the body, and T for the absolute temperature at which the heat is received. The importance of the entropy function, namely, the integral $\int \frac{dQ}{T}$, in thermodynamics is due to the fact that it is, like the internal energy of the substance, a function of the state of the substance only, and consequently in any temperature cyclic change in which the final state of the substance is the same as its initial state A, the total change, either of its internal energy or of its entropy, is zero. The fact that the total change in the internal energy of the

substance is zero is practically equivalent to the *First Law of Thermodynamics*, while the fact that the total change of the entropy of the substance is zero is equivalent to the *Second Law of Thermodynamics*.—BIBLIOGRAPHY: J. H. Poynting and J. J. Thomson, *Textbook of Physics* (vol. 3): *Heat*.

Envelopes, the paper covers that enclose letters or notes. They became common shortly after the introduction of the penny postage system; were at first made chiefly by hand, but are now not only shaped, but folded and gummed, by machinery.

Enver Pasha, Turkish soldier and politician, born at Constantinople in 1879. He entered the Turkish army in 1896, and in 1905 took part in the Young Turk movement at Salonica. He joined the revolutionaries in 1908, was for a short time military attaché in Berlin, but in 1909 returned to Salonica, and assisted in the deposition of Sultan Abdul Hamid. He then took part in the Tripoli War and the second Balkan War, and recaptured Adrianople from the Bulgarians in July, 1913. After being Minister of War, Enver subsequently became one of the leaders of the Committee of Union and Progress. A staunch pro-German, he was to a great extent responsible for Turkey's entry into the European War as an ally of Germany. After the armistice of 1918, Enver Pasha fled to the Caucasus, and was active in inciting his countrymen to resist the terms of the Peace Treaty of 1920.

Environment, in biology, the surroundings of an organism, including non-living factors, such as climate and weather; and also other organisms. Plants and animals are more or less adapted to their surroundings, a good example being the mutual adaptations of flowers and insects, but there has been much controversy as to the way in which such adaptations have come about. Among all but unicellular organisms any individual consists of (1) a general body (*soma*), by which the life of the individual is maintained, and (2) germ cells, capable of becoming fresh individuals, and thus providing for the continuance of the species. According to a school of thought founded by some of the pre-Darwinian evolutionists, notably Buffon, Lamarck, and Treviranus, modifications of the soma (acquired characters) of an individual, brought about by the action of the environment (e.g. thickening of parts of the skin as the result of constant pressure), or by use and disuse (e.g. increased size of muscles; diminished wings of poultry), can be inherited, leading to increasing alteration capable of ending in the production of new species. Most living biologists, however, hold with Weismann that only *germinal variations*, i.e. variations in the substances of the germ-cells, are heritable. Much further

research is necessary before it is possible to pronounce with certainty on many of the complex details involved in these theories. As to the part played by the environment, cases are known where this acts directly on the germ-cells, so as to influence their variation. But these are among some of the lower animals, in which the eggs develop outside the body of the parent, and we know hardly anything about the action of the environment on germs that develop internally. It has been suggested that modifications of the soma undoubtedly brought about by the influence of the surroundings may react upon the germ-cells and cause these to vary, but of this no proof has so far been forthcoming. Even if we admit that modifications of the soma are not inherited, they may nevertheless play a part in evolution by aiding the development of germinal variations that take the same direction. The whole subject is one of more than academic interest, especially in regard to the further evolution of human beings. Comparatively rapid advance, either in desirable or undesirable directions, would be possible if modifications acquired by the soma of an individual were capable of being inherited. So far as we know at present, acquired improvements in physique and mentality of individuals are not inherited by their offspring, which seems rather disappointing, but, on the other hand, undesirable modifications, including those due to disease, appear to be in the same case, and there is little reason to think that the children of parents possessing undesirable acquired characters are unduly handicapped from the very start. We must, of course, exclude cases of antenatal infection by the microbes of certain infectious or contagious diseases to which one or both parents have fallen victims, and also those of direct poisoning of germ-cells as the result of alcoholism.

En'voy, a person deputed by a Government to negotiate a treaty, or transact other business, with a foreign Government. We usually apply the word to a public minister sent for one particular purpose; hence an *envoy* is distinguished from an *ambassador*, and is of inferior rank.

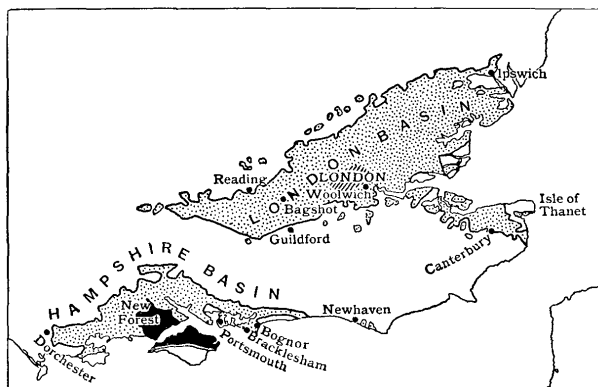
Enzymes. See *Fermentation, Physiological Chemistry*.

E'ocene, in geology, a term applied to the lower division of the Tertiary strata, from Gr. *ēōs*, dawn, and *kainos*, recent, because remains of existing organic species first occur here. The Eocene beds are arranged in two groups, termed the Lower and Upper Eocene; the strata formerly called Upper Eocene being now known as Oligocene. They consist of marls, limestones, clays, and sandstones, and are found in the Isle of Wight and in the south-east of England

and north-west of France, in Central Europe, Western Asia, Northern Africa, and the Atlantic coast of North America.

Éon de Beaumont. See *D'Éon de Beaumont*.

E'os, among the ancient Greeks the goddess of the dawn. See *Aurora*.



Map of Eocene System in England

Eötvös (eut'veush), Baron Joseph, a Hungarian statesman and author, born 1813, died 1871. He completed his studies at the University of Pesth in 1831. He had already, before leaving the university, produced three dramas—*The Critics*, *The Wedding*, and *Revenge*—the last a tragedy, all of which were well received. He became a friend of Kossuth, and distinguished himself as a journalist and orator of the popular party. In 1848, after the revolution of 15th March, he was appointed Minister of Public Instruction, resigned the same year, but was again appointed Minister of Public Instruction in 1867, and filled this office until his death. Among his works are the novels: *The Carthusian*, *The Village Notary* (translated into English), and *Hungary in 1514*—giving vivid pictures of Hungarian life in modern and more remote epochs.

Eozo'ic Rocks, the name given to the pre-Cambrian rocks, from their containing the first or earliest traces of life in the stratified systems.

Eozo'on, a supposed gigantic fossil foraminifer found in the limestone of the pre-Cambrian rocks of Canada, whence the name *Eozoön canadense*. The structure, however, which is recognized also in Bavaria and in County Galway, has proved to be due to a zonal development of serpentine during metamorphism of the ancient limestones concerned. A similar structure occurs in limestone associated with the volcanic focus of Vesuvius.

Ep'acris, a genus of gamopetalous Dicotyledons, the typical genus of the nat. ord. Epacridaceæ, distinguished by having a coloured calyx with many bracts, a tubular corolla with smooth limb, stamens affixed to the corolla, and a five-valved many-seeded capsule. The species are shrubby plants, with axillary, white, red, or purple flowers, generally in leafy spikes. Among those cultivated in Britain we may mention *E. grandiflōra*, which has flowers nearly an inch in length, of a brilliant reddish purple at the base and pure white at the apex. The

order Epacridaceæ consists of plants allied to the heaths, chiefly natives of Australia. The fruit of some species is eaten under the name of Australian cranberry, and they are cultivated in greenhouses for their flowers.

Ep'act (Gr. *epaktos*, added), in chronology, the excess of the solar month above the lunar synodical month, and of the solar year above the lunar year of twelve synodical months. The epacts then are *annual* and *menstrual* or *monthly*. Suppose the new moon to be on the 1st of January: the month of January containing 31 days, and the lunar month only 29 days, 12 hours, 44 minutes, 3 seconds; the difference, 1 day, 11 hours, 15 minutes, 57 seconds, is the *menstrual epact*. The *annual epact* is nearly 11 days; the solar year being 365 days, and the lunar year 354. The epacts were once of some importance in ecclesiastical chronology, being used for finding when Easter would fall.

Epaminon'das, an ancient Greek statesman and general, who, for a short time, raised his country, Thebes, to the summit of power and prosperity. He was born about 418 B.C., and killed at the battle of Mantinea, 362 B.C. He took the leading part in the struggle during which Spartan supremacy in Greece was destroyed, and the supremacy of Thebes temporarily secured. Four times he successfully invaded the Peloponnesus at the head of the Thebans, but after his death Thebes soon sank to her former secondary condition. Throughout life Epaminondas was distinguished for the friendship subsisting between him and Pelopidas, with whom he served in the Spartan campaign, 385 B.C. His character is one of the finest recorded in Greek history. and his virtues have been praised by both Xenophon and Plutarch.

Eparch (ep'ärk), in Greece, the governor or prefect of a provincial division called an *eparchy*, a subdivision of a nomarchy or province of the kingdom. In Russia, an eparchy is the diocese or arch-diocese of a bishop or archbishop of the Greek Church.

Epaulement (e-pa'l'ment: Fr. *épaule*, shoulder), in fortification, a term for the mass of earth or other material which protects the guns in a battery in front and on either flank.

Ep'aulet, or Ep'aulette (Fr. *épaulette*, dim. of *épaule*, the shoulder), an ornamental shoulder-piece belonging to a military or other dress. Epaulettes were worn in the British army till 1855, and in the United States as late as 1872, and are still worn in the navy by all officers of and above the rank of lieutenant, and by some civil officers.

Épée (è-pā), Charles Michel, Abbé de l', French philanthropist, born in 1712, died 1789. He had chosen the clerical profession, but had to leave the Church on account of Jansenist opinions. The great object of his life was the instruction of the deaf and dumb, upon whom he spent his whole income, besides what was contributed by benevolent patrons. In 1770 he founded at his own expense an institution for the deaf and dumb. He left several works on his method of instruction, one of these being *Institution des sourds et muets* (1774).

Épéhy, a town of France, department of Somme, about 13 miles S.E. of Cambrai. It was the scene of fierce fighting during the European War, and was captured by the British in Sept., 1918.

Epeira (e-pī'ra), a genus of spiders, comprising the largest and best-known British species. *E. diadēma*, the common garden spider, is a handsomely marked species, which constructs a beautifully symmetrical wheel-shaped web.

Eperies (ep'er-yāsh), a town of Czecho-Slovakia, formerly in Hungary, on the Tarcza, the seat of a Greek Catholic bishop. Pop. 16,323.

Épernay (ep-er-nā; ancient **Sparnacum**, and the Roman **Aquæ Perennes**), a town of North-Eastern France, department of Marne, on the Marne, the central depot of the wine trade of Champagne. The vast wine-cellars of the town form a labyrinth of galleries cut in the tufa or calcareous soil of the district. Épernay was occupied for a short time by the Germans at the beginning of the European War, and was one of the enemy's objectives in the second battle of the Marne (July, 1918). Pop. 21,811.

E'phah, or **Bath**, a Hebrew measure of capacity, containing, according to one estimate or calculation, 8.6696 gallons; according to another, only 4.4286 gallons.

Ephedra, the principal genus of the Gnetales family of Gymnosperms. The species are shrubby switch-plants, natives of the warm temperate zone, found especially on sandy soil. The ripe seeding cones have fleshy scales, and those of *E. distachya* are eaten in South Russia.

Ephem'era, the typical genus of the neuropterous insects constituting the family Ephemeridæ, so named from the extreme shortness of their lives in the perfect state. They are known as *may-flies* or *day-flies*, and are characterized

by the slenderness of their bodies; the delicacy of their wings, which are erect and unequal, the anterior being much the larger; the rudimentary condition of the mouth; and the termination of the abdomen in three filiform appendages. In the state of larvæ and pupæ they are aquatic and exist for years. When ready for their final change, they creep out of the water, generally towards sunset of a fine summer evening, beginning to be seen generally in May. They shed their whole skin shortly after leaving the water, propagate their species, and die, taking no food in the perfect state. The may-fly is well known to anglers, who imitate it for bait.

Eph'e'sians, The Epistle to the, a canonical epistle addressed by the Apostle Paul to the Church which he had founded at Ephesus. It was written during his first captivity at Rome, immediately after he had written the *Epistle to the Colossians* (A.D. 62); and was sent by the hands of Tychicus, who also bore the message to the Church at Colossæ.

Eph'esus, an ancient Greek city of Lydia, in Asia Minor, one of the twelve Ionian cities, on the south side of the Caystrus, near its mouth. It was at one time the grand emporium of Western Asia, having a convenient and spacious harbour. The Apostle Paul visited Ephesus and established a Christian Church there, to which he dedicated one of his Epistles. It was famous for its temple of Artemis (Diana), called *Artemision*, the largest and most perfect model of Ionic architecture, and reckoned one of the seven wonders of the world. The first great temple, begun about 650 B.C. and finished after 120 years, was burnt by the notorious Herostratus in order to perpetuate his name, 356 B.C. (the night of Alexander the Great's birth). A second and more magnificent was then erected, which was burned by the Goths in A.D. 262. Some interesting remains have been discovered by excavation since 1896. Several Church councils were held here, especially the Third Ecumenical Council of 431, at which Nestorius was condemned. The site of the city is now desolate; near it is a poor village, Aiasoluk.

Eph'od, a species of vestment worn by the Jewish high-priest over the second tunic. It consisted of two main pieces, one covering the back, the other the breast and upper part of the body, fastened together on the shoulders by two onyx stones set in gold, on each of which were engraved the names of six tribes according to their order. A girdle or band, of one piece with the ephod, fastened it to the body. Just above the girdle, in the middle of the ephod, and joined to it by little gold chains, rested the square breastplate with the Urim and Thummim. The ephod was originally intended to be worn by the high-

priest exclusively, but a similar vestment of an inferior material seems to have been in common use in later times among the ordinary priests.

Eph'ors, or **Eph'ori** (Gr. *ephoroi*, overseers), magistrates common to many Dorian communities of ancient Greece, of whom the most celebrated were the Ephori of Sparta. They were five in number, were elected annually, and both the judicial authority and the executive power were almost entirely in their hands. Their power became an intolerable burden, especially to the kings, and in 225 B.C. Cleomenes III murdered the whole college and abolished the office.

E'phraem Syrus, that is, 'Ephraim the Syrian', writer of the Syrian Church, born at Nisibis, in Mesopotamia, about A.D. 306, died at Edessa in 373 or 378. He wrote several commentaries on Scripture, numerous homilies, and other works (as well as hymns), which have come down to us partly in Syriac, partly in Greek, Latin, and Armenian translations. They were edited by Assemani at Rome between 1732 and 1746, and by Overbeck at Oxford in 1865.

E'phraim, the younger son of Joseph, and the founder of one of the twelve tribes of Israel. When the Israelites left Egypt, the Ephraimites numbered 40,500, and their possessions in the very centre of Palestine included most of what was afterwards called Samaria. Ephraim is also a town mentioned in *John*, xi, 54, and to which Jesus retired after His raising of Lazarus, when the Jewish authorities manifested their hostility against Him.

Ep'ic, a poem of the narrative kind, dealing with a series of events or actions of permanent interest. Some authorities restrict the term to narrative poems written in a lofty style and describing the exploits of heroes. Others widen the definition so as to include not only long narrative poems of romantic or supernatural adventure, but also those of an historical, legendary, mock-heroic, or humorous character. Epic poetry is distinguished from drama in so far as the author frequently speaks in his own person as narrator; and from lyrical poetry by making the predominant feature the narration of action rather than the expression of emotion. Among the more famous epics of the world's literature may be noted: Homer's *Iliad* and *Odyssey*, Virgil's *Aeneid*, the German *Nibelungenlied*, the Anglo-Saxon poem of *Beowulf*, the French *Song of Roland*, Dante's *Divina Commedia*, Tasso's *Gerusalemme Liberata*, Ariosto's *Orlando Furioso*, Milton's *Paradise Lost*, Spenser's *Faerie Queene*, Camoens' *Lusiads* (Portuguese), and Firdusi's *Shah Namah* (Persian). Hesiod's *Theogony*, the *Elder Edda*, the Finnish *Kalevala*, and the Indian *Mahâbhârata* may be described as collections of epic legends. The historical epic has an excellent

representative in Barbour's *Bruce*; and specimens of the mock-heroic and humorous epic are found in *The Battle of the Frogs and Mice*, *Reynard the Fox*, Butler's *Hudibras*, and Pope's *Rape of the Lock*.—BIBLIOGRAPHY: Chassang and Marcou, *Les Chefs-d'œuvre épiques de tous les peuples*; W. M. Dixon, *English Epic and Heroic Poetry*; A. Lang, *Homer and the Epic*.

Epicharmus (ep-i-kär'mus), a Sicilian comic poet and philosopher of the Pythagorean school, born in the Island of Cos about 540 B.C., died 450 B.C. He removed to Syracuse, where at the court of Hieron he spent the remainder of his life. He is credited with the invention of written comedy, and Plato called him "a master of the comic type".

Epictet'us, a Greek Stoic philosopher, born at Hierapolis, in Phrygia, about A.D. 60. He lived long at Rome, where, in his youth, he was a slave. Though nominally a Stoic, he was not interested in Stoicism as an intellectual system; he adopted its terminology and its moral doctrines, but in his discourses he appeared rather as a moral and religious teacher than as a philosopher. His doctrines approach more nearly to Christianity than those of any of the earlier Stoics, and although there is no trace in what is recorded of them of his having been directly acquainted with Christianity, it is at least probable that the ideas diffused by Christian teachers may have indirectly influenced them. The excellence of his system was universally acknowledged. When Domitian banished the philosophers from Rome (A.D. 94), Epictetus retired to Epirus, where he is supposed to have died. His disciple Arrian collected his opinions, which are preserved in two treatises called the *Discourses of Epictetus*, and the *Manual or Enchiridion*.

Epicu'rus, a Greek philosopher, founder of the Epicurean school, was born in the Island of Samos 342 B.C., died at Athens 270 B.C. He settled at Athens 306 B.C., and purchased a garden in a favourable situation, where he established a philosophical school. Here he spent the remainder of his life, living in a simple manner and taking no part in public affairs. His pupils were numerous and enthusiastically devoted to him. His theory of the universe was based on the atomic theory of Democritus. The fundamental principle of his ethical system was that pleasure and pain are the chief good and evil, the attainment of the one and the avoidance of the other of which are to be regarded as the end of philosophy. The term 'Epicurean' has come to signify one who is indulging his sensual appetites without measure, but this is really due to a misapprehension of the meaning of the word pleasure as used by the philosopher. Epicurus himself was not an 'Epicurean' in this sense, for he endeavoured to give a

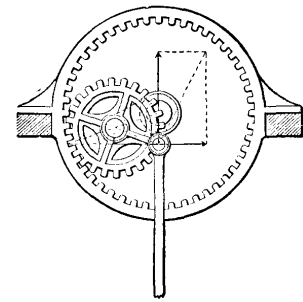
moral tendency to this doctrine. He exalted the pure and noble enjoyments derived from virtue, to which he attributed an imperishable existence, as incalculably superior to the passing pleasures which disturb the peace of mind, the highest good, and are therefore detrimental to happiness. Peace of mind, based on meditation, he considered as the origin of all good. It is, however, easy to see that his use of the word 'pleasure' was calculated to produce the mischievous results with which Epicureanism has been charged. The philosophy of Epicurus has, therefore, been violently opposed and frequently misrepresented; but while it is not open to the charges of gross sensualism which have been brought against it, it cannot be considered as much better than a refinement of sensualism. In ancient times his philosophy appears to have been more popular in Greece than in Rome, although his disciples were numerous in both, and the Latin poem of Lucretius, *De Rerum Natura*, is a poetical exposition of his doctrines. Epicureanism was resuscitated in France by Pierre Gassendi, and its principles have been professed by De la Rochefoucauld, Rousseau, and Voltaire. Epicurus was a very voluminous writer, but few of his writings are extant, what we possess comprising only some fragments of a *Treatise on Nature*, two letters, and detached passages. Lucretius, Cicero, Pliny, and Diogenes Laertius are our chief authorities for his doctrines.—BIBLIOGRAPHY: Lange, *History of Materialism*; W. Wallace, *Epicureanism*; Guyau, *La Morale d'Epicure*; Taylor, *Epicurus*; W. Pater, *Marius the Epicurean*.

Ep'icycle, a conception of the ancient astronomy used to explain the irregular, and at times retrograde, motions of the planets. Corresponding to each planet there was supposed to be a circle called a *deferent*, which had the earth as its centre. Round this circle a point was imagined to revolve with uniform motion. That point formed the centre of a second and smaller circle, called an epicycle, and the actual planet was supposed to revolve with uniform motion round the circumference of the epicycle.

Epicy'cloid, in geometry, a curve generated by a point on the circumference of a circle which rolls on the convex side of another fixed curve. The curve generated by rolling on the concave side is called a 'hypocycloid'. If the point is not on the circumference, the generated curves are called 'trochoids'.

Epicycloi'dal Wheel, a wheel or ring fixed to a framework, toothed on its inner side, and having in gear with it another toothed wheel of half the diameter of the first, fitted so as to revolve about the centre of the latter. It is used for converting circular into alternate motion, or alternate into circular.

While the revolution of the smaller wheel is taking place, any point whatever on its circumference will describe a straight line, or will pass and repass through a diameter of the circle, once during each revolution. In practice, a piston-rod or other reciprocating part may be attached to any point on the circumference of the smaller wheel.



Epicycloidal Wheel

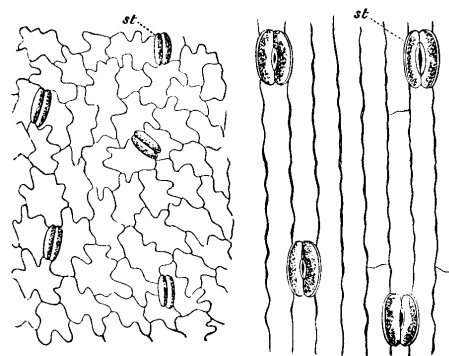
Epidau'rus, a town and seaport of ancient Greece, situated in Argolis, in the Peloponnesus, particularly celebrated for its magnificent temple of Æsculapius, which stood on an eminence not far from the town. It had also temples of Artemis, Dionysus, Aphrodite, and Hera, and a splendid theatre still in fair preservation. The site is now occupied by the village *Epidavro*, where a congress met in 1822 and promulgated the 'Constitution of Epidaurus'.

Epidem'ic, or **Epidemic Disease** (Gr. *epi*, upon, and *dēmos*, people), signifies a disease which attacks a people, suddenly spreading from one to the other in all directions, prevailing a certain time and then dying away. It usually travels from place to place in the direction of the most-frequented lines of communication. The reason is that such diseases are commonly due to some infective material capable of being conveyed from one individual to another, and of being transported from place to place. In Britain smallpox and cholera are occasionally epidemic, whilst scarlet fever, measles, chickenpox, diphtheria, typhoid fever, &c., are almost invariably so. Certain diseases which appear to be more mental than physical sometimes occur so numerously as to assume an epidemic form, such as St. Vitus's dance, convulsionary diseases, or suicidal mania.

Epiden'drum (Gr. *epi*, upon, and *dendron*, a tree), a large genus of tropical American orchids, most of the species of which are epiphytic, growing on trees. The flowers are very handsome, and a large number of the species are in cultivation.

Epider'mis, in anatomy, the cuticle or scarf-skin of the body; a thin membrane covering the true skin of animals, consisting of two layers, an inner or mucous layer, called the *rete mucosum*, composed of active cells containing granules of colouring matter, and an outer or horny layer, consisting of flattened scale-like cells, dry, inactive, and effete, which are constantly being shed in the form of dust. Both layers are destitute of blood-vessels or nerves.

Epidermis, in botany, the superficial layer of cells covering leaves and young stems. Its principal function is to restrict transpiration, for which purpose its outer wall is more or less cutinized, i.e. chemically modified so as to be very impervious to water and gases, especially the outermost part thereof, the so-called *cuticle*. Naturally both cuticle and epidermis as a whole are most strongly developed in drought-adapted plants or xerophytes (q.v.); and conversely the epidermis of submerged plants is not cutinized, nor is the superficial layer of ordinary roots. The epidermis frequently bears hairs of various kinds. Stems which undergo secondary growth in thickness soon cast off their epidermis, its rôle being assumed by cork or bark. The water- and gas-proof covering provided by the epidermis is not continuous, but is interrupted by numerous minute pores or *stomata*, capable of opening and closing, through which accordingly a regulated interchange of gases takes place.



Surface View of Epidermis
st, Stomata.

Ep'idote, a mineral of a green or grey colour, vitreous lustre, and partial transparency, a member of the garnet family. The primary form of the crystals is a right rhomboidal prism. The crystals occur in Norway, Siberia, Tyrol, and the United States.

Epigæa (-jē'a), a genus of Ericaceous shrubs. *E. repens*, the trailing arbutus, is the May-flower of North America.

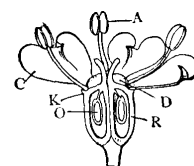
Epiglottis is a cartilaginous plate behind the tongue, which covers the glottis like a lid during the act of swallowing, and thus prevents foreign bodies from entering the larynx. In its ordinary position during respiration it is pointed upwards, but in the act of swallowing it is pressed downwards and backwards by the drawing up of the windpipe beneath the base of the tongue, and thus closes the entrance to the air-passages. See *Larynx*.

Ep'igram (Gr. *epi*, upon, *graphein*, to write), in a restricted sense, a short poem or piece in verse, which has only one subject, and finishes by a witty or ingenious turn of thought; in a general sense, a pointed or witty and antithetical saying. The term was originally given by the Greeks to a poetical inscription placed upon a tomb or public monument, and was afterwards extended to

every little piece of verse expressing with precision a delicate or ingenious thought, as the pieces in the *Greek Anthology*. In Roman classical poetry the term was somewhat indiscriminately used, but the epigrams of Martial contain a great number with the modern epigrammatic character. Epigrams flourished in modern times after the Revival of Learning period, and all the Elizabethan versifiers tried their hand at them. Pope was a great master of the epigram, and the art was practised by Clément Marot, Boileau, Voltaire, Schiller, Goethe, Byron, and Moore, and more recently by Sir William Watson.—Cf. Dodd, *Epigrammatists of Mediæval and Modern Times*.

Epigraphy, a term used both for the study of inscriptions as a whole, and for the science which deals with their classification and decipherment. The attention of the epigraphist is given to inscriptions upon stone, brick, metal, and other comparatively permanent material, as compared with writings upon parchment, papyrus, or paper; but he excludes inscriptions upon coins, which are in the department of the numismatist. The science of epigraphy is of immense importance for a knowledge of the past, the subject including inscriptions so far apart in point of time as Egyptian records of the days of Mena (4700 B.C.), and the Greek hexameters that commemorate the death in Westmorland of a young Syrian soldier in the army of Septimius Severus. Of still more recent date are the Runic inscriptions discovered in Greenland, which seem to place beyond a doubt the fact of Icelandic explorers having reached that country in the eleventh or twelfth century. The most important inscriptions are Egyptian, Cuneiform (Babylonian and Assyrian), Semitic, Greek, Latin, Indian, and Runic. The inscribed writings include epitaphs on the dead, records of important events, dedications of public buildings, with such comparatively private matters as receipts, contracts, and other business transactions. While inscriptions form a valuable source of knowledge, they cannot be accepted as invariably reliable. Reasons might in some cases exist for making a false or misleading record, as in the case of a eulogistic tombstone, while mistakes in spelling and other details may be due to a careless workman. The literature which deals with the science of epigraphy is very large.

Epigynous (e-pij'i-nus) **Flowers**, those in which the gynæcium is *inferior*, i.e. embedded in, and adherent to, the hollowed-out receptacle, so that the other parts of the flower appear to be inserted on the top of the ovary.



Vertical Section

Ep'ilepsy (Gr. *epilēpsia*, literally, a seizure), a nervous disease, the falling-sickness, so called because the patient falls suddenly to the ground. It depends on various causes, often exceedingly complicated and incapable of being removed; hence it is often an incurable periodical disease, appearing in single paroxysms. In its fully developed form, convulsions, attended by complete unconsciousness, are the prominent feature. Among the different causes may be mentioned intense emotional disturbance in early childhood, injury to the brain or its coverings at birth or subsequently, or some irritation within the skull itself, such as tumours, &c., developing later in life. Epileptiform fits due to the last-mentioned cause differ from those of true epilepsy, and are known as *Jacksonian epilepsy* (cf. Sir W. K. Gowers, *The Borderland of Epilepsy*). It is, for the most part, preceded by a tingling sensation, creeping up from the foot or hand to the breast and head, or some other premonitory symptom such as spectral illusions, headache, giddiness, confusion of thought, sense of fear, &c.; but sometimes there are no precursive symptoms. During the paroxysm all that is to be attended to is to prevent the patient from injuring himself; and this is to be accomplished by raising the head gently and loosening all tight parts of the dress. It is advisable to protect the tongue from being bitten by introducing a piece of india-rubber, cork, or soft wood between the teeth.

of an Epigynous
Flower
R,
Receptacle. K,
Calyx. C,
Corolla. A,
Andræcium. D,
Disc. O, Ovule.

Epilo'bium, the willow-herbs, a genus of plants, nat. ord. Onagraceæ. The species are herbs or under-shrubs with pink or purple, rarely yellow, flowers, solitary in the axils of the leaves or in terminal leafy spikes. The seeds are tipped with a pencil of silky hairs, and are contained in a long four-celled capsule. There are more than fifty species scattered over the arctic and temperate regions of the world, ten of them being natives of Britain.

Epimen'ides (-dēz), an ancient Greek philosopher and poet, born in Crete in the seventh century before Christ, he was held for an infallible prophet, and by some is reckoned among the seven wise men, instead of Periander. He is supposed to be the prophet referred to by St. Paul in *Titus*, i, 12: "One of themselves, even a prophet of their own, said, The Cretians are alway liars, evil beasts, slow bellies".

Epimetheus (ep-i-mē'thūs), in Greek mythology, the son of Iapetus, brother of Prometheus, and husband of Pandora. Epimetheus may be translated 'afterthought', as Prometheus 'forethought'.

Épinal, a town of Eastern France, capital of the department of the Vosges, on the Moselle. It is well built and has handsome quays, an ancient Gothic church, a communal college, a public library of 30,000 volumes, a museum, and extensive fortifications. The town was occupied by the Germans in the Franco-Prussian War of 1870, and since that time a modern fortress has been constructed. The manufactures consist of articles in metal, cottons, linens, woollens, earthenware, and leather. The famous paper-mills of Archettes are in the vicinity. Pop. 30,000.

Épinay, Louise Florence Pétronille, Madame d', French authoress, born in 1726, died 1783. She became the wife of M. Delalive d'Épinay, who was collector-general of taxes. In 1748 she became acquainted with Rousseau, and gave him a cottage in which he passed many of his days. She was the author of *Les Conversations d'Émilie*, a companion-volume to Rousseau's *Émile*; *Lettres à mon Fils*; and *Mes Moments heureux*. She left interesting memoirs and correspondence.

Epipha'nius, St., was born in Palestine about 310, died 403. About 367 he was consecrated Bishop of Salamis or Constantia, in Cyprus. A zealous denouncer of heresy, he combated the opinions of Arius and Origen. His work *Panarion* gives the history, together with the refutation, of a great number of heresies. His festival is on the 12th of May.

Epiph'any (Gr. *epiphaneia*, a manifestation or showing forth), a festival, otherwise called the *manifestation of Christ to the Gentiles*, observed on the 6th of January in honour of the adoration of our Saviour by the three Magi, or wise men, who came to adore him and bring him presents, led by the star. As a separate festival it dates from 813.

Ep'iphyte (Gr. *epi*, on, *phyton*, a plant), a plant which grows and flourishes on the trunks and branches of trees, adhering to the bark, as a moss, lichen, fern, &c., but which does not, like a parasite, derive any nourishment from the plant on which it grows. Most orchids are epiphytes, and so are many Bromeliaceæ and Cactaceæ. Epiphytic Angiosperms are characteristic of humid tropical regions. Depending as they do entirely on atmospheric moisture, they show many curious adaptations, and are nearly always more or less xerophytic in structure.

Epi'rus (Gr. *Epeiros*), a country of ancient Greece corresponding to Southern Albania and the north-western division of modern Greece. The most

interesting locality in it was Dodona. The inhabitants were only in part Greeks. The Molossians at last acquired the ascendancy, and the kings of this tribe took the name of kings of Epirus. The most celebrated King of Epirus was Pyrrhus, who made war upon the Romans. Epirus became a Roman province in 168 B.C., and shared the fortunes of Rome till it was conquered by the Turks. The population is about 250,000. In Nov., 1914, Greece, with the consent of the Great Powers, occupied North Epirus, and formally took possession of it in March, 1916. By the end of 1920, however, the occupation had not yet been recognized.—Epirus is also the name of an administrative province of Greece, formed after the Balkan campaigns (1912-3) out of the territory acquired by the country.

Epistemol'ogy (Gr. *epistēmē*, knowledge), that department of metaphysics which investigates and explains the doctrine or theory of knowing. It deals with the validity of knowledge rather than with the analysis of the knowing mind, and is thus distinguished from *psychology*. It is also distinguished from *ontology*, which investigates real existence or the theory of being.

Epis'tolæ Obscuro'rum Viro'rum (*Letters of Obscure Men*), the title of a collection of satirical letters which appeared in Germany in 1515, and professed to be the composition of certain ecclesiastics and professors in Cologne and other places. It is considered as one of the most masterly pieces of sarcasm in the history of literature, and its importance is enhanced by the effect it had in promoting the cause of the Reformation. The authorship of this satire has been a fertile subject of controversy, and is yet apparently far from being settled. It was ascribed to Reuchlin, and afterwards to Reuchlin, Erasmus, and Hutten. By a Papal bull the work was placed on the Index of forbidden books.

Ep'itaph (Gr. *epi*, upon, and *taphos*, tomb), an inscription upon a tomb or monument in honour or memory of the dead. Epitaphs were in use both among the Greeks and Romans. The Greeks distinguished by epitaphs only their illustrious men. Among the Romans they became a family institution, and private names were regularly recorded upon tombstones. The same practice has generally prevailed in Christian countries. On Christian tombstones epitaphs usually give brief facts of the deceased's life, sometimes also the pious hopes of survivors in reference to the resurrection or other doctrines of the Christian faith, &c. Many so-called epitaphs are mere witty *jeux d'esprit*, which might be described as epigrams, and which were never intended

seriously for monumental inscriptions. Dr. Johnson and William Wordsworth wrote essays on epitaphs.—Cf. Andrews, *Curious Epitaphs*.

Epithalamium (Gr. *epi*, on, and *thalamos*, a chamber), a nuptial song or poem in praise of a bride and bridegroom. Among the Greeks and Romans it was sung by young men and maids at the door of the bridal chamber of a newly-married couple. Epithalamia have been written by Spenser, Ben Jonson, and Donne.

Epithe'lium, in anatomy, the cellular layer which lines the internal cavities and canals of the body, both closed and open, as the mouth, nose, respiratory organs, blood-vessels, &c., and which is analogous to the cuticle of the outer surface. There are several varieties of epithelium. The epithelium lining the blood-vessels is called sometimes *endothelium*.

Epizo'a, a term applied to those parasitic animals which live upon the bodies of other animals, as lice, the itch-mite, &c.

Epizoöt'ic, or **Epizoötic Disease**, a disease that at some particular time and place attacks great numbers of the lower animals just as an epidemic attacks man. Pleuro-pneumonia is often an epizoötic, as is also the rinderpest.

Epoch, or **Era**, is a fixed point of time, commonly selected on account of some remarkable event by which it has been distinguished, and which is made the beginning or determining point of a particular year from which all other years, whether preceding or ensuing, are computed. The creation and the birth of Christ are the most important of the historical epochs. The creation has formed the foundation of various chronologies, the chief of which are: (1) The epoch adopted by Bossuet, Ussher, and other Catholic and Protestant divines, which places the creation in 4004 B.C. (2) The *Era of Constantinople* (adopted by Russia), which places it in 5508 B.C. (3) The *Era of Antioch*, used till A.D. 284, placed the creation 5502 B.C. (4) The *Era of Alexandria*, which made the creation 5492 B.C. This is also the *Abyssinian Era*. (5) The *Jewish Era*, which places the creation in 3760 B.C. The Greeks computed their time by periods of four years, called *Olympiads*, from the occurrence every fourth year of the Olympic games. The first Olympiad, being the year in which Corœbus was victor in the Olympic games, was in the year 776 B.C. The Romans dated from the supposed era of the foundation of their city (*Ab Urbe Condita*, A.U.C.), the 21st of April, in the third year of the sixth Olympiad, or 753 B.C. (according to some authorities, 752 B.C.). The *Christian Era*, or mode of computing from the

birth of Christ as a starting-point, was first introduced in the sixth century, and was generally adopted by the year 1000. This event is believed to have taken place earlier, perhaps by four years, than the received date. The Julian epoch, based on the coincidence of the solar, lunar, and indictional periods, is fixed at 4713 B.C., and is the only epoch established on an astronomical basis. The *Mohammedan Era*, or *Hejra*, commences on 16th July, 622, and the years are computed by lunar months. The Chinese reckon their time by cycles of 60 years. Instead of numbering them as we do, they give a different name to every year in the cycle.

Epping, a village of England, in Essex (giving name to a parliamentary division), 17 miles from London, in the midst of an ancient royal forest which one time covered nearly the whole of Essex. The unenclosed portion (5600 acres) was bought by the Corporation of London in 1882, and secured to the public as a free place of recreation. Pop. 4253.

Epsom, a town in the county of Surrey, England, 15 miles s.w. of London, formerly celebrated for a mineral spring, from the water of which the well-known Epsom salts were manufactured. The principal attraction Epsom can now boast of is the grand race-meeting held on the Downs, the chief races being the Derby and Oaks. Epsom gives name to one of the seven parliamentary divisions of the county. Pop. 19,156.

Epsom Salts, sulphate of magnesium ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$), a cathartic salt which appears in capillary fibres or acicular crystals. It is found covering crevices of rocks, in mineral springs, &c.; but is commonly prepared by artificial processes from magnesian limestone by treating it with sulphuric acid, or by dissolving the mineral *kieserite* ($\text{MgSO}_4 \cdot \text{H}_2\text{O}$) in boiling water, allowing the insoluble matter to settle, and crystallizing out the Epsom salts from the clear solution. It is employed in medicine as a purgative, and in the arts. The name is derived from its having been first procured from the mineral waters at Epsom.

Epworth, a small town of N. Lincolnshire, 9 miles N. of Gainsborough, the birth-place of John Wesley, the founder of Methodism. Pop. 1836.

Equation, in algebra, a statement that two expressions have the same numerical value. An equation may be either identical or conditional. An example of an *identical equation*, or *identity*, is $(x + y)(x - y) = x^2 - y^2$. The left side here can be transformed into the right side, simply by applying the laws of algebra so as to carry out the operations indicated, without taking account in

any way of the numerical values of x and y . An identical equation is, therefore, true for all values of the variables which appear in it. A *conditional* equation is not true unless certain special values are assigned to the variables. Thus the equation $4x + 7 = 15$ is not true for any value of x except 2. This value 2 is called a *root*, or *solution*, of the equation. An equation may have more than one root, e.g. $x^2 + 6x = 7$ has two roots, 1 and -7; and $2x^3 + 3x^2 = 2x + 3$ has three roots, 1, -1, $\frac{3}{2}$.

Rational Integral Equations (one Variable).—The three equations just given are special cases of the class of rational integral algebraic equations. The general form of these is $ax^n + bx^{n-1} + \dots + kx + l = 0$, where n is a positive integer, and $a, b, \dots, k, l$ are given numbers. This equation is said to be of degree n . The branch of mathematics called the Theory of Equations is conventionally restricted to equations of this type. The fundamental result in this subject is that every rational integral equation has a root, a theorem which it is by no means easy to prove. It follows without difficulty that an equation of degree n has exactly n roots, real or imaginary. Two or more of the roots, however, may be equal to each other. To *solve* an equation is to find its roots. The general equation of degree n can always be solved to any degree of approximation desired, when the numerical values of the coefficients $a, b, \dots$ are assigned. Graphical methods of solution are often the best (see *Graph*). When the coefficients $a, b, \dots$ are arbitrary, the general equation can be solved algebraically if n does not exceed 4, but not for greater values of n . It is not that the algebraical solution, or algebraic formula for the roots, when n is greater than 4, has not been discovered; it does not exist. This was proved more than a hundred years ago by Abel and Galois, two mathematicians of the highest distinction, who both died before they were thirty. For $n = 2$, the roots of the *quadratic* equation $ax^2 + bx + c = 0$ are $(-b \pm \sqrt{b^2 - 4ac})/2a$. For $n = 3$, the *cubic* equation $ax^3 + bx^2 + cx + d = 0$ is reduced to the form $z^3 + pz + q = 0$ by putting $x = z - b/3a$; the solution of $z^3 + pz + q = 0$ can be verified to be $z = u - p/3u$, where u is any one of the three cube roots of the quantity $\frac{1}{2}q + \sqrt{\frac{1}{4}q^2 + \frac{1}{27}p^3}$. For $n = 4$, the *biquadratic* equation is solved with the help of the solution of the cubic. The cubic was first solved by the Italian mathematician Tartaglia, who communicated the solution to Cardan, after binding him to keep it a secret. Cardan, however, gave the solution in his *Algebra*, published at Nürnberg in 1545.

Equations with more than one Variable.—A solution of an equation which contains more than one variable is a set of values of the variables making the equation true. Thus the equation $x^2 - y^2 = 9$ has solutions $(x = 5, y = 4)$, $(x = 3, y = 0)$, $(x = 5, y = -4)$, and an unlimited number of others. When several variables occur, there are usually also several *simultaneous* equations connecting them; a solution of these is a set of values of the variables making *all* the equations true. When the number of equations is equal to the number of variables, there is in general a limited number of solutions of the system. Thus, e.g. the system of equations $x^2 - y^2 = 9$, $2x - y = 6$ has two solutions $(x = 3, y = 0)$ and $(x = 5, y = 4)$, and no others. A useful rule is that the number of solutions of a system of this type is equal to the product of the degrees of the equations. Exceptions may arise when two solutions coalesce, or when infinite values of the variables occur.

Equations are of great importance in applied mathematics. The data of a problem generally lead to an equation, or a set of equations, among the quantities concerned. In practice a certain number of these quantities are known in any given case; the unknown quantities are then found by the solution of an equation or equations. Non-algebraic equations occur frequently—equations involving trigonometrical functions, for example. For a modern practical method of solving equations of many types, see *Nomography*.—BIBLIOGRAPHY: A. E. Layng, *Elementary Algebra*; C. Smith, *Algebra*. More advanced works are: G. Chrystal, *Algebra*; W. S. Burnside and A. W. Panton, *Theory of Equations*.

Equation, Personal, the accustomed error, almost a constant quantity in the case of a practised observer, in timing a celestial phenomenon.

Equation of Payments, an arithmetical rule for the purpose of ascertaining at what time it is equitable that a person should make payment of a whole debt which is due in different parts, payable at different times.

Equation of the Centre, the difference between the actual heliocentric longitude of a planet revolving in an elliptic orbit and that which it would have at the same instant if it revolved in a circular orbit. It is zero at perihelion and aphelion.

Equation of Time, the difference between mean and apparent time, or the difference of time as given by a clock and as given by a sun-dial, arising chiefly from the varying velocity of the earth in its orbit and the eccentricity of

the orbit. The sun and the clock agree four times in the year; the greatest difference between them at the beginning of November is fully sixteen minutes. See *Day*.

Equa'tor, that great circle of our globe every point of which is 90° from the poles. All places which are on it have invariably equal days and nights. Our earth is divided by it into the northern and southern hemispheres. From this circle is reckoned the latitude of places both north and south. There is also a corresponding celestial equator in the plane of the terrestrial, an imaginary great circle in the heavens the plane of which is perpendicular to the axis of the earth. It is everywhere 90° distant from the celestial poles, which coincide with the extremities of the earth's axis, supposed to be produced to meet the heavens. During his apparent yearly course the sun is twice in the celestial, that is, vertically over the terrestrial equator, on 21st March and 23rd September. Then the day and night are equal all over the earth, whence the name *equinox*.—The *magnetic equator* is a line at every point of which the vertical component of the earth's magnetic force is zero; that is to say, a dipping needle carried along the magnetic equator remains horizontal. It is hence also called the *acclinic line*. It has a slightly devious course, but upon the whole keeps fairly near the geographical equator.

Equato'rial, an astronomical instrument contrived for the purpose of directing a telescope upon any celestial object, and of keeping the object in view for any length of time, notwithstanding the diurnal motion of the earth. For these purposes a principal axis resting on firm supports is mounted exactly parallel to the axis of the earth's rotation, and consequently pointing to the poles of the heavens, being fixed so as to turn on pivots at its extremities. To this there is attached a telescope moving on an axis of its own in such a way that it may either be exactly parallel to the other axis, or at any angle to it; when at right angles it points to the celestial equator. The two axes carry graduated circles, with the help of which, even during the day, the telescope can be pointed to any star whose declination and right ascension are known. By means of clockwork the instrument is given such a motion round its principal axis that the star is kept stationary in the field of view.

Eq'uary, in Britain, the name of certain officers of the royal household, in the department of the Master of the Horse, whose duties consist in attendance when the sovereign rides abroad. Equerries also form part of the establishments of the members of the royal family.

Equestrian Order, the order of 'Knights' in ancient Rome. The *equites* or knights originally formed the cavalry of the army. They are said by Livy to have been instituted by Romulus, who selected 300 of them from the three principal tribes. About the time of the Gracchi (123 B.C.) the equites became a distinct order in the state, and the judges and the farmers of the revenue were selected from their ranks. They held their position in virtue of a certain property qualification, and towards the end of the Republic they possessed much influence in the state. They had particular seats assigned to them in the circus and theatre, and the insignia of their rank, in addition to a horse, were a gold ring and a robe with a narrow purple border (the *clavus angustus*). Under the later emperors the order grew less influential, and finally disappeared.

Eq'uidæ, the horse family, a division of the odd-toed (perissodactyle) Ungulates or hoofed mammals. There is but one existing genus, *Equus*, distinguished by the possession of a mane; hard pads (callosities) on the inner side of each fore-limb (and sometimes of the hind-limb); a single functional digit (the third or middle one) terminating in a large curved hoof; a simple stomach; 44 teeth, including 12 incisors with pitted crowns, 4 canines (tushes) reduced in the female, and 28 grinding teeth with broad crowns, except the first (wolf tooth), which is rudimentary. The forms included are horses, asses, and zebras; the first being distinguished from the others by the presence of callosities ('chestnuts') on the hind-limbs as well as the fore. The domesticated horse (*E. caballus*) has a large flat tail abundantly hair-clad, and is not known with certainty in the wild state, though possibly the tarpan of South Russia (Tartary) may represent the original stock. Another candidate for this honour is the small wild species (*E. przewalskii*) native to the deserts of Central Asia. The domestic ass (*E. asinus*) is related to a number of wild species, such as the onager (*E. onager*) of South Asia, the kiang (*E. hemionus*) of Tibet, and two African species (*E. africanus* and *E. somalicus*). The striped zebras are purely African, and four species are generally recognized—the common or mountain zebra (*E. zebra*), Burchell's zebra (*E. burchelli*), Grevy's zebra (*E. grevyi*), and the quagga (*E. quagga*). The geological record enables us to derive horses from a small plantigrade five-toed form (*Phenacodus*), by gradual increase in size, complication of teeth, loss of digits, and elongation of limbs, to the unguligrade condition.

Equilib'rium, in statics, the condition when a body is acted on by two or more forces which balance one another. The body may be either at rest or moving with uniform speed in a straight line. In the first case, when the body, being

slightly moved out of any position, always tends to return to its position, that position is said to be one of *stable equilibrium*; when the body, after a slight displacement, tends to move away from its previous position, the body is in *unstable equilibrium*. If, after displacement, the body tends to remain at rest, its state is one of *neutral equilibrium*.

Equinoc'tial, in astronomy, the circle in the heavens otherwise known as the celestial equator. When the sun is on the equator, there is equal length of day and night over all the earth: hence the name *equinoctial*.—*Equinoctial gales*, storms which have been supposed to take place about the time of the sun's crossing the equator, that is, at the vernal and autumnal equinoxes, in March and September.—*Equinoctial points* are the two points wherein the celestial equator and ecliptic intersect each other; the one, the first point of Aries, is called the *vernal point*; and the other, in Libra, the *autumnal point*. These points move backward or westward at the rate of 50" of arc in a year. This is called the precession of the equinoxes.

Eq'uinox, one of the equinoctial points. The term is also applied to the dates at which the sun passes through them, viz. 21st March and 23rd September, when day and night are of equal length all over the world. See *Day*; *Earth*; *Equinoctial*; *Seasons*.

Equisetales, a group of Pteridophytes, represented at the present day only by the genus *Equisetum* (q.v.). It was much more prominent in the Carboniferous flora, in which large woody horse-tails (*Calamites*) played an important part.

Equise'tum, a genus of vascular cryptogamous plants with hollow jointed stems, type of the group Equisetales, growing in wet places, and popularly called *horse-tails*.

Eq'uity (Lat. *aequus*, fair, equal), in English law, the system of supplemental law administered in certain courts, founded upon defined rules, recorded precedents, and established principles, the judges, however, liberally expounding and developing them to meet new exigencies. While it aims at assisting the defects of the common law, by extending relief to those rights of property which the strict law does not recognize, and by giving more ample and distributive redress than the ordinary tribunals afford, equity by no means either controls, mitigates, or supersedes the common law, but rather guides itself by its analogies, and does not assume any power to subvert its doctrines. The Court of Chancery was formerly in England the especial court of equity,

but large powers were by the Judicature Act of 1873 given to all the divisions of the Supreme Court to administer equity, although many matters of equitable jurisdiction are still left to the chancery division in the first instance.—

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Equity of Redemption, in law, the advantage allowed to a mortgager of a reasonable time to redeem an estate mortgaged, when it is of greater value than the sum for which it is mortgaged.

Equiv´alent, in chemistry, the number of parts by weight of an element which will combine with or displace 8 parts by weight of oxygen or 1.008 parts by weight of hydrogen.

Eranthis. See *Winter Aconite*.

Érard, Sébastien, a celebrated musical-instrument maker, born at Strasbourg in 1752, died 1831. He went to Paris at the age of eighteen, and in concert with his brother, Jean Baptiste, produced pianofortes superior to any that had previously been made in France. He afterwards established a manufactory in London, and made considerable improvements in the mechanism of the harp.

Erasis´tratus, an ancient Greek physician and anatomist, said to have been a grandson of Aristotle. He lived in the third century before the Christian era, and was court physician of Seleucus Nicator, King of Syria. He was the first who systematically dissected the human body, and his description of the brain and nerves is much more exact than any given by his predecessors. He classified the nerves into nerves of sensation and of locomotion, and, it is said, almost stumbled upon the discovery of the circulation of the blood. Of his works only the titles and some fragments remain.

Eras´mus, Desiderius, a Dutch scholar, one of the greatest of the Renaissance and Reformation period, born at Rotterdam in 1467, died in 1536. His original name was Gerard, but this he changed according to a fashion of the time. After the death of his parents, whom he lost in his fourteenth year, his guardians compelled him to enter a monastery; and at the age of seventeen he assumed the monastic habit. The Bishop of Cambrai delivered him from this constraint. In 1492 he travelled to Paris to perfect himself in theology and literature. He became the instructor of several rich Englishmen (from one of whom—Lord Mountjoy—he received a pension for life), and accompanied them to England in 1497, where he was graciously received by the king. Returning soon after to

the Continent, he took his doctor's degree, was relieved from his monastic vows by dispensation from the Pope, and published several of his works. In 1510 he returned to England, wrote his *Praise of Folly* while residing with Sir Thomas More, and was appointed Lady Margaret professor of divinity and Greek lecturer at Cambridge. In 1514 he returned to the Continent and lived chiefly at Basel, where he died. To extensive learning Erasmus joined a refined taste and a delicate wit, and rendered great and lasting service to the cause of reviving scholarship. Although Erasmus took no direct part in the Reformation, and was reproached by Luther for lukewarmness, he attacked the disorders of monasticism and superstition, and everywhere promoted the cause of truth. A humanist rather than a reformer or a theologian, he waged war upon ignorance and superstition. He edited various classics, the first edition of the Greek Testament from MSS. (with Latin translation), &c., but his best-known books are the *Encomium Moriae* (Praise of Folly) and his *Colloquies*. His letters are very valuable in reference to the history of that period.—BIBLIOGRAPHY: S. Knight, *Life of Erasmus*; C. Butler, *Life of Erasmus*; E. F. H. Capey, *Life of Erasmus*; P. S. Allen, *The Age of Erasmus*.

Eras'tus (Gr. *erastos*, lovely, translation of Ger. *Lieber*), the learned name of Thomas Lieber, a Swiss physician, who maintained the opinions from which the well-known epithet of *Erastian*, as now used, is derived. He was born at Baden in 1523, and died at Basel 1584. He was successively professor of medicine at Heidelberg, and of ethics at Basel. In his writings he maintained the complete subordination of the ecclesiastical to the secular power; and denied to the Church the right to exclude any one from Church ordinances, or to inflict excommunication.

Er'ato, in Greek mythology, one of the nine Muses, whose name signifies loving or lovely. She presided over lyric and especially amatory poetry, and is generally represented crowned with roses and myrtle, and with the lyre in the left hand and the plectrum in the right in the act of playing.

Eratos'thenes, an ancient Greek astronomer, born at Cyrene, in Africa, 276 B.C., died about 194 B.C. He was librarian at Alexandria, and gained his greatest renown by his investigations of the size of the earth. He rendered much service to the science of astronomy, and first observed the obliquity of the ecliptic. Of the writings attributed to him one only remains complete—*Katasterismoi*—which treats of the constellations.

Er'bium, a rare metal found along with yttrium, terbium, and other rare elements in some rare minerals. Its properties are but little known. It was discovered by Mosander in 1843.

Ercilla y Zuñiga (er-thil'ya' ē thö-nyē'ga'), Don Alonso de, Spanish soldier and poet, born 1533, died 1595. He became page to the Infant Don Philip, accompanied him on his travels, and in 1554 went with him to England, on the occasion of his marriage with Queen Mary. After this he fought against the Araucanians of South America (Chile), and his epic *La Araucana* is based on the events of this war. It is written in excellent Spanish, and occupies an honourable position in the national literature. The first fifteen cantos were published in 1569, and the continuations, thirty-seven cantos, appeared in 1578 and 1589.

Erckmann-Chatrian (sha' t-ri-än'), the joint name of two French-Alsatian writers of fiction. Émile Erckmann, born at Pfalzburg 1822, studied law at Paris, and died in 1899. Alexandre Chatrian, born near Pfalzburg in 1826, died in 1890, was for some time teacher in the Pfalzburg College. They formed a literary partnership in 1847, but it was not till the appearance of *L'Illustre Docteur Mathéus* in 1859 that success attended them. Among their most popular books are: *L'Ami Fritz*, *Madame Thérèse*, *Histoire d'un Conscrit de 1813*, *L'Histoire d'un Paysan*, and *Waterloo*, most of which have been translated into English. Their drama *Le Juif Polonais* was made famous by Sir Henry Irving under the name of *The Bells*.

Erdmann, Johann Eduard, German philosopher, born 1805, died 1892. He studied theology at Dorpat and Berlin; in 1829 became a clergyman, but in 1832 returned to Berlin and took his degree in philosophy. In 1836 he became professor extraordinary of philosophy at Halle, being appointed ordinary professor in 1839. He wrote numerous philosophical works, mostly characterized by Hegelian tendencies, including: *Body and Soul*, *Nature and Creation*, *Outlines of Psychology*, *Outlines of Logic and Metaphysics*, *Psychological Letters*, and *Belief and Knowledge*. His greatest work is his *Outlines of the History of Philosophy*, which has been translated into English (3 vols., 1889).

Er'ebus, in Greek mythology, the son of Chaos and Darkness, and father of Æther and Hemera (day). The name Erebus was also given to the infernal regions.

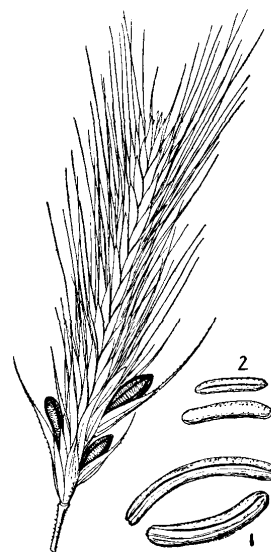
Er'ebus, Mount, a volcano of the antarctic regions in S. Victoria Land; height, 12,400 feet; discovered by Ross, 1841.

Erechtheus (e-rek'thūs), in Greek mythology, a mythical king of Athens to whom a fine temple, the *Erechthēum*, was built on the Acropolis. In some representations of him he is depicted as half snake, so that he was one of the autochthones, the earth-born ancestors of the Athenians.

Erection, Lords of, in Scots history, those private owners into whose hands the ecclesiastical estates belonging to the clergy had passed during the religious changes of the Reformation period.

Er'furt (Lat. *Erfordia*, ford of Erpe, its legendary founder), an important town in the Prussian province of Saxony, on the River Gera, formerly a fortress with two citadels, now given up as such. It has a fine cathedral dating from the thirteenth century and several handsome Gothic churches. The university, founded in 1378 and suppressed in 1816, was long an important institution. There is still an academy of science and a library with 60,000 volumes. The monastery (now an orphanage) was the residence of Luther from 1501 to 1508. Erfurt is a busy industrial town and is in a very flourishing condition. The industries are varied, including clothing, machinery, leather, shoes, ironmongery, and chemicals. Flower-growing is extensively carried on in the neighbourhood, plants and seed being produced for sale in great quantities. Pop. 123,550.

Er'got, the altered grain of rye and other grasses caused by the attack of an ascomycetous fungus called *Claviceps purpurea*. The grain is replaced by a dense fungoid tissue (sclerotium) largely charged with an oily fluid. In its perfect state this germinates and produces the *Claviceps* fructification. When diseased rye of this kind is eaten in food for some time, it sometimes causes death by a kind of mortification called dry gangrene. Ergot is used in obstetric practice to promote the contraction of the uterus.



Ergot of Rye
1, Spanish ergot. 2,
Russian ergot.

Erica (e-rī'ka), the heaths, a large genus of branched rigid shrubs, type of the nat. ord. Ericaceæ, most of which are natives of South Africa, a few being found in Europe and Asia. The leaves are narrow and rigid; the flowers are globose or tubular, and four-lobed. Five species are found in Britain.

Ericaceæ, a nat. ord. of gamopetalous Dicotyledons. Representative genera: *Calluna*, *Erica*, *Rhododendron*.

Erichsen (er'ik-sen), Sir John Eric, surgeon, born 1818, died in 1890. He was the son of a Copenhagen merchant, but spent nearly all his life in England. He studied at University College, London, became a member of the Royal College of Surgeons in 1839, a fellow in 1845, and in 1850 professor of surgery and hospital surgeon at University College. In 1865 he succeeded Quain as professor of clinical surgery in the same college, but retired in 1875. Appointed president of University College in 1887, he also held that post till his death. He was chief surgeon extraordinary to Queen Victoria, and in 1895 was made a baronet. His most important work was his *Science and Art of Surgery* (1853), which has gone through many editions, and has been translated into several languages. He also published a volume on *Concussion of the Spine* (1875).

Er'icsson, John, engineer, born in Sweden 1803, died in 1889. He served for a time in the Swedish army; removed to London in 1826, and to New York in 1839. He is identified with numerous inventions and improvements

in steam machinery and its applications. His chief inventions are his caloric engine, the screw propeller (1836), which has revolutionized navigation, and his turret-ships, the first of which, the *Monitor*, distinguished itself in the American Civil War, and inaugurated a new era in naval warfare. He afterwards devoted himself to studies of the earth's motion and the intensity of solar heat.

Eridanus, the River Eridanus (modern Po), one of the constellations of the ancient astronomy, in which Ptolemy catalogued thirty-four stars. Appropriately to its name, it covers a large expanse of the heavens, its northern portion, just to south-west of Orion, reaching the celestial equator. The part visible in our latitudes does not contain bright stars, but at the southern extremity is the first-magnitude Achernar, a conspicuous object to southern observers.

Erie (ē'ri), one of the great chain of North American lakes, between Lakes Huron and Ontario, about 265 miles long, 63½ miles broad at its centre, from 40 to 60 fathoms deep at the deepest part; area, 6900 sq. miles. The whole of its southern shore is within the territory of the United States, and its northern within that of Canada. It receives the waters of the upper lakes by Detroit River at its south-western extremity, and discharges its waters into Lake Ontario by the Niagara River at its north-east end. The Welland Canal enables vessels to pass from it to Lake Ontario. It is shallow compared with the other lakes of the series, and is subject to violent storms. The principal harbours are those on the United States side—Buffalo, Erie, and Cleveland.

Erie, a city, Pennsylvania, United States, an important railway and commercial centre on the southern shore of Lake Erie. There are numerous ironworks (including foundries, rolling-mills, and blast-furnaces), petroleum refineries, breweries, tanneries, and wood-working factories. The harbour is one of the best on the lake. Pop. 76,600.

Erie Canal, the largest in the United States, serving to connect the great lakes with the sea. It begins at Buffalo on Lake Erie, and extends to the Hudson at Albany. It is 363 miles long; has in all 72 locks; a surface width 70 feet, bottom width 42 feet, and depth 7 feet. It is carried over several

large streams on stone aqueducts; cost nearly £2,000,000, and was opened in 1825. The navigation is free.

Erigena (e-rij'e-na), Joannes Scotus (*Scotus*, Scot, and *Erigena*, Irish-born), an eminent mediæval scholar and metaphysician, probably born of Scotch parentage in Ireland about 800-810, died in France about 875. He spent a great part of his life at the court of Charles the Bald of France, and was placed at the head of the school of the palace. The king further imposed upon him the double task of translating into Latin the Greek works of the pseudo Dionysius the Areopagite, and of composing a treatise against Godeschale on *Predestination and Free-will*. This treatise, and another, *De Divisione Naturæ*, contained many views in opposition to the teachings of the Church. They were condemned by the Councils of Valencia in 855 and of Langres in 859, and Pope Nicholas I demanded the immediate disgrace of the culprit. His subsequent history is not known.—Cf. Gardner, *Studies in John the Scot*.

Erin'na, a Greek poetess who lived about 600 B.C. She is said to have been an intimate friend of Sappho, and died at the age of eighteen. She acquired a high reputation for poetry, and her chief work was called *Elakatē* (The Distaff), of which nothing has come down to us. An epitaph or two which are still extant, and believed by some to be hers, are by others deemed spurious.

Erioden'dron, the wool tree, a genus of plants, nat. ord. Malvaceæ (mallows). There are eight species natives of America, but one belongs to Asia and Africa. The species are noble plants, growing from 50 to 100 feet high, having palmate leaves, and red or white flowers. The woolly coat of the seeds of some of the species is used in different countries for stuffing cushions and similar purposes.

Eris, in Greek mythology, the goddess of discord, the sister of Ares, and, according to Hesiod, daughter of Nyx (night). Not being invited to the marriage of Peleus, she revenged herself by means of the *apple of discord*.

Er'ith, a town of England, in Kent, on the Thames, about 14 miles east of London, a pleasant summer resort. Pop. 27,755.

Eritre'a, or **Erythræ'a** (from Gr. *erythros*, red, referring to the Red Sea), the official name of an Italian colonial possession stretching along the African shore of the Red Sea, and between it and Abyssinia, from the Egyptian coast territory to the French territory of Obok, at the Strait of Babel-Mandeb. The coast-line is about 670 miles in length, the area of the colony about 45,800 sq. miles. Pop., largely nomadic, about 450,000. The chief town is Massowah.

Er'ivan, a fortified city in Armenia, formerly the capital of a Russian government of the same name in Transcaucasia, on the Sanga, north of Mount Ararat. It has a citadel, barracks, a cannon foundry, and some manufactures. The Armenian Republic of Erivan was constituted in May, 1918. Pop. 34,000. The former Russian government of Erivan had an area of 10,725 sq. miles, and a pop. of 970,000.

Erlang'en, a town of Bavaria, 10 miles N.N.W. of Nürnberg. The Protestant university, founded in 1743, is the chief institution. The industries include cotton spinning and weaving, mirrors, hosiery, gloves, and combs. Pop. 24,874.

Erlau, or **Eger**, a town, Hungary, on the Eger, 65 miles E.N.E. of Budapest. It has sundry manufactures; and the red wines of the district, esteemed the best in Hungary, are largely exported. Pop. 28,050.

Erl-king, the English form of the name given in German and Scandinavian poetical mythology to a personified natural power which devises and works mischief, especially to children. Goethe's celebrated poem *Der Erbkönig* (literally 'elf-king') has rendered this malicious spirit universally known.

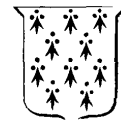
Er'mine, the stoat (*Putorius ermineus*), a mammal of the weasel family widely distributed through the northern parts of both hemispheres, with a considerable range to the south. It is not generally known that the ermine and stoat are the same. In winter, in cold countries or severe seasons, the fur changes from a reddish-brown to a yellowish-white, or almost pure white, under which shade the animal is recognised as the ermine. In both states the



Ermines (*Putorius ermineus*)

tip of the tail is black. Its fur is short, soft, and silky, the best skins being brought from Russia, Sweden, and Norway. It is in great request, and was formerly one of the insignia of royalty, and is still used by judges. When used as linings of cloaks the black tuft from the tail is sewed to the skin at irregular distances. Stoats are among the enemies of the poultry-keeper, but by keeping down small rodents they benefit agriculture to a considerable extent.—In heraldry, ermine is one of the furs, represented with its peculiar spots black on a white ground.

Erne (èrn), the name often given to all the eagles of the genus *Haliaeetus*, but more specifically to the white-tailed sea-eagle.



Ermine

Erne, Lough, a lake, Ireland, County Fermanagh, consisting of a north or lower, and a south or upper lake (with the town of Enniskillen between), connected by a narrow winding channel, and properly forming only expansions of the River Erne. Its entire length is about 40 miles; average breadth, 6 miles. It contains numerous small islands, and is well stocked with fish.—The River Erne rises in Lough Gowna, in the county of Longford, flows through Loughs Oughter and Erne, and falls into Donegal Bay below Ballyshannon. Length, 72 miles.

Ernest Augustus, King of Hanover and Duke of Cumberland, the fifth son of George III, born 1771, died 1851. In 1799 he was created Duke of Cumberland, in England, and became a field-marshal in the British army. On the death of William IV in 1837 he ascended the throne of Hanover, in consequence of the succession to the sovereignty of that country being limited to heirs male. He was succeeded by his son, George V, the last of the Hanoverian kings.

Eros, an asteroid discovered in Aug., 1898. It completes its orbit in 642 days, and has a mean distance from the sun of $135\frac{1}{2}$ million miles, or 6 million less than that of Mars, and was the first to be discovered of the class of minor planets which come within the orbit of Mars. It can approach at times to $13\frac{1}{2}$ million miles from the earth. It is supposed to have a diameter of 20 miles or less.

Erosion Theory, in geology, the theory, now held by all geologists, that valleys are, in the great majority of cases, due to the wearing influences of subaerial agents, such as rivers and glaciers, as opposed to the theory which

regards them as the result of fissures in the earth's crusts produced by strains during its upheaval.

Erot'ic (from the Gr. *erōs*, love), relating to love.—*Erotic poetry*, amatory poetry.—The name of *erotic* writers has been applied, in Greek literature, particularly to a class of romance writers, and to the writers of the *Milesian Tales*.

Errat'ics, or Erratic Blocks, in geology, boulders or large masses of angular rock which have been transported to a distance from their original positions by the action of ice during a glacial period. Thus on the slopes of the Jura Mountains immense blocks of granite are found which have travelled 60 miles from their original situation. Similarly, masses of Scottish and Lake-district granites and of Welsh rocks (some of which weigh several tons) occur not uncommonly in the surface soil of the Midland counties of England.

Erroman'go, or Erroman'ga, one of the more important of the New Hebrides Islands, with an area of about 400 sq. miles, hilly and not very fertile, but with spots well cultivated. Several missionaries have been murdered by the natives—including the missionary John Williams—but perhaps half of the 2500 natives are now Christians.

Errors of Observation. In scientific measurements, objects and instruments alike are so constituted that numerical results can only be approximate. We have to find the value of some quantity, not exactly, but to so many significant figures. Even so, when a number of measurements are made of the same quantity, it regularly happens that different values are obtained, the difference between a value as obtained and the true value being called an *error of observation*. It remains to combine the various measurements in such a way as to obtain the best result which they are capable of yielding.

The usual method is to take the arithmetic mean of the values obtained as the correct value. It is also customary in careful work to state the average deviation of the observed values from the mean. For example, various experimenters found the following numbers for the charge on an electron: 4.67, 4.77, 4.65, 4.79, 4.69. Here the *mean* is 4.71, and the average *deviation* from the mean, taken without regard to algebraic sign, is .05. The

final result is stated as $4.71 \pm .05$. The ambiguous term $\pm .05$ is sometimes called the probable error. The smaller the probable error, the more reliable is the mean result.

A case of much practical importance occurs when the results obtained by two distinct methods differ by greater amounts than can be accounted for by the uncertainty of either result. In this case there must be a *constant error* present in at least one of the sets of measurements. Recognition of a constant error has occasionally led to an important discovery; for instance, the hint which led to the detection of argon in the atmosphere came from the observed discrepancy in the densities of atmospheric nitrogen and nitrogen from ammonia.

In many measurements what is sought is not the value of a single quantity, but the relation between the values of two variable quantities. In such cases graphical methods are of great service. Corresponding values of the two variables are found and plotted; and a smooth curve, or it may be a straight line, is drawn to lie as evenly as possible among the plotted points. Where great accuracy is wanted, analytical methods are also available. See *Squares, Method of Least; Probability*.

Ersch (ersh), John Samuel, German bibliographer, born 1766, died 1828. He was principal librarian and professor of geography and statistics at Halle. Among his publications are: a *Dictionary of French Writers*; a *Manual of German Literature*; and, in connection with Gruber, the *Universal Encyclopædia of Arts and Sciences*.

Ers'kine, Ebenezer, the founder of the Secession Church in Scotland, born 1680, died 1754. He studied at Edinburgh, and was ordained minister of Portmoak, in Fife, in 1703, in which situation he continued for twenty-eight years, when he removed to Stirling. His attitude towards patronage and other abuses in the Church led to his being deposed, when, in conjunction with his brother and others, he founded the Secession Church. Erskine was the leader of the Burghers (q.v.). He is the author of several volumes of sermons.

Erskine, The Hon. Henry, Scottish barrister, was the third son of Henry David, tenth Earl of Buchan: born at Edinburgh 1746, died 1817. After studying at the Universities of St. Andrews, Edinburgh, and Glasgow, he

adopted the legal profession, and in 1768 was called to the Bar. He twice held the office of Lord-Advocate, was for long the leader of the Scottish Bar, and held a high reputation as a wit.

Erskine, John, of Carnock, afterwards of Cardross, Scottish jurist, born 1695, died 1768. He was called to the Scottish Bar in 1719, and was author of *Principles of the Law of Scotland*, and the *Institutes of the Law of Scotland*, both works of authority.

Erskine, Ralph, brother of Ebenezer Erskine, born 1685, died 1752. He was ordained to the parish of Dunfermline in 1711, and in 1737 joined his brother, who had seceded from the Established Church. His *Gospel Sonnets* and other religious works were once very popular.

Erskine, Thomas, Lord Erskine, Scottish lawyer, the youngest son of the tenth Earl of Buchan, was born in 1750, and died in 1823. He was educated partly at the High School of Edinburgh, and partly at the University of St. Andrews. After serving four years in the navy and seven in the army, he commenced the study of law, and in 1778 both took his degree at Cambridge and was called to the Bar. His success was immediate. In May, 1783, he took silk, and the same year was elected member of Parliament for Portsmouth, a seat he held (except from 1784-90, when he had no seat) till 1806, when he was raised to the peerage. The rights of juries he firmly maintained on all occasions, but particularly in the celebrated trial of the Dean of St. Asaph for libel. In 1789 he defended Stockdale, a bookseller, for publishing what was charged as a libellous pamphlet in favour of Warren Hastings. In 1792, being employed to defend Thomas Paine, when prosecuted for the second part of his work *The Rights of Man*, he declared that, waiving all personal convictions, he deemed it right, as an English advocate, to obey the call: by the maintenance of which principle he lost his office of Attorney-General to the Prince of Wales. In the trials of Hardy, Tooke, and others for high treason in 1794, which lasted for several weeks, the ability displayed by Erskine was acknowledged by all parties. He was a warm partisan of Fox, and a strenuous opposer of the war with France. In 1802 the Prince of Wales not only restored him to his office of Attorney-General, but made him Keeper of Seals for the Duchy of Cornwall. On the death of Pitt, in 1806, Erskine was created a peer, and raised to the dignity of Lord Chancellor. During his short tenure of office the Bill for the

abolition of slavery was passed. After he retired with the usual pension, he took little part in politics.

Eruptive Rocks, in geology, those which, as lavas, have broken through other rocks while in a molten state, and become eruptive at the surface.

Ervum. See *Lentil*.

Eryngium, a genus of plants belonging to the nat. ord. Umbelliferae. There are upwards of 100 species found in temperate and sub-tropical climates, but chiefly in South America. *E. maritimum*, also called sea-holly, is the only truly native British species. It frequents sandy shores, and is distinguished by its rigid, spiny, glaucous, veined leaves, and its dense heads of blue flowers. The roots are sometimes candied, and are reputed to be stimulating and restorative, as well as to have aphrodisiac properties. It is mentioned by Shakespeare, *Merry Wives*, v. 5, 23, as an aphrodisiac.

Erysip'elas, Rose, or St. Anthony's Fire, is a contagious disease of the skin due to infection by a germ, the Streptococcus, and accompanied by severe general disturbance. Cold, damp weather favours its appearance. It rarely affects those under fifteen years, and is commoner in women than men. The disease is characterized by sudden onset, with shivering, headache, vomiting, and occasionally sore throat, followed by the appearance of the typical erysipelatous flush on the skin of the affected part, most usually the face. This part becomes deep red, and is much swollen, with a glossy, tender surface. It is definitely raised, and has a spreading edge merging into the normal parts around. In extreme cases there is marked disfigurement. Local treatment to allay pain and prevent spreading is by the application of lotions and ointments, and general treatment in the form of stimulating foods is given to maintain strength. Serum treatment has been used, but so far there have been very conflicting results. The disease is not so common nor so fatal as previously.

Erysipha'les, an important family of ascomycetous Fungi, distinguished by the presence of typical sexual organs and closed ascus-fruits (*cleistocarps*) which bear characteristic appendages concerned with dispersal; also by the fact that each segment of the septate mycelium contains a single nucleus. They are all parasites, appearing on leaves, stems, or fruits as white patches of mycelium ('mildew'). During summer innumerable conidia are produced,

which spread the disease rapidly; in autumn the black ascus-fruits develop and carry the fungus through the winter. Erysiphales are responsible for many important plant-diseases, e.g. the mildew of hops (*Sphærotheca Castagnei*), vine (*Uncinula spiralis*), wheat (*Erysiphe communis*), and the American gooseberry mildew (*Sphærotheca Mors-uvæ*), a 'notifiable' disease in Britain.

Erythe'ma is redness of the skin, and in this sense is applied to a number of general conditions which bring about redness of the skin, e.g. abscess, œdema, scarlet fever, &c. Of late, in medicine, its use has been more restricted, and refers only to an inflammation of part of the skin. This disease is characterized by redness and tenderness, and may become sufficiently severe to lead to the production of bullæ in the centre of the affected part. Dermatologists recognize various types of erythema.

Erythræ'an Sea, in ancient geography, a name given to what is now called the Indian Ocean, but including the Persian and Arabian Gulfs. The name was eventually restricted to the Arabian Gulf.

Erythri'na. See *Coral Tree*.

Erythro'nium. See *Dog's Tooth Violet*.

Erythrophlœ'um, a genus of tropical trees, nat. ord. Leguminosæ, containing three species, two found in Africa and the third in Australia. The *E. guineense* of Guinea has a poisonous juice, which is used by the natives as a test of innocence and guilt, hence the name 'ordeal tree'.

Eryx, an ancient city and a mountain in the west of Sicily, about 2 miles from the sea-coast. The mountain, now Monte San Giuliano, rises direct from the plain to a height of 2184 feet. On the summit anciently stood a celebrated temple of Venus. All traces of the ancient town of Eryx have now disappeared, and its site is occupied by the modern town of San Giuliano.

Erzberger, Matthias, German politician, born at Buttenhausen in 1875. Educated at Freiburg, where he studied political economy, he took an interest in 1897 in the Christian Socialist movement, and entered the Reichstag as a member of the Centre or Catholic party. He became prominent in 1917, when he accused the German Government of misrepresenting the military situation, and urged for a statement of

Germany's peace aims. Secretary of State in 1918, he became Minister of Finance in 1919 in Bauer's Cabinet, but was compelled to resign in 1920. He was murdered on 26th Aug., 1921, by two young men of the militarist party.

Erzerum, Erzeroum, or Erzeroom (er'ze-röm), a city of Armenia, formerly the capital of a Turkish vilayet with an area of 27,000 sq. miles, and a pop. of 582,745. The town is about 6000 feet above sea-level, and forms an important strategical centre. It is irregularly built, its narrow dirty streets, flanked by mean houses, being crowded together in the small space enclosed by its lofty walls. The Moslem element prevails largely over the Christian, although it is the metropolis of the Armenian Church in union with Rome. In addition to important manufactures, especially in copper and iron, it carries on an extensive trade, and is a chief halting-place for Persian pilgrims on their way to Mecca. The town was captured by the Russians in Feb., 1916, and recaptured by the Turks in March, 1918. Pop. (before the European War), about 80,000.

Erzgebirge (erts'ge-bir-ge; 'Ore Mountains'), a chain of European mountains forming a natural boundary between Saxony and Bohemia, nearly 120 miles in length and 25 miles broad. The highest summits, which are on the side of Saxony, rise to 3800 or 3900 feet. The mountains are rich in silver, iron, copper, lead, cobalt, and arsenic.

Esarhad'don (Assyr. *Asur-akhi-iddina*, Asur has given a brother), the son of Sennacherib, and one of the most powerful of all the Assyrian monarchs. He extended the empire on all sides, and is the only Assyrian monarch who actually reigned at Babylon. He died about 667 B.C.

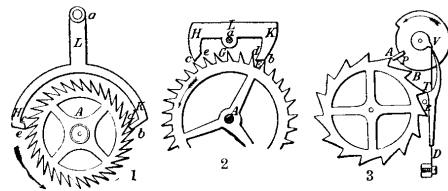
E'sau, the eldest son of Isaac, and twin-brother of Jacob. His name (which signifies rough, hairy) was due to his singular appearance at birth, being "red, and all over like an hairy garment". The story of his losing the paternal blessing through the craft of Rebekah and Jacob, with other facts, is told in *Genesis*, xxvii. He was the progenitor of the Edomites.

Esbjerg, a Danish seaport in South-West Jutland, opposite the Island of Fanö. Pop. 18,000.

Escallonia, a genus of saxifragaceous shrubs and trees, natives chiefly of the Andes. *E. rubra* is a handsome evergreen shrub, with shiny, resinous, aromatic leaves, and fine pink flowers; it is hardy in many parts of Britain, and makes an excellent hedge, especially near the sea, where it bears the salt-laden winds without damage.

Escape´ment, the general contrivance in a timepiece by which the pressure of the wheels (which move always in one direction) and the vibratory motion of the pendulum or balance-wheel are accommodated the one to the other. By this contrivance the wheelwork is made to communicate an impulse to the regulating power (which in a clock is the pendulum and in a watch the balance-wheel), so as to restore to it the small portion of force which it loses in every vibration, in consequence of friction and the resistance of the air. The leading requisite of a good escapement is that the impulse communicated to the pendulum or balance-wheel shall be invariable, notwithstanding any irregularity or foulness in the train of wheels. Various kinds of escapements have been contrived, some of which are shown in the accompanying figure. See *Clock; Watch*.

Es´car, or **Esker**, a geological formation in the superficial drift, generally consisting of a long linear ridge of sand and gravel, sometimes including blocks of considerable size. The materials are derived from the waste of till or boulder-clay, and their arrangement took place probably in water flowing in channels beneath ice-sheets, the escar becoming exposed as the ice finally melted away. In Sweden escars have been formed, season by



1, Dead-beat or repose escapement. The pallets are concentric with the axis *a*, and thus while a tooth is against the pallet the wheel is stationary.

2, Recoil escapement. The pallets are not concentric to the axis *a*, and therefore a slight recoil of the wheel takes place after the escape of a tooth (whence the name escapement). When the pallets leave a tooth, the teeth slide along their surfaces, giving an impulse to the pendulum. Lettering for 1 and 2: The anchor H L K is made to oscillate on the axis *a* by the pendulum. The teeth of the escapement-wheel A come alternately against the outer surface of the pallet K and the inner surface of the pallet H.

3, Chronometer escapement. As the balance rotates in the direction of the arrow, the tooth V presses the spring against the lever, thus pressing aside the lever and removing the detent from the tooth of the wheel. As the balance returns, V presses aside and passes the spring without moving the lever, which then rests against the stop E.

season, at the mouths of glacier-tunnels as the ice shrank back, the ice-front opening on a lake. See *Kames*.

Eschar (es'ka'r), a slough or portion of dead or disorganized tissue. The name is commonly applied to the crust or scab occasioned on the skin by burns or caustic applications.

Eschatol'ogy (es-ka-; Gr. *eschatos*, last, and *logia*, account), in theology, the 'doctrine respecting the last things', which treats of the millennium, the second advent of Christ, the resurrection, judgment, conflagration of the world, and the final state of the dead.

Escheat (es-chēt'), in law, a species of reversion arising from default of heirs. Lands, if freehold, escheat to the king or other lord of the manor; if copyhold, to the lord of the manor. By modern legislation there can be no escheat on failure of the whole blood wherever there are persons of the half-blood capable of inheriting.

Eschenbach (esh'en-ba' h), Wolfram von, German mediæval poet or minnesinger, flourished in the first half of the thirteenth century. The most esteemed of his numerous works are: *The Parzival* (printed 1477); *The Titurel*, or *The Guardian of the Graal* (printed 1477); and *The Willehalm*, a poem on the deeds of William of Orange, a contemporary of Charlemagne.

Eschscholtzia (esh-sholt'si-a), a small genus of glabrous whitish plants, of the poppy order, natives of California and the neighbouring regions. They have divided leaves, and yellow peduncled flowers. The sepals cohere and fall off as the flower opens in the form of a cap. They are now common in the gardens of Great Britain.

Eschwege (esh'vā-ge), a town of Prussia, province of Hesse-Nassau, on the Werra, 26 miles E.S.E. of Cassel. Pop. 12,540.

Eschweiler (esh'vī-lèr), a town of Prussia, in the province of Rheinland, 9 miles E.N.E. of Aix-la-Chapelle, on the Inde. It is the seat of large and varied manufacturing industries, especially in iron, copper, and zinc, and has coal-mines. Pop. 24,718.

Escobar y Mendoza (es-ko-bär' ē men-do'-tha'), Antonio, a Spanish casuist and Jesuit, born 1589, died 1669. His principal works are: *Summula*

Casuum Conscientiæ, and several scriptural commentaries. His casuistry was severely criticized by Pascal in his *Lettres Provinciales*, and the extreme laxity of his moral principles was ridiculed by Boileau, Molière, and La Fontaine.

Escrow', a legal writing delivered to a third person to be delivered by him to the person whom it purports to benefit, when some condition is performed. Upon the performance of this condition it becomes an absolute deed, but if the condition be not performed, it remains an *escrow* or scroll.

Escu'rial (Sp. *el Escorial*), a remarkable building in Spain, comprising at once a palace, a convent, a church, and a mausoleum. It is distant from Madrid about 24 miles in a north-westerly direction, and situated on the acclivity of the Sierra Guadarrama, the range of mountains which divides New from Old Castile. It was built by Philip II, and dedicated to St. Lawrence, in commemoration of the victory of St. Quentin, fought on the festival of the saint in 1557. It is popularly considered to be built on the plan of a gridiron, from the fact that St. Lawrence is said to have been broiled alive on a sort of large gridiron. The building is a rectangular parallelogram measuring 744 feet in length by 580 feet in breadth. The interior is divided into courts, formerly inhabited by monks and ecclesiastics, while a projection 460 feet in length (the handle of the gridiron) contains the royal palace. It was begun in 1563 and finished in 1584. It is of moderate height, and its innumerable windows (said to be 11,000) give it (apart from the church) somewhat the aspect of a large mill or barracks. The church is the finest portion of the whole building. The dome is 60 feet in diameter, and its height at the centre is about 320 feet. Under it is the Pantheon or family vault of the Spanish sovereigns. The library contains a valuable collection, including a rich store of Arabic MSS. The Escorial was partly burned in 1671, when many MSS. were destroyed, and was pillaged by the French in 1808 and 1813. It was restored by Ferdinand VII, but the monks, with their revenues which supported it, have long since disappeared. In 1872 it was fired by lightning, and suffered serious damage.—Cf. A. F. Calvert, *The Escorial*.

Esdraë'lon, Plain of, a fertile plain in Northern Palestine, between the Mediterranean and the Jordan, drained by the River Kishon, and now traversed by the railway from Haifa to Damascus. This plain is celebrated

for four battles having been fought there. Sisera was defeated there; Gideon and his three hundred won a battle there; Saul and Jonathan fought there; and it was there that Josiah was killed, In the centre of the plain is Megiddo (q.v.), identified with Armageddon (*Rev.* xvi, 16). Allenby won a great victory here in Sept., 1918.

Esdras, Books of, two apocryphal books, which, in the *Vulgate* and other editions, are incorporated with the canonical books of Scripture. In the *Vulgate* the canonical books of *Ezra* and *Nehemiah* are called the first and second, and the apocryphal books the third and fourth books of *Esdras*. The *Geneva Bible* (1560) first adopted the present nomenclature, calling the two apocryphal books first and second *Esdras*. The subject of the first book of *Esdras* is the same as that of *Ezra* and *Nehemiah*, and in general it appears to be copied from the canonical Scriptures. The second book of *Esdras* is supposed to have been either of much later date or to have been interpolated by Christian writers.

E'serin, or **Physostigmin**, a drug obtained from Calabar-bean, the active principle of this plant, used as a remedy in cases of tetanus (lockjaw). A solution of eserin dropped in the eye causes contraction of the pupil, and hence its use in some eye ailments, as, for instance, glaucoma.

Esher, a village and parish of England, north-west Surrey. Here is Claremont, built by Sir John Vanbrugh, in 1816 settled upon Princess Charlotte and her husband, afterwards the residence of the Orleans family when expelled from France. The so-called 'Wolsey's Tower' is the gatehouse of a palace built by William Waynflete, Bishop of Winchester. Pop. 2609.

Esk (Celtic for water), the name of two small rivers in England—one in Cumberland and the other in Yorkshire; and of several in Scotland, the chief being the Esk in Dumfriesshire, the North Esk and South Esk in Forfarshire, and the North Esk and South Esk in Edinburghshire.

Eski-jumna, a town of Bulgaria, on the northern slope of the Binar-Dagh. Pop. 10,000.

Eskilstu'na, a town of Sweden, on a river of the same name connecting Lake Maelar with Lake Hjelmars, with ironworks and manufactures of steel

goods and weapons. It is named after St. Eskil, the English apostle of Christianity in Södermanland. Pop. 28,500.

Es'kimos. See *Esquimaux*.

Eski-Sagra, or **Stara-Zagora**, a town of Bulgaria, on the south slope of the Balkans, 50 miles N.E. of Philippopolis. In its vicinity are extensive rose-gardens, orchards, and mineral springs. Pop. 28,480.

Eski-Shehr, a town of Asia Minor, 90 miles S.E. of the Sea of Marmora, with warm baths and manufactures of meerschaum pipes. Fighting took place near the town in 1921, between the Greeks and Turks. Pop. 20,000.

Esmarch (es'märh), Johannes Friedrich August von, German surgeon, born in 1823, died in 1908. He held high official positions during the Schleswig-Holstein and Franco-German Wars, and was a great authority on gunshot wounds. He also originated valuable improvements in barrack-hospitals and ambulances, introduced the antiseptic treatment into Germany, and was the author of several surgical works.

Es'neh, a town of Upper Egypt, on the left bank of the Nile, 28 miles S.S.W. of Thebes, on the site of the ancient Latopolis, now easily reached by railway and river. Among the ruins there is a beautiful portico of twenty-four lofty and massive columns, belonging to a temple of Kneph (the only portion of the temple cleared out), and erected in the Ptolemaic and Roman period, with a zodiac on the ceiling. Esneh has a caravan trade, manufactures cottons and pottery, and is very healthy. There is an irrigation barrage here. Pop. 15,800.

Esoc'idæ, the family of fishes to which the true pike (*Esox lucius*) belongs, as also the much larger maskinongy (*E. nobilior*) of America.

Espal'ier, in gardening, a sort of trelliswork on which the branches of fruit trees or bushes are extended horizontally, with the object of securing for the plant a freer circulation of air as well as a full exposure to the sun. Trees thus trained are not subjected to such marked nor so rapid variations of temperature as wall trees.

Espartero (es-pa ' r-tā'rō), Baldomero, Duke of Vittoria, a Spanish statesman, born 1792, died 1879. The son of a wheelwright, he was

educated for the priesthood, but joined the army as a volunteer in 1808. He took a leading part in the conflict with the Carlists, and was one of the most prominent men in Spain during several decades of the nineteenth century. He was regent of the kingdom from 1841 to 1843, and again head of the Government from 1854 to 1856. He was exiled to England for several years (1843-7). In 1870 his name was vaguely put forward in the Cortes as a candidate for the throne, but the proposal was not supported with any enthusiasm, and the closing years of his life were spent in retirement.

Espar'to, or **Alfa**, a plant growing in Spain and North Africa, long applied to the manufacture of cordage and matting, and also extensively used for paper-making. This plant, called by botanists *Stipa* or *Macrochlōa tenacissima*, is a species of grass 2 to 4 feet high, covering large tracts in its native regions, and also cultivated, especially in Spain.

Esperanto, an artificial language for international use invented by Dr. Zamenhof of Warsaw, who first published an account of it in 1887. The language was afterwards taken up for practical purposes in many countries, its use being promoted by special societies and periodicals. Its structure is so simple that the whole grammar can be completely mastered in an hour. There are no exceptions to the rules, perfect regularity being a leading feature of the language. The essential roots number only some 900, including grammatical inflexions, prefixes, and suffixes, and these are chosen from the principal European languages in such a way as to make their mastery easy to any person of ordinary education. The alphabet consists of twenty-eight letters, each with an invariable sound. There are no silent letters. The accent is always on the penultimate syllable. All nouns end in *-o* in the singular, and all adjectives in *-a*. The plural of these is formed by adding *-j* (pronounced *y*). All derived adverbs end in *-e*. The only case inflexion is *-n* for the objective. The verbal endings are: *-i* for the infinitive; *-as*, *-is*, *-os* for the present, past, and future tenses respectively; *-us* for the conditional; *-u* for the imperative; *-anta*, *-inta*, *-onta* for the present, past, and future participles active respectively; -



Esparto or Alfa.

ata, *-ita*, *-ota* for the present, past, and future participles passive respectively. The definite article is *la* in all cases and numbers, and there is no indefinite article. An ingenious system of prefixes and suffixes enables all shades of meaning to be expressed. Thus: *bona*, good, *malbona*, evil; *patro*, father, *patrino*, mother; *gepatroj*, parents; *kudri*, to sew, *kudrilo*, needle; *arbo*, tree, *arbaro*, forest; *bela*, beautiful, *beleco*, beauty; *morti*, to die, *mortigi*, to kill. The following is the Lord's Prayer in Esperanto: Patro Nia, kiu estas en la cielo, sankta estu Via nomo. Venu regeco Via. Estu farata volo Via, kiel en la cielo, tiel ankaŭ sur la tero. Panon nian ciutagan donu al ni hodiaŭ, kaj pardonu al ni ŝuldojn niajn, kiel ni ankaŭ pardonas al niaj ŝuldantoj. Ne konduku nin en tenton; sed liberigu nin de la malbono: car Via estas la regado, la forto, kaj la gloro eterne. Amen! The British Esperanto Association was founded in the autumn of 1904; its official organ is *The British Esperantist*. International Esperanto congresses have been held since 1905, the last in 1920 at the Hague.—BIBLIOGRAPHY: J. C. O'Connor, *Esperanto: the Student's Complete Text-Book* (revised by Dr. Zamenhof); Underhill, *Esperanto and its Availability for Scientific Writings*.

Espionage (from the French word *espion*, a spy) is the acquirement of information by secret methods and by special agents, as opposed to its acquirement openly by combatants in the ordinary course of military operations. Espionage is recognized by international law under the Hague Convention, Article 24 of the Annexe to which reads as follows: "Ruses of war and the *employment of measures necessary for obtaining information* about the enemy and the country are considered permissible". The right given by this rule does not, however, extend to the employment of force to extract information from enemy subjects as to their own armies, so that it follows that methods of espionage must be of a persuasive, and, so to speak, peaceful nature.

Espionage is carried on both in peace and war, but the conditions under which secret service agents work differ to a very marked extent according to the state of affairs between the two countries. In peace-time, though many countries maintain secret service agents in other states, yet these same agents can expect no assistance from their Governments in the event of their being detected. In this case it is a diplomatic fiction that nothing is known of them or of the reasons for their activities. The agent, therefore, in

consideration of a sufficient allowance, takes the risk of a lengthy term of imprisonment if he is so unfortunate as to be found out.

In time of war the condition of non-interference naturally exists as a matter of course, and the secret service agent or spy is liable to the death penalty if discovered, and the fact that he has or has not obtained and transmitted information does not affect the case. In time of peace every nation of any importance maintains representatives in other states. Among the recognized duties of these representatives is the obtaining and transmitting of information about naval and military matters which may be of interest to their Governments. This is not regarded as espionage provided the information is obtained by the representative in his official capacity; it becomes so when resort is had to disguise or dissimulation, and, in fact, dissimulation is the essence of the offence. It follows, therefore, that a spy—one who practises espionage—must act in a clandestine manner in order to bring himself within the technical definition of the offence (by international law).

The characteristics of the act of spying are laid down in Article 29 of the Hague Convention, and the definition there given is as follows: "A person can only be considered a spy when, acting clandestinely or on false pretences, he obtains or endeavours to obtain information in the zone of operations of a belligerent, with the intention of communicating it to the hostile party...".

From this definition it appears that action in the 'zone of operations' is a necessary concomitant of the offence, and that, therefore, persons operating outside that zone cannot technically be charged with espionage; and to a certain extent this is so. A person may be domiciled in a belligerent country, and may, while pursuing his ordinary vocation, collect and transmit openly information of value to his own country; in the absence of dissimulation, such a person could not be charged with espionage, though he could be with war-treason. As, by international law, war-treason is punishable by death, the result is the same as if all the characteristics of spying had been present.

Espionage has been brought to a fine art in many countries, and complex organizations for its practice exist. Information may conceivably be collected with comparative ease by trained agents, but it is when it comes to

disposing of that information that the troubles of the secret service agent begin. A poison requires an antidote, and the system of counter-espionage to a great extent provides this antidote. In accordance with this system, steps are taken to mark down and know all secret-service agents engaged in espionage work in the country concerned; their operations are then followed and, to a certain extent, controlled till such time as the psychological moment arrives when all, including the master-brain, are drawn into the net and disposed of.

In a military sense a spy means a man, whether soldier or civilian, who penetrates in disguise behind the enemy lines and brings back information about his dispositions. By the customs of war the penalty inflicted on a spy caught in the act is death after trial; but should a man known to have acted as a spy on some former occasion be subsequently captured in the course of military operations, he cannot be punished for his former act, and must be treated as a prisoner of war.

The following examples may serve to show what can be considered spying and what cannot. 'A', a soldier, in presence of the enemy, volunteers to obtain exact information as to the strength of a certain hostile post. To this end he, wearing his uniform and carrying a weapon of some kind, approaches the post by stealth, and secretes himself in a convenient place for seeing and hearing. If he is discovered, and attempts to escape, he may be shot in the process; but if he is captured, he must be treated as a prisoner of war and not as a spy. 'B', another soldier, speaking the enemy language, disguises himself as an officer of the enemy forces, and in this disguise penetrates behind the lines and mixes with the enemy troops. On discovery and capture he may be tried as a spy and shot.

In the first case 'A' was acting as a combatant in the ordinary course of military operations, and no disguise was present; in the second case 'B' was acting clandestinely and under false pretences, i.e. was masquerading as an officer of the enemy forces, and the necessary dissimulation was present.

Espir'ito-Santo ('Holy Spirit'), one of the maritime states of Brazil, bounded north by Bahia, south by Rio-de-Janeiro; length, about 260 miles; breadth, about 120 miles; area, 17,310 sq. miles. Pop. 434,500.

Espir'itu-Santo, an island of the Pacific, the largest of the New Hebrides, with some 20,000 inhabitants.

Esprits Forts (Fr., bold spirits), a term applied to the French school of freethinkers, which included Voltaire, Diderot, Helvetius, D'Alembert, and others. The Esprits Forts, are, however, distinguished from the English free-thinkers. Whilst the latter were only aiming at freedom of religious thought, the Esprits Forts were more radical and revolutionary, seeking to bring about the abolition of the existing order and the substitution of a system based upon pure reason and the supremacy of intellect.

Esquimault (es-kwī'ma'lt), a harbour and naval station on the south-east coast of Vancouver Island, about 3 miles from Victoria, the capital of British Columbia. The harbour is almost landlocked, and, with the 'Royal Roads' outside, is capable of giving safe anchorage to a fleet of vessels of the largest size. It is the station of H.M. ships on the Pacific coast, is a fortified naval arsenal, and since 1906 has been garrisoned by Canadian troops.

Esquimaux (es'ki-mōz), or **Eskimos**, a race inhabiting the Arctic coasts of North America, from Greenland to Behring's Strait, and extending into Asia. They call themselves *Innuits*, 'the people', 'men'; their other name is from an Algonquin word signifying eaters of raw flesh, and seems to have been given them first by the Jesuit Father Biard in 1611. They consist of three principal stocks—the Greenlanders; the Esquimaux proper, in Labrador; and the Western Esquimaux, found along Hudson's Bay, the west side of Baffin's Bay, the polar shores as far as the mouths of the Coppermine and Mackenzie Rivers, and both on the American and Asiatic sides of Behring's Strait. The entire Eskimo population is estimated at 27,000, of which 15,600 live in North America and 11,000 in Greenland. Their leading physical peculiarities are a stunted stature, flattened nose, projecting cheek-bones, eyes often oblique, and yellow and brownish skin. Seal-skins, reindeer and other furs are used as materials for dress, according to the season, as well as skins of otters, foxes, and martens. In summer they live in tents, covered with skins; in winter they may be said to burrow beneath the snow. In Greenland houses built of stone and cemented with turf are used as permanent habitations. Vegetation being extremely stunted within the limits of their territories, their food consists of the flesh of whales, seals, and

walruses, often eaten raw; and they show remarkable skill in fishing and hunting. Their weapons are bows and arrows, spears or lances, generally pointed with bone, but sometimes with metal. Their only domestic animal is the Esquimaux dog. In intellect they are by no means deficient; in manners they are kind and hospitable. Their religious ideas appear scanty, but success has attended the labours of the Danish missionaries in teaching them the Christian religion.—BIBLIOGRAPHY: H. Rink, *Tales and Traditions of the Eskimo*; V. Stefansson, *My Life with the Eskimo*.

Esquimaux Dog, or **Eskimo Dog**, a breed of dogs extensively spread over the northern regions of America and of Eastern Asia. It is rather larger than the English pointer, but appears smaller on account of the shortness of its legs. It has oblique eyes, an elongated muzzle, and a bushy tail, which give it a wolfish appearance. The colour is generally a deep dun, obscurely barred and patched with darker colour. It is the only beast of burden in these latitudes, and with a team of such dogs attached to his sledge the Eskimo will cover 60 miles a day for several successive days.

Es'quire (O.Fr. *escuyer*, from Lat. *scutum*, a shield); originally, a shield-bearer or armour-bearer; an attendant on a knight; hence in modern times a title of dignity next in degree below a knight. In England this title is properly given to the younger sons of noblemen, to officers of the king's courts and of the household, to counsellors at law, justices of the peace while in commission, sheriffs, gentlemen who have held commissions in the army and navy, &c. It is usually given to all professional and literary men, and nowadays, in the addresses of letters, *esquire* may be put as a complimentary adjunct to almost any person's name. In heraldry the helmet of an esquire is represented sideways, with the vizor closed.

Esquiros (es-kē-ros), Henri Alphonse, French poet, romancist, and miscellaneous writer, born at Paris 1812, died at Versailles 1876. His first work, a volume of poetry, *Les Hirondelles*, appeared in 1834. This was followed by numerous romances, and a commentary on the life of Christ (*L'Évangile du Peuple*), for which he was prosecuted and imprisoned. He then published *Les Chants d'un Prisonnier*, poems written in prison; *Les Vierges Folles*; *Les Vierges Sages*; *L'Histoire des Montagnards*. Having to leave France in 1851, he resided for years in England, and wrote a series of essays for the *Revue des Deux Mondes* on English life and character, which

were translated under the title of *The English at Home*, and were very popular. He also wrote a similar work on the Dutch. Other works are: *Religious Life in England*, and *Charlotte Corday*.

Essad Toptani, Pasha, Albanian soldier and national leader, born at Tirana in 1856. He was a descendant of the Toptani family who had ruled in Albania in the fifteenth century. Trained for the army, he served in Macedonia and Anatolia, and in 1897 was rewarded with the title of Pasha for his services in the war against Greece. Abdul Hamid, however, who feared the power of the Toptani family, had the brother of Essad Pasha murdered, and the latter became the mortal enemy of the Sultan. He nevertheless accepted the rank of brigadier-general, and commanded the local troops at Janina. In 1908 he joined the Young Turks, and was one of the deputation which brought the news of his deposition to the Sultan. He was in command of the troops at Scutari, when the powers declared in favour of the autonomy of Albania in 1912. Essad Pasha had hoped to be chosen ruler of the new state of Albania created by the Treaty of London, but as the Prince of Wied had been appointed *mbret*, he accepted the office of Minister of War and of the Interior. Suspected by the *mbret*, he was compelled to flee from Durazzo. After the departure of the Prince of Wied, at the outbreak of the European War, he returned to Durazzo, and was appointed by the Senate (on 5th Oct., 1914) President of the Provisional Government. In spite of Austrian advances he declared war on the Central Powers, and escaped when the Austrians entered Albania. He rendered valuable services to the Allies at Salonica, but the Italians, who saw in the Pasha an enemy to their own views upon Albania, refused to grant him permission to return to his country. Essad Pasha, therefore, remained in Paris, where he was assassinated by an Albanian student named Averic Rustem on 13th June, 1920. The assassin was acquitted by a French jury in December of the same year, prominent Albanians having pleaded in favour of the murderer, and maintained that the Pasha was an ambitious adventurer and a traitor to his country.

Es'say, a composition in which something is attempted to be proved or illustrated, usually shorter and less methodical and finished than a systematic or formal treatise; so that it may be a short disquisition on a subject of taste, philosophy, or common life. The essay was the invention of Montaigne in the sixteenth century, and Francis Bacon was another

illustrious author who employed the literary form of the essay. Caution or modesty has induced many writers of note to give the title of essay to their most elaborate productions: thus we have Locke's *Essay on the Human Understanding*. There is a class of English writers to whom the descriptive term *essayist* is applied, the most illustrious being Addison, Steele, Charles Lamb, Hazlitt, De Quincey, Macaulay, Carlyle, Froude, Matthew Arnold, R. L. Stevenson, and Austin Dobson.

Essen, a town of Rhenish Prussia, situated between the Ruhr and the Emscher, 18 miles north-east of Düsseldorf, founded in the ninth century, and adorned with a fine church dating from 873. It increased with great rapidity, and became celebrated for the steel and ironworks of Krupp, the most extensive in Europe, employing till the end of the European War over 27,000 workmen. This great establishment was started in 1827 with only two workmen. In March and April, 1920, heavy fighting took place at Essen between the Government and the Communist troops. Pop. (1910), 294,629.

Essenes (es-sēnz'), or **Essæans**, a sect among the Jews, the origin of which is unknown, as well as the etymology of their name. The word may be a derivation from the Syr. *hasya*, the pious ones, or *āsyā*, physician. The Essenes appear to have sprung up in the course of the century preceding the Christian era, and disappeared on the dispersion of the Jews after the siege of Jerusalem. The sect appears to have been an outcome of Jewish mysticism and asceticism, which gradually assumed the form of a distinct organization. They were remarkable for their strictness and abstinence, and had a rule of life analogous to that of a monastic order. Property was owned in common.

Essential Oils. An essential oil is distinguished from a fatty oil by its characteristic odour, and by being slightly soluble in water and more volatile. Most of the essential oils are decomposed by alkali, but they do not yield soaps as do the fatty oils. An essential oil usually contains one chief ingredient, which may be a compound of carbon and hydrogen, e.g. *turpentine*, in which the characteristic odour is due to *pinene* (C₁₀H₁₆); or a compound of carbon, hydrogen, and oxygen, e.g. bitter almond oil where the chief ingredient is *benzaldehyde* (C₆H₅CHO); or *cinnamon bark*, containing *cinnamic aldehyde* (C₆H₅CH:CH·CHO). The extraction of these oils from plants containing them is usually accomplished by a process of

distillation with water. In some cases this is not practicable, as the oil may be decomposed by water, e.g. to obtain the essential oil from violets the flowers are macerated with hot lard; the fat absorbs the essential oil, which is then extracted from the lard by means of alcohol. In other cases the oil is extracted by means of a solvent such as petroleum spirit. Large quantities of essential oils are extracted yearly for the preparation of perfumes, the preparation of various flavourings (essences), and for use in the soap industry. Many essential oils are now manufactured synthetically, e.g. oil of wintergreen owes its fragrance to methyl salicylate, pineapple oil to ethylbutyrate, pear oil to amylacetate.

Essequibo (es-se-kē'bō), a river of British Guiana, which flows into the Atlantic by an estuary 20 miles in width after a course of about 450 miles. The district or division of Essequibo is well cultivated and extremely fertile, producing coffee, cotton, cocoa, and sugar. It was the subject of a discussion between the British and Venezuelan Governments, settled by the Arbitration Treaty of 2nd Feb., 1897.

Essex, Earl of. See *Cromwell, Thomas*.

Essex, Robert Devereux, second Earl of, in the Devereux line, was born at Netherwood, Herefordshire, in 1567. Having appeared at court, he soon became a favourite of Queen Elizabeth, by whom he was kept in attendance against his will during the defeat of the Armada. He served with more or less distinction in expeditions to Portugal and France, the latter on behalf of Henry of Navarre. In 1596 he was commander of the troops in an expedition against Spain, and distinguished himself by the capture of Cadiz. In an expedition next year he was less fortunate, and the queen, with whom he was always quarrelling, received him coldly. Presuming on the favour of Elizabeth, he behaved with rudeness to her at a Privy Council, received a box on the ear, and was told to "go and be hanged". After some months a reconciliation took place, and he was appointed Lord-Lieutenant of Ireland (1599), which was then in a state of rebellion. He returned to England in September, having been entirely unsuccessful in his government, was made a prisoner in his own house, and foolishly tried to excite an insurrection in London. After a skirmish with a party of soldiers he was compelled to surrender, and sent to the Tower. Tried for treason on 19th Feb., he was executed on 26th Feb., 1601.

Essex, a maritime county in the south-east of England, bounded by Suffolk, the Thames, Hertford, and Middlesex; area, 979,532 acres. The surface is generally level, except in the north-west, where it is undulating and sometimes hilly. The soil is in general extremely fertile, and particularly well adapted for the growth of wheat. Beans and pease also thrive uncommonly well. The other principal productions are potatoes, barley, oats, mangolds, turnips, tares, rape, mustard, and trefoil. The raising of caraway, coriander, and teasel is almost peculiar to this county. It had formerly a great extent of forest, the only survival of which is Epping Forest. The principal rivers in the county are the Roding, Crouch, Chelmer, Blackwater, and Colne. It has also the Thames, Lea, and Stour as boundary rivers. On the coast are some valuable oyster-beds, the oysters from which are exported in considerable quantities. The manufactures of the county are not very extensive, the chief being crape, silks, and straw-plait. The chief towns are: Chelmsford, the county town; West Ham, Colchester, Southend, and Harwich. The county has eight parliamentary divisions, each returning one member. Pop. 1,468,341 (1921).—Cf. *Victoria History of the Counties of England*.

Esslingen (es'ling-èn), a town of Germany, in Würtemberg, on the Neckar, 7 miles E.S.E. of Stuttgart. It is of Roman origin, was long an imperial free town, has walls flanked with towers, a castle, and an ancient Gothic church, dating from the thirteenth century, with a tower 230 feet high. In 1488 the Swabian League was formed at Esslingen. It has manufactures of machinery, articles of wood, cutlery, philosophical instruments, and spinning and other mills. Pop. 32,364.

Established Church, a Church having a form of doctrine and government established by law in any country for the teaching of Christianity within its boundaries, and usually endowed by the State. The upholders of the establishment theory maintain that it is the duty of a State to provide for the religious instruction of the people. On the other hand, it is argued that the State has no right to endow or support any particular sect or denomination, unless they assume that that denomination alone is possessed of religious truth and worth. Regarding the established *Church of England*, see *England*; for *Church of Scotland*, see *Scotland*.

Estate, the interest or quantity of interest a man has in lands, tenements, or other effects. Estates are *real* or *personal*. *Real estate* comprises lands, tenements, and hereditaments, held in freehold. *Personal estate* comprises interests for terms of years in lands, tenements, and hereditaments, and property of every other description. *Real estate* descends to heirs; *personal* to executors or administrators. In ordinary language, an estate is a piece of landed property, especially one of some size. *Estate duty*, see *Death Duties*. In political history the term estate is applied to a distinct order or class in society. The term 'fourth-estate' is often used to designate the Press.

Estates of Scotland, the name given to a body of similar constitution to the English Parliament, but with important differences, the king himself, as well as his officers, being responsible to the Estates for wrongs done. They held the power of declaring war, or entering on a peace or treaty, and with them rested the right of declaring, with or without the consent of the king, resolutions of the assembly to be law. To prevent a Bill being hurried through Parliament, it was submitted to and discussed by a committee called the *Lords of the Articles*. If sanctioned by this committee, the Bill was passed on to the whole House for approval. Another committee appointed by the Estates was called the *Auditors of Complaints*, whose duty was to hear appeals against the decisions of the king's judges, and, if necessary, to reverse their sentences.

Estates of the Realm, in Britain, are the Lords Spiritual, the Lords Temporal, and the Commons. From the circumstance that the Lords Spiritual and Temporal meet in one House, and practically form one branch of the legislature, the popular error has arisen that the sovereign forms one of the three Estates of the Realm.

Este (es'tā), a town of North Italy, 16 miles s.w. of Padua. It has a castle, the cradle of the Este family. It has also manufactures of silk goods, earthenware, and majolica; and numerous silk-mills and whetstone quarries. Pop. 11,704.

Este (es'tā), one of the most ancient and illustrious families of Italy. In the eleventh century the House of Este became connected by marriage with the German Welfs or Guelphs, and founded the German branch of the House of Este, the Dukes of Brunswick and Hanover. The sovereigns of Ferrara and

Modena were of this family, several of them being famous as patrons of letters. The lives of Boiardo, Ariosto, and Tasso were closely connected with members of this House. The last male representative of the Estes died in 1798. His daughter married a son of the German emperor Francis I, and her grandson disappeared from the land of his fore-fathers at the consummation of Italian unity in 1860.

Estella (es-tel'ya'), a town of N.E. Spain, in Navarre, on the Ega, 24 miles south-west of Pampeluna. Pop. 5658.

Este'pa, a town of Southern Spain, province of Seville, 50 miles east by south of Seville. It has a handsome Gothic church. Pop. 8234.

Estepo'na, a seaport of Southern Spain, province of Malaga, 23 miles north-east of Gibraltar. Pop. 9600.

Esterha'zy, a family of Hungarian magnates whose authentic genealogy goes back to the first half of the thirteenth century. They were zealous partisans of the House of Habsburg, to whom, during the reigns of Frederick II and Leopold I, they lent a powerful support. Among the more prominent members of the family are: Paul IV, Prince Esterhazy, a general and literary savant, 1635-1713. His grandson, Nicholas Joseph, a great patron of arts and music, founder of the school in which Haydn and Pleyel, among others, were formed, 1714-90. Nicholas, Prince Esterhazy, distinguished as a field-marshal and foreign Ambassador, 1765-1833. Prince Paul Anthony, a distinguished and able diplomatist, born 1786, died 1866; was successively Austrian Ambassador at Dresden, Rome, and Britain. He was a supporter of the national Hungarian movement.

Esters, or **Ethereal Salts**, in chemistry, a general term for substances formed by the union of an acid and an alcohol with elimination of water. Thus ethyl acetate is formed from ethyl alcohol and acetic acid. Many of them are volatile, pleasant-smelling substances.

Esther, a Jewess, who became the queen of Ahasuerus, King of Persia, and whose story is told in the book of the Old Testament called by her name. This book is supposed by some to be the composition of Mordecai himself, the uncle of the heroine. Various opinions are held regarding the time and

truth of the story; but the feast of Purim, which commemorates the events narrated, is still observed by the Jews during the month of Adar.

Esthonia, a new republic of North-Western Europe, formerly a dependency of Imperial Russia, and one of the Baltic Provinces. It is situated south of the Gulf of Finland, and is bounded by Russia, the Republic of Latvia, the Gulf of Riga, and the Baltic. The Republic of Esthonia comprises the former Russian government of Esthonia, the northern part of Livonia, and the north-western portion of Pskov. The country is divided into nine districts. It has an area of about 23,160 sq. miles, and a pop. of 1,750,000. It has for the most part a flat or undulating surface. The whole of the north side, however, rises considerably above the sea, and presents to it ranges of cliffs. The Narva is the only river of any importance; but minor streams, as well as small lakes, are very numerous. About a fourth of the surface is covered with forests of pine, birch, and alder. The crops include a little wheat, much barley and oats, and some flax, hops, and tobacco. Cattle are reared, and active fisheries are carried on. The peasantry are almost all of Finnish origin, and speak a Finnish dialect. Five-sixths of the population are Lutherans. Elementary education is compulsory, illiterates numbering about 3 per cent. There is a university at Dorpat, now called Tartu, founded in 1632, and reopened as an Esthonian university on 1st Dec., 1919. In the tenth and twelfth centuries Esthonia belonged to Denmark; it was afterwards annexed by Sweden, and in 1710 was seized by Russia. Esthonia is one of the new states formed in consequence and as a result of the European War. On 24th Feb., 1918, Esthonia declared her independence, and was recognized by Great Britain (3rd May, 1918), France, Italy, Japan, Poland, and Sweden. On 31st Dec., 1919, Esthonia concluded an armistice with the Bolshevik Government of Moscow, which recognized the republic *de jure*. In 1921 the supreme power was vested in a Constituent Assembly (elected 23rd April, 1919). Esthonia was admitted a member of the League of Nations on 22nd Sept., 1921. Reval is the capital.—Cf. M. Martna, *L'Esthonie*.

Eston, a town of England, North Riding of Yorkshire, 4 miles S.E. of Middlesbrough, with important steelworks and iron-mines. Pop. 30,634.

Estop'pel (Fr. *étouper*; Lat. *stuppeare*, to stuff with tow, to cram), in law, anything done by a party himself, which puts a period to an action by

closing the ground of controversy. Estoppels are divided into three classes: by Record; by Deed; and in Pais, or by Conduct.

Esto'vers (O.Fr. *estover*, need, necessity), in law, necessities or supplies. *Common of estovers* is the liberty of taking the necessary wood for a house or farm from another's estate.

Estrad'iot, an Albanian dragoon or light-horseman, employed in the French army in the fifteenth and sixteenth centuries. They sometimes fought on foot as well as on horseback.

Estremadu'ra, a western division of Spain, consisting of the provinces of Badajoz and Caceres. It is fertile, but not cultivated to its full extent. The Tagus and Guadiana intersect it east to west. Immense flocks of sheep graze on the rich plains. The area is about 16,000 sq. miles, and the pop. 990,990.

Estremadura, a maritime province of Portugal, divided by the Tagus into two nearly equal parts, of which the northern is the more mountainous. Wines and olives are the principal produce. The principal city is Lisbon. Area, 6937 sq. miles. Pop. 1,438,726.

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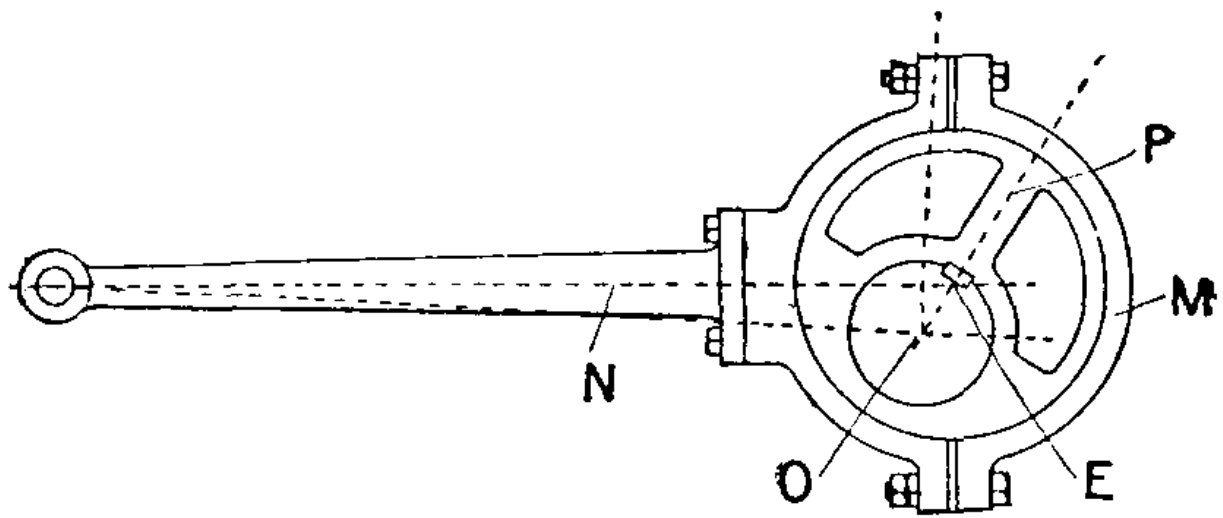
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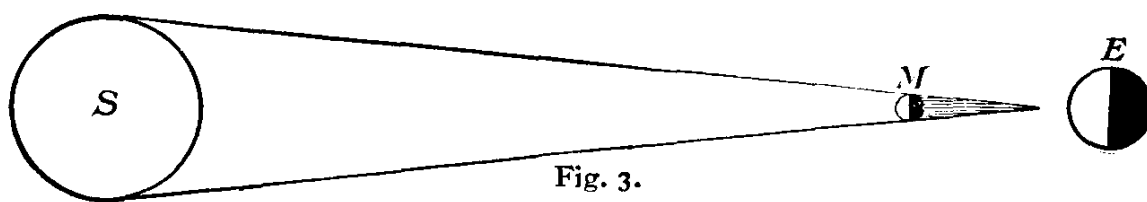
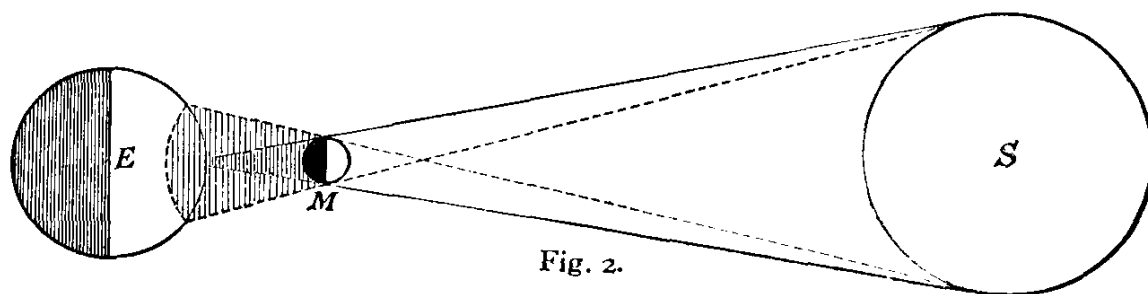
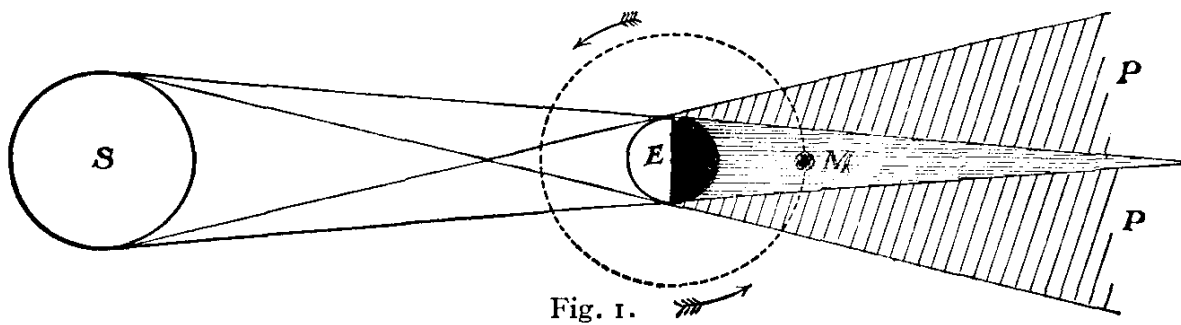
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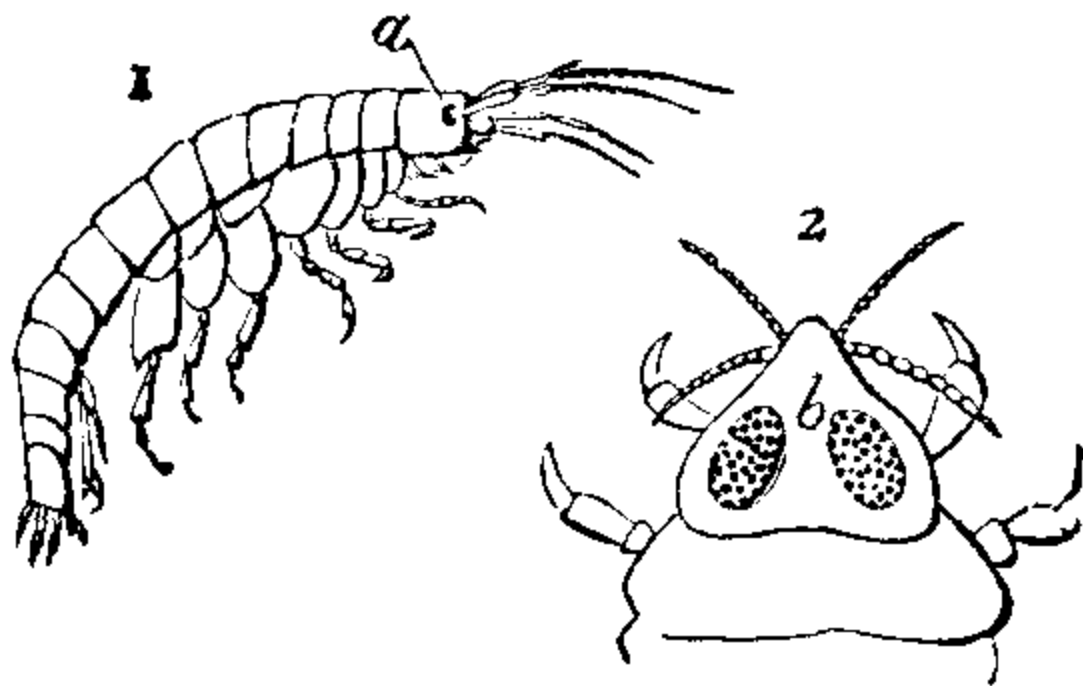


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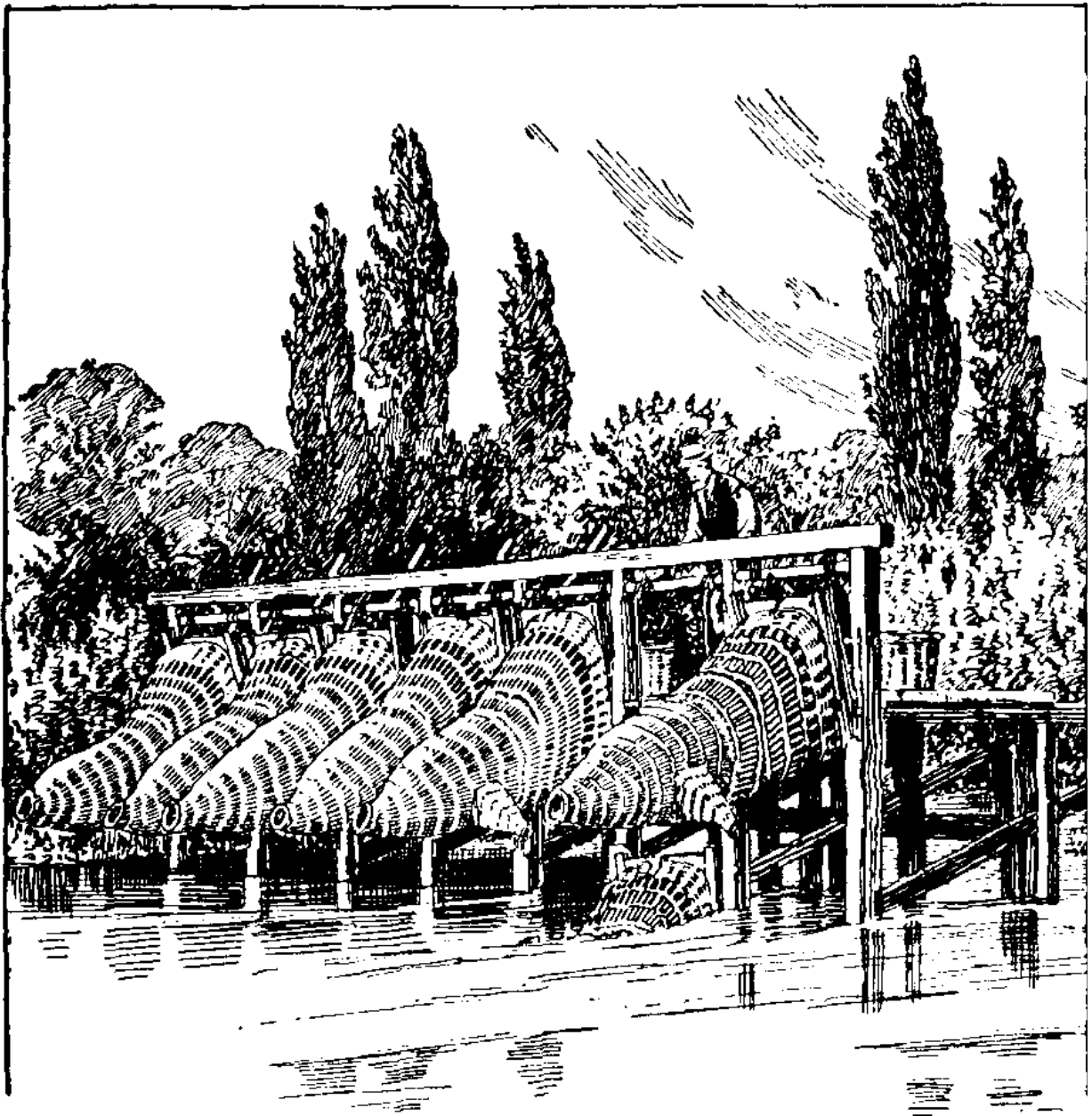
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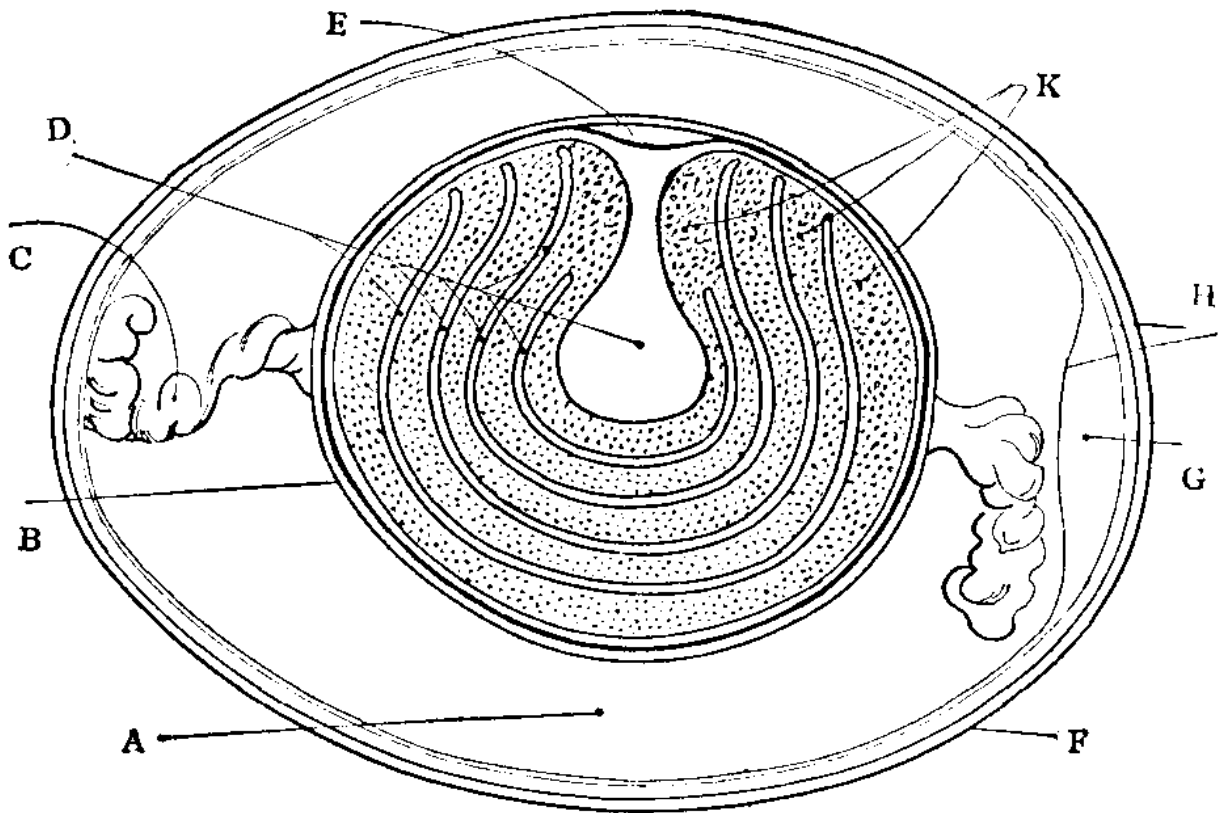
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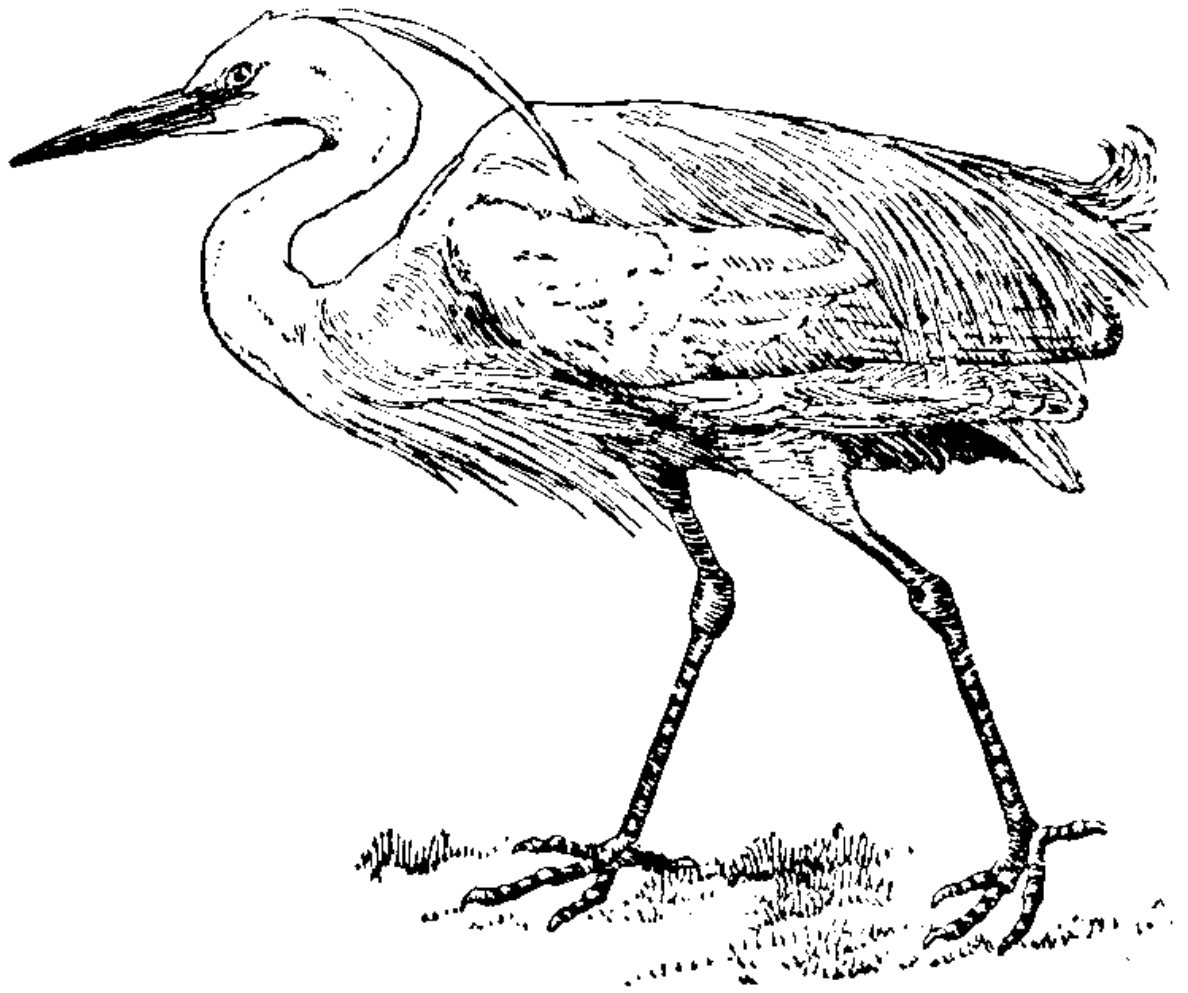
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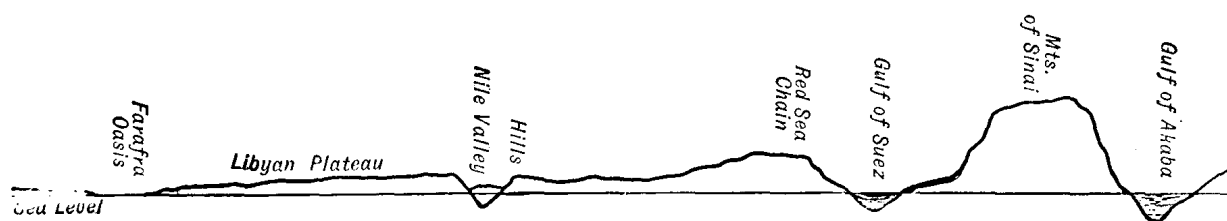
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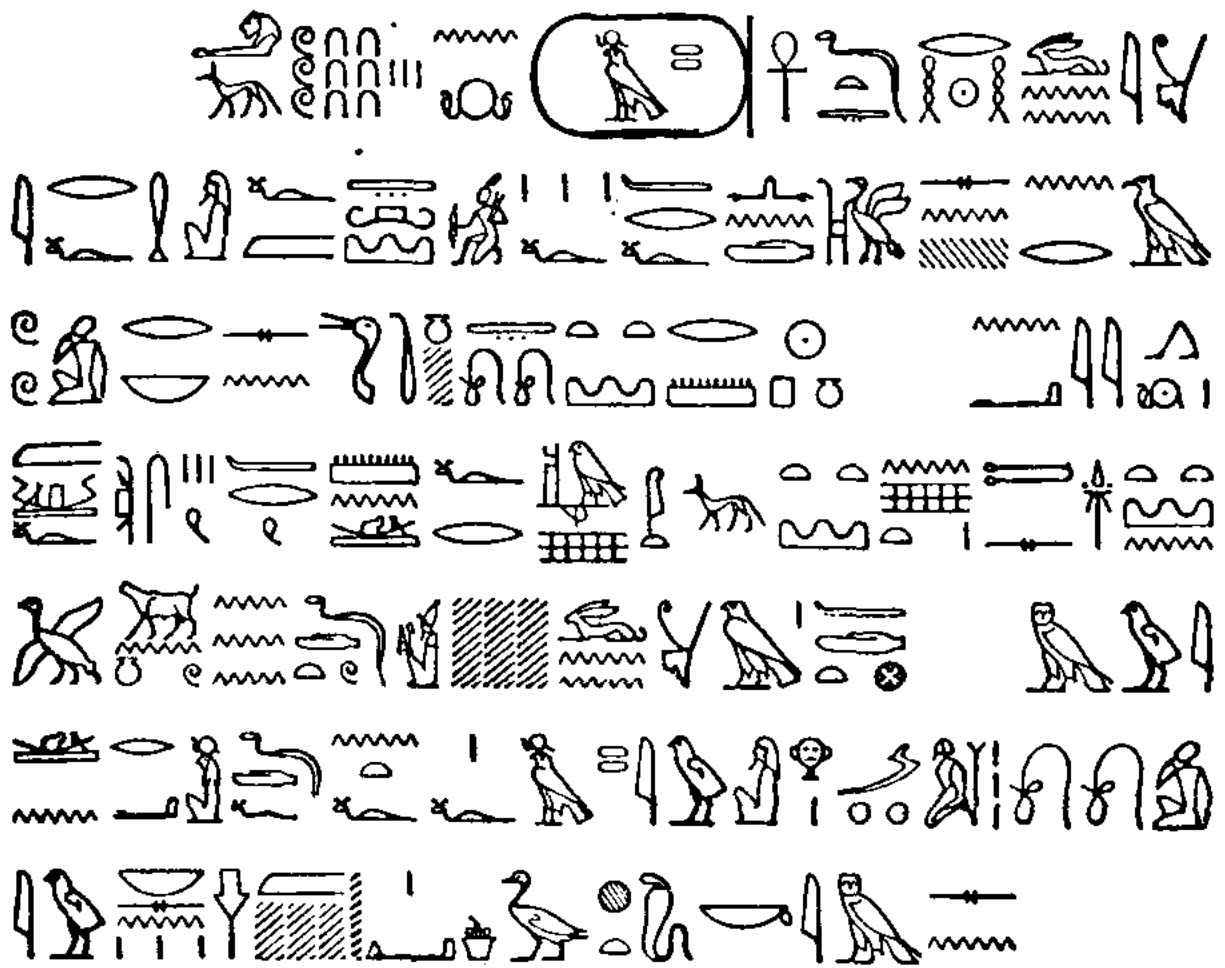
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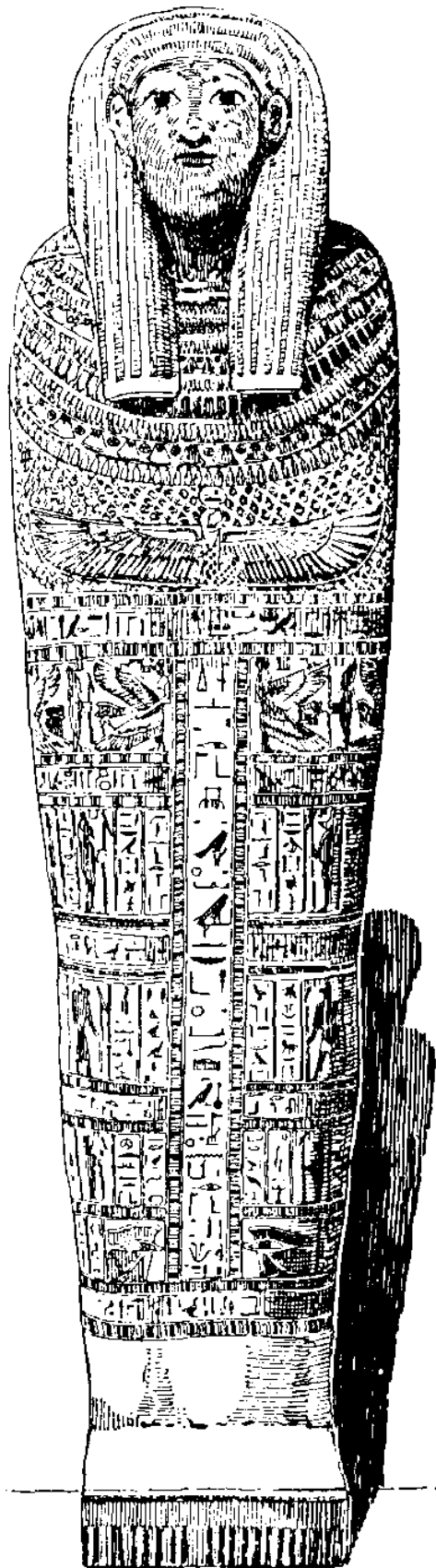
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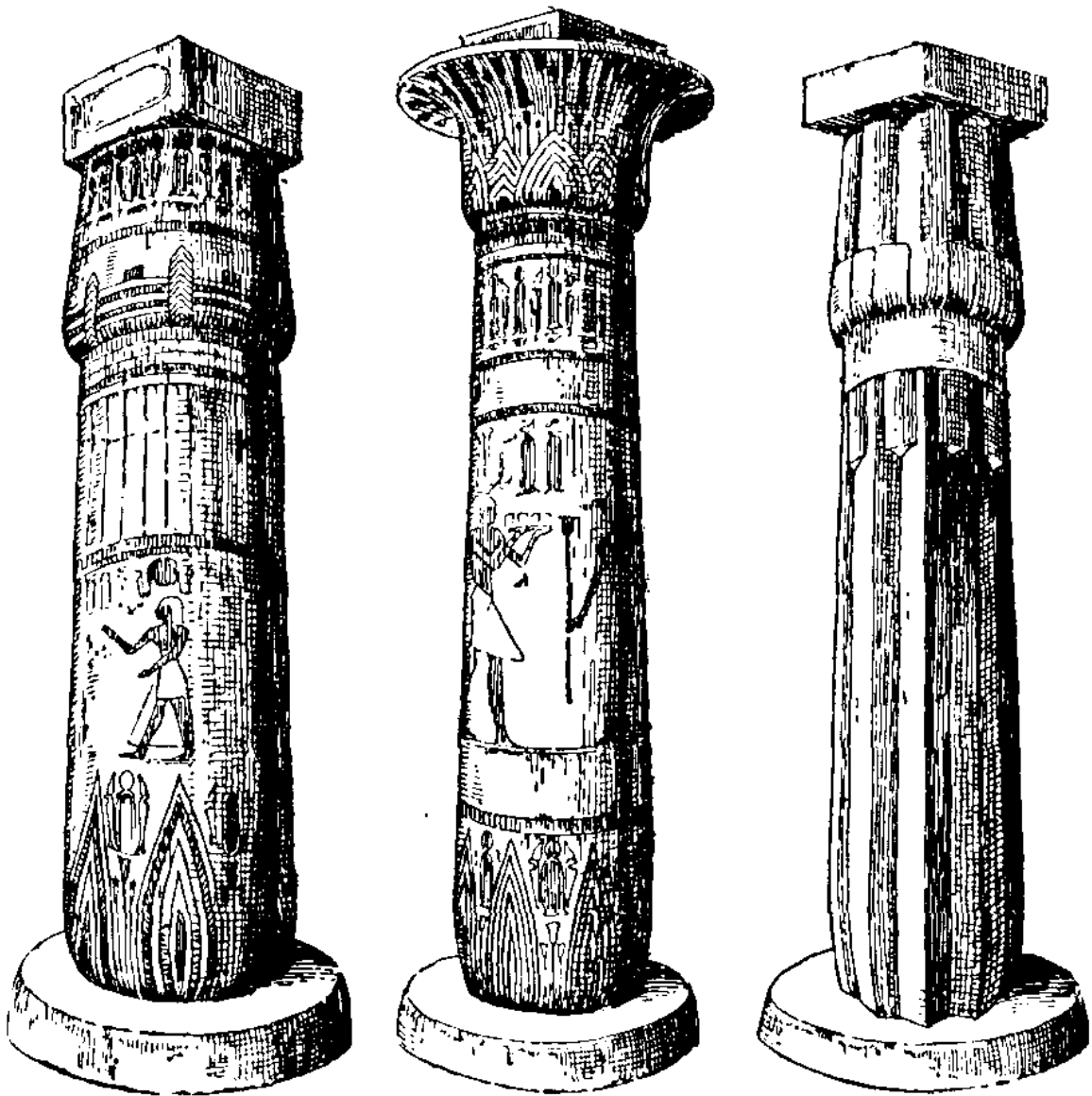
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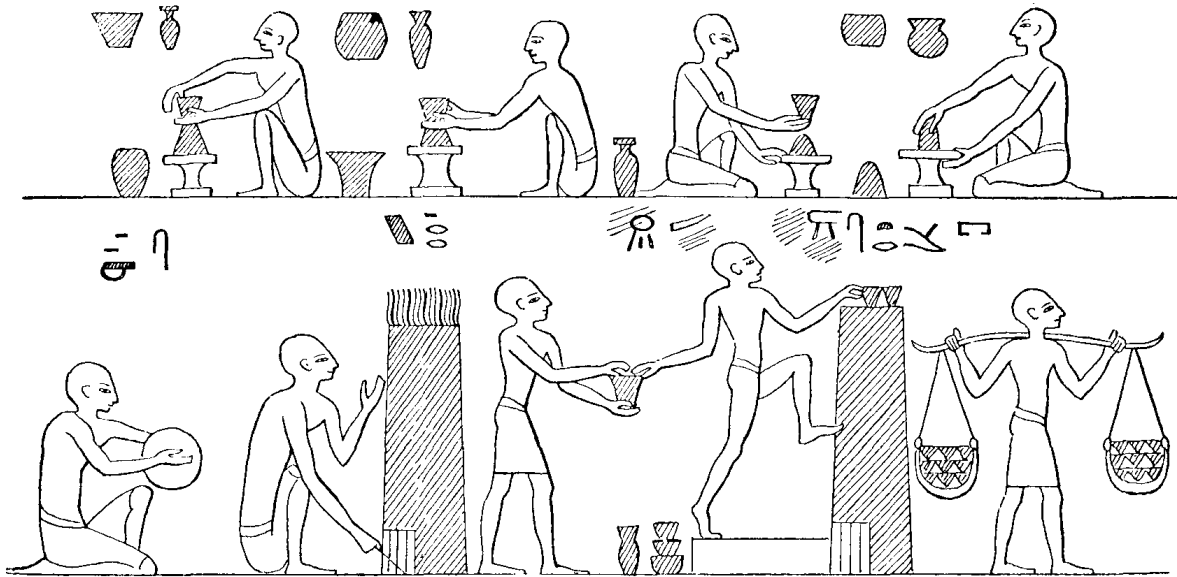
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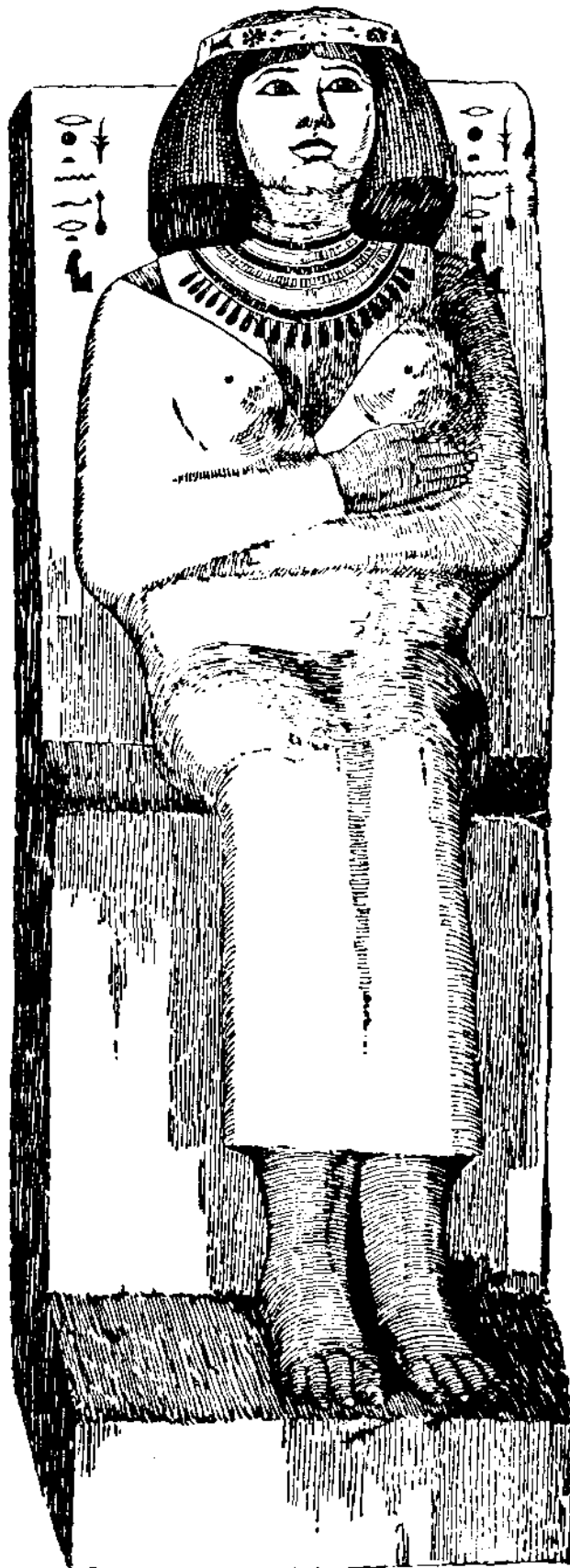
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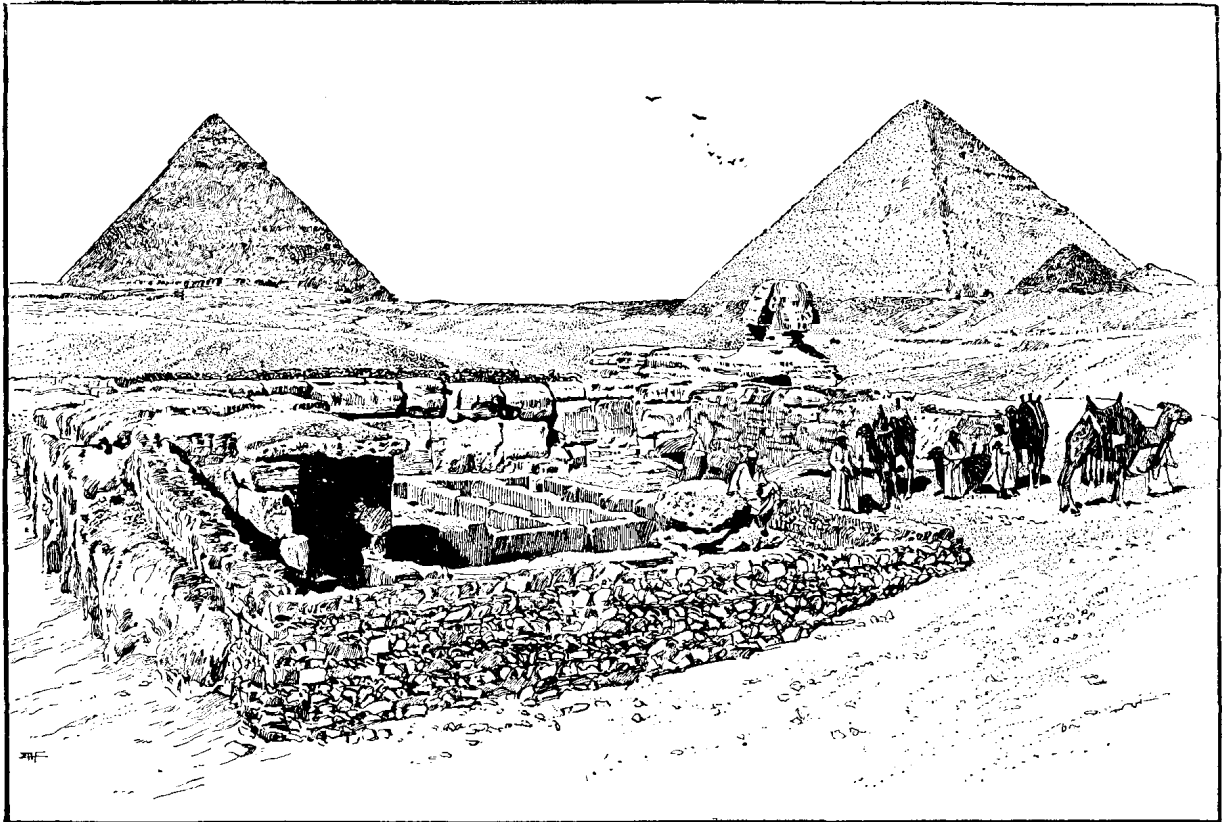


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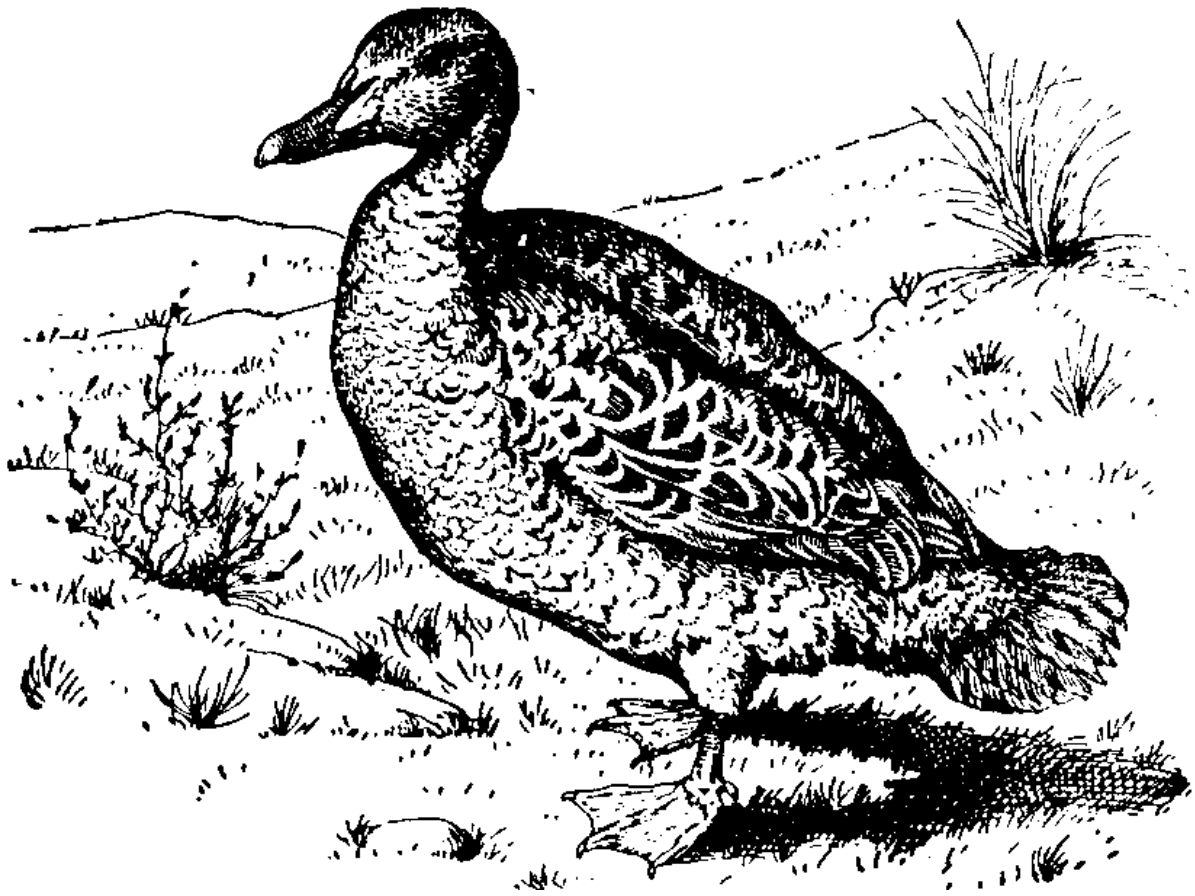
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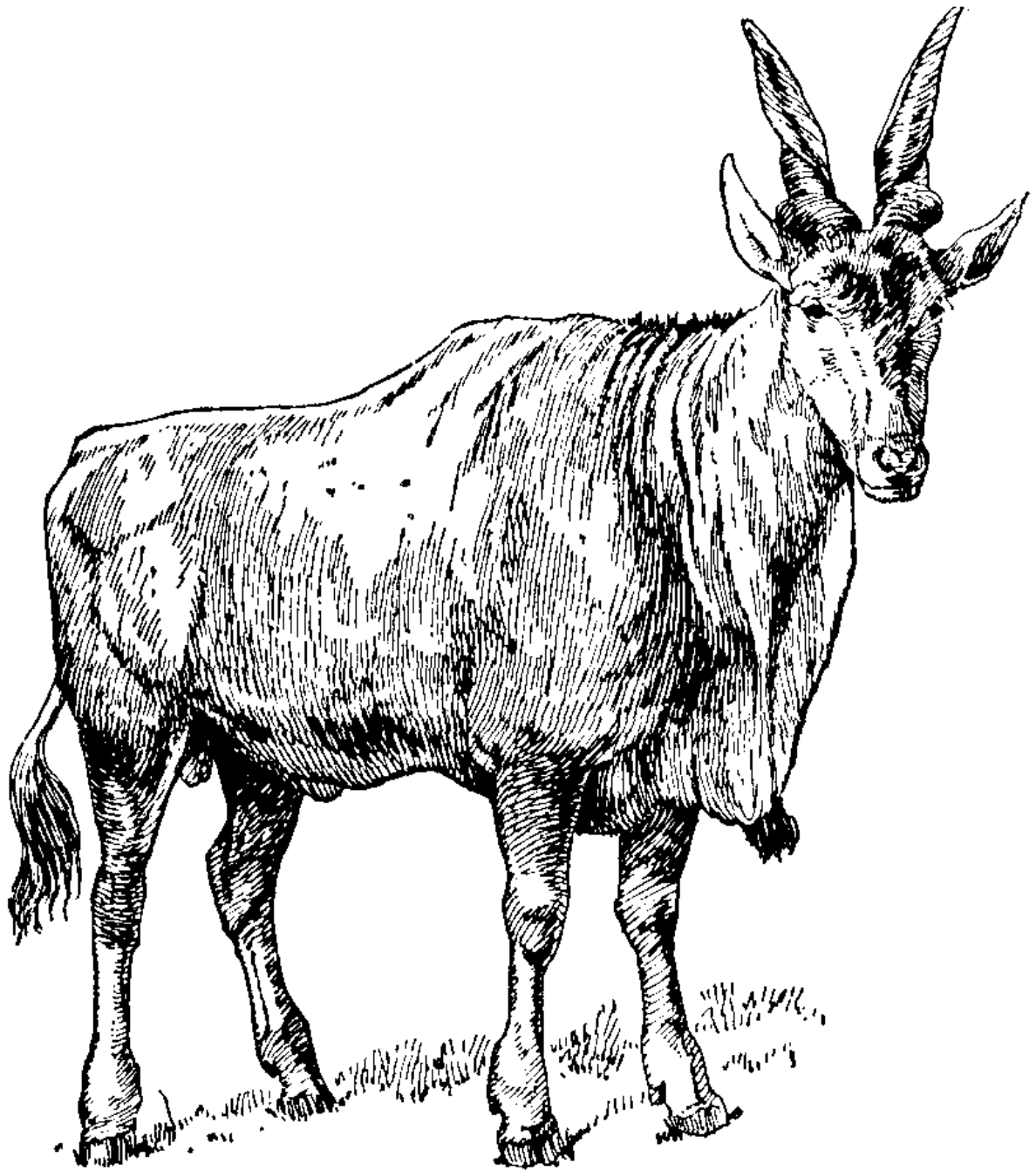
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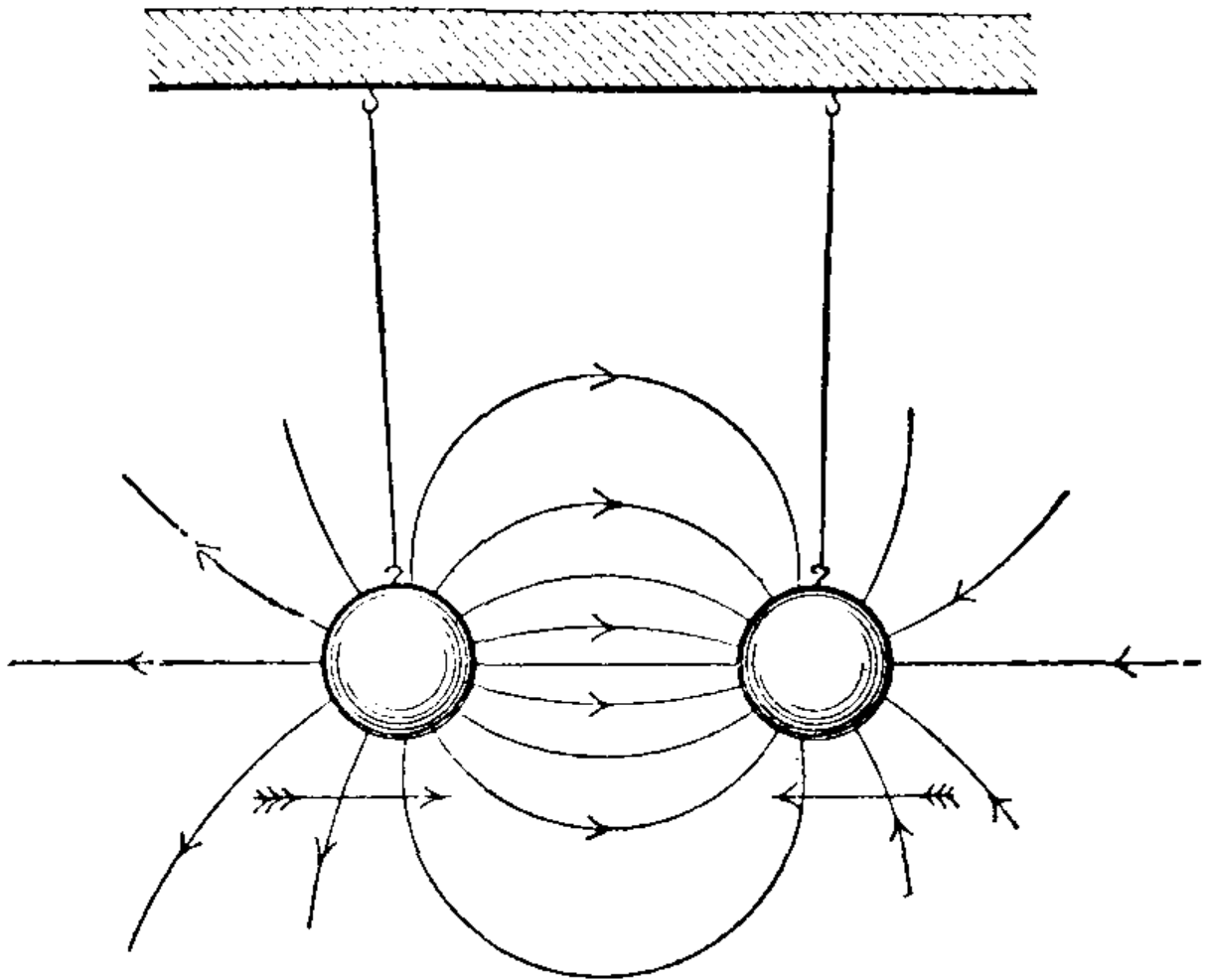
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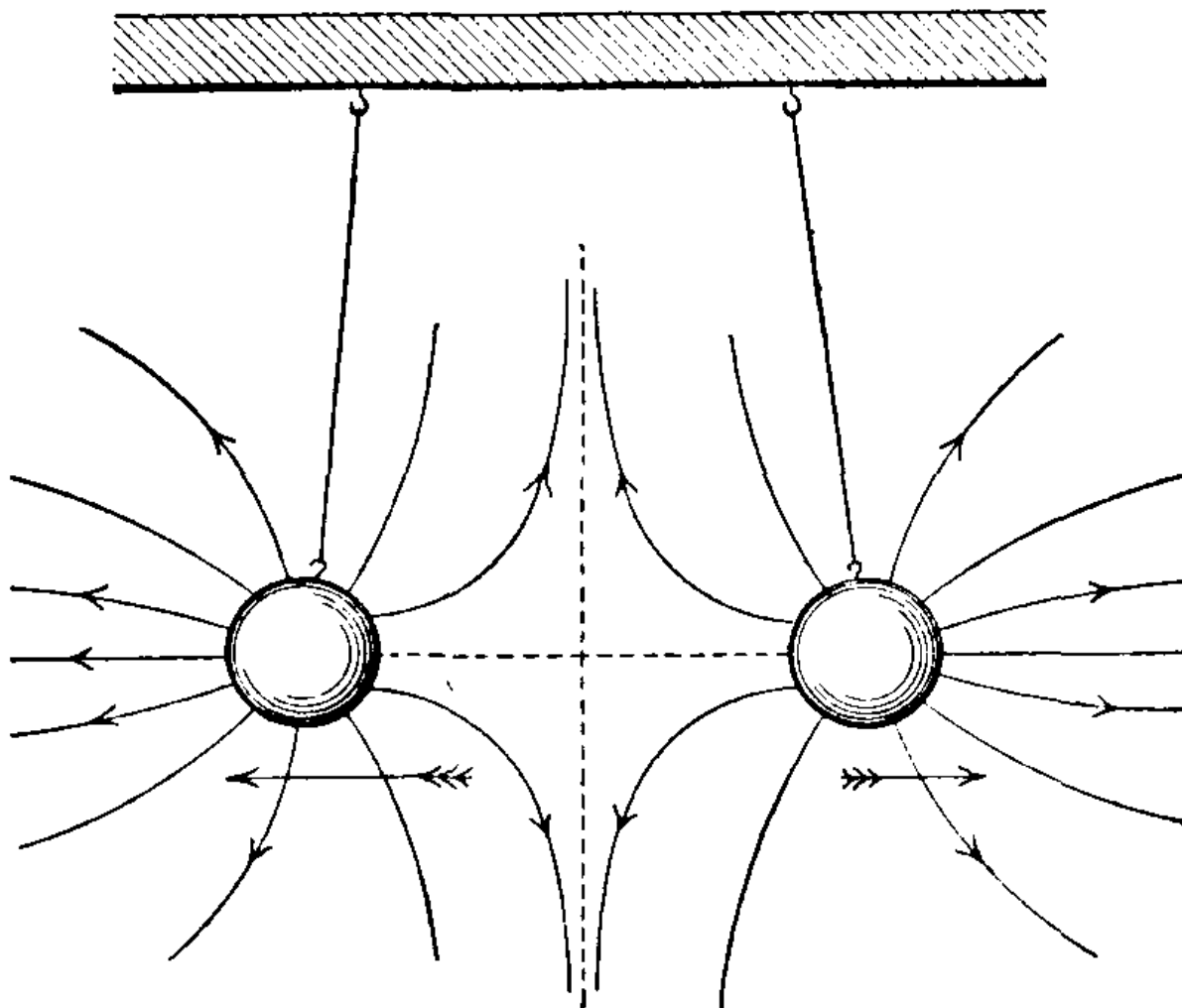
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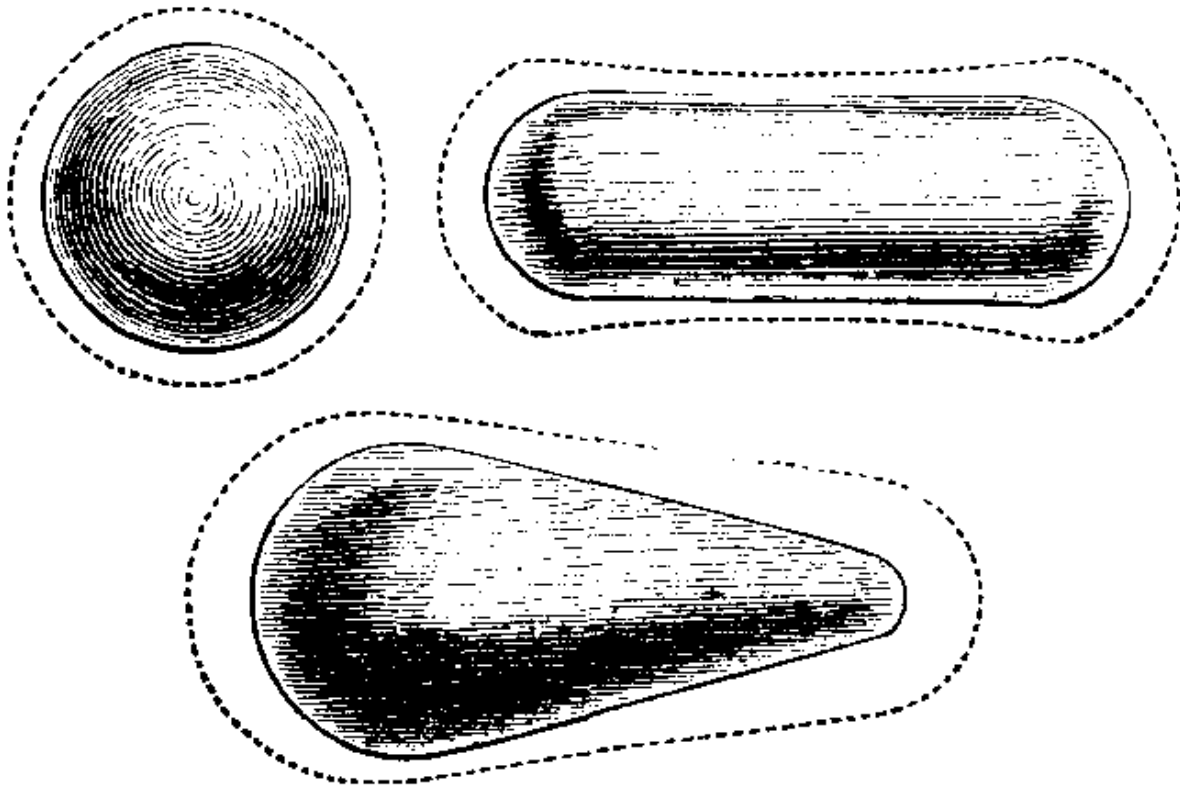
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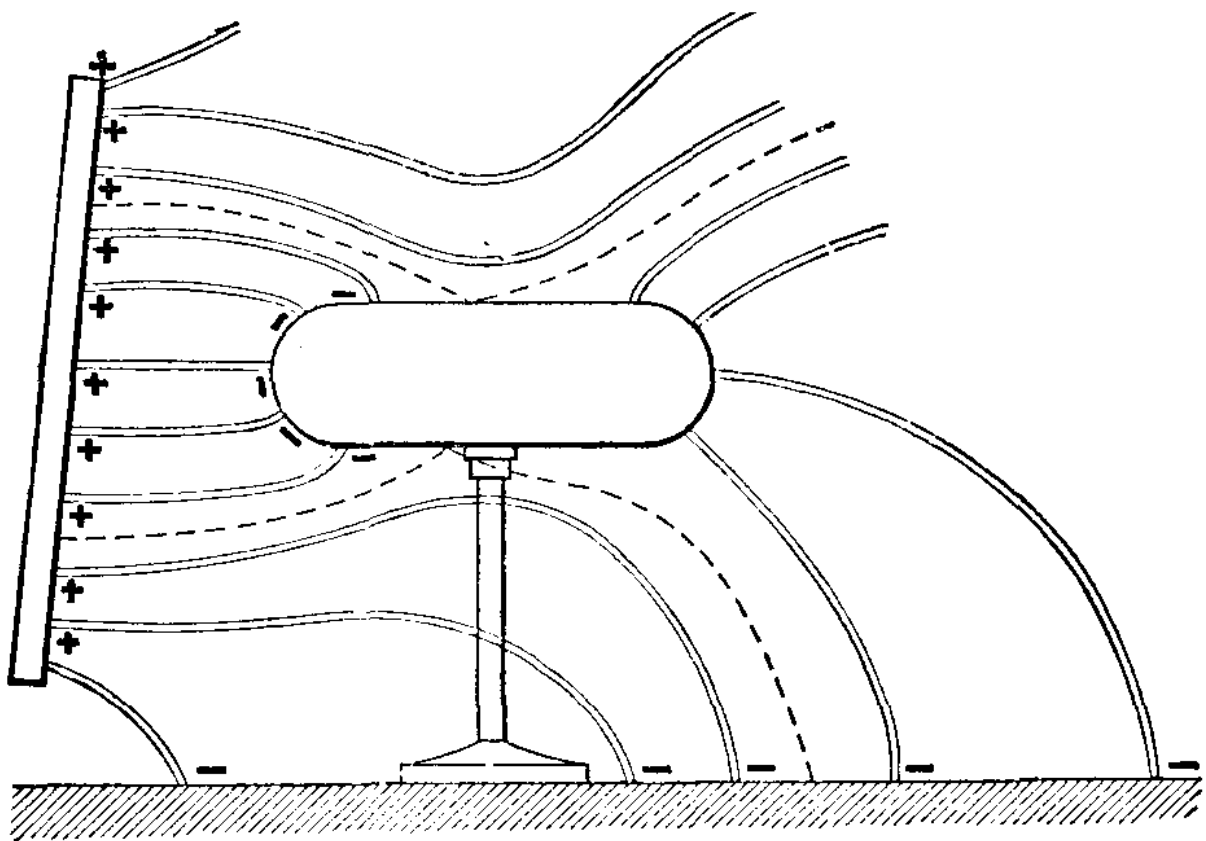
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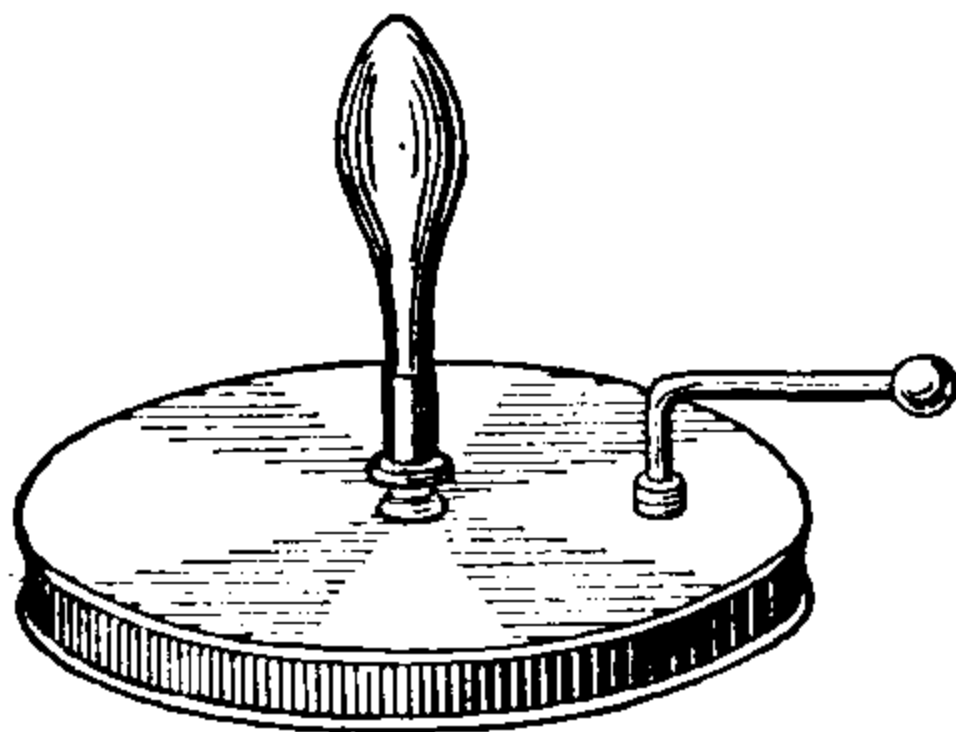
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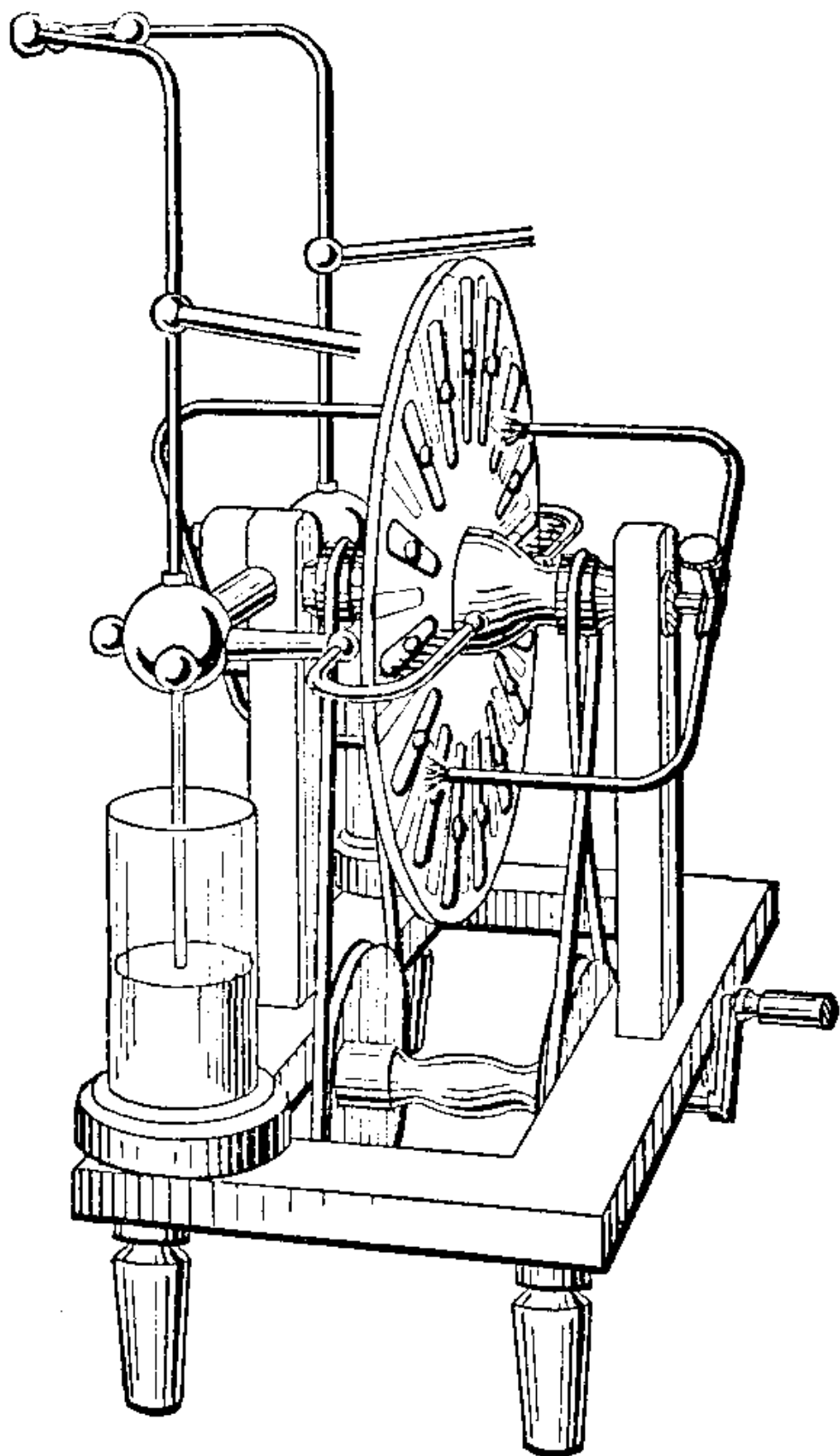
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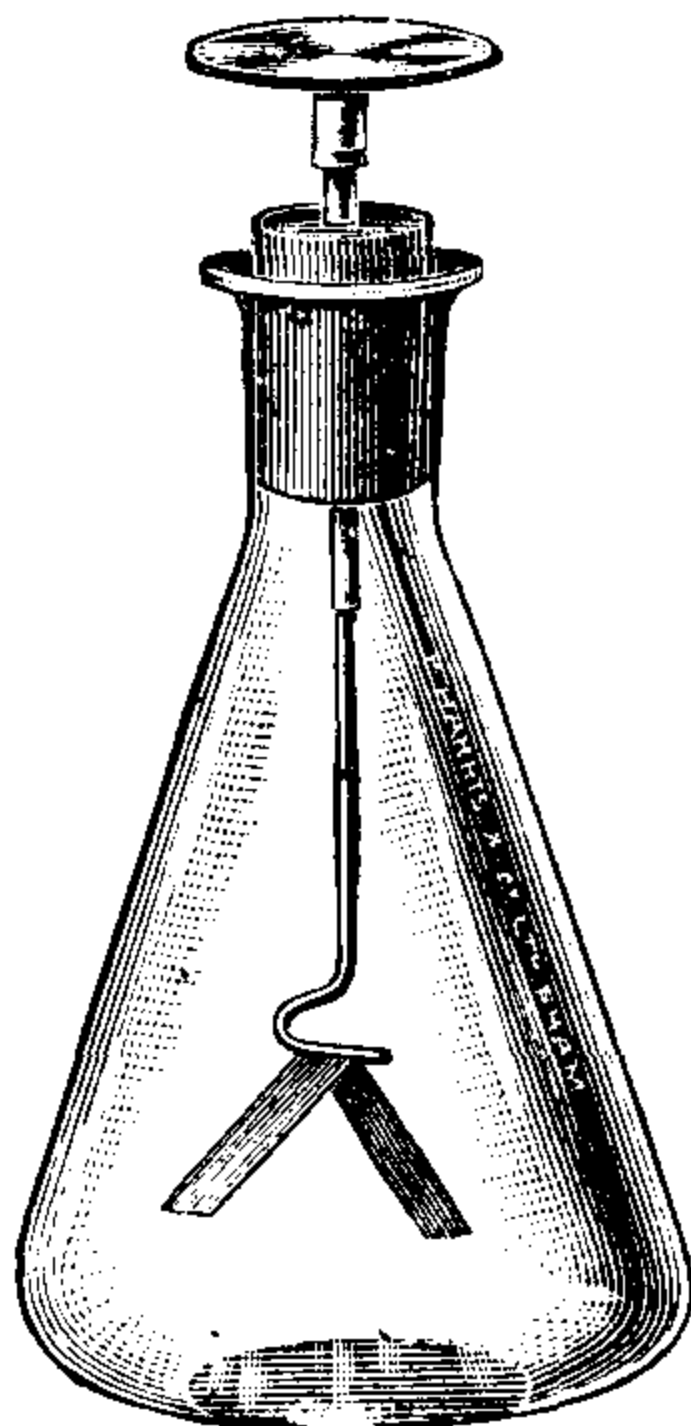
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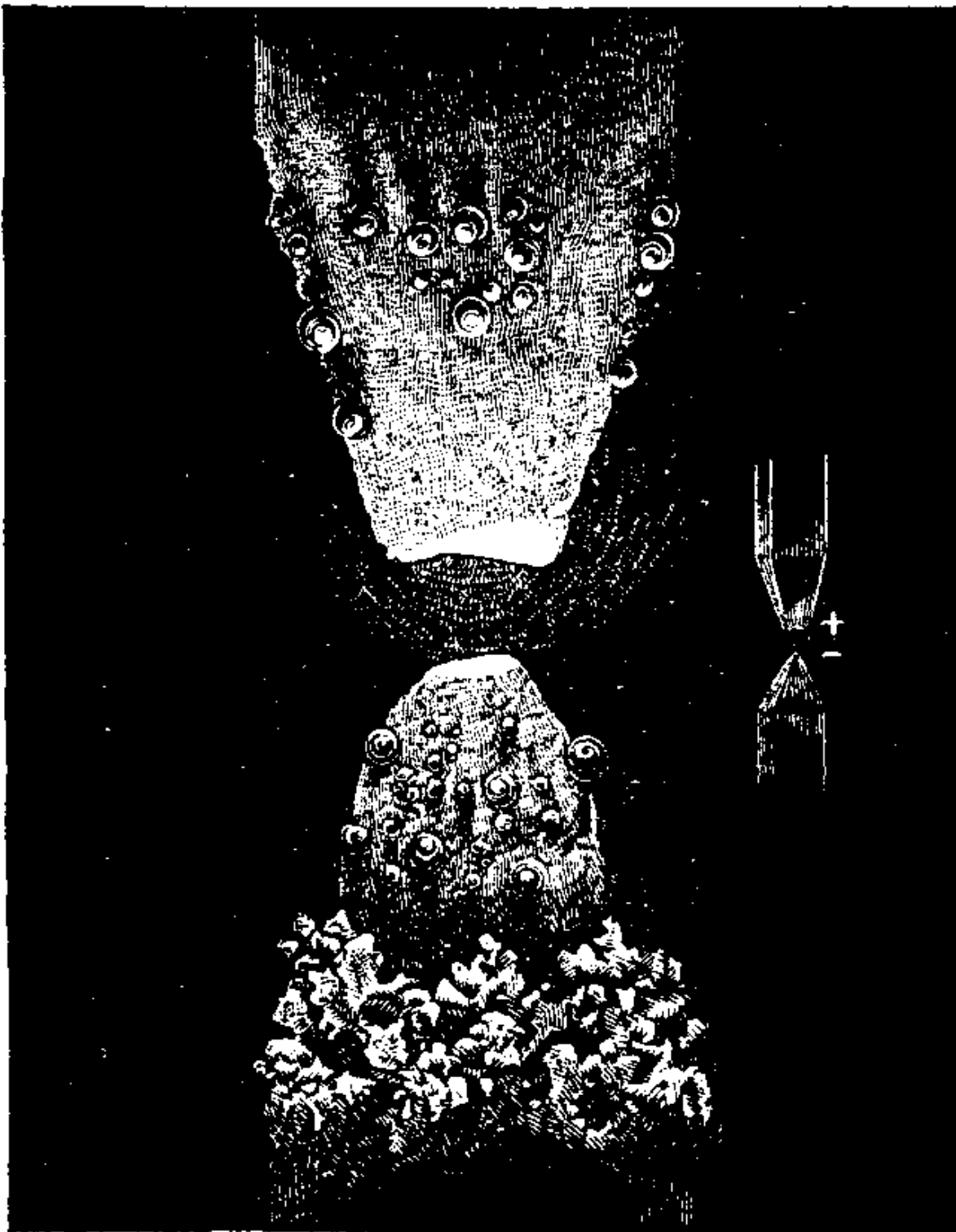
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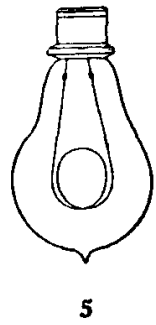
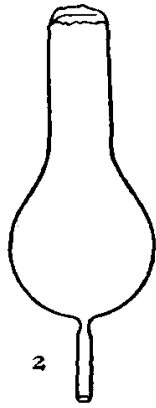
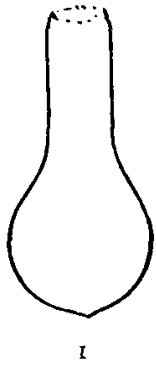
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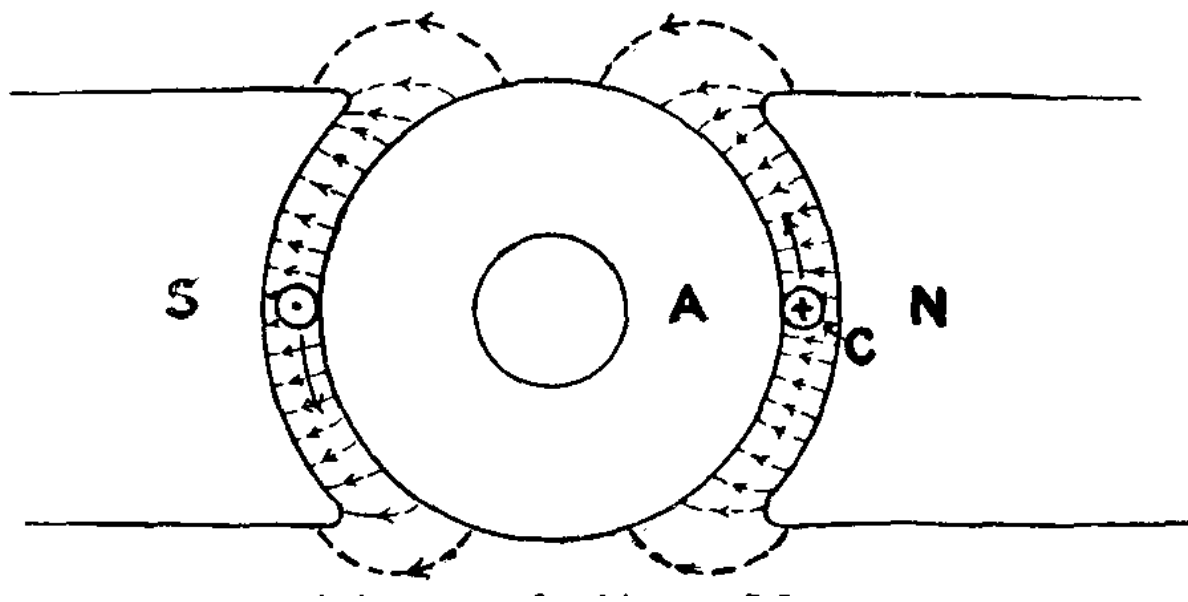
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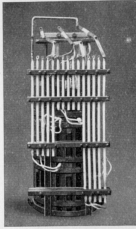


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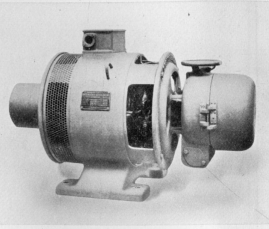
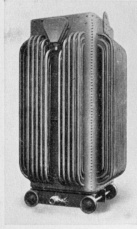


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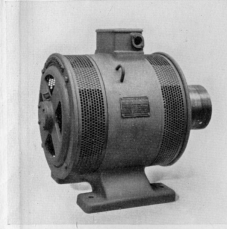
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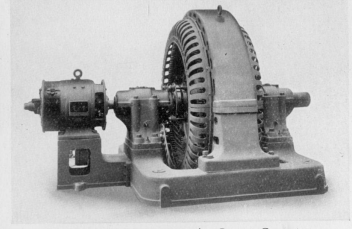
A Standard "Berry" Transformer and its Containing Tank (on right, smaller scale)



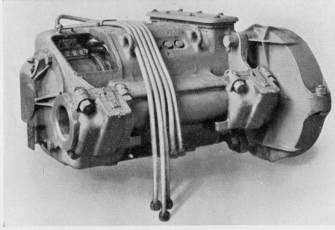
Three-phase Slipring Induction Motor, Protected Type. 15 h.p., 1425 r.p.m.



Three-phase Squirrel-cage Induction Motor. Enclosed Ventilated Type. 15 h.p.



Open Protected Type Alternating Current Generator. 500 k.w., 300 r.p.m., 440 volts



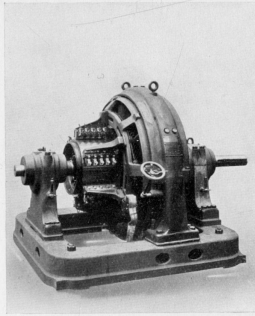
250 h.p. B.T.H. Railway Motor



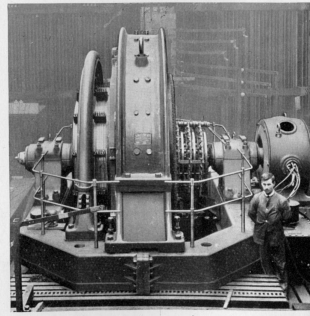
B.T.H. Shunt-wound Protected Type Direct-current Motor. 50 h.p., 800 r.p.m.



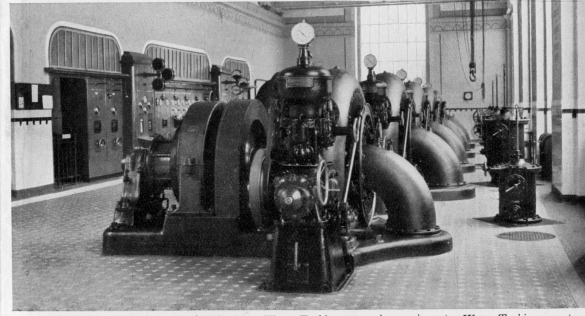
Electric Coal-cutting Machine in operation in a Mine



Direct-current Generator. 100 k.w



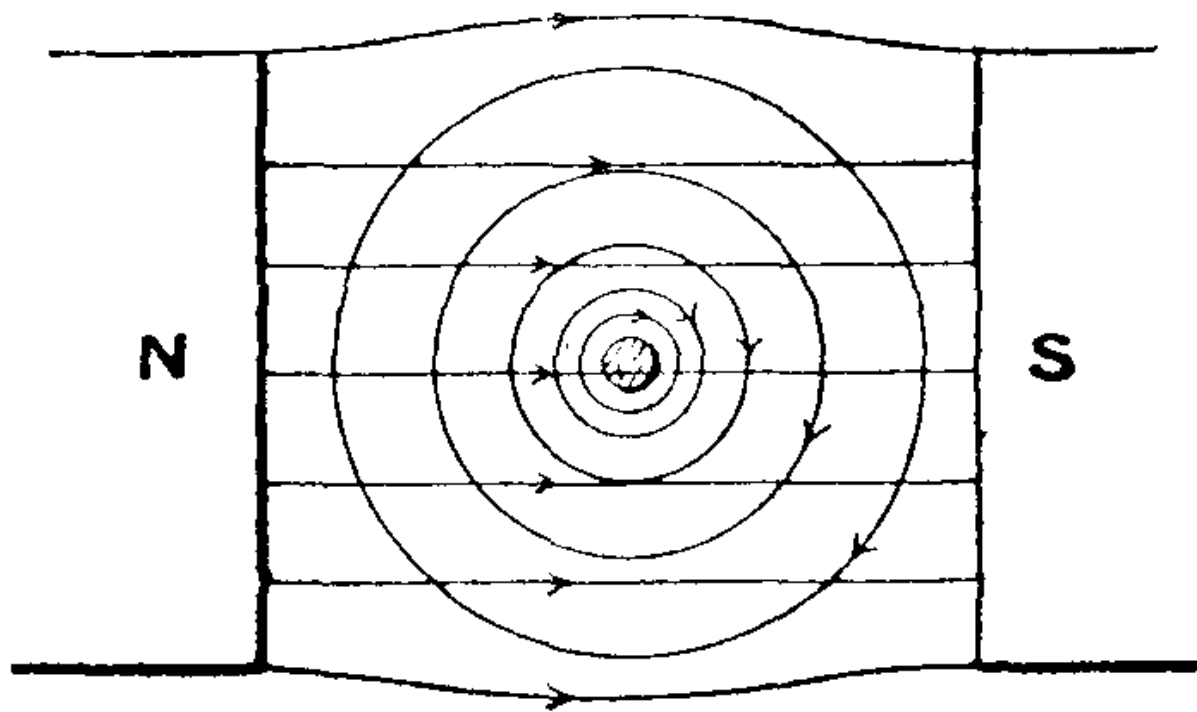
Heavy Traction Rotary Converter. 2000 k.w., 1500 volts. Starting motor at right hand



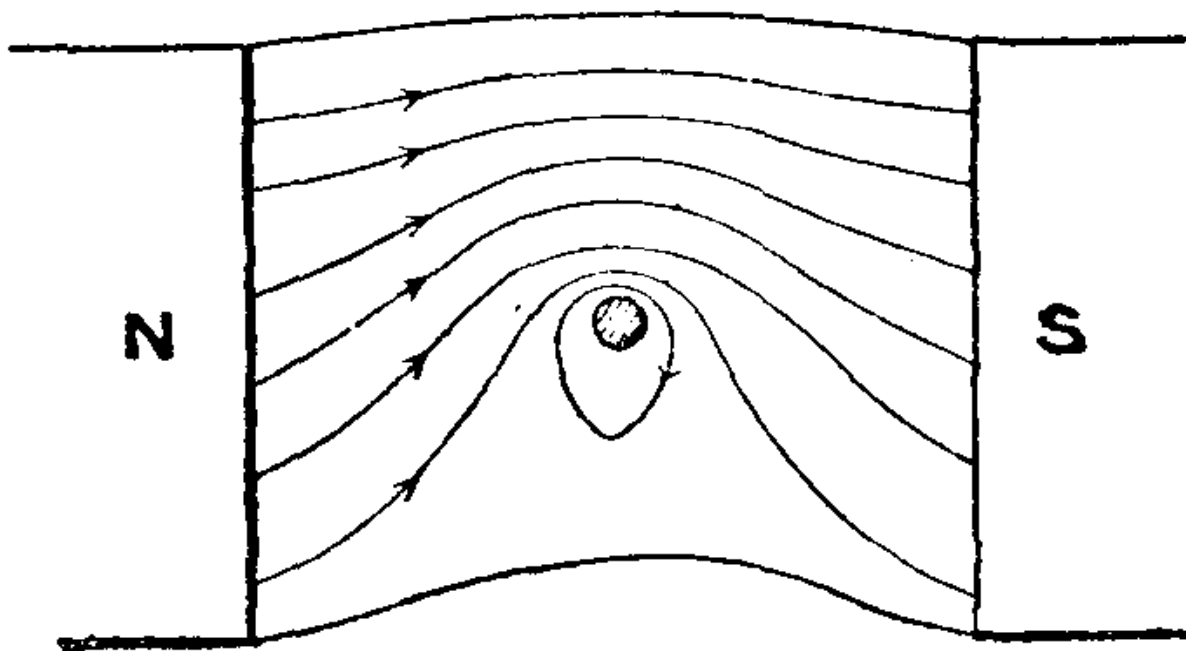
Electric Power Station, Chanet, Switzerland. 4 Water Turbines, 1350 h.p. each, and 1 Water Turbine, 400 h.p.

By courtesy of Messrs. The English Electric Company, Ltd., The Metropolitan-Vickers Electrical Co., Ltd., Massey & Co., Ltd., The British Thomson-Houston Co., Ltd.,

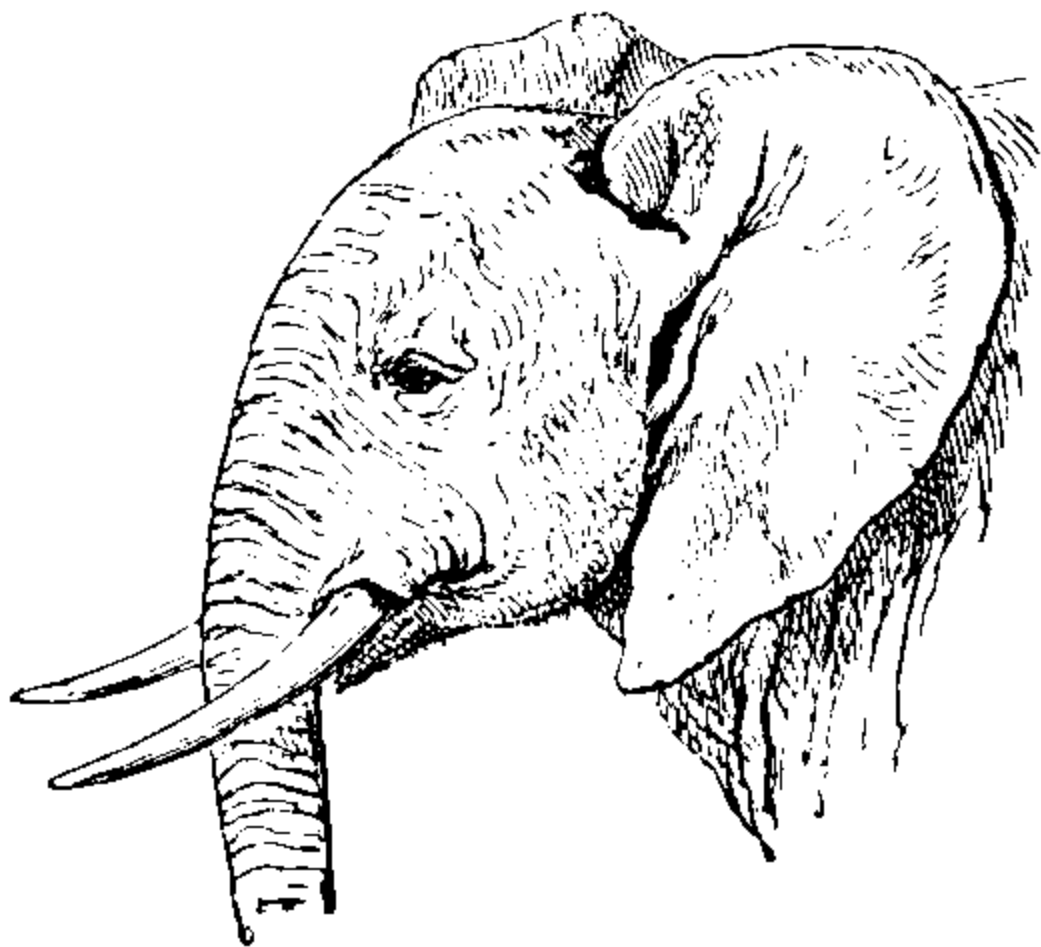
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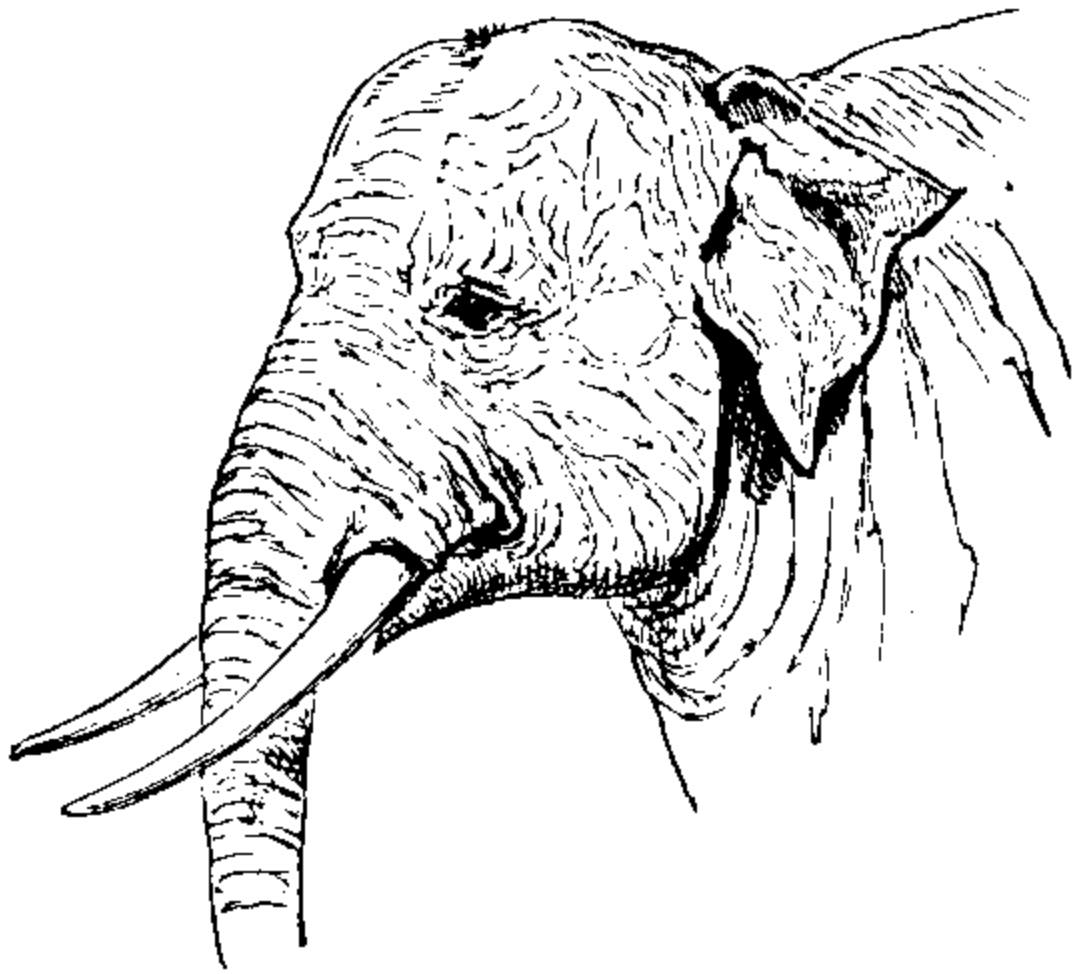
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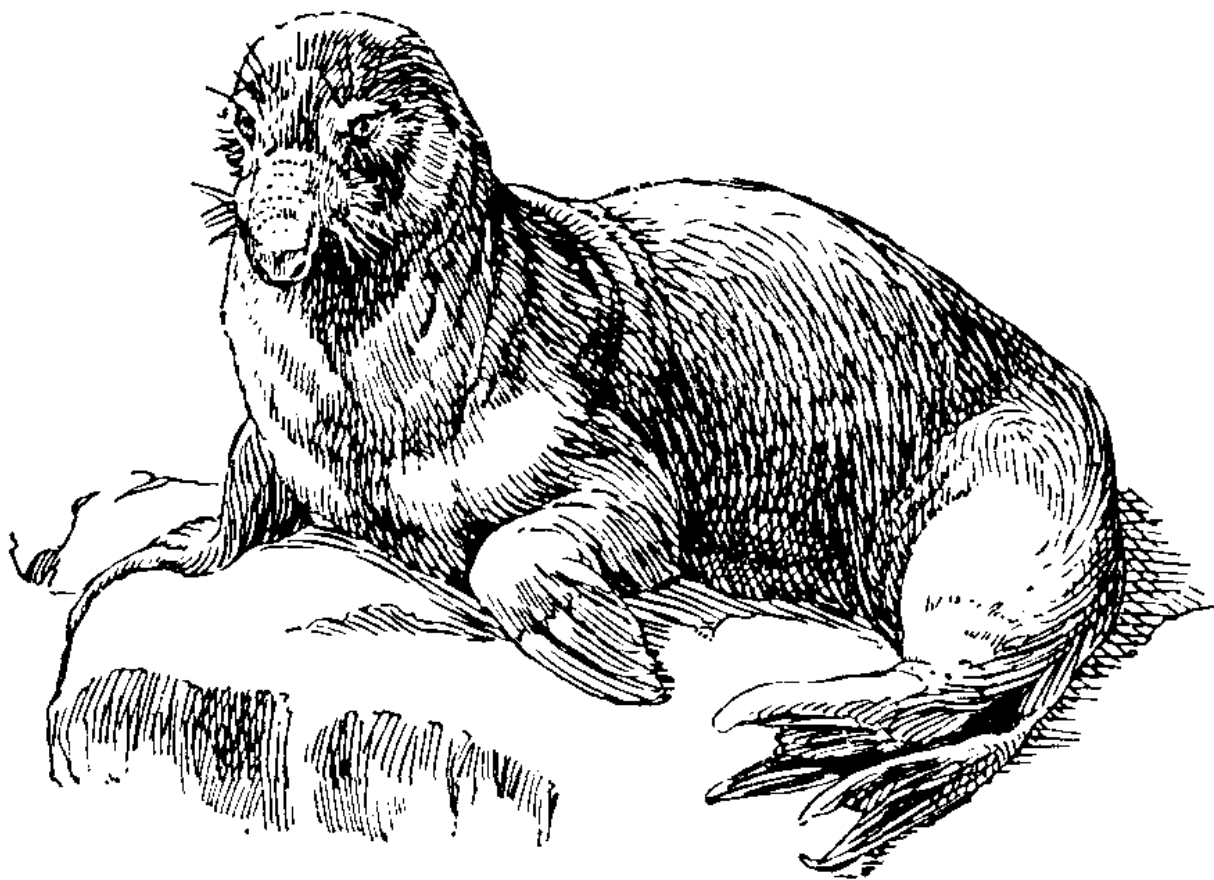
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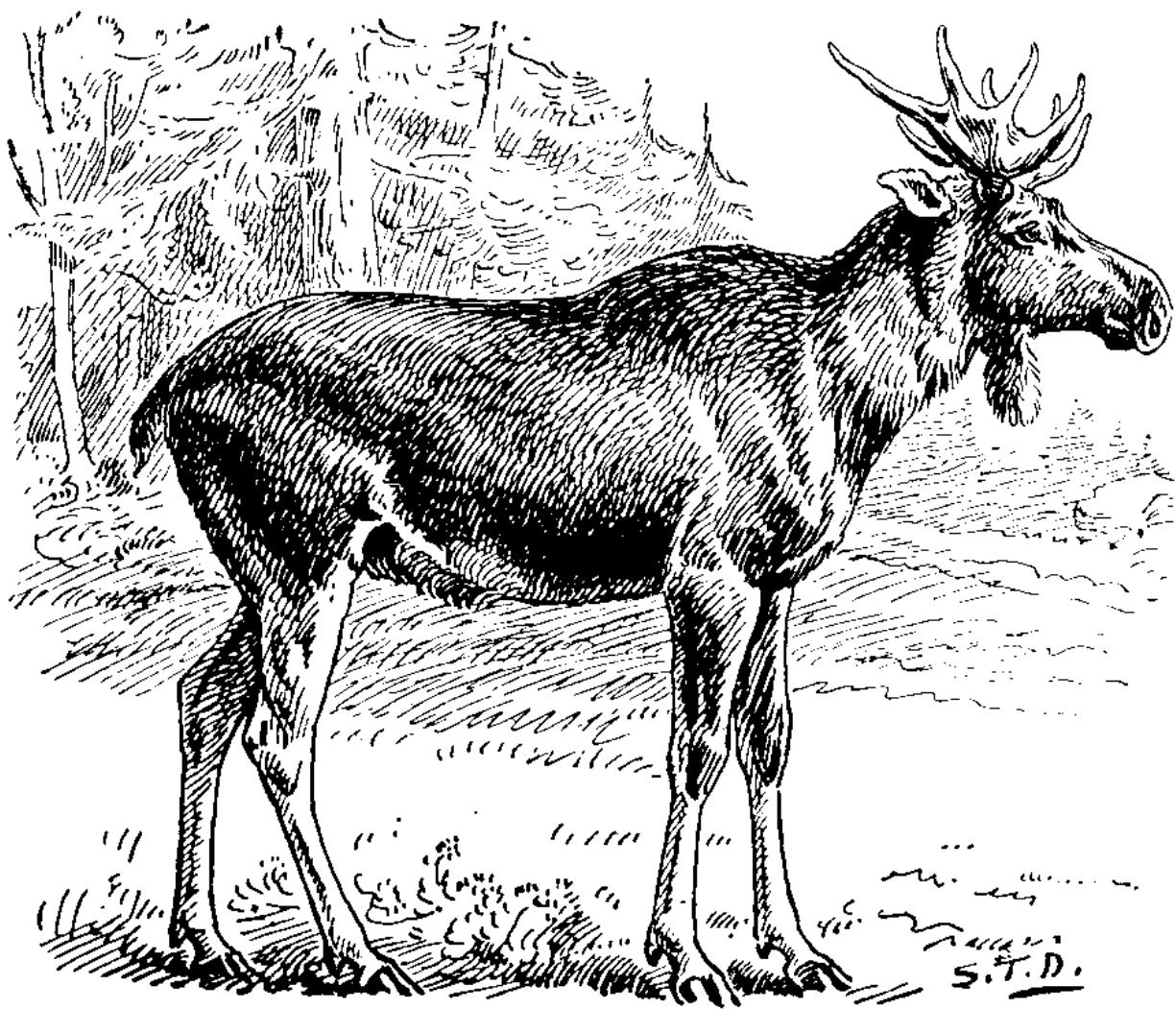


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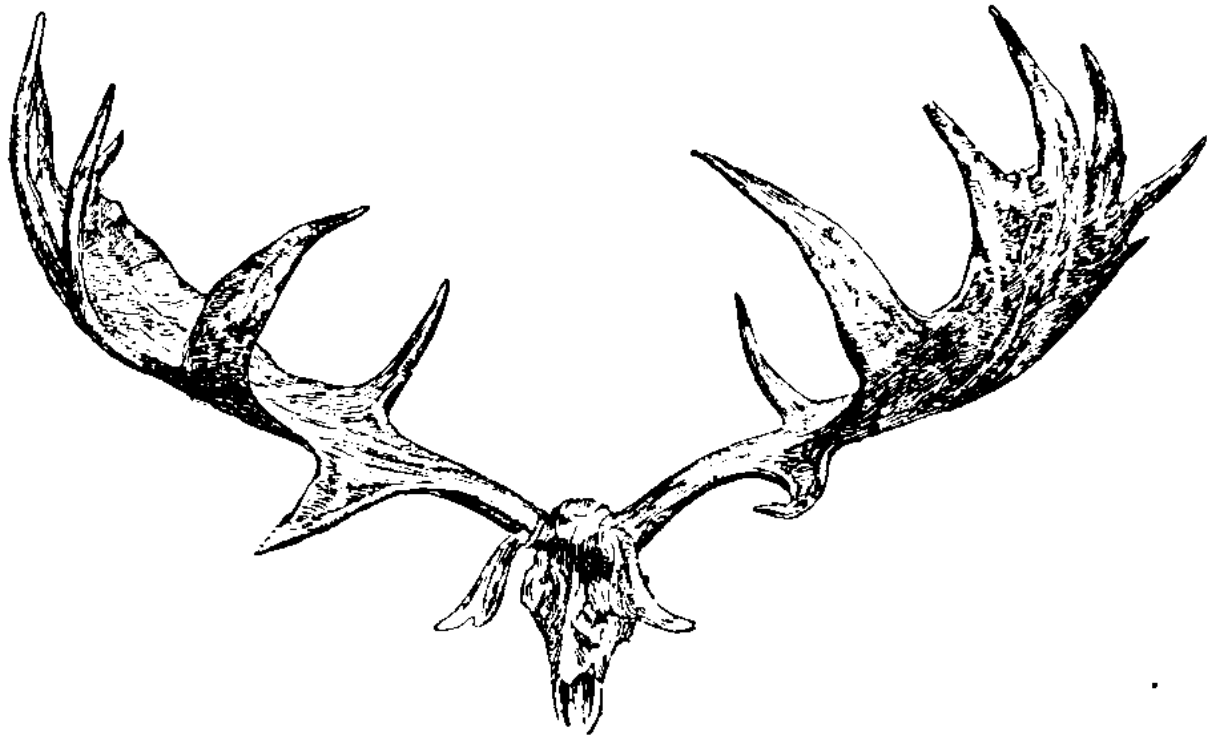


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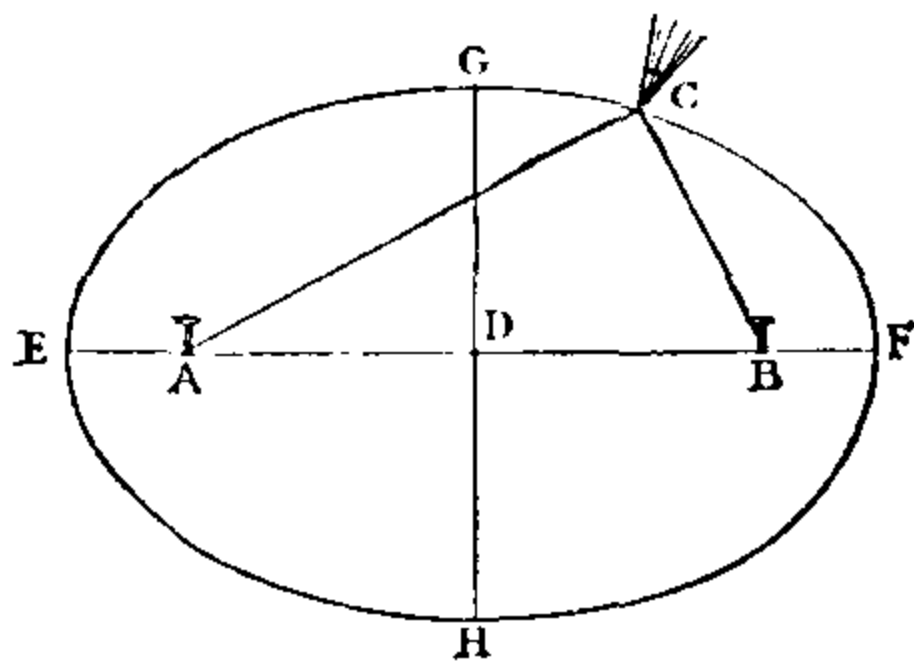
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$$u = \int_0^x \frac{dx}{\sqrt{1-x^2}} = \sin^{-1}x,$$

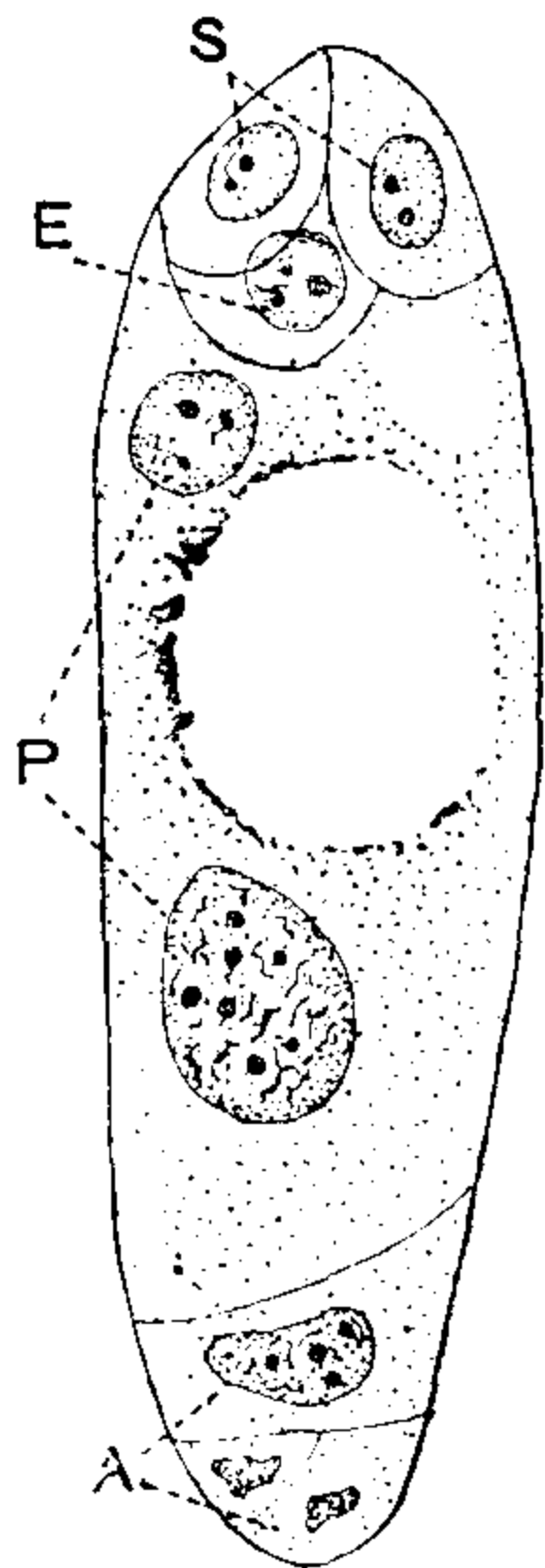
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$$u = \int_0^x \frac{dx}{\sqrt{(1-x^2)(1-k^2x^2)}},$$

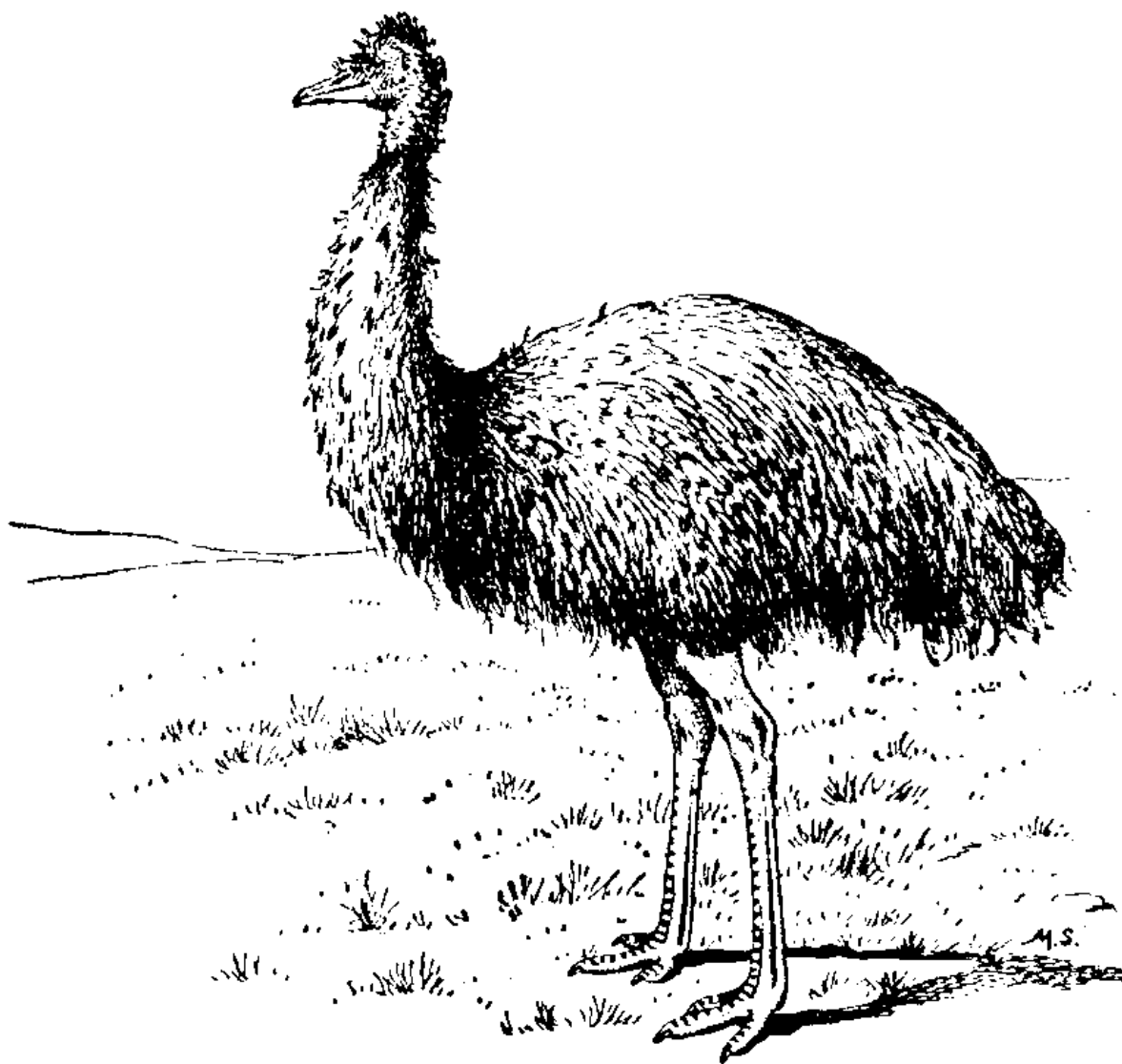
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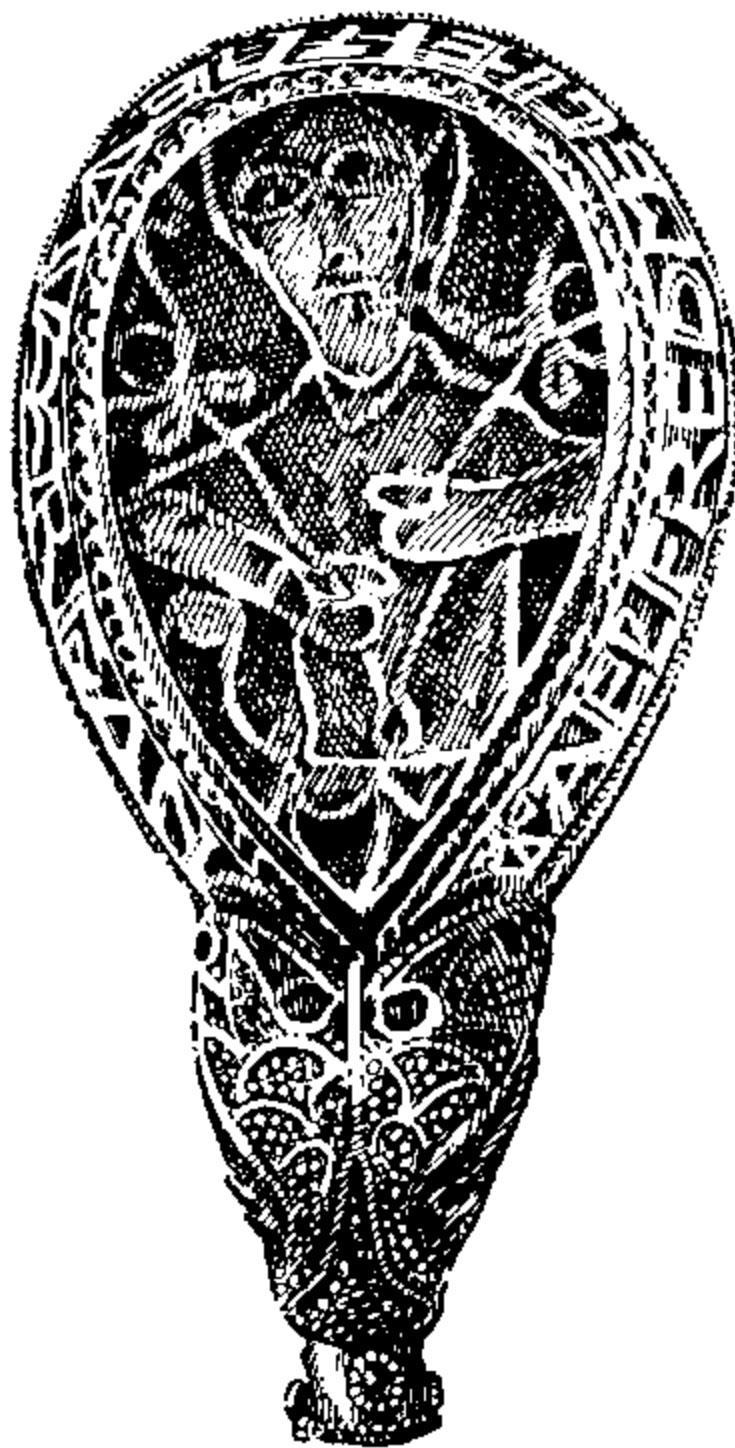
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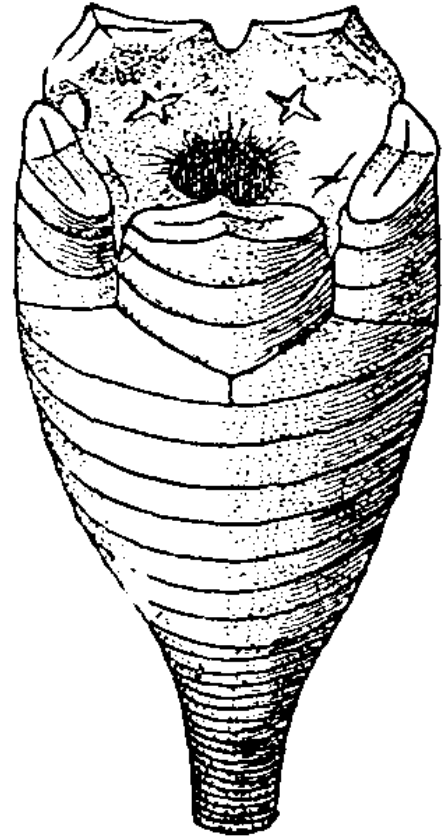
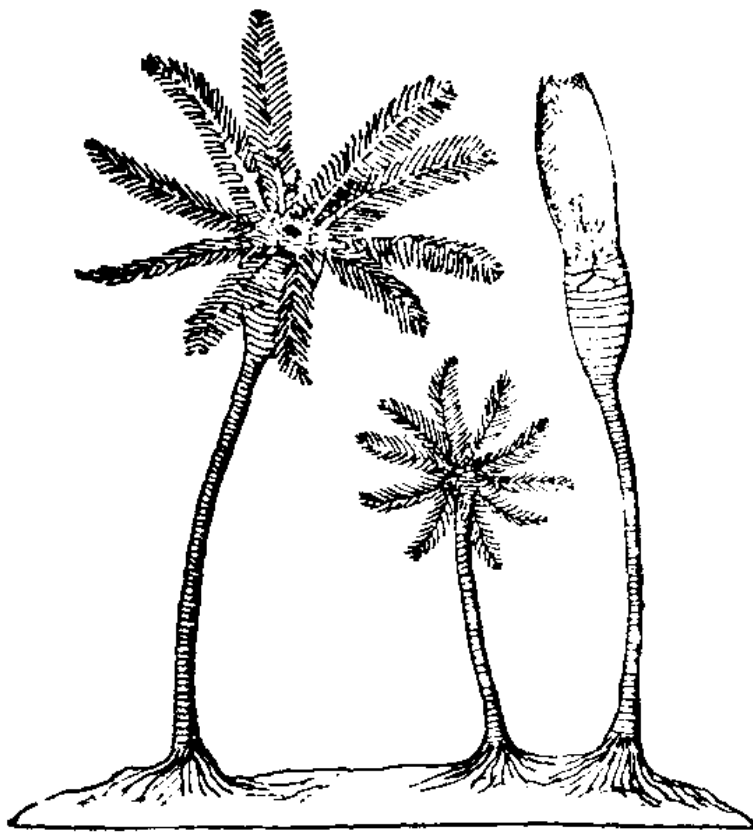
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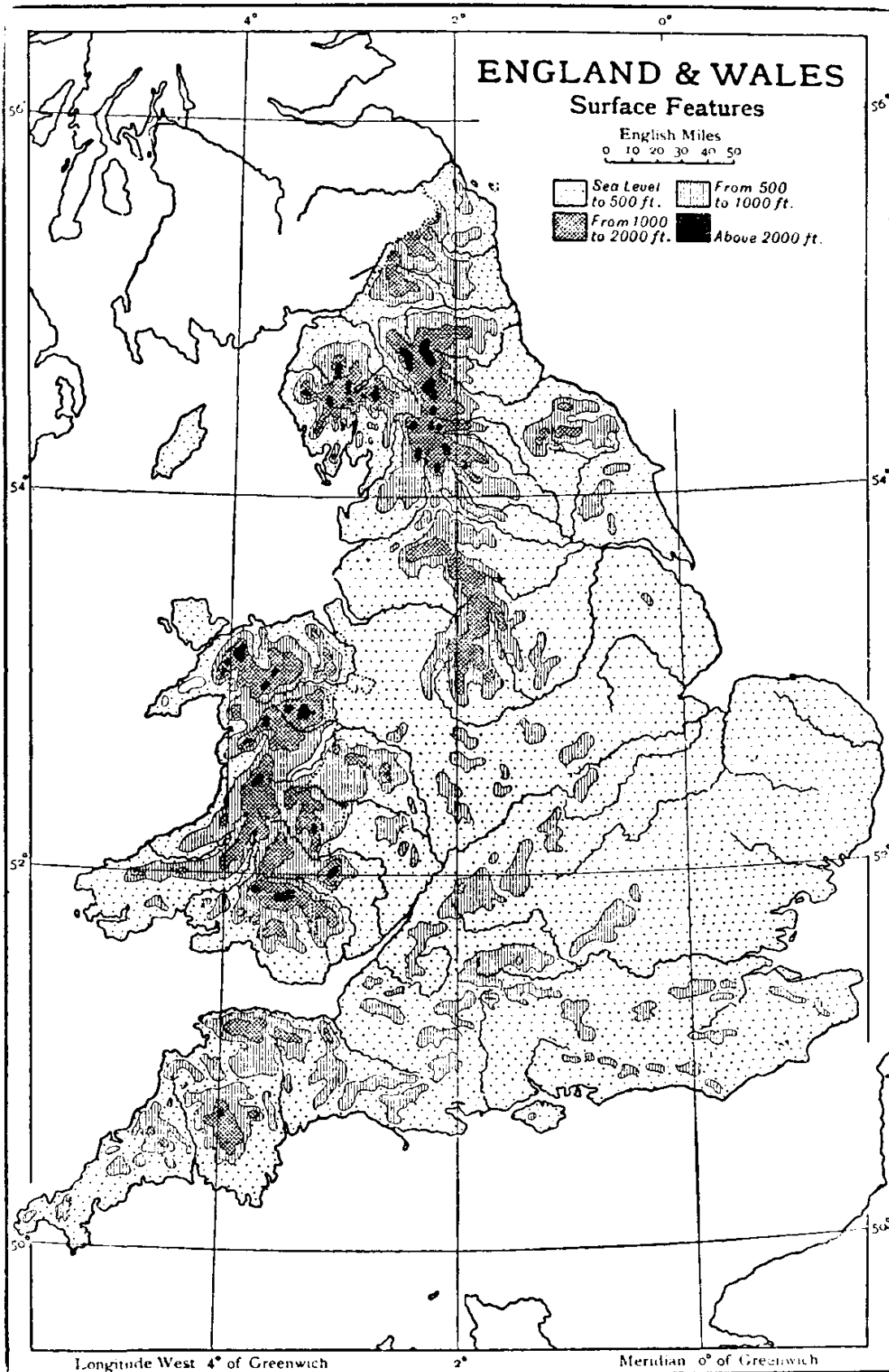
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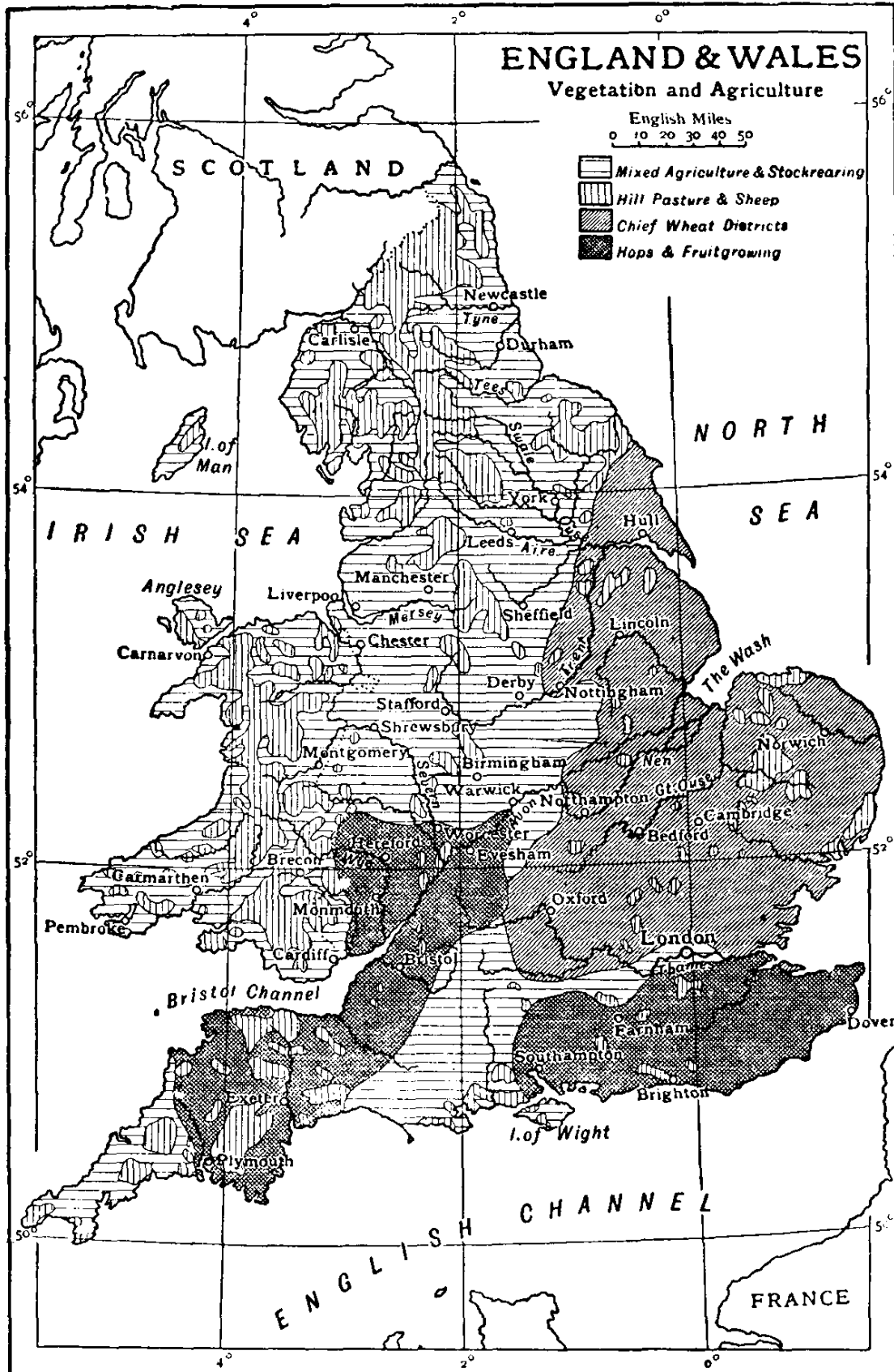


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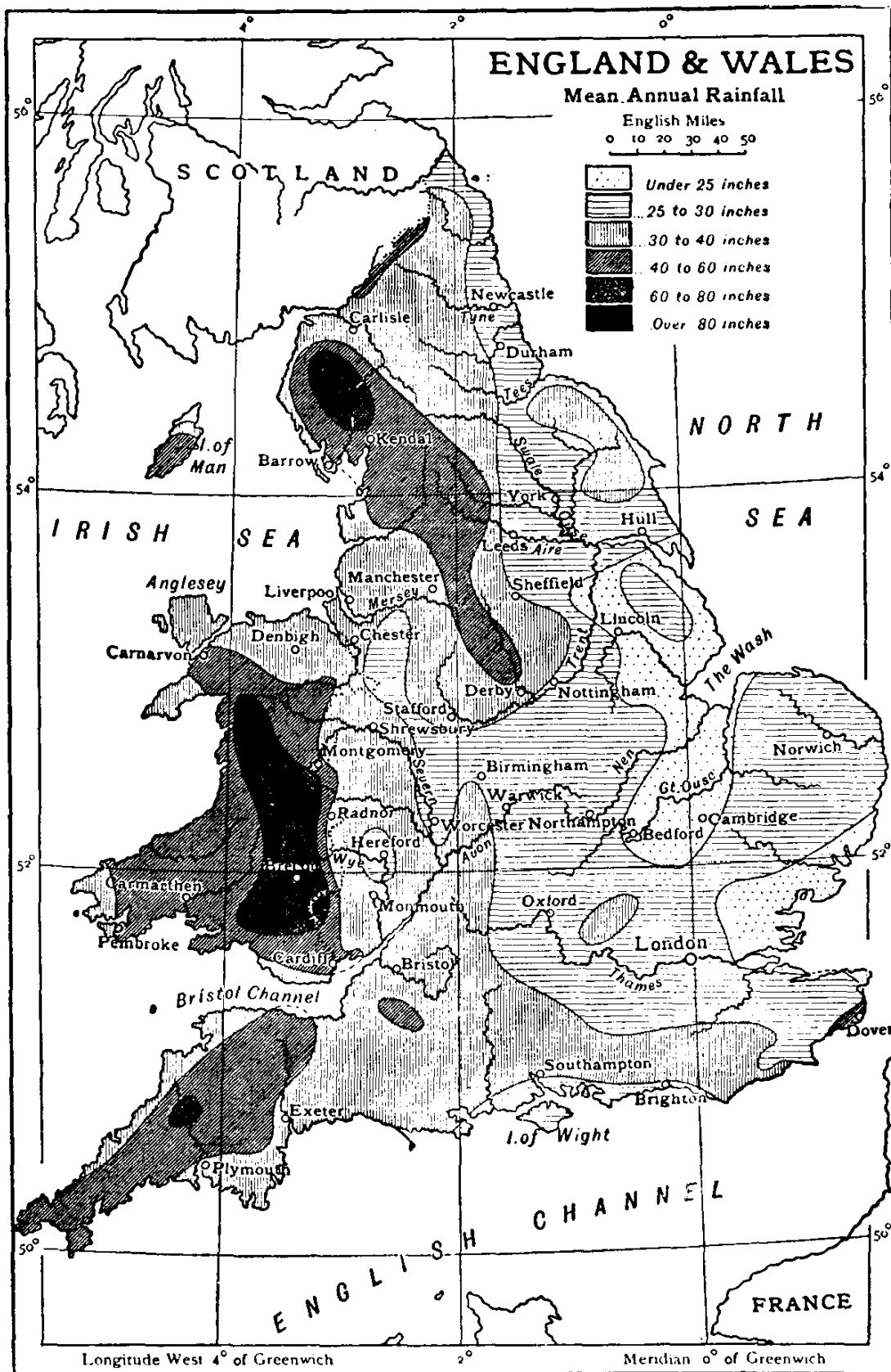


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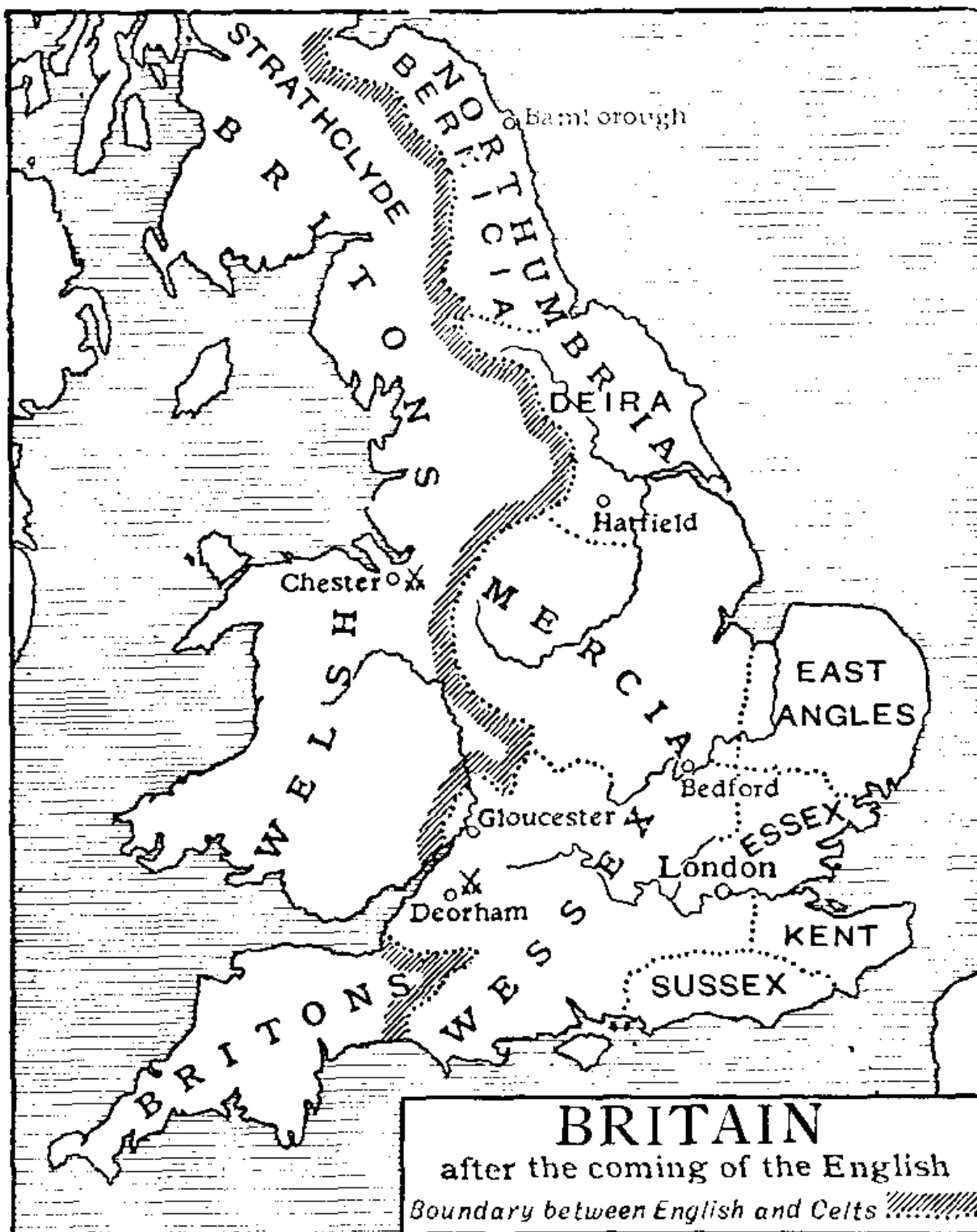
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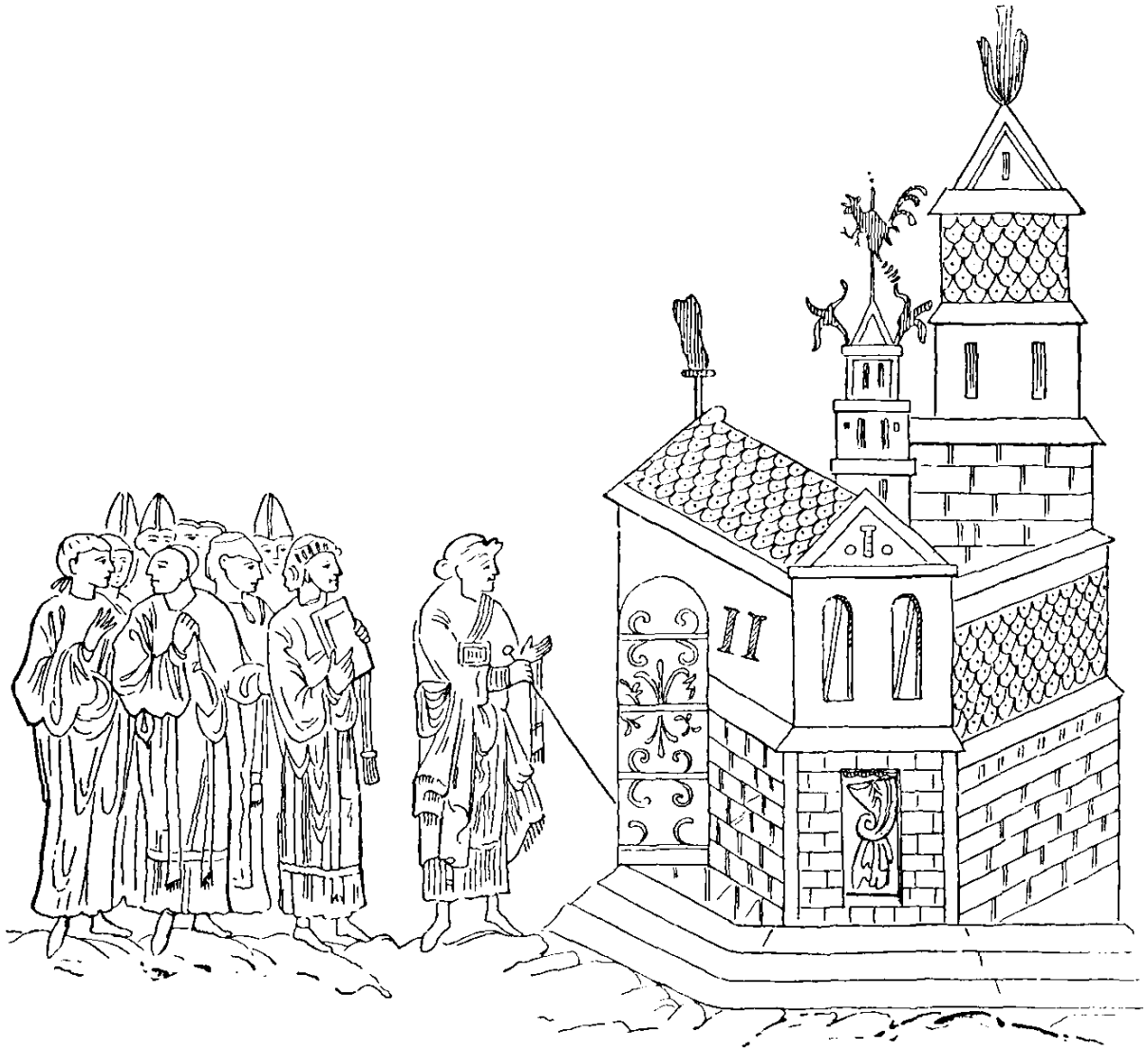
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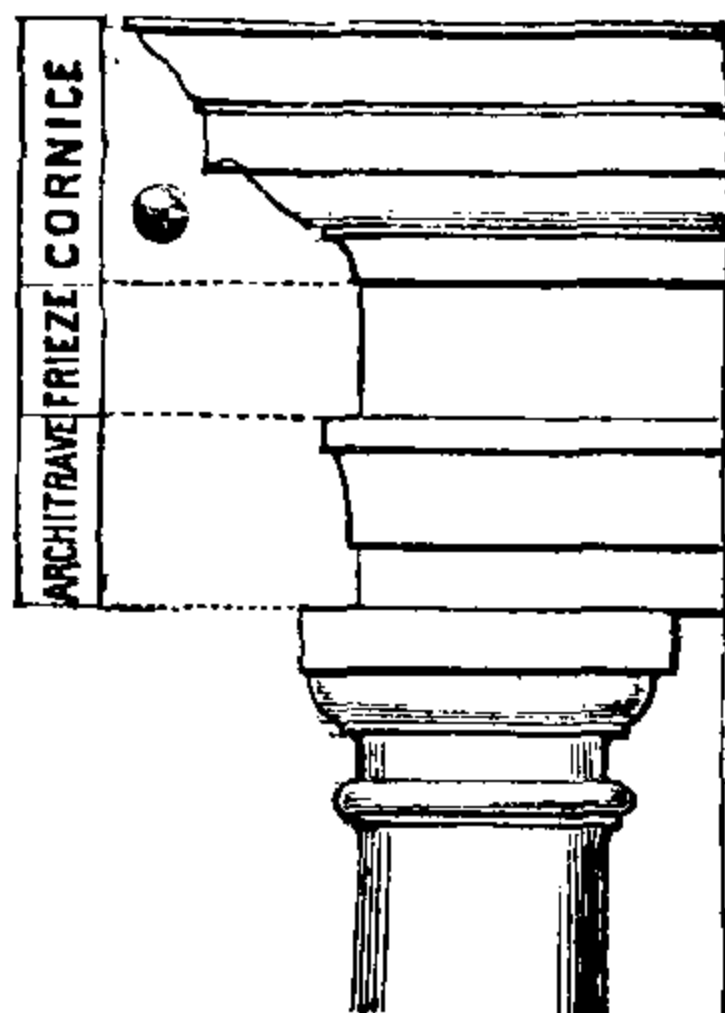
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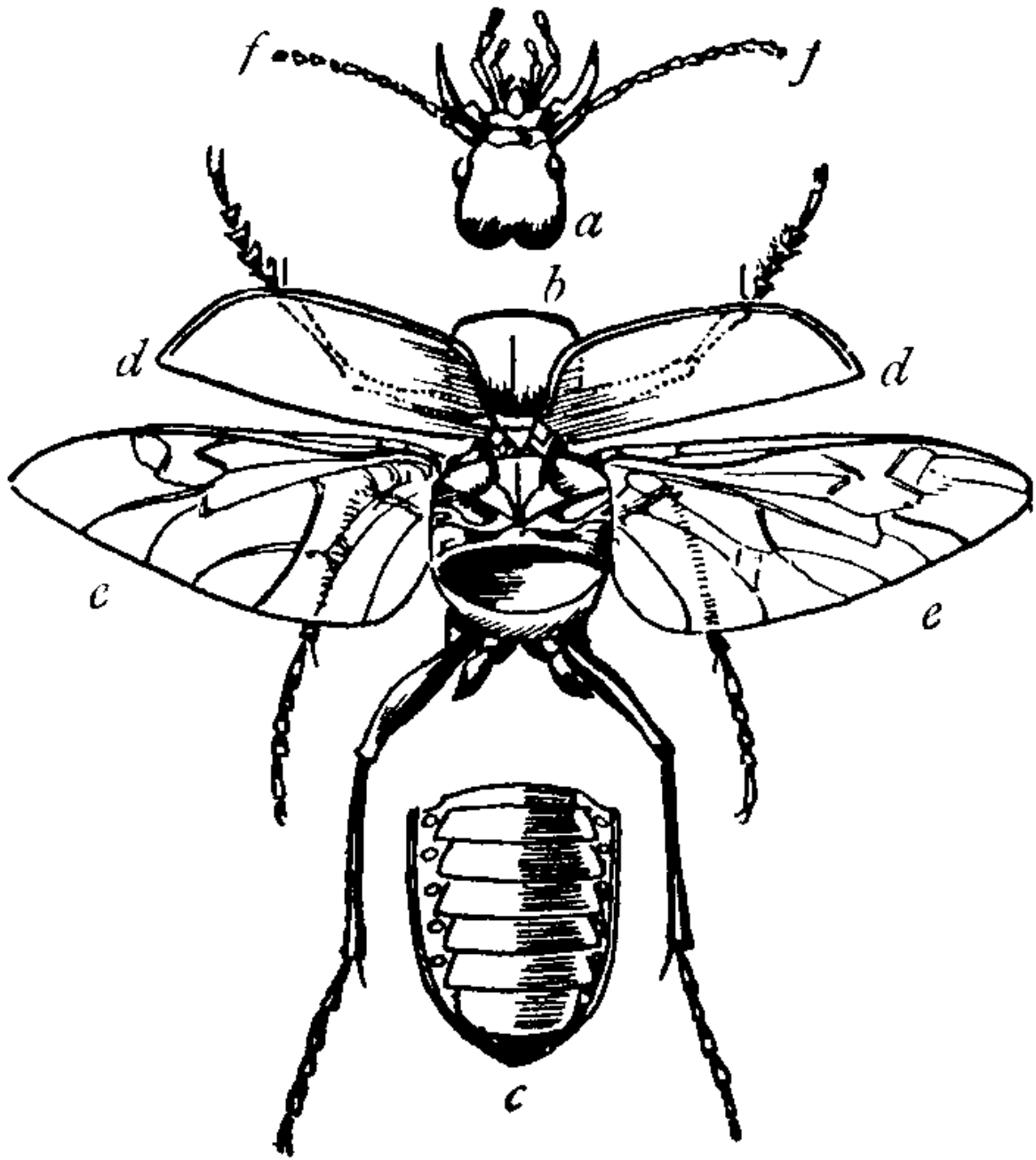
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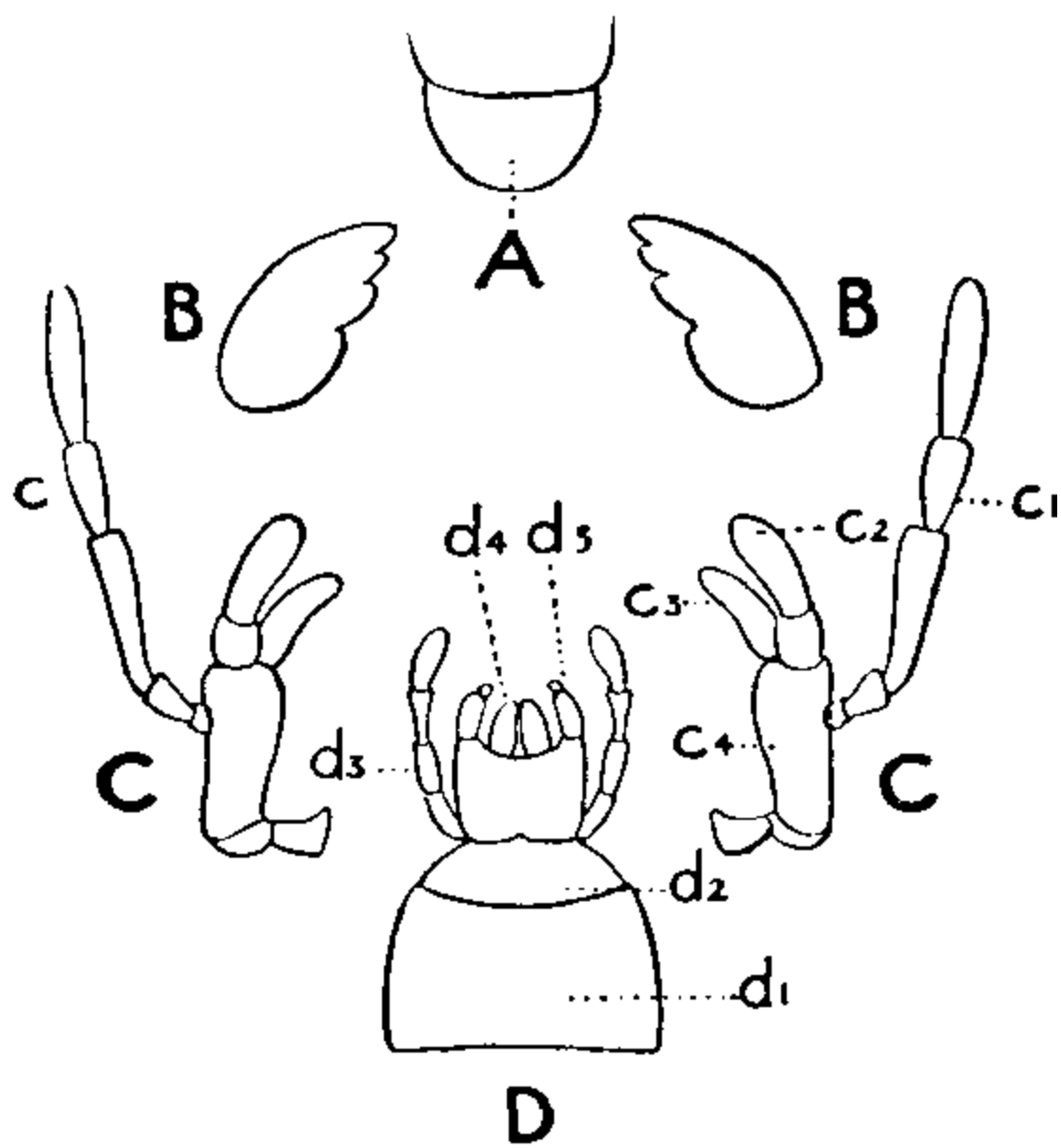
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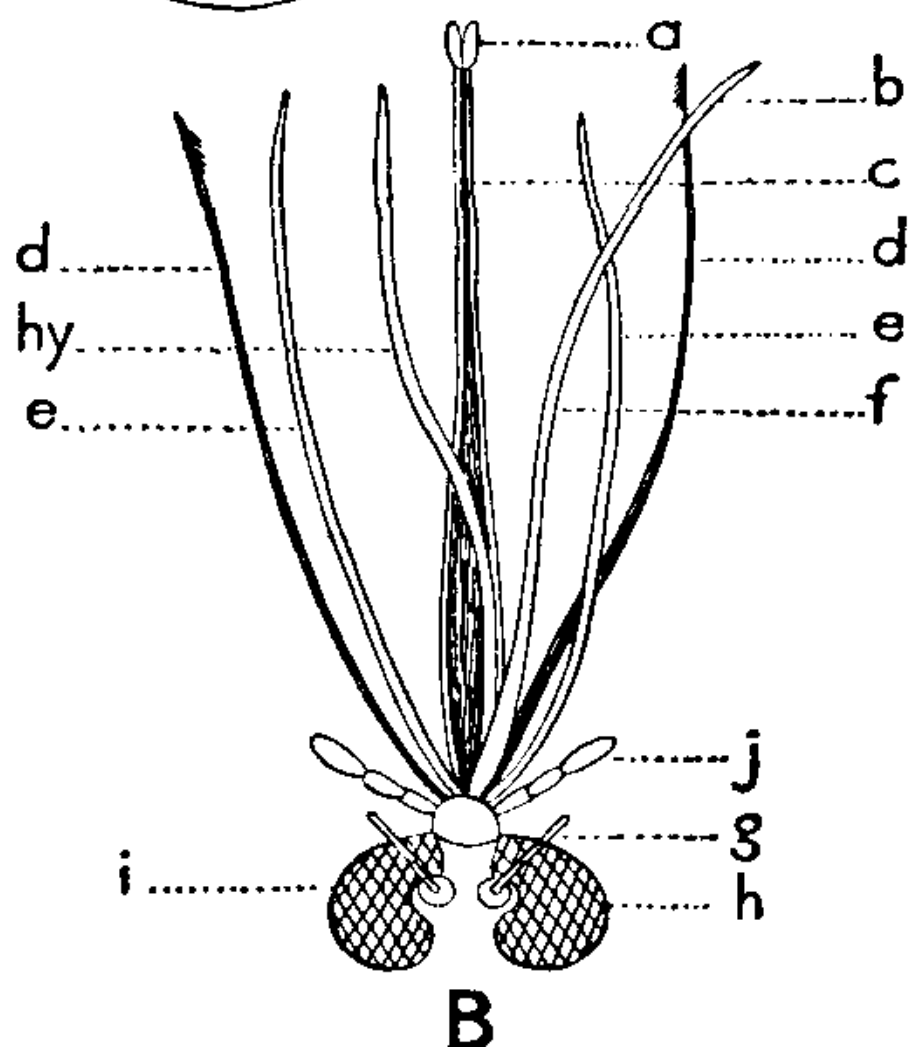
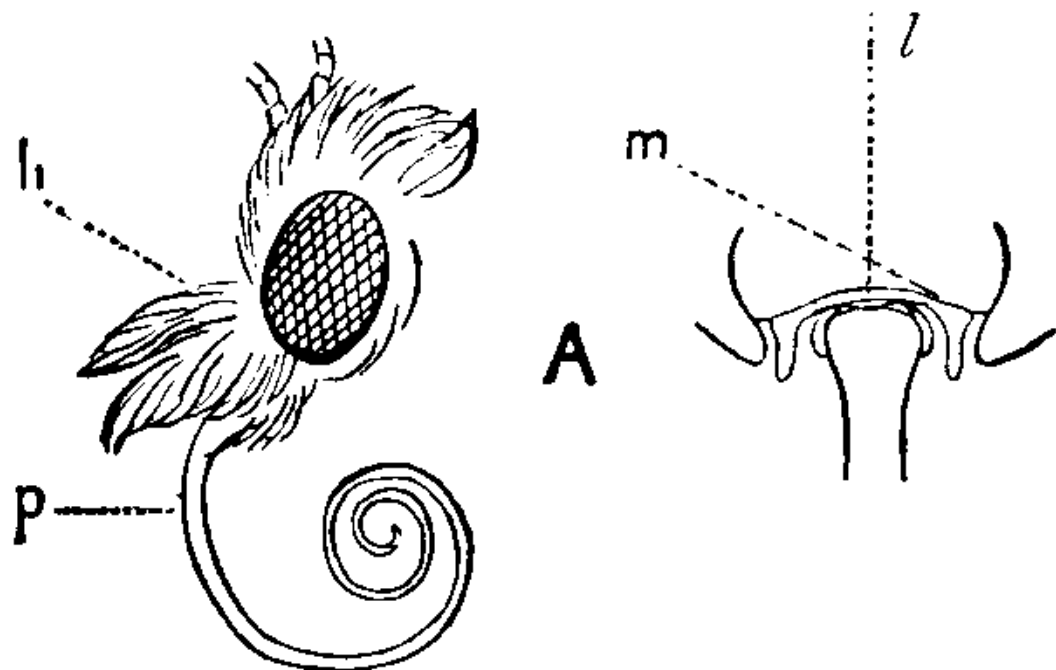
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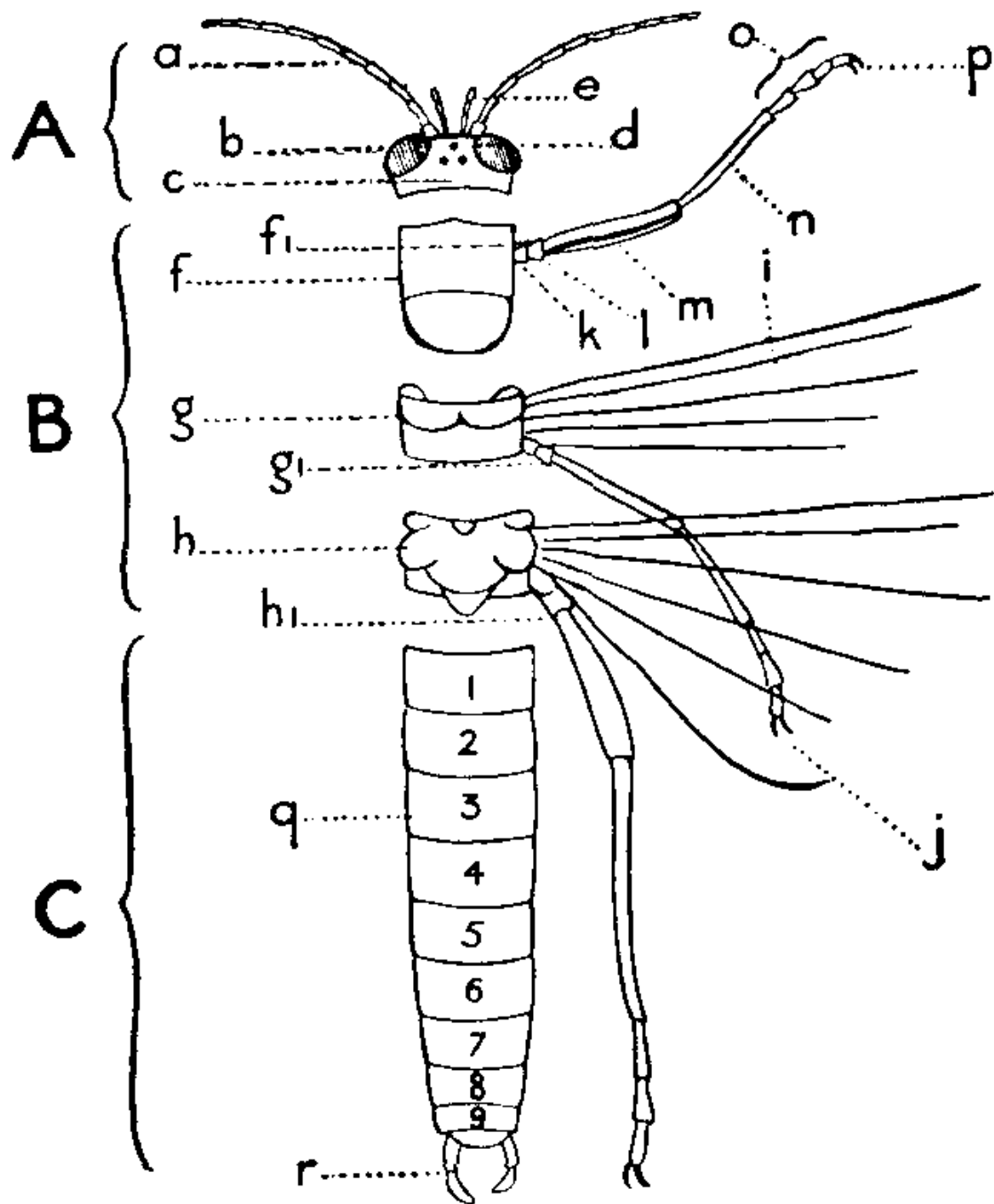
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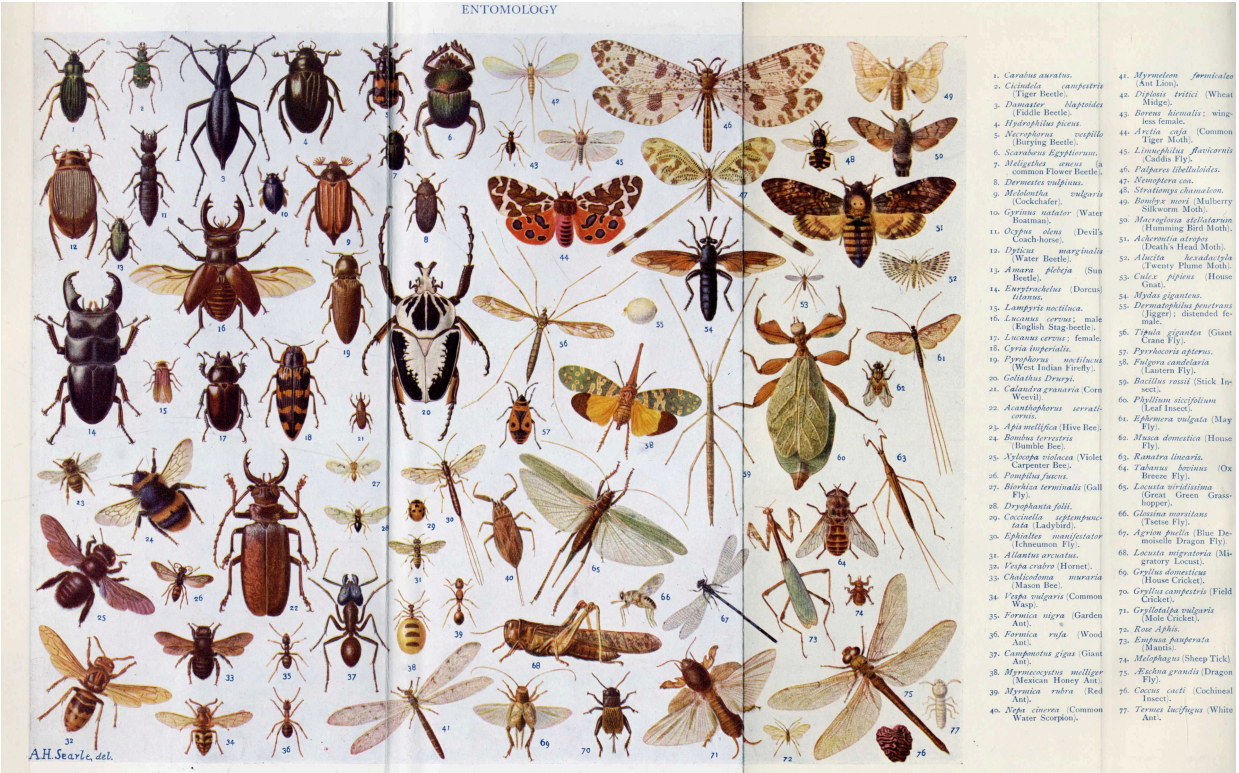


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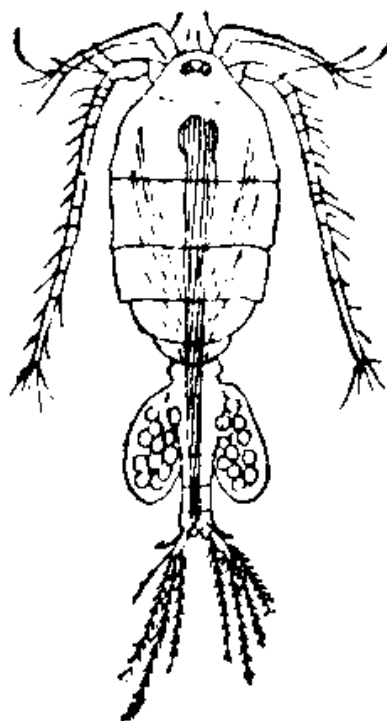
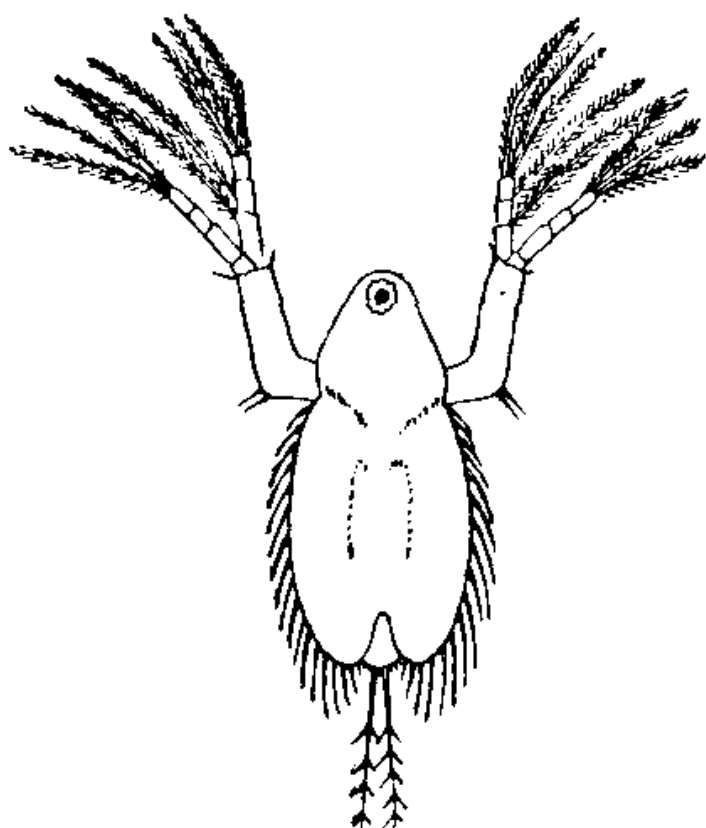


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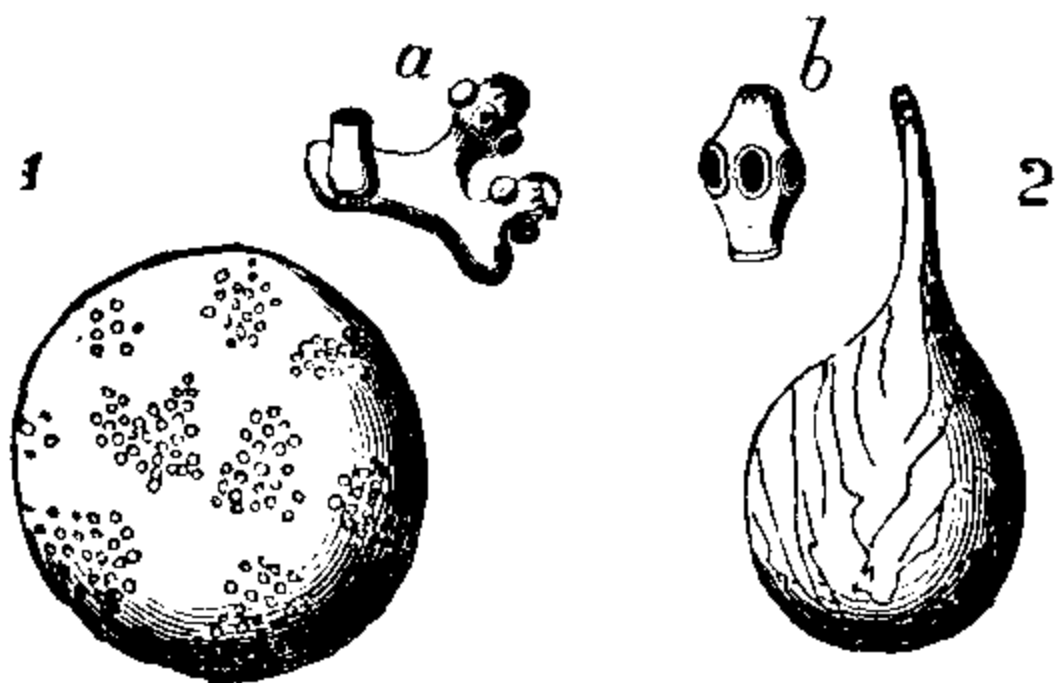
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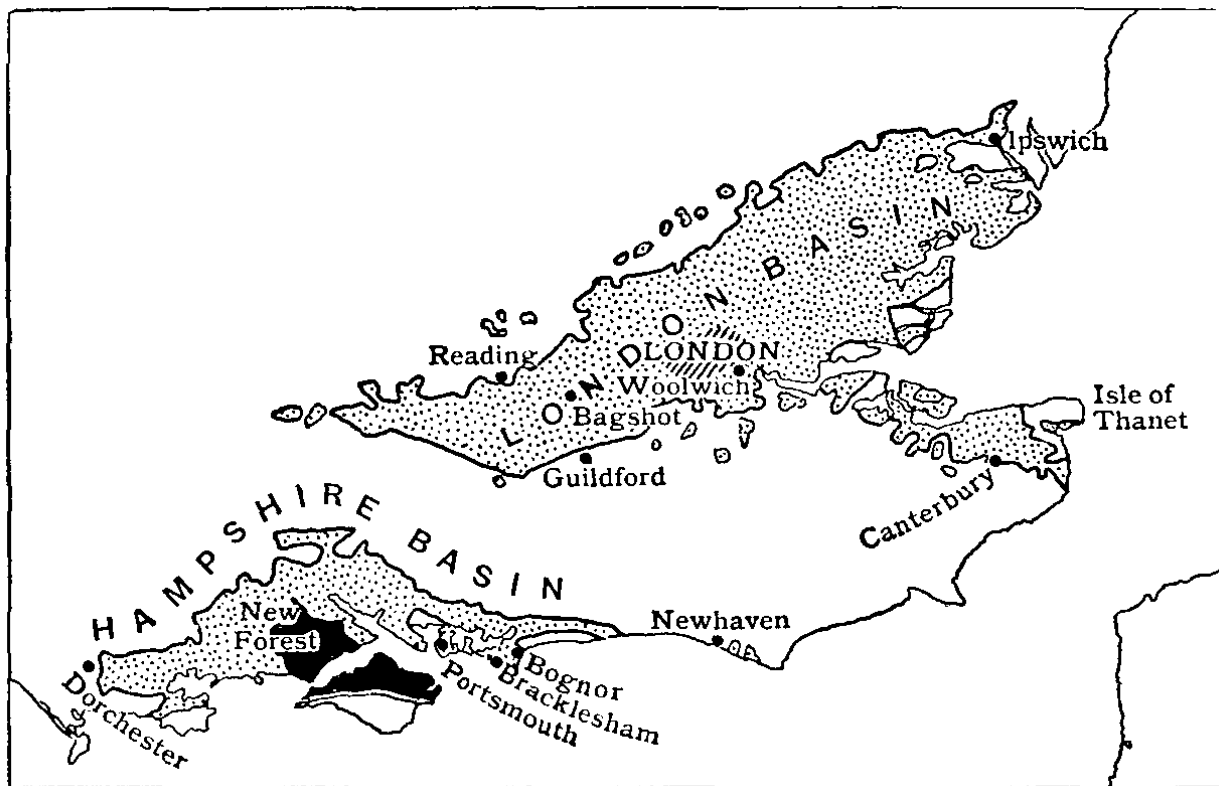
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$$\int_A^B \frac{dQ}{T}$$

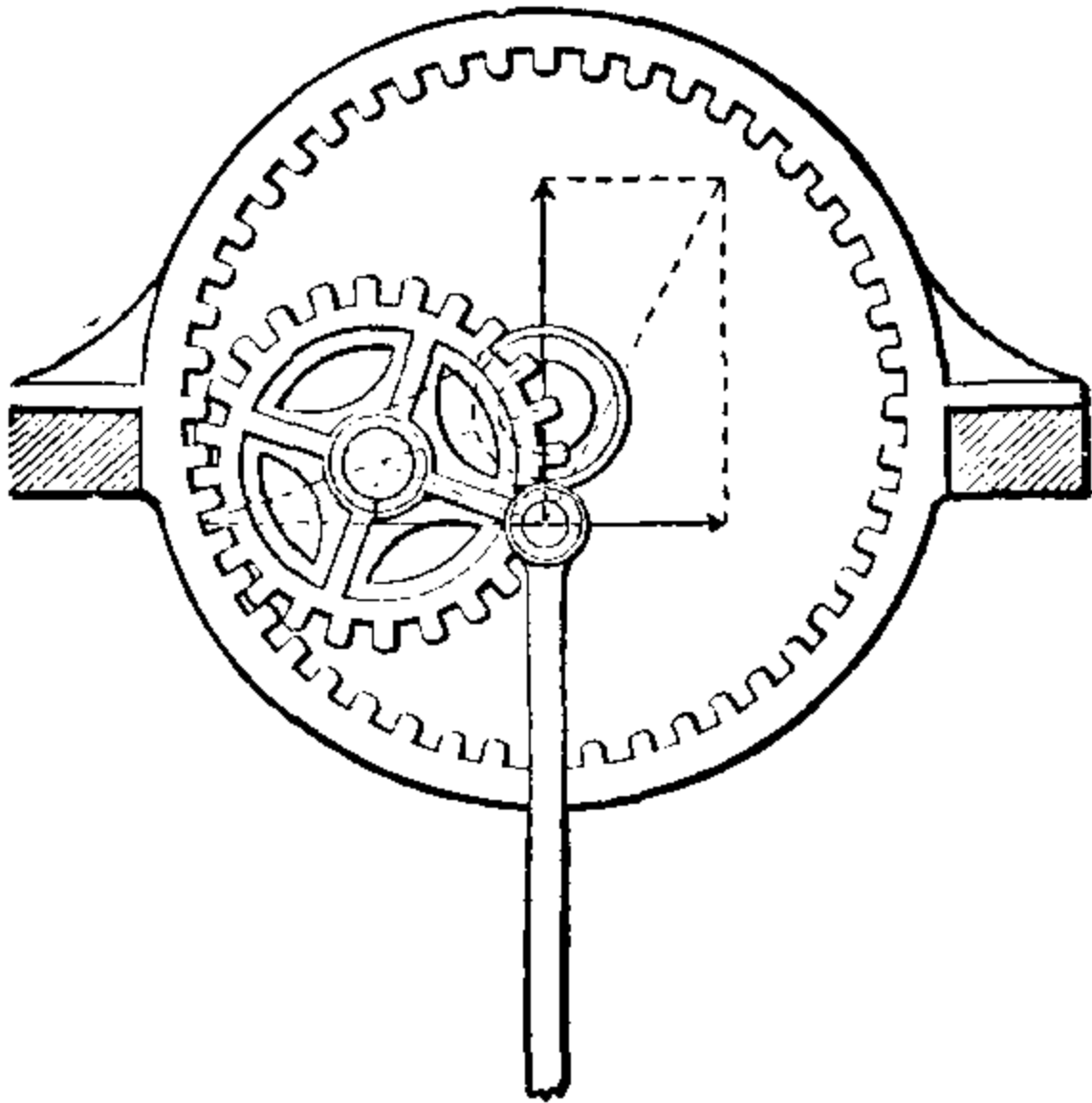
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$$\int \frac{dQ}{T}$$

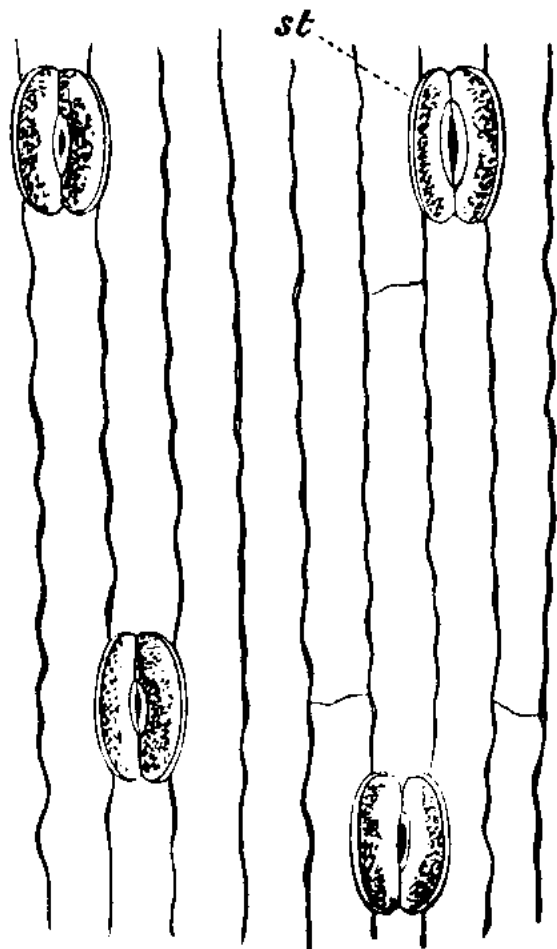
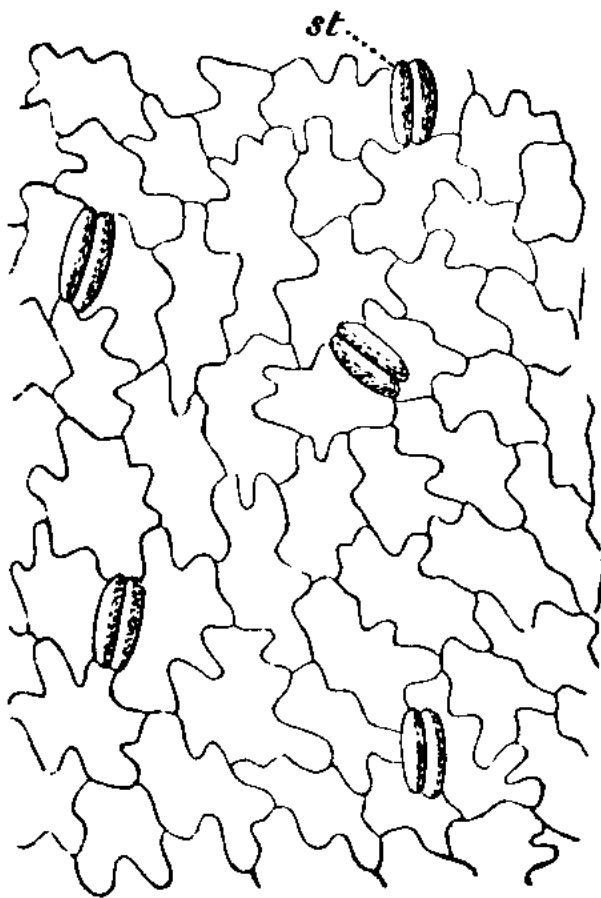
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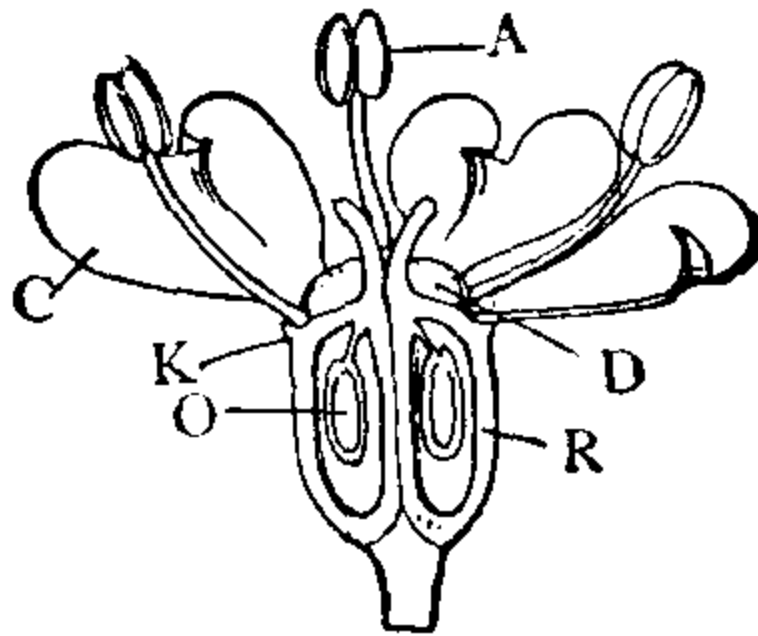
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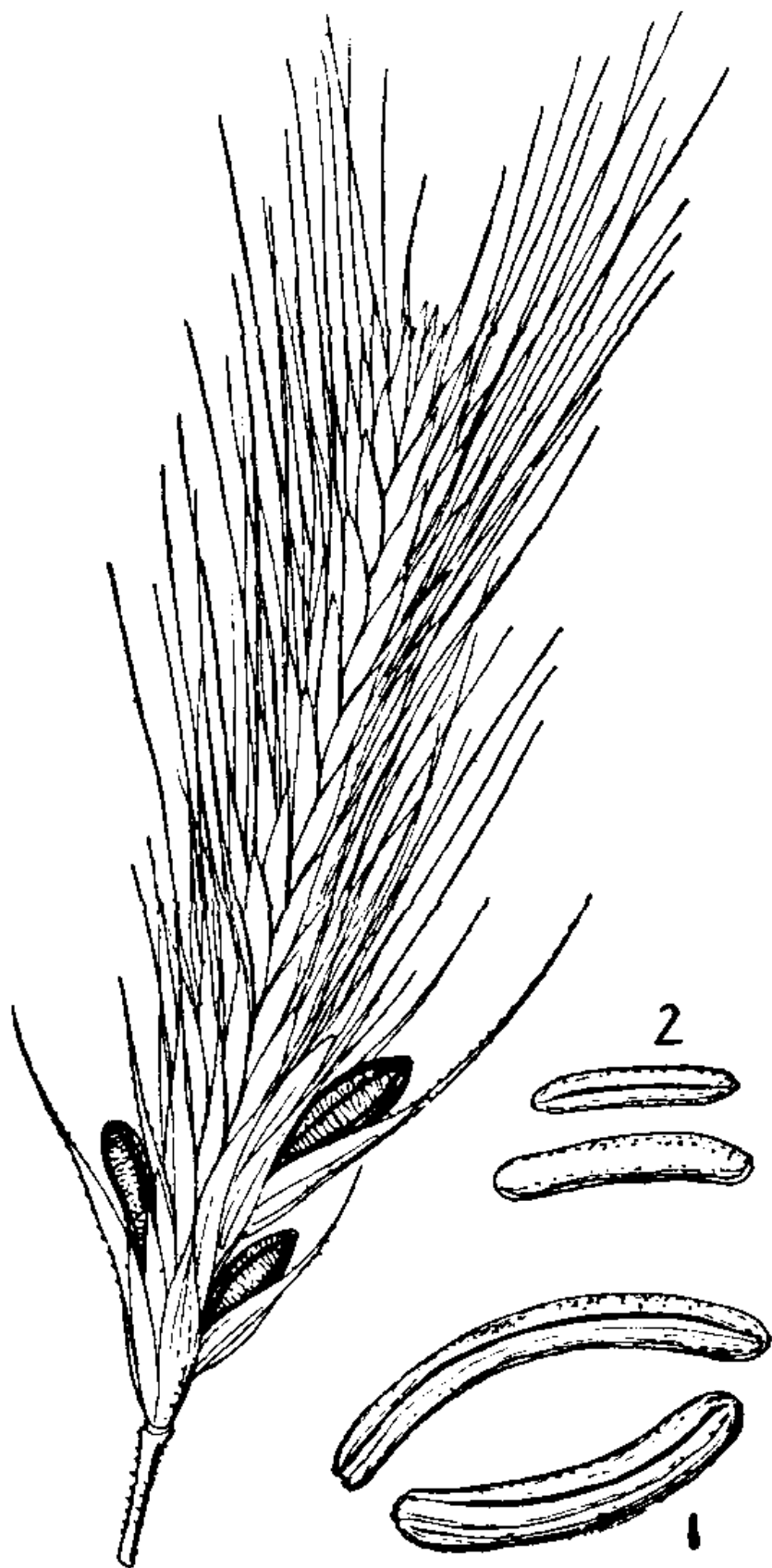
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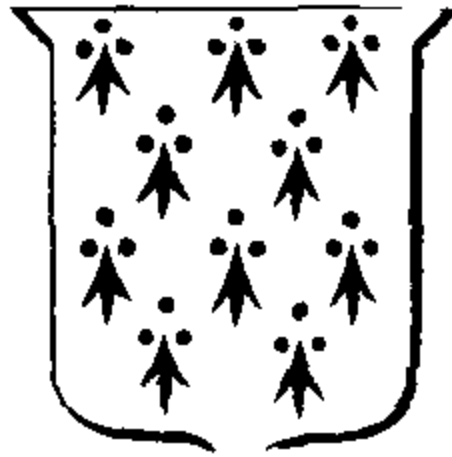
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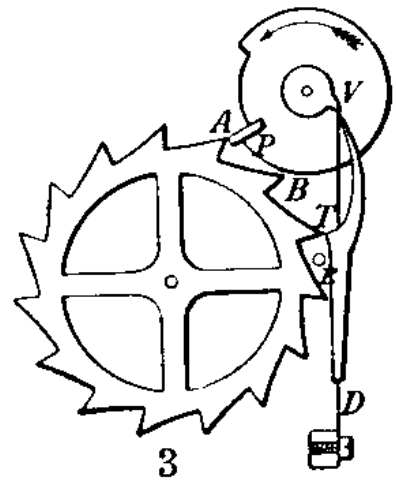
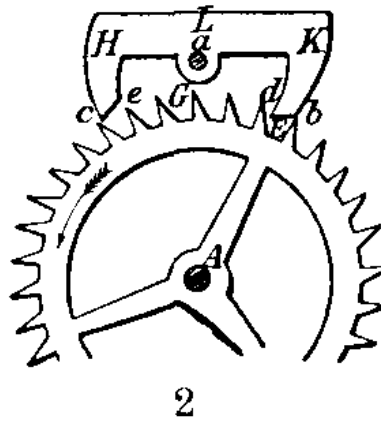
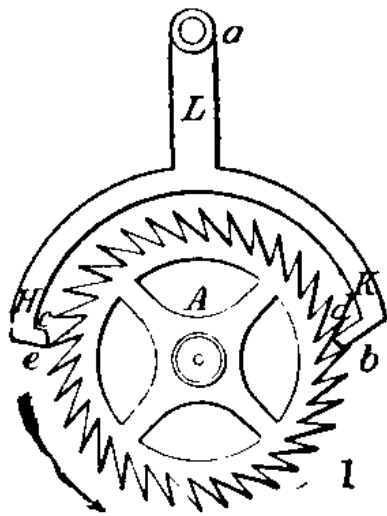
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