which are formed. Breccias differ from conglomerates in the angular nature of their fragments, and in the method of their origin.

Brecey, tn., Manche dep., France, 22 m. S.E. of Granville. Pop. 9,000.

Brechin, par. (13,922 ac.), tn., parl. and royal bur., Forfarshire, Scotland, on the South Esk, and on C.R., 8 m. by road W. of Montrose; manufactures paper, linen, and sailcloth; has bleach-fields and distilleries. Its antiquities include the castle, the round tower, dating from about 1000, and the 12th-century cathedral. Pop. tn. 9,000.

Breckinridge, JOHN CABELL (1821–75), American lawyer, general, and statesman, was born near Lexington, Kentucky. He first saw service in the Mexican war (1846–7), and was a member of Congress (1851–5), being elected vice-president of the United States in the next year. For the presidency (1860) he was beaten by Lincoln, but was made a senator. This office he resigned in order to join the Confederate army, in which he rose to be major-general. He was prominent throughout the war, and was present at the battles of Shiloh, Murfreesboro, Chickamauga, Chattanooga, and Cold Harbour. In 1864 he was second in command during the Shenandoah campaign, and in the following year was secretary of war under Jefferson Davis. On the fall of the Confederacy he escaped to Europe, where he remained until 1868, when he returned and resumed the practice of law.

Brecknock, or BRECON, munic. bor. and mrkt. tn., cap. of Brecknockshire, on the Usk, 36 m. W.S.W. of Hereford; contains Christ College (originally a Dominican friary, and converted by Henry VIII. into a grammar school), and a congregational memorial college founded in 1869. There is a considerable trade in lime, and in the manufacture of flannels and woollens. Mrs. Siddons, the actress, was born here in 1755. In the vicinity are Roman remains. Pop. 6,000.

Brecknockshire, or BRECON, an inland county of Wales, W. of Herefordshire. Length N. and S. 37 m.; breadth E. and W. about 30 m. Area, 740 sq. m. Pop. 55,000. The surface is very mountainous, and presents much picturesque scenery. The chief mountain ranges are the Black Mts. in the S.E., the Brecknockshire Beacons in the centre (highest point, 2,907 ft.), the Black Mts. in the S.W., and the Epynt Hills in the N. The principal rivers are the Usk, Wye, and Yrfon, and the upper courses of the Towy, Neath, Tawe, and Taff. The county forms part of the great S. Wales coal field. Iron, building-stone, limestone, lead, and copper also occur. The soil is very varied—fertile along the banks of the Wye and the Usk, but the higher mountainous districts are suited only for pasturage. Oats and corn are the chief crops. Coarse woollens and hosiery represent the textile industries, and there are iron works at Beaufort and Clydach, lead-mining at Nant-y-garw (8 m. from Rhayader), and slate at Cwm Yrfon (3 m. from Llanwyrtyd). After the departure of the Romans, who conquered this territory in 70 A.D., Brecon formed a native Welsh state. In 728 the Saxons conquered the county, and in 1088 the Normans. In 1282 Llewellyn was slain near Builth. There are many remains of antiquarian interest, such as Roman stations, stone circles, and cromlechs. See T. Jones's *History* of the county (2 vols. 1805–9; reprinted 1898); Poole's *Illustrated History* (1886); Lloyd's *Historical Memoranda* (1899–1904); and E. A. Kilner's *Four Welsh Counties* (1891).

Breda, tn., prov. N. Brabant, Netherlands, 19 m. S.E. of Dordrecht. The Reformed Church contains fine burial monuments to the early counts of Nassau-Dillenburg. The old castle (1536–1696) is now used as a military academy. Carpets, cloth, and hosiery are manufactured. The defences were first laid out in 1534, and razed in 1876. The town capitulated to the Spaniards in 1581 and 1625, to the Dutch in 1590 and 1637, and to the French in 1793 and 1795. Here were signed the compromise of Breda in 1566, a protest of the Dutch nobility against the Spanish rule; the declaration of Breda in 1660 by Charles II. of England, in which he granted a free pardon and promised religious toleration; and the peace of Breda in 1667 between England and Holland. Pop. 28,000.

Bredahl, CHRISTIAN HVIID (1784–1860), Danish poet, born and died a poor peasant; an opponent both of the romantic poetry of Oehlenschläger and of the realistic novels of Gyllembourg-Ehrensvärd; wrote *Dramatiske Scener* (1819–33; new ed. 1855).

Bredasdorp, Dutch rural dist. (pop. 6,600) and tn. (pop. 600) at the extreme S. of Cape of Good Hope, 100 m. E.S.E. of Cape Town, bordering on Cape Agulhas (long. 20° E.). The district was formerly famed for its wild ostriches.

Bredero, GERBRANT ADRIAENSS (1585–1618), Dutch comic dramatist, was born at Amsterdam, and professed painting; but his reputation rests upon the farces *Kluchten* (1612), *Symen sonder Soeticheyt* (1613), and *Van den Meulenaer* (1613); the comedies *Moortje* (1615), and *Spaansche Brabander Jerolimo* (1618); and a volume of verse, *Groot Liedboeck* (1622). His collected works were edited by Jan ten Brink and others in 1885–90 (3 vols.). See a monograph in Dutch by Jan ten Brink (2nd ed. 1888).

Brederode, HENRY, COUNT OF (1531–68), Dutch patriot, leader, with Egmont and Horn, in the revolt against the Spanish rule of Cardinal Granvella. In 1566 he presented to Granvella's successor, Margaret, Duchess of Parma, the famous 'Request,' the refusal of which led to the insurrection of the Gueux, or 'Beggars.' He died in Germany.

Bredow, a suburb of Stettin, Germany, with factories, iron works, and shipbuilding yards. The Atlantic liners *Deutschland*, and *Kaiser Wilhelm der Grosse*, and the *George Washington* (1908), the largest vessel in the German mercantile marine, were built here. It was absorbed in Stettin in 1900.

Bredow, GOTTFRIED GABRIEL (1773–1814), German historian, author of popular historical works, such as *Merkwürdige Begebenheiten aus der Weltgeschichte* (some 40 eds.), *Handbuch der alten Geschichte* (several eds.), *Weltgeschichte in Tabellen* (nearly a dozen eds.), *Chronik des 19 Jahrhunderts* (1808), etc. See *Life* by Kunisch (1823).

Brée, MATTHIAS IGNATIUS VAN (1773–1839), Flemish painter, was born at Antwerp, and studied art in Paris under Vincent. He won the Prix de Rome in 1797, and in 1827 was appointed director of the Academy at Antwerp. A painter of historical and allegorical subjects, he excelled in colouring. His principal pieces were *Napoleon's Entry into Antwerp*, *Death of Rubens*, and *Van der Werff at the Siege of Leyden*. His brother Philip (1786–1871) was also a painter of some note. The Van Brées painted in the somewhat conventional style of the 18th-century Flemish school.

Breech, Breechloader. See GUNS and RIFLE.

Breeches Bible. See BIBLE.

Breede, one of the largest and deepest rivers of Cape of Good Hope, rising about 33° S. and 19° E. and flowing S.E., to enter the sea at Port Beaufort.

Breeding, a term particularly applied to man's control over the pairing of domesticated and semi-domesticated animals. The domestication of all the more important components of what we may call 'stock' was effected in prehistoric times. Modern attempts to extend the list have not been attended with important success; and, in explanation of the relative failure, it may be suggested—(1) that the number of docile forms which can breed in captivity or under artificial conditions may actually be very small; (2) that domestication may require a longer time and a greater care in graduating the imposed restrictions than modern attempts have afforded; and (3) that in primitive times men may have possessed some secret in regard to the treatment of wild animals which has been lost with the growth of civilization. But although civilized man has not been able to add much to the roll of domesticated animals, he has done a great deal in the way of multiplying *breeds*, and of improving them along lines which he has selected for his advantage or amusement.

General Theory of Breeding.—In general theory, by some form of isolation, man secures the inbreeding of similar variants until the characters he desires to foster have become more or less prepotent in inheritance, and a new breed is established. His interference consists in selecting particular variants, and in restricting their reproductive radius—positively, by bringing similar forms together; negatively, by preventing intercrossing with dissimilar forms: and this may imply the elimination of many members of the young breed itself.

Complications.—The success of breeding experiments requires attention to a large number of factors which are still imperfectly understood. (1.) Much depends on the original choice of the character, or group of characters, which the breeder seeks to develop. There are well-known 'incompatibles' in the characters of organisms; and groupings of characters which may occur together in a casual freak may entirely fail to be realized in a stable breed. (2.) So far as we know, the breeder cannot expect success if the observed peculiarity which he starts with turns out to be an 'acquired character,' a 'modification' due to habits and surroundings, and not an inborn or germinal variation. (3.) It is easy to speak of securing the inbreeding of similars, and of preventing mixture with other breeds or sub-breeds; but in practice the difficulties are in some cases great—*e.g.* with pigeons, dogs, and cats. (4.) A stable breed may be established quickly, as in the case of the ancon sheep; but it may be the work of a lifetime or more, demanding infinite patience and the most sedulous care. (5.) The essential process of inbreeding may be pursued too far, and degeneration may set in, ending perhaps in impotence; or the introduction of 'fresh blood,' intended to save the desired breed, may be followed by results which give a quite new turn to the reproductive events. (6.) In many cases the development of a breed implies artificial conditions of life (surroundings, food, and habits), which complicate the problem by inducing 'modifications' or acquired bodily characters, theoretically, at least, quite distinct from those inborn or germinal peculiarities which form the only secure foundation of a breed. (7.) Moreover, though we cannot here discuss the details, the breeder has to take account of the age of

the parents, their bodily vigour, the relative ripeness of the germ-cells, the normal time of pairing, and a dozen other factors of importance in reproduction.

Some Results of Breeding Experiments.—It is not possible at present to formulate 'laws of breeding.' There are, however, some valuable results which will eventually be incorporated in a unified theory. We propose to refer to a few of these.

1. Carefully-kept records—*e.g.* of Basset hounds—have formed part of the basis of Galton's law of ancestral inheritance—an average statistical statement of the fact that inheritance is like a mosaic, the two parents contributing one-half, the four grandparents one-fourth, the eight great-grandparents one-eighth, and so on, of the total heritage of the average offspring.

2. There is no doubt that a variation sometimes crops up which is almost certain to be transmitted in its full strength, even although its possessor is paired with a form that does not possess the peculiarity in question. This prepotency of certain individual variations was probably operative in the origin of some of the more extraordinary breeds, such as ancon sheep, pug-dogs, and short-faced tumbler pigeons.

3. It seems certain that, given healthy stock, breeding in-and-in—*i.e.* within a small circle of blood relations—may be carried much further than most practical breeders are at present inclined to allow. The history of some breeds—*e.g.* of polled Angus cattle—shows in the early years a closeness of inbreeding which could hardly be exaggerated.

4. There is ample evidence to show that inbreeding in a healthy stock tends to develop the prepotency of the breed, giving fixity and stability and certainty of transmission to their peculiar characters. Galloway cattle may be cited as a good example of an extremely prepotent breed.

5. The experiments of Ritzema-Bos and others on the inbreeding of rats and mice, and the less precise experience of breeders of valuable stock, show, on the other hand, that inbreeding may be carried too far, and may lead to degeneration, frequent abnormalities, abortions, and sterility. Sometimes, however, the collapse may be traceable to the artificial preservation of notably weak members who should have been detected and eliminated before they became reproductive. This leads to the question of intercrossing or outbreeding (exogamy) between members of different breeds.

6. While inbreeding induces fixity and prepotency, outbreeding or intercrossing of breeds is certainly provocative of variation. As Professor Ewart puts it: 'It is only necessary to interbreed half-bred animals, the offspring of two varieties that have long lived apart,.... in order to obtain an epidemic of variation, to induce a more or less prolonged period of "sporting."' Ewart's experiments with rabbits seem to prove this conclusively.

7. But the results of intercrossing different breeds are so diverse that they may be called unpredictable. Following Ewart, we may summarize the more striking results:—(1.) The offspring, down to minute details, may be all but intermediate between the two parents; but this is not very common. (2.) The offspring may resemble one of the parents. (3.) Some of the offspring may resemble one of the parents, and some the other. (4.) The offspring may combine, almost unimpaired, the more striking characters of both breeds; but this is very rare. In regard to pigeons, for instance, it seems very difficult to combine

the distinctive characters of two well-marked breeds. (5.) Sometimes new, or at least unexpected, characters appear in the offspring—*e.g.* a tailless rabbit, a spinning rabbit like a Japanese dancing mouse, a chestnut crow, and so on. (6.) The offspring of half-breeds are usually extremely variable. (7.) Sometimes the offspring, instead of resembling the parents, resemble former ancestors—a phenomenon which is, in some cases, interpretable as a reversion. See HEREDITY and VARIATION.

8. In 1865 Gregor J. Mendel published the results of numerous experiments on the hybridization of plants, of varieties of pea in particular, and formulated what is now called Mendel's law—an induction of profound importance in connection with breeding. His masterly work remained all but unknown till 1900, when De Vries, Correns, and Tschermak reached similar conclusions. These have been confirmed by the experiments conducted by Bateson and Saunders, for animals as well as plants; and no one should now theorize or experiment on breeding without first making himself familiar with Bateson's statement and vindication of Mendel's law. Within our space we cannot do justice to Mendel's discovery, but the gist of it, in Bateson's words, is this: 'The germ-cells or gametes produced by crossbred organisms may, in respect of given characters, be of the pure parental types, and consequently incapable of transmiting the opposite character; that when such pure similar gametes of opposite sexes are united together in fertilization, the individuals so formed and their posterity are free from all taint of the cross; that there may be, in short, perfect or almost perfect discontinuity between these germs in respect of one of each pair of opposite characters.' See MENDELISM.

9. A careful scrutiny of the results of breeding does not seem to furnish any secure evidence in favour of the belief in the transmission of acquired characters or 'modifications;' but it is only fair to say that some expert breeders—*e.g.* Brewer—find the evidence satisfactory. The same remark must be made in regard to telegony—the supposed influence of a previous sire on the subsequent offspring of the same mother by a different father.

See W. Bateson and Miss E. R. Saunders, *Reports to the Evolution Committee, Royal Soc., Lond., 1901*—a very valuable record of experiments; W. H. Brewer, series of papers in the American journal *Agricultural Science*, 1892 and 1893; E. D. Cope, *The Primary Factors of Organic Evolution* (1896)—deals at some length with breeding, and expounds Brewer's conclusions; Ch. Cornevin, *Traité de Zootechnie Générale* (1891)—an important treatise; Charles Darwin, *Variation of Plants and Animals under Domestication* (1868)—the classic work on the variations of breeds; J. Cossar Ewart, *The Penicuik Experiments* (1899); 'Variation: Germinal and Environmental,' in the *Scientific Transactions, Royal Dublin Soc.*, vii. 353–378 (1901)—a valuable continuation of the book above cited; P. Geddes and J. Arthur Thomson, *The Evolution of Sex* (4th ed. 1901); V. Hensen, *Physiologie der Zeugung* (1881)—a valuable treatise, necessarily a little out of date; G. J. Mendel, *Versuche über Pflanzenhybriden* (Abh. Nat. Ver., Brünn), reprint in Ostwald's *Klassiker* (1901), also in *Flora* (1901), and trans. in *Jour. Roy. Horticultural Soc.* (1901)—a very valuable record of experiments not as yet duly appreciated; H. von Nathusius, *Vorträge über Viehzucht und Rassenkenntniss*

(1872); G. J. Romanes, *Darwin and after Darwin* (3 vols. 1893, 1895, 1897)—giving many illustrations of the evolutionary interest of breeding; A. Sanson, *Traité de Zootechnie* (2nd ed., five small vols., 1874-8; vol. ii. on laws and methods of breeding), and *L'Hérédité Normale et Pathologique* (1893)—paying much attention to breeding; H. Settegast, *Die Thierzucht* (2 vols. 5th ed. 1888)—a valuable treatise by an expert in touch with biological progress; H. de Vries, *Die Mutationstheorie*, vol. i. (1901); Alfred Russel Wallace, *Darwinism* (1889); August Weismann, *The Germ-Plasm* (1893), and *The Evolution Theory* (Eng. trans. 1904).

BREED SOCIETIES IN UNITED KINGDOM.—In addition to the permanent Royal Commission on Horse Breeding (President, Duke of Portland) the following societies may be mentioned:—

Horses.—Shire Horse Society; Clydesdale Horse Society; Hackney Horse Society; Hunters' Improvement Society; Polo and Riding Pony Society; Cleveland Bay Horse Society; Yorkshire Coach Horse Society.

Cattle.—Shorthorn Society; Hereford Herd-Book Society; Devon Cattle Breeders' Society; Sussex Herd-Book Society; English Jersey Cattle Society; Galloway Cattle Society; Ayrshire Cattle Herd-Book Society; Highland Cattle Society; Jersey Herd-Book Society; English Guernsey Society; Kerry and Dexter Herd-Book Society; Red Polled Society.

Sheep.—National Sheep Breeders; Oxford Down Breeders; Southdown; Hampshire Down; Wensleydale; Leicester.

Pigs.—National Pig Breeders' Association; British Berkshire Society; Large Black Pig Society.

Poultry.—National Poultry Organization Society; Poultry Club.

There is also a British Goat Society.

Breeze-fly. See CLEG.

Breezes, LAND AND SEA. Land and sea breezes which are purely local are met with in their most perfect form in hot countries. Towards noon a breeze sets in from the sea in the direction of the land, and dies slowly away towards sunset. About midnight a breeze begins to blow in the reverse direction, or from the land to the sea. Mr. H. F. Blanford's explanation (*Meteorological Vade Mecum*, ii. 70; 1877) is that when the air over the land is expanded by heat and raised, the upper strata gravitate off towards the cooler sea, and thereby produce an increase of barometric pressure at some distance from the shore. The air accordingly flows from this area of relatively high pressure towards that where pressure is lower, so that the sea breeze is first felt in the offing. During the night the contrary action takes place, the radiation over the land cooling the atmosphere, which contracts. The air above slides down from the sea, circles over the land, and pushing its way out, is felt as a land breeze. In the tropics the land and sea breezes blow with great regularity, except when masked by stronger winds, as during the monsoons. In England land and sea breezes do not attain any marked development, and extend only a short distance. See 'An Investigation of the Sea Breeze,' *Annals of the Astron. Observ., Harvard Coll.*, vol. xxi. (1890).

Bregenz (anc. *Brigantium*), tn. and summer resort of Austria, the cap. of Vorarlberg, stands at the E. end of the Lake of Constance, 121 m. N.W. of Innsbruck. It consists of the upper old town and the lower new town down beside the lake. Its chief feature is the National Museum of Antiquities, with many Roman re-

mains. The people are engaged in the silk industry, and make fancy ornaments. Pop. 8,000.

Brehm, ALFRED EDMUND (1829–84), German naturalist, the son of a Thuringian pastor. Brehm's most famous work was his *Illustriertes Thierleben*, or 'Animal Life' (10 vols.; latest. ed. 1890–7; Eng. trans. 1895), which won immediate admiration from zoologists and travellers for the accuracy of its delineations, and to which Charles Darwin, among many others, acknowledged his indebtedness. But what Brehm himself regarded as 'the pet child of his pen' was his book on *Das Leben der Vögel* (1867–8; Eng. trans. by Labouchere and Jesse, 1874), a work addressed primarily to the general reader, although it is full of deep scientific interest. Brehm studied at Jena and at Vienna, and travelled extensively in Europe, Asia, and Africa. He was also director of the zoological gardens at Hamburg (1863–7), and founder and director of the aquarium at Berlin (1867–75).

Brehon Laws. The name 'Brehon' is the English form of the Gaelic *breitheamh*, 'a judge;' and the Brehon Laws denote the jurisprudence of ancient Ireland. The Gaelic MSS. embodying these laws, of which the *Senchus Mòr* (Great Book of the Ancient Law) and the *Book of Aicill* are the most noteworthy, have been translated into English and published in a series of five volumes, with a sixth volume as *Glossary*, under the title of *The Ancient Laws of Ireland* (1865–1901). It is the work of half a century, authorized by a royal commission constituted on Nov. 11, 1852, and carried out by various distinguished scholars. Some of these laws are clearly of great antiquity. Sir Henry Maine, who ably summarizes them in his *Lectures on the Early History of Institutions* (1875), observes 'some strong and even startling points of correspondence between the functions of the Druids, as described by Cæsar, and the office of the Brehon.' Prof. Atkinson (*Ancient Laws of Ireland*, vi. 344–45; 1865), in drawing attention to the *Feinechas*, or customs and regulations of the Feine, a people whose influence permeates the Brehon Laws, draws the inference that these were a later caste of Teutonic invaders, whose formulated customs 'have strong resemblances to the *Lex Salica* and other codes of Germanic origin.'

Breisach, also known as ALT BREISACH ('Old Breisach'), and in Latin *Mons Brisiacus*, tn. in grand-duchy of Baden, Germany, stands on a basalt table above r. bk. of the Rhine, 14 m. W.N.W. of Freiburg. It was formerly one of the strongest fortresses of Germany, commanding the passage of the Rhine between France and S. Germany. In 1805 it was assigned to Baden, and its defences razed. Pop. 3,600.

Breisgau, in the middle ages, a *gau*, or district of Alemannia, being the country of the Germanic tribe of the Alemanni. It included the valley of Freiburg and the S. of the Black Forest, and embraced an area of 600 to 700 sq. m.

Breitenfeld, vil., dist. Leipzig, Saxony, 4 m. N. of Leipzig. Here, in 1631, Gustavus Adolphus of Sweden defeated the forces of the Catholic League of the empire, commanded by Tilly, and in 1642 the Swedish general Torstensson defeated the imperialists under the Archduke Leopold. For the third battle see LEIPZIG.

Breitinger, JOHANN JAKOB (1701–76), Swiss man of letters; born in Zürich; professor of Hebrew (1731) and Greek (1745) at Zürich; was an ally of Bodmer in his polemic against Gott-

sched and the artificial French conception of the import and essence of literature. His chief work was *Kritische Dichtkunst* (1740). See *Life* by H. Bodmer (1897).

Breitkopf, BERNHARD CHRISTOPH (1695–1777), founder of the Leipzig printing-house of Breitkopf, now Breitkopf and Härtel; established himself at Leipzig in 1718, and attracted notice by his admirable printing of Gottscheid's works from 1726 onwards. His only son, JOHANN GOTTLIEB EMMANUEL (1719–94), invented movable music type in 1750, improved the shape of the German characters, and devised a method of printing maps, pictures, etc., from movable pieces. Breitkopf was a friend of Goethe, and set his earliest poems to music. He also printed the musical compositions of Beethoven and Mozart, and wrote several valuable works on typography.

Breitmann, Hans. See LELAND, CHARLES GODFREY.

Bremen. (1.) Free state of Germany, between the grand-duchy of Oldenburg and the Prussian province of Hanover, on both sides of the Weser and embracing the towns of Bremen, Vegesack, and Bremerhaven. Its total area is 99 sq. m. To the Imperial Diet it sends one representative, and has one vote in the Imperial Council. The state and town of Bremen form a democratic republic, governed by a senate of sixteen elected members (the executive), presided over by two burgomasters elected for four years, and an assembly of 150 citizens (the legislative authority). The old duchy of Bremen was assigned in 1648 to Sweden, whence it was sold in 1715 to Hanover, with which it is now incorporated. Pop. 285,000. (2.) Seaport town, German empire, on the Weser, 72 m. by rail S.W. of Hamburg. It is one of the busiest ports in the empire, its exports and imports being each valued at about £85,000,000 per annum. The chief articles of trade are cotton and woollen goods, jute, rice, iron and steel, building materials, petroleum, and tobacco. The port (inclusive of Bremerhaven) is entered annually by some 5,500 vessels (tonnage, 4 millions). Bremen is one of the ship-owning ports of Germany, and is the headquarters of the N. German Lloyd (registered tonnage, 800,000) and the Hansa (tonnage, 260,000) lines. Bremen has extensive industries—shipbuilding, jute spinning, wool combing and cleaning, worsted spinning, and oil mills. The most notable edifices are the cathedral (built in 11th century) and the town hall. The public park, 337 ac. in extent, was laid out in 1866–84. Pop. 220,000. The town owes its origin to a bishopric founded in 788 by Charlemagne. It joined the Hanseatic League in the 13th century, and was very prosperous in the 16th. Its modern commercial prosperity dates from the founding of Bremerhaven in 1830. See Bippen's *Geschichte der Stadt Bremen* (1898).

Bremer, FREDERIKA (1801–65), Swedish novelist, was born at Tuorla, near Åbo, in Finland. In 1828 appeared *Axel och Anna*, the first of a whole series of romances with the common title of *Teckningar ur Hvardagslifvet.* Of these, *Familien H...* (1833), *Grannarne* (1837), *Presidentens Döttrar* (1834), *Hemmet* (1839), *I Dalarne* (1845), all translated into English by Mary Howitt, are generally regarded as the best. She is the chronicler of Swedish middle-class life. In 1844 the Swedish Academy conferred upon her its gold medal. After 1840 her works generally assumed a more serious tone. Two years (1849–50) she spent in America, where her books

were much admired, and where she made the acquaintance of Longfellow, Lowell, Emerson, and Beecher. The result of her experiences is recorded in *Hemmen inya verlden* (1853). The romance *Hertha* (1856), in which she advocated 'women's rights,' was very unpopular. From 1856–61 she travelled all over Europe, chiefly with the object of studying the religious life of the various nationalities; but none of them came up to her ideal religion. See collected works in Swedish (1868–72); works in English (trans. Howitt, 1846; another ed. 1849); also Howitt's *Twelve Months with Frederika Bremer* (1866); *Life, Letters, and Posthumous Works* (trans. Milow, 1868); R. Petersen's *Frederika Bremer* (1892); and *Life* (in Swedish) by S. Adlersparre (1895).

Bremer Beiträge, abbreviated name of a literary journal which played a prominent part in German literature. It was published by Rabener, Gellert, and others as *Neue Beiträge zum Vergnügen des Verstandes und Witzes* (1745–8). In it were printed (1748) the first three cantos of Klopstock's *Messias*.

Bremerhaven, or BREMERHAFEN, seapt. tn. (outport of Bremen), Germany, belonging to the free state of Bremen; stands at the mouth of the Weser, on its r. bk., and 45 m. N.N.W. of Bremen. The town dates only from 1827, when Bremen bought land from Prussia, whereon she has since constructed three large harbour basins, besides docks (including the dry dock of the N. German Lloyd) and wharves. Pop. 24,000.

Bremersdorp, tn., Swaziland, S. Africa, 80 m. S.W. of Lourenço Marques; until 1905 the seat of government.

Brendan, or BRENAINN, ST. (484–577), of Clonfert, called 'son of Finnloga' to distinguish him from St. Brendan of Birr, is the hero of the *Navigation of St. Brendan*, a very popular tale of the middle ages, which was carried to the Continent in the 9th century by Irish monks. He is said to have visited certain islands in the Atlantic, which suggest the familiar Greek legend of the Isles of the Blest. The islands of St. Brendan are represented on maps as being west of the Canaries as late as 1755, and in 1526 the Spaniards sent out more than one exploring expedition in search of them. Brendan visited St. Columba (563) at Iona. His day is May 16. See Schröder's *Sankt Brandan* (1871); Lanigan's *Eccles. Hist.*, ii. (2nd ed. 1829); *Early English Ballads*, Percy Soc., xiv. (1844); *Voyage of Bran*, ed. Kuno Meyer (1896); Wahlund's *Brendans Meerfahrt* (1900); and Moran's *Acta Sancti Brendani* (Dublin, 1872).

Brendan, ST. (?490–573), of Birr, now Parsonstown, in King's Co., Ireland. A disciple of St. Finnian of Clonard, he was the friend of Columba, and advised him to settle at Hy (Iona). His day is November 29. See Reeve's *Adamnan* (1857); *Martyrology of Donegal* (1864).

Brenham, co. seat of Washington co., Texas, U.S.A., 75 m. W.N.W. of Houston; manufactures cotton products and iron goods. Pop. 6,000.

Brennan, LOUIS (1852), inventor of the Brennan torpedo, was born at Castlebar in Ireland, and worked as a watchmaker in Melbourne. Recognizing the value of his torpedo, the British Admiralty invited him to England, and in 1882 Brennan was paid a retaining fee of £5,000, and engaged for three years at a salary of £2,000 a year and expenses, for which he was to give his whole services to the improvement of his invention. He was afterwards given a reward of

£110,000 and a salary of £1,500 for five years. Brennan is still consulting engineer to the Government Brennan Torpedo Factory. His latest invention is the monorail.

Brenner. (1.) Village and summer resort of Austria, in Tyrol, near the head of the Brenner Pass, 20 m. S.S.E. of Innsbruck; has warm baths. (2.) B. PASS, connects the valley of the Inn with that of the Etsch (Adige). It is the lowest (4,485 ft.) of the great Alpine passes, and lay on the Roman highroad from Verona to Augsburg. It was made practicable for wheeled vehicles in 1772, and in 1864–7 a railway, 78 m. long, was constructed through it.

Brennus. (1.) The leader of the Gallic tribe of the Senones, who, in 390 B.C., after besieging Clusium, marched on Rome, defeated the Romans at the battle of the Allia, and took and burnt their city. The Senones were probably bribed to retire by a ransom. See Livy, v.; and Mommsen's discussion of the incident, *Roman History*, vol. i. (1894.) (2.) The leader of the Gauls who invaded Greece in 279 B.C. After being checked at Thermopylæ, they devastated Ætolia, and advanced on Delphi; but the Delphians, aided by the nature of the ground, completely defeated them. Few escaped, and Brennus killed himself. See Cortzen's *Die Wanderungen der Kelten* (1861).

Brenta, riv., N. Italy; rises in the S. of Tyrol, flows E., S., and S.E., and originally discharged into the lagoon of Venice, but has been artificially carried round the S. end of the lagoon, so as to reach the Adriatic at Chioggia. Though its lower course is embanked, it is the cause of frequent inundations. Length, 106 m., of which 56 m. are navigable.

Brentano, CLEMENS (1778–1842), born at Frankfort, was the son of Maximiliane la Roche, and brother of Bettina von Arnim, the correspondent of Goethe. In 1797 he was a student at Jena, where he became acquainted with the brothers Schlegel and other early romanticists. In 1801 he wrote *Godwi, oder das steinerne Bild der Mutter*, which reveals many traces of the influence of Goethe's *Werther* and *Wilhelm Meister*, still more of Jean Paul's works. Three years later he went to Heidelberg, and there, together with Achim von Arnim, edited (1805–8) the collection of popular ballads entitled *Des Knaben Wunderhorn*. On leaving Heidelberg he led an unsteady, wandering life; but in 1817 he became a devout Roman Catholic, and from 1818 to 1824 associated with Katharina Emmerich at Dülmen, a 'stigmatized' woman of overwrought religiosity. In 1817 he published *Die Geschichte vom braven Kaspar und dem schönen Annerl*, probably his best tale. Brentano was the black sheep of the romanticists—a vagabond with a love of shocking people—and in some respects resembled Heine. There is a good cheap edition of *Des Knaben Wunderhorn* in Meyer's *Volksbücher*, an excellent account of its editors by R. Steig (*A. von Arnim und Clemens Brentano*, 1894), and an edition of his *Gesammelten Schriften* in 9 vols. (1852–5).

Brentano, LUDWIG JOSEF, 'LUJO' (1844), nephew of Clemens Brentano, was born at Aschaffenburg in Bavaria. A political economist of some note, he has made a special study of the working classes both from the historical point of view and from the actual present-day conditions. He has been professor of political economy at Breslau (1872), Strassburg (1882), Vienna (1888), Leipzig (1889), and Munich (1891). His chief works are *Die Arbeitergilden der Gegenwart* (1871–2), *Ueber das*

Verhältnis von Arbeitslohn und Arbeitszeit zur Arbeitsleistung (2nd ed. 1893), *Das Arbeitsverhältnis gemäss dem heutigen Recht* (1877), *Die Arbeitsversicherung* (1879), *Der Arbeiterversicherungszwang* (1881), *Die Christlich-soziale Bewegung in England* (2nd ed. 1883), *Agrarpolitik* (1897), *Ethik und Volkswirtschaft in der Geschichte* (1901), and *Die wirtschaftlichen Lehren des christlichen Altertums* (1902), *Der Unternehmer* (1907), *Wirtschaftspolitik und Finanz-politik* (1909), etc. See his *Hours and Wages in Relation to Production* (Eng. trans. by Mrs. Arnold, 1878).

Brentford, mrkt. tn., Middlesex, England, on riv. Thames and L. & S.W.R., 10 m. w. of St. Paul's, London. It is the county town of Middlesex. There are soap works, distilleries, breweries, and market gardens. Here, in 1016, Edmund Ironside defeated the Danes; and in 1642 it was the scene of Prince Rupert's victory over Colonel Hollis. Brentford and its 'Two Kings' figures in Buckingham's *Rehearsal* and in Cowper's *Task*. Pop. 15,000.

Brent Goose (*Bernicla brenta*), a near ally of the barnacle or bernicle goose. It resembles that species in general colour, in distribution, and in habit, except that it feeds by day, and not by night, as the former does. It weighs from 3½ to 4½ lbs., and is the best of the geese from the gastronomic point of view.

Brenton, Sir Jahleel (1770–1844), British vice-admiral, served in the *Barfleur* at Cape St. Vincent in 1797. He was flag-captain to Saumarez in the actions in Algeciras Bay and the Gut of Gibraltar in 1801; was wrecked, and taken prisoner in the *Minerve*, off Cherbourg, in 1803, and imprisoned until 1806, when he was exchanged; assisted in the reduction of the Ionian Islands (1809); and, in the *Spartan*, defeated a Franco-Neapolitan flotilla in May 1810. For this he was made a baronet in 1812, and a K.C.B. in 1815. He was subsequently commissioner at the Cape of Good Hope, and lieutenant-governor of Greenwich Hospital. At the time of his death he was a vice-admiral of the White. See *Life* by Raikes (1846).

Brentwood, eccles. par. (459 ac.) and tn., Essex, England, 11 m. s.w. of Chelmsford; has a free grammar school founded in 1557, and part of a chapel built by St. Osyth in 1221 in memory of St. Thomas à Becket. Pop. 5,000.

Brenz, Johann (1499–1570), German theologian, the Protestant reformer of Würtemberg, where he had held office as canon until converted to Lutheranism. He took part in the Marburg Disputation (1529), the Augsburg Conference (1530), and the Conferences of Hagenau (1540), Worms (1540), and Ratisbon (1541 and 1546); was one of the authors of the Würtemberg Confession; and his Catechism ranks next to Luther's. In 1553 he became superintendent of Stuttgart, whither he betook himself on the issue of Charles v.'s 'Interim,' which he strenuously opposed. See Hartmann and Jäger's *Life of Brenz* in German (1840 and 1862).

Brescia. (1.) Province (area, 1,806 sq. m.), N. Italy, between Tyrol, L. Garda, and river Oglio. The principal products are rice, maize, wine, and fruits. Silk, machinery, and leather are the chief manufactures. Pop. 575,000. (2.) Town (anc. *Brixia*) and episc. see, cap. of above, 50 m. E.N.E. of Milan. Its chief manufactures are woollens, linens, and silks, and it is famous for its iron and steel wares, especially arms for the Italian army. The cathedral, of white marble, begun in 1604, was not finished until 1825. The town hall dates from 1499–1775, the Broletto (the assembly

hall of the Brescian republic) from the 12th century. Several of the churches contain valuable pictures by native painters, such as Moretto (b. 1498) and Romanino (b. *c.* 1485), also by Paolo Veronese and Tintoretto; and its museums and picture galleries are very fine. There are statues to Garibaldi (1889) and Arnold of Brescia (1883), a reformer of the church in the 12th century. The town was destroyed by Attila in 452. It held a leading place in the Lombard league against Frederick Barbarossa in the end of the 12th century. From 1516 to 1797 it was subject to Venetian rule. In 1849 it was taken by the Austrian general Haynau. Ten years later it was annexed by Sardinia. The Brescian school of painting flourished in the 16th and 17th centuries. Pop. 75,000.

Breslau, tn., cap. of prov. of Silesia, Prussia, on the Oder, 224 m. S.E. of Berlin, is commercially and educationally the principal city in E. Germany. It consists of the old town and six suburbs. Near the imposing and richly-decorated town hall (14th century) are fine statues to Frederick the Great, Frederick William III. of Prussia, and Blücher. The oldest ecclesiastical edifices are the cathedral and the churches of St. Elizabeth and St. Magdalene, all of the 13th century. Among the most important buildings are the university, the archiepiscopal palace, and the palace of the king of Prussia. The chief industries are the manufacture of machinery, beet sugar, and chemical manures; printing, brewing, distilling, and flour-milling. Breslau is an important railway junction and commercial centre. It has been the see of a bishop since the 11th century. It was subject to Austria from 1526 to 1741, at which latter date it was conquered by Frederick the Great. Pop. 510,000. See Stade's *Breslau* (1895).

Bressay, par. (7,738 ac.) and isl., E. Shetland, Scotland, separated from Mainland by Bressay Sound, part of which forms the harbour for Lerwick; 142 m. by steamer N.W. of Aberdeen. Parish includes the islands of Noss and Inner and Outer Score. Flagstones and slates are quarried. Pop. 700.

Bresse (Lat. *Brissa, Bressia*), anc. prov. of France, now forming the dep. of Ain. It formed part of Burgundy, and in 1601 was definitely assigned to France by Henry IV.

Brest, most important naval harbour of France, on the Atlantic, dep. Finistère. There are naval schools, an arsenal employing 9,000 hands, and various hospitals. The harbour is on the river Penfeld, separating Brest from its suburb Recouvrance. The castle, built in the 12th century, was modified by Vauban. There are manufactures of candles, cork, hats, ropes, soap, and leather. Strawberries, vegetables, and superphosphates are the principal exports. Brest was in the hands of the English from 1342 to 1397, and resisted afterwards several English attacks (1513 to 1694). Brest Roads are formed of an irregular bay, 14 m. long by 7 m. wide, connected with the ocean by a channel on the N., called the Goulet. Pop. 85,000.

NAVAL BATTLES OFF BREST.—In 1512 an English fleet, under Lord Edward Howard, with forty-five sail, made the mouth of Camaret Bay on August 10, just as the French, with thirty-nine sail, were leaving Brest. A bloody but indecisive battle followed. The battle is sometimes known as that of St. Mathieu. Lord Edward Howard, with forty-two ships, besides small craft, blockaded Brest and the French fleet within it. While he lay before it, a force of French galleys from the Mediterranean entered the neigh-

bouring bay of Blanc Sablon. On April 25, 1513, Howard, with his boats, attempted to cut them out; but his little force was repulsed with heavy loss, and the lord high admiral himself was driven overboard and drowned. In 1594, when Brest was held by the Catholic league and its Spanish sympathizers, it was blockaded by a small British squadron under Sir Martin Frobisher, who was mortally wounded while serving ashore in the final and successful assault that was made on it by the allied troops of Henry IV. of France and Queen Elizabeth.

Brest Litovsk (*Brzesc*), tn. of Grodno gov., Russia, centre of industry, and important fortress, 131 m. by rail S. of Grodno city, on the (Polish) Bug, important junction at crossing of Moscow-Warsaw and Königsberg-Odessa Railways. Trade in grain, wood, cattle; tobacco manufacture; military college. It is the see of a Greek Orthodox bishop and of a Catholic Armenian bishop, who is head of the Armenian Catholic Church in Russia. Pop. 52,000.

Bretagne. See BRITTANY.

Brethren, APOSTOLIC. (1.) A Gnostic sect of the 3rd and 4th centuries, which condemned marriage and followed Christian communism. (2.) A German communist body of the 12th century, near Cologne, which rejected the Roman Church and professed to revive the original doctrines of the apostles. (3.) A North Italian sect of the 13th and 14th centuries, which urged a return to the primitive communism of the apostolic church. Its founder, Gerhard Sagarelli, a Parma weaver, was, after twenty years' successful preaching as an apostle, burned at the stake (1300), and the brethren suffered persecution. From 1290 his adherents began to denounce infant baptism, the dogma of purgatory, invocation of saints, prayers for the dead, and the corrupt lives of the clergy. His successor, Dolcino of Novara, an able and learned man, maintained himself in arms against Pope Boniface VIII. for two years, but was captured, and was burned at the stake at Vercelli in 1307. See BROTHERHOODS and CHRISTIAN BROTHERS.

Brethren of the Common Life, semi-monastic associations founded by Gerhard Groot at Deventer, in Holland, about the year 1376, for teaching children, copying books, and generally labouring and living in Christian communion. They were likewise known as Brethren of Good Will, Hieronymites, Gregorians, and Collation Brethren. After Groot, the leaders were Radewin and Zerbolt. There were also bands of women working for similar purposes. The most illustrious member was Thomas à Kempis, and the most distinguished pupil of its schools was Erasmus. See Ullmann, *Reformers before the Reformation* (Eng. trans. vol. ii. 1855); Kettlewell, *Thomas à Kempis and the Brothers of Common Life* (1882); Hoening, *Die Brüder des gemeinsamen Lebens* (1894).

Brétigny, vil. in dep. Eure-et-Loir, France, 6 m. S.E. of Chartres. By the treaty of Brétigny, May 8, 1360, Edward III. of England gave up his claim to the throne of France; retained Gascony and Guienne; abandoned Anjou, Maine, Normandy, and Touraine; and agreed to release King John on receipt of a ransom of 3,000,000 crowns. See Cosneau's *Les Grands Traités de la Guerre de cent ans* (1889).

Breton, CAPE. See CAPE BRETON.

Breton, JULES ADOLPHE AIMÉ LOUIS (1827–1906), French painter, born at Courrières (Pas-de-Calais), was pupil of De Vigne and Drolling, and a master of the realist

school of peasant-painters. He was in touch with the Barbizon school, and one of the first to follow Millet and Courbet in the revolution against academic tradition; but his subjects were always less uncompromising and more convincing than theirs, and this tendency towards idealization became still more developed in his later works. His colour is beautiful, his composition simple and attractive. His best pieces include *Blessing the Fields* (1857), *Return of the Gleaners* (1859), *Evening* and *Weeders* (1861), *Potato Harvest* (1868), *The Fountain* (1872), *St. John's Feast* (1875). See Breton's autobiographical *Vie d'un Artiste* (1890), and Vachon's *Jules Breton* (1899).

Breton, NICHOLAS (?1545–1626), English poet and pamphleteer, was son of a London merchant, and stepson of George Gascoigne. Some charming pastoral lyrics in the Spenserian vein are to be found in his *Passionate Shepheard* (1604), and in the miscellany *England's Helicon* (1600). See *Collected Works*, ed. A. B. Grosart (1876); *Selections*, Grosart, 'A Bower of Delights' (1893); and A. H. Bullen's *Poems, chiefly lyrical, of the Elizabethan Age* (1890).

Bretón de los Herreros, MANUEL (1796–1873), Spanish scholar and dramatist, was perpetual secretary to the Royal Spanish Academy and chief of the National Library; an indefatigable writer of poems, articles, sketches, and tales, but more memorable as a dramatist. Much of his work still holds the stage. Some of his most notable pieces are *A Madrid me vuelvo* (1828), *Marcela* (1832), and *Un Novio para la Niña* (1836). The best collected edition of his works is that of Madrid (1884). See the Marquis of Molins's *Bretón de los Herreros* (1883), and Piñeyro's *El Romanticismo en España* (1904).

Breton Language and Literature. Breton (Fr. *Bas Breton*) is a Celtic dialect spoken in Brittany. Together with Welsh and the extinct dialect of Cornwall, it constitutes the Cymric group of the Celtic languages. It was carried to France by the British Celts who fled from England upon the invasion of the Anglo-Saxons between the 5th and 6th centuries. It is sometimes called Armorican, and is spoken at the present time by about 1¼ million persons. Although it comprises several dialects, four of them only are of any moment, and of these the most important is the so-called Léon dialect. A good grammar and dictionary of this dialect were published by Le Gonidec (3rd ed. 1847–50), and a good French and Breton dictionary (of the same dialect) by Froude (new ed. 1876). The oldest fragments of Breton literature belong to the 14th century—*e.g. Le Mystère de Saint Nonne* (ed. Le Gonidec, 1837) and *Le Grand Mystère de Jésus* (ed. La Villemarqué, 1866). The Breton language has long ceased to be used by the gentry; on the other hand, an extensive popular literature has been developed, to which special attention was drawn in the 19th century. The popular *contes* and legends are characterized by the exceptionally large place which sea stories and miraculous narratives occupy in them. (See Luzel's *Contes Bretons*, with Fr. trans. 1870.) In 1863 Luzel published, further, a good specimen of the Breton mystery in *Sainte Tryphine et le Roi Arthur*. The popular songs are divided into two distinct types — the *gwerz*, or historic poems, and the *sonn*, or lyric poetry. Collections were published by La Villemarqué under the title *Barzaz-Breiz* (1839; 7th ed. 1867; Eng. trans. by Tom Taylor, 1865); by Luzel in *Gwer-*

ziou Breiz-Izel (2 vols. 1868–74), *Contes Bretons* (1870), and *Soniou Breiz-Izel* (2 vols. 1890). See E. Renan's 'La Poésie des Races Celtiques,' in *Revue des Deux Mondes* (1854), and *Souvenirs d'Enfance et de Jeunesse* (1883); D'Arbois de Jubainville's *Les Celtes et les Langues Celtiques* (1883); Quellien's *Chansons et Danses des Bretons* (1889); and *La Revue Celtique*.

Bretschneider, HEINRICH GOTTFRIED VON (1739–1810), Austrian satirist, who, after travelling in England, France, and Hungary, and making the acquaintance of Nicolai, Lessing, Gellert, Swedenborg, and Goethe, published an account of his travels, as well as numerous volumes of satires and poems. See Linger, *Denkwürdigkeiten...von Bretschneider* (1892).

Bretschneider, KARL GOTTLIEB (1776–1848), German theologian, was born at Gersdorf, Saxony. Of his numerous works, the chief are: *Handbuch der Dogmatik der evangelischlutherischen Kirche* (1838); *Probabilia de Evangelii et Epistolarum Joannis Apostoli Indole et Origine* (1820); *Melanchthoniana Pædagogica* (1834; new ed. 1892); *Selbstbiographie* (1851).

Brett, JOHN (1830–1902), British painter, who began to exhibit in 1856, and was elected A.R.A. in 1881, is the chief exponent of the pre-Raphaelite method as applied to seascapes and landscapes. His *Stonebreaker* (1858) was so much admired by Ruskin that he commissioned the fine *Val d'Aosta* (1859). *Britannia's Realm* (1880) is in the Tate Gallery, London, *The Norman Archipelago* (1885) in Manchester, and *North-west Gale off the Longships Lighthouse* in Birmingham. See Percy Bate's *English Pre-Raphaelite Painters* (1899).

Brettes, LOUIS JOSEPH, VICOMTE DE, French traveller; born at Limoges. In 1877–83 he visited the N.W. coast of Africa and the S. of Algeria. In 1886–9 he made an expedition to the Gran Chaco in S. America; in 1890–1 he explored the Sierra Nevada de Santa Marta in Colombia; and in 1892–3, at the request of the French Board of Trade, he made another journey to Colombia, when he surveyed the province of Magdalena. See Mallat de Bassilan's *L'Amérique Inconnue, d'après le Journal de Voyage de J. de Brettes* (1895).

Bretts and Scots, LAWS OF THE. In the *Regiam Majestatem* there are, in the words of Hill Burton, 'some fragments of a mysterious old code, called the Laws of the Bretts and Scots,' evidently a survival of Cymric and Gaelic jurisprudence in Scotland. Edward I. of England, in his ordinance made for the government of Scotland (1305), specially cancels these laws, as unsuited to the existing civilization of Scotland. According to Burton, the element which made them so repugnant to the French ideas of Edward and his nobles was the practice of dealing with crimes of violence as only affairs for pecuniary settlement, regulated according to the rank of the offender. This feature, the only known characteristic of these laws, seems to connect them with the Brehon Code. But the ideas of this ancient code were embodied in Scottish law until recent times, under the form of 'letters of slains' or of 'assythement.'

Bretwalda, or BRYTENWALDA, a title of dignity among the Saxon invaders of Britain, borne as early as 477 A.D. by Ælla of Sussex, in recognition of his victory at Anderida. That it was not a supreme title is shown by the fact that Ethelbert of Kent and Rædwald of East Anglia held it simultaneously. The etymology of the word is uncertain. See Elton's *Origins of Eng. Hist.*, p. 392 (1882).

Breughel, or BRUEGHEL. (1.) PIETER (*c.* 1530–69), Flemish painter of peasant life, country fairs, and weddings; named from the village of his birth, and surnamed the 'Droll.' He was a pupil and the son-in-law of Koek. (2.) PIETER (1564–1637), his son, painted sieges, conflagrations, hags, witches, devils; hence called the 'Infernal.' (3.) JAN (1568–1625), a younger brother of the second Pieter, the best of the three, called the 'Velvet,' from his dress; painted miniatures, flowers, and landscapes—*e.g. Paradise, The Four Seasons*—and collaborated with Rubens in the great painting *Adam and Eve in Paradise* (in the Louvre), the figures in which were painted by Rubens. See Michel's *Les Brueghels* (1892).

Breun, JEAN E., COMTE DE L'HÔPITAL (1862), portrait painter, of French birth, was educated and resides in London. Among his best-known portraits are *Princess Victoria, Princess Henry of Pless, Countess of Londesborough, Earl and Countess of Carnarvon, Sir Redvers Buller, W. G. Grace,* and *Madame Patti.*

Breve. See MUSIC.

Breve, an old Scots law term signifying a short, compendious writ issued from the crown to a judge, ordering him to try by jury the points outlined in the writ. Procedure by breve was introduced into Scotland by James I.

Brevent, to the N.W. of Chamonix, one of the finest view-points (8,284 ft.) for the range of Mont Blanc.

Breves, tn., Marajo I., Para state, Brazil, 140 m. W. of Belem. Pop. about 10,000.

Brevet, in the British army. In recognition of meritorious service in the field, or for service of an exceptional nature other than in the field, it is the custom to promote an officer above his regimental rank—*i.e.* that which he holds in his regiment. No brevet promotion, however, can be granted until an officer has served six years in the army, and is of the rank of captain. The highest brevet rank is that of colonel. An officer wears the usual badges, and receives allowances, but, with the exception of brevet-majors, draws no extra pay. Brevet-majors receive an additional 2s. per diem. When parading with his unit a brevet officer takes post according to his regimental rank; but he assumes his seniority by brevet when with other troops.

Breyell, tn., Rhenish Prussia, 15 m. W. by S. of Crefeld; has silk mills. Pop. 6,000.

Breviary, a book containing the divine office, which every Roman cleric in holy orders and choir, monks, and nuns are bound to recite daily. This recitation is the continuation, though in a more elaborate and systematic form, of a practice which was in use from the infancy of the church, which adopted it from the synagogue. The Roman office in its complete state dates from the latter part of the 7th century or the beginning of the 8th, and continued unchanged for at least four hundred years. In the 13th century it received various additions, chiefly taken from the Franks; and this, which was called by Gregory IX. the 'modern office,' was given by him to the Franciscans in the form of a breviary, properly so called, in 1241. This breviary was introduced into the Roman basilicas under Nicholas III. in 1280, and into the churches of Avignon in 1337 by Benedict XII. The Council of Trent called for a revision of the breviary, and the result was the breviary (1568) of Pius V., with subsequent amendments by Clement VIII. (1602) and Urban VIII. (1632), the breviary of the latter being that now in use. The psalter is

the backbone of the breviary. Around the psalms have grown up antiphons, responses, lessons, hymns, collects. The breviary is divided into four parts — viz. a winter, spring, summer, and autumn quarter. Each part contains (1) the *Psalter*—*i.e.* the psalms arranged for each day of the week; (2) the *Proprium de Tempore* (the proper of the season)—*i.e.* hymns, antiphons, chapters, and lessons, with responsories and versicles for each day of the church year, including the movable feasts; (3) the *Proprium Sanctorum* (the proper of the saints)—*i.e.* prayers, lessons, responsories, etc., for the immovable feasts; (4) the *Commune Sanctorum* (the common of the saints)—*i.e.* psalms, with antiphons, lections, etc., for feasts of a particular class (*e.g.* of the Blessed Virgin, of a martyr, etc.): to this division the little office of the Blessed Virgin, the office of the dead, and the penitential and gradual psalms are added; (5) a supplement containing offices which do not bind the whole church, and are recited only in particular countries. Every day the office begins with matins and lauds, which form together the longest of the seven canonical hours. These are followed by prime, terce, sext, none, vespers, and compline. In religious communities a shorter office is substituted, and in churches the services are usually combined—matins and lauds at 7.30 or 8 a.m.; prime, terce, sext, and none at 9.30 or 10; and vespers and compline at 4.

It was on the lines of the breviary that the English order of Morning and Evening Prayer was drawn up. They retain their old features so fully that the English Prayer Book may be regarded as an improved breviary and missal. A strong feature of the modern breviary is the skill and taste which have been brought to bear upon the translation (by Newman, Neale, and others) of the hymns, as shown in the edition of the breviary edited by the third Marquis of Bute (1879). See Grancolas's *Commentarius Historicus in Romanum Breviarium*, Batiffol's *Histoire du Bréviaire Romain* (1893), and article in *Catholic Encyclopædia*, vol. ii. (1908). See also LITURGY.

Brevier. See TYPES.

Brewer, EBENEZER COBHAM (1810–97), born in London, and studied at Cambridge. He is best known as the compiler of the *Dict. of Phrase and Fable* (new ed. 1895); *Reader's Handbook* (1898; new ed. 1902); *Dict. of Miracles* (1884); and *The Historic Notebook* (1891).

Brewer, JOHN SHERREN (1810–79), English historical writer, was chaplain to the workhouse of St. Giles-in-the-Fields and St. George, Bloomsbury, London (1837); professor of classical literature (1839) and of English literature (1855) at King's College, London; and for a short time edited the *Standard*. In 1856 he began a calendar of *State Papers* (4 vols. 1856–76) of Henry VIII. The prefaces to the various volumes have been edited by Gairdner (1884), under the title, *The Reign of Henry VIII.* See *English Studies*, edited by Wace, with Memoir of Brewer (1881).

Brewing. The process by which malted grain is treated with hot water to produce a wort. This is boiled with hops, filtered and cooled, and is then made to undergo alcoholic fermentation. In the preparation of native beers, such as *bousa* (Abyssinian beer), *samshoo*, and others, spontaneous fermentation is allowed; but in civilized countries the greatest care is taken to prevent this process. Beer is a beverage of the most remote antiquity. The Egyptian god Osiris is said to have taught mankind to make a drink from barley not much

inferior to wine. Isidorus (5th century A.D.) describes the method employed by the ancient Britons: 'The grain is steeped in water and made to germinate; it is then dried and ground, after which it is infused with water, which, being fermented, becomes a pleasant and intoxicating drink.'

Only since the middle of the 19th century has beer been brewed on scientific principles. This change is due to the great advances made in chemistry, bacteriology, and agriculture. Of all the members of the grass family, barley is the most convenient grain for the manufacture of beer; and of this only the two-rowed variety is suitable for malting purposes. Some of the more important varieties are Chevalier, Champion, Big Ben, Goldthorpe, Golden Melon, and Goldendrop. When fully matured these barleys are plump, thin-skinned, bright, and yellowish in colour. In weight they average 56 lbs. per bushel, and yield a malt of 42 lbs., showing a loss of about 25 per cent. in the process. Barley is used in preference to other cereals for the following reasons: it germinates rapidly and readily; the growth of the acrospire (plumule) is within the husk; it yields a starch comparatively free from fatty matter; it contains a relatively high proportion of suitable nitrogenous matter and a large amount of starch.

Analysis of two Samples of Malting Barley.

Constituents.	Percentage.	
	(1.)	(2.)
Starch	57·98	63·51
Nitrogenous matter	11·74	11·46
Water	12·19	13·06
Cellulose	10·51	7·28
Gums, sugars, pectins, colouring matters, etc.	2·83	1·34
Fatty bodies	2·17	1·03
Ash	2·58	2·32
Total	100·00	100·00

Light chalky and dry gravelly loams, or medium to light soils, produce the best malting barleys; but much depends on the season and climate, which should be warm and rather dry. Strong lands and soils rich in humus produce heavy crops of coarse barleys; while heavy and clayey soils yield a dull-looking barley, which contains too high a percentage of glutinous matters.

Malting.—Two systems are in general use—the old *flooring* and the *pneumatic*. The chief objects to be attained in malting are: (*a*) the modification or rendering naked of the starch cells; (*b*) the development of the diastatic, proteolytic, and other enzymes present in the grain; and (*c*) alterations of a physical nature by growth of the acrospire and rootlets. These changes are brought about by germination under starvation conditions. Before malting, barleys are sweated on a kiln for some hours at about 105° F., and stored so as to mature and assist their vitality. They are next freed from all foreign seeds, dead and broken corns, dust, dirt, pieces of string, and other particles, by special machinery, and finally graded into sizes.

The processes by the flooring system are—steeping, couching, flooring, withering, drying, curing, and storing.

Steeping is carried out in oblong troughs of iron, concrete, or brickwork. In these the barley is covered with a hard pure water, especially one containing sulphates and carbonates of lime, as these salts prevent the extraction of potassium phosphates, colouring matters, and nitrogenous

bodies. English barley is usually steeped from sixty to seventy-two hours, while Smyrna and foreign varieties require rather longer. The object of steeping is to get rid of certain bitter bodies, and to allow of the absorption of enough water for germination. The grain increases in bulk from 100 to about 120 bushels, and by weight from 100 to 147 or 150 lbs. At the same time it loses inorganic and organic salts from 0·90 to 1·60 per cent.

After draining, the barley is thrown on to the couch to a depth of 11 to 14 in. It is stirred several times, to permit of an equal distribution of heat, moisture, and aeration. When little white protuberances show at the lower end of the corn, it is said to 'chit.' The couch is broken down, and the barley is spread evenly over a section of the malting floor, forming a 'piece.' The depth varies, according to circumstances, from 4 to 11 in. It is turned frequently during the growing, and, if necessary, sprinkled with water containing an antiseptic (bisulphite of lime), to prevent mould growth. In about nine to twelve days the rootlets and acrospire will have developed to the proper stage; the growing is then stopped by spreading the grain in thin layers over the floor.

Withering takes place as the moisture evaporates. The barley is now said to be 'green malt,' and is air-dried. Its moisture should not exceed 25 per cent.; the acrospire is grown nearly up; the rootlets are thick and bushy; the enzymes are developed, and the starch has been completely modified.

The green malt, transferred to the upper floor of the drying kiln, is spread out on the wire gauze or perforated tiles forming the bottom to a depth of from 4 to 7 in., and large volumes of dry air are passed through it. During the first day the temperature slowly rises to between 95° and 100° F., while the malt loses from 80 to 90 per cent. of its remaining moisture; on the second day, to between 110° and 125° F.; and on the third, to between 135° and 150° F. By this time all moisture has been evaporated. Turning is carried out, either by hand or by machinery, as often as is necessary.

Air is now shut off, and the temperature is raised to the maximum point for curing for from six to twelve hours. This maximum varies according to the class of malt required, and is very carefully regulated. A wise German once stated that beer is made on the kiln, and undoubtedly there is much truth in the statement. Pale malts are cured between 160° and 180° F.; high-cured malts vary from 185° to 210° F. Mr. Free, a well-known maltster, advocates curing at 200°, the results being good both as to the quantity and the quality of the extract.

Drying is necessary to expel moisture, to restrict the diastase and other enzymes, to arrest germination, and to check bacterial action. Curing renders malt friable, and gives it the proper aroma and flavour. After curing it is cooled, cleaned, graded, and stored—the latter to mellow it before it is sent on to the market.

Barley loses from 4 to 5 per cent. of starch in malting. The sugars in barley average 0·85 to 1·43 per cent.; in green malt, 4·6 to 5·1 per cent.; and in finished malt, from 11·8 to 15·2 per cent. Any considerable increase over these figures causes unsound beers.

The size of a flooring plant is as follows:—Steeping troughs, from 12 to 12½ cub. ft. per qr. of barley; couch, about 13½ cub. ft. per qr. of grain; floors, from 170 to 200 sq. ft. per qr. of barley; and kilns, from 20 to 25 sq. ft. per qr. of green malt.

Of pneumatic malting, the two more important systems are those of Galland and Saladin. Steeping is carried out in conical or rectangular troughs for shorter periods than in the flooring system—viz. from forty-eight to sixty hours. Couching, growing, and withering are secured, in the Galland-Hennings process, by huge iron cylinders, somewhat resembling a black-ash revolver, capable of containing 100 qrs. of barley. The time varies from ten to thirteen days, and the temperature from 50° to 68° F.; the latter usually increases with the increase in volume of air supplied.

Continental malts are, as a rule, harder and less friable than English ones. The periods of steep vary greatly, as also do the drying and curing temperatures. Thus, for many Munich beers a long steep and high-curing temperature are employed. According to Lintner, the browning of isomaltose—a malt sugar—begins at 185° F., and gives to these beers that pleasant, full, and sweet taste for which they have long been famous.

Brewing Processes.—The processes of the English infusion system are—crushing, mashing, sparging, boiling, cooling, fermenting, cleansing, racking, and storing. The raw materials are—malt, raw grain (as grits, flaked and torrefied maize, rice, and wheat), various brewing sugars (including glucoses, inverts, cane or sucrose, amyloins, malto-dextrins, saccharine, etc.), and water.

For all but mashing an ordinary pure water, such as is supplied by water companies or wells, is satisfactory; but for the production of worts water of special types is necessary. The great success of the Burton breweries is due in large measure to the saline water obtained from the marls and sandstones underlying that district; of the Dublin stout breweries, to the calcareous waters of the Grand Canal or limestone springs around Dublin. For brewing, waters may be classed as soft and pure, calcareous, saline, and those of no special character. The first class requires the addition of suitable salts; gypsum, selenite, epsomite, sylvine, common salt, kainite, and calcium chloride are largely used for the purpose of 'burtonizing.'

Of soft waters, we may instance the water supply of Glasgow, Manchester, and Liverpool; of permanent hard waters, containing sulphates and chlorides of lime and magnesia, the Burton breweries' supply; and of temporary hard waters, containing carbonates of lime and magnesia in the form of bicarbonates which are precipitated by boiling, the waters around Dublin, in Derbyshire, London, Kent, Surrey, and Sussex. Waters containing alkaline compounds and nitrates are unsuited for mashing.

The malt is first weighed, and placed in a hopper which carries it into the malt rolls. Before crushing, pieces of iron, rootlets, string, and other rubbish, are removed. The crushed malt (grist) falls into the grist-case, where hardening materials, flaked malts, and similar grist-forming bodies are well stirred in; and from this grist-case the malt passes into the mash-tun, either directly, or through an external mashing machine, where it is thoroughly mixed with water of a suitable temperature.

The chief objects of mashing are, to gelatinize the starch and so obtain the wort or sugar solution, and to make use of the diastatic, proteolytic, and other enzymes of the malt. Two systems of mashing are in use—the infusion method in Britain, and that of decoction in other parts of the world. The limited decoction system is also used to some ex-

tent in the British Isles. A good idea of the infusion system can be obtained from the method of making porridge. In the older breweries mashing is effected by running a certain proportion of water at the proper temperature into the mash-tun—a metallic or wooden vessel fitted with rakes, false bottom, sparge, and other accessories—and stirring in the grist in a thin stream until the mash is complete. But modern breweries are fitted with an external masher, which is either power-driven or automatic. In these the grist enters at the upper portion, meets with jets of water, and the mixture is carried forward into the mash-tun. Here the mash 'stands on' for about two hours, during which time chemical action takes place, resulting in the conversion of starch into maltose, intermediate carbohydrates, and dextrins by the agency of the diastatic enzymes, and of the nitrogenous matter by the proteolysts into yeast foods. Maltose readily breaks down on fermentation, yielding alcohol and carbon dioxide. Intermediate bodies, known also as amyloins, maltodextrins, or isomaltose, are less easily decomposed. For the most part they are fermented in the casks, thus bringing the beers into condition and made fit for consumption. Dextrins are generally unfermentable, but confer body and fullness on beers.

The above changes are very complex, and have not yet been studied satisfactorily. Considerable differences of opinion are prevalent. The changes depend on the types of malt and water, and on the temperature of both at the time of mashing. The 'touching' or 'striking heats' vary between 150° and 167° F. The quantity of water to grist generally runs between 2 and $3\frac{1}{2}$ barrels per quarter of malt. A thin mash gives, as a rule, more extract and a higher proportion of maltose than a thick one. Malts should yield from 80 to 95 brewers' lbs. per quarter of 336 lbs. Malt substitutes, such as flakes, are usually mixed with the crushed malt; but grits require a separate vessel, the converter, to gelatinize the starch:

Examples of Brewing Waters.

1. Saline, for Ales and Beers.		2. Calcareous, for Stouts and Porters.		3. Pure Drinking Water.	
Constituent.	Grains per Gall.	Constituent.	Grains per Gall.	Constituent.	Grains per Gall.
$CaSO_4$.....	71·86	$CaCO_3$.....	13·79	$CaSO_4$.....	1·741
$MgSO_4$	11·98	$MgCO_3$.....	2·68	$MgSO_4$.....	0·662
$CaCO_3$.....	8·36	$CaSO_4$.....	0·69	$MgCl_2$.....	0·574
$MgCO_3$.....	2·91	$MgSO_4$	1·85	NaCl.....	0·478
Na_2SO_4.....	3·34	$CaCl_2$.....	0·79	SiO_2,Fe_2O_3, Al_2O_3....	0·139
NaCl.....	10·15	NaCl.....	6·47		
SiO_2,Fe_2O_3, Al_2O_3....	0·37	SiO_2,Fe_2O_3, Al_2O_3....	0·38		
	108·97		26·65		3·594

the cooled contents of this are run down into the mash-tun. Sugars may either be dissolved by the worts as they run into the copper, or be mashed separately.

At the end of from two to two and a quarter hours all the starch will have become converted into wort sugars. The taps are then set, and sparging begins. The objects of sparging are, to wash out the extract from the grains, to control the temperature in the mash-tun, and to 'get up the copper lengths.' It is carried out by perforated revolving arms of such length as to cover the whole area of the tun. These send down on the grains a continuous shower of water of the right temperature.

In boiling malt, a brewing copper is used. This is a metallic vessel heated either by direct fire, or by internal steam coils, or by steam jacket. Some coppers are closed, others open. In all cases they should be of sufficient size to contain one-third more than the complete 'length' or volume of wort. The word length is used to denote the total volume of wort liquor obtained by mashing and sparging. A brewer boils his worts for the following reasons—to concentrate the wort, to sterilize it and prevent further enzyme action, to assist in the aeration, and to extract the hop constituents. Boiling must be thorough, otherwise unsound beers are certain to result.

We must now turn our attention to hops. Of this plant the female alone is cultivated, and the only portions of use to the brewer are the unfructified or fructified cones or strobiles. The cones, built up on a spindle, are composed of the bracts (bracteoles), on the lower portions of which grow the lupulin granules, or 'condition,' or hop-flour; and the seed, a fruit about the size of a hemp seed, also covered with 'condition,' and contained in a kind of sac at the lower end of the bracts. When ripe, the lupulin granules are filled with a pale yellow-green coloured oil. According to Haberlandt, the cones consist of—

Lupulin granules, from	8·0	to	16	per cent.
Spindles.....	,, 8·5	,,	18	,,
Bracts.....	,, 70·0	,,	80	,,
Fruits.....	,, 0·1	,,	8	,,

There are many varieties of hops, but the whole may be divided into three classes—reds, greens, and pale-greens. The reds exhibit a fine delicate aroma, and include the best Spalts, Saaz, and English Goldings and Jones. The greens are much coarser, and yield an aroma less pleasant than the reds. They include the hops grown in Belgium, Bohemia, America, the English Grapes and Colegates. The pale-greens are intermediate between the other two, and are not largely cultivated.

In a brewery, hops are used in the copper to give the wort its peculiar flavour and aroma, to precipitate certain nitrogenous compounds, to assist in clarification, to preserve the finished beers by the antiseptic properties of some of the hop constituents, and to act as a filtering medium for the wort. The quantity employed for the copper varies with the type of beer—from 4 lbs. for a running mild beer to 20 lbs. for a high-class pale ale per quarter of malt. In addition, they are used for the purpose of dry-hopping. Only the very best varieties can be employed, otherwise there is a serious risk of introducing infection into the beers. Choice Kents, Worcesters, Spalts, and Californians, from ½ lb. to 2 lbs. per barrel are the usual quantities.

In choosing hops the following points should be considered: the

amount of lupulin granules; the balling together when rubbed, which is due to resins; general appearance and feel of the cones; freedom from mould; the delicacy of aroma; and the colour of both the hops and the flour.

From the copper the boiled wort passes into an iron vessel known as a hop-back, which is fitted with a false bottom of perforated gun-metal plates, and on these the hop cones settle down to form a filter-bed. In fifteen or twenty minutes the taps of the hop-back are opened, and the hot wort is allowed to spray into a shallow iron tank —the 'cooler.' This permits of aeration, and causes a much more vigorous fermentation; at the same time there is a deposit of hop and albuminous matter, spoken of as 'cooler sludge.' As soon as the temperature has fallen to between 130° and 140° F. the wort is passed over the refrigerator, and when cooled to the proper pitching temperature, is run into the fermenting vats or tuns.

There are three principal systems of fermentation in general use in the United Kingdom:— (1) Skimming, and its modification, the dropping system; (2) Pontoon cleansing and Burton Unions system; (3) Yorkshire squares system.

For mild and running beers, especially those brewed for quick consumption, skimming is a useful and simple method. The wort being collected in the fermenting vats at from 58° to 62° F., is pitched with the proper quantity of yeast in the following way:— The yeast (barm) is well mixed with some wort at about 70°, then stirred into the main bulk of the wort. The yeast thus obtains a good start, and bacteria are not so likely to do mischief. The quantity of yeast varies with the system, and depends on the specific gravity of the wort, the quality and quantity of the hops used, the type of wort (whether dextrinous or otherwise), the nature and amount of malt substitutes, the composition (type) of the water used for mashing, and the condition of the yeast. For running beers the quantity is from 1 to 1½ lbs. per barrel; for stronger and more heavily hopped worts, from 2 to 3½ lbs.

In about forty-eight hours after 'pitching' the temperature will have risen 6° or 8° F., and the attenuation, due to the formation of alcohol and disappearance of sugars, nitrogenous bodies, and mineral matter, should have reduced the specific gravity to one-half of its original figure.

The fermenting liquid is now skimmed to remove a dirty, frothy mass composed of hop resins, albuminous compounds, bacteria, and the like, which have come to the surface. When fermentation is about a third way through, skimming again takes place, the yeast removed being placed in yeast troughs for future use.

Rousing and skimming are continued until it is judged that the yeast is capable of throwing up one more head of sufficient thickness to shield the beer from the atmosphere and prevent the escape of carbon dioxide. Rousing is then discontinued, and the beer, which has now attenuated to nearly the required gravity, is allowed to remain quiet for a day or two to settle or cleanse. When complete, the last head (consisting, for the most part, of old or dead cells) is cleanly skimmed, and the beer is drawn off ('racked') into the trade casks. After standing for a short period, it is fined with a preparation of isinglass, sulphurous acid, and water, and sent out to the retailer.

In some breweries, where the dropping modification is in use,

the wort, while fermentation is at its height (from forty-eight to sixty hours after pitching), is dropped into a shallower vessel underneath. The object is to remove the carbon dioxide and ensure the aeration both of the fermenting liquid and of the yeast.

The cleansing system is one of the oldest in common use, and possesses certain distinct advantages: it yields a cleaner beer, and produces better yeast than can be obtained from the skimming system. In Burton, where the Burton Unions modification is employed, this system is seen in its perfection. The Yorkshire stone square system is confined chiefly to the north of England. Beers fermented in the squares are clean, drink very full for their gravity, undergo a good cask fermentation, and, as they retain much carbon dioxide, are full of life. The squares themselves are cumbersome and costly, and are difficult to keep clean. See FERMENTATION.

After racking off from the fermenting vats, the method of treatment varies with the class of beer. Running and cheap mild beers are sent out in a few days either with merely the addition of about a pint of strong sugar solution as a priming agent and a small quantity of isinglass solution as a fining agent, or after the addition of the finings alone. With lower-grade beers some kind of antiseptic is added in the trade casks, as well as the priming and fining solutions. Bitter beers and ales are generally racked into casks containing some of the very best hops, together with a priming solution. The casks are then placed in a cool cellar, and are rolled occasionally; and when the contents come into condition, finings are added, and the beers are sent out. For strong beers, pale ales, and the best beers—all of which are brewed from the best materials, and hence are very stable—little more than ordinary cellar treatment is necessary.

There is a tendency at the present time to put on the market a cheap carbonated bottled beer. Generally such beers are produced from inferior materials by a limited decoction process of brewing; and after six or eight weeks' storage they are fined. The carbonating and bottling are carried out simultaneously. The flavour of these beers is very insipid and thin compared with the average Burton type of bottled beer, in fact, they appear to be deficient in most of the essential features of a beer fit for consumption—viz. an agreeable flavour and aroma, a palate fullness, foamy head, slight acidity, perfect clearness and brilliancy, and perhaps a certain sweetness.

Decoction Mashing is the system in common use in most countries outside the British Isles. Several modifications are adopted. That known as the 'three-mash' system is employed to the greatest extent; but there are also two-mash systems in daily use. The processes involve the following operations—mashing, clarifying, boiling with hops, cooling, fermenting, and storing.

In the three-mash system, the crushed malt and other grist materials are mixed with cold water by an external masher. The mixture falls into a mash-tun which is fitted with powerful rakes, and is connected with the mash-pan or copper: the latter contains chain rakes to keep the materials from burning on to the bottom. Rather more than half the required water is used at this stage. When all the grist is in the mash-tun, about a third of the remaining water, heated to the boiling-point, is slowly pumped into the mash,

the rakes going at full speed until the temperature is raised to about 95° F.—a very suitable point for the conversion of certain nitrogenous constituents into peptones and other yeast foods. About a third of this thick mash is run down into the mash-copper, the chain rakes are set going, and the contents are brought to the boil. This continues for approximately half an hour. The pump and the rakes of the mash-tun are now set on, and the boiled mash is pumped into the mash-tun until the temperature is raised to 127° F. A second quantity of mash is run down to the copper and treated as before. This action gelatinizes the starch and increases the extract. Again the mash is pumped back, and the temperature of the tun contents raised to about 149° F. Then a third portion of the mash, preferably composed of clear wort, is run into the copper, and boiled for fifteen to thirty minutes. It is pumped back into the mash-tun until the temperature is about 166° F. The whole of the mash is now pumped over into the clarifying tun—a vessel fitted with a false bottom, sparge, and less powerful rakes. The latter are run round to level the contents, and the whole is allowed to rest or 'stand on' for from fifteen to sixty minutes. The clear, bright wort is then run off into the ordinary copper to be boiled with hops. The grains or spent malt are thoroughly sparged with the remainder of the water, while the rakes of the tun are occasionally run round to stir up the grains and assist in getting out the extractive matter. The quantity of water required in this system is approximately twice the volume of the finished beer. The rest of the operations resemble those of the infusion system already described—viz. boiling with hops, filtering, cooling, and pitching with yeast.

Fermentation of the worts so obtained is carried out in cold cellars (38° to 43° F.), either by the bottom yeast or by the vacuum system. In about twenty-five to thirty-five hours a thick white foam forms on the surface, and the actual fermentation begins. This comes to its maximum in six or seven days, and at the same time the temperature is also at its maximum—viz. from 45° to 50° F. After this the primary fermentation gradually slackens, while the temperature falls to 40° or 41° F.

The yeast, instead of working to the top as in English fermentation, settles to the bottom, and can be removed when the beer has been transferred to the lager or storage casks. The surface of the beer at the close of the vat fermentation presents an appearance not unlike that of a tiger's skin. This froth consists of hop resins and other matter of light gravity, which have been ejected from the wort. The lager casks are large, unwieldy vessels of oak, capable of containing from 40 to 75 barrels of beer. Internally they are coated with a special pitch; and a quantity of well-boiled beechwood chips is generally thrown in, to afford a means of attachment for the yeast. As a rule, several brews are distributed among a number of the casks, so as to ensure uniformity and colour. When the cask fermentation has well started, the bungs or shives are securely fixed, and the casks are placed in their positions in the lager cellar. As the cask fermentation only goes on slowly, the beers mature and come into condition gradually, and become quite brilliant. They are then racked off into the trade casks in the main cellar by machines which prevent the loss of carbon

dioxide and the access of air. The lager beer is now ready for consumption.

Just as there are many varieties of beers brewed by the English system, so there are a number of different types of beers obtained by varying the materials and processes of the decoction system. The more common are—the ordinary lager, bock beers, Pilsener, the dark and the so-called white beers. Usually each important brewery has a speciality of its own. See LICENCE AND LICENSING LAWS.

See Thausing's *Theory and Practice of the Preparation of Malt and the Fabrication of Beer* (1882); Dr. Sykes's *Principles and Practice of Brewing* (1897); Moritz and Morris's *Science of Brewing* (1891); Hansen's *Practical Studies in Fermentation* (1893); Lafar's *Technical Mycology* (trans. 1898); Reynolds Green's *Soluble Ferments* (1896); Dr. Effront's *Enzymes* (1902); Dr. Carl Oppenheimer's *Ferments and their Actions* (trans. 1901); *Transactions of Federated Institutes of Brewing;* Southby's *Practical Brewing* (1885); Wanklyn and Chapman's *Water Analysis* (5th ed. 1879); Baker's *The Brewing Industry* (1905).

Brewster, SIR DAVID (1781–1868), Scottish natural philosopher, was born at Jedburgh. In 1802 he was appointed editor of the *Edinburgh Magazine*, and devoted himself to scientific studies and literary pursuits, especially to a series of experiments in optics. At the age of twenty-six he undertook the editorship of the *Edinburgh Encyclopædia.* In 1813 he published a *Treatise on New Philosophical Instruments;* and in the following year he commenced a series of papers contributed to the Royal Society on the *Polarization of Light*, for which he was awarded the Copley medal, afterwards receiving the Rumford and Royal medals—the only other scientist to obtain the three medals being Faraday. In 1816 the Institute of France adjudged to him the half of the prize for physics of 3,000 francs, awarded for the two most important scientific discoveries which had been made in Europe during the two previous years; and in the same year he invented the kaleidoscope, which, though patented, obtained for him more fame than remuneration. He afterwards divided with Wheatstone the merit of introducing the stereoscope, by means of his lenticular instrument. Along with Professor Jameson he founded the *Edinburgh Philosophical Journal* in 1817, and afterwards the *Edinburgh Journal of Science.* His next work, *An Account of a New System of Illumination for Lighthouses* (1827), the dioptric system, was not crowned with success till 1835, with the Inchkeith lighthouse. In 1831, in conjunction with Herschel, Babbage, and other kindred minds, he originated the British Association, and in the same year was knighted by William IV. He was appointed principal of the united colleges of St. Salvator and St. Leonard at St. Andrews in 1838, and in 1849 he was chosen president of the British Association. The last and crowning recognition of his celebrity was his election, in 1849, as one of the eight foreign associate members of the National Institute of France, on the death of Berzelius, the chemist. He became principal of the University of Edinburgh in 1859. Among his general works may be mentioned *Martyrs of Science* (1841), *More Worlds than One* (1854), *Life of Newton* (1828; new and fuller ed. 1855), and *Letters on Natural Magic* (1831). See *The Home Life of Sir David Brewster*, by his daughter, Mrs. Gordon (1869).

Brezova, Hungary. See ZOLYOM-BREZO.

Brialmont, HENRY ALEXIS (1821–1903), Belgian general and writer on fortification, was born at Venloo. Entering the army in 1843, he was in 1847 entrusted with the fortification of Diest. In 1859 he planned and (1860–70) constructed the strong entrenched camp at Antwerp. In 1877—two years after his appointment as inspector-general of Belgian fortifications—he, on the invitation of the Roumanian government, went to Bucharest to devise a system of fortification for that country; and in 1885 he made a second visit. The works, begun in 1886, were completed in 1899. Meanwhile Brialmont had finished plans for the fortification of the Belgian frontier along the Meuse, and the works are now (1905) mostly completed. In 1883 he submitted a plan for fortifications in Greece, at the request of the Greek government, and four years later retired from active service. Brialmont was a very prolific writer, amongst his more important books being *Histoire du Duc de Wellington* (1856–7); *Système de Défense de l'Angleterre* (1859); *Etudes sur la Fortification des Capitales et l'Investissement des Camps Retranchés* (1873); *La Fortification du Champ de Bataille* (1879); *La Fortification du Temps Présent* (1885), a capital book, forming a sort of *résumé* of his own works; *Influence du Tir plongeant et des Obus-Torpilles sur la Fortification* (1888).

Brian (926–1014), king of Ireland, known as Brian Boroimhe (Boru), or 'Brian of the tribute,' defeated the Danes at Sulcoit, near Tipperary (968), fighting under his brother Mathgamhain, who had possessed himself of the kingship. After his brother's murder (976), Brian seized the kingship, allied himself with Maelsechlainn or Malachy, chief king of Ireland, defeated the Leinster men (984) and the Danes of Dublin, and finally seized Tara and subdued Maelsechlainn himself (1002). He then made a triumphal circuit of Ireland, receiving hostages from all the tribes. He was slain at the battle of Cluantarbh or Clontarf (April 23, 1014), where the power of the Danes, however, was effectually broken.

Briançon (anc. *Brigantium*), cap. dep. of Hautes-Alpes, France, 37 m. by rail N.E. of Gap, on r. bk. of the Durance. It is a fortress of the first class, and the most elevated town (alt. 4,330 ft.) in France. In 1815 Briançon withstood a three months' siege of the allies. There are silk and Briançon chalk industries, and coal is mined in the neighbourhood. Pop. 7,500.

Briand, ARISTIDE (1862), French statesman, was born at Nantes. He studied law, and in 1902 was elected to the Chamber of Deputies as a socialist by the miners of St. Etienne. He reported the Church and State Separation Bill, and in recognition of his tact and moderation was made, in 1906, minister of public instruction and worship. In 1908 he also became minister of justice. He succeeded Clémenceau as prime minister, July 1909, but resigned at the end of February 1911. It was largely owing to his efforts that the great railway strike in France in 1910 was peacefully terminated.

Briansk, or BRYANSK, tn., Orel gov., Russia, 75 m. by rail W.N.W. of Orel city, on the Desna, an affluent of the Dnieper. Arsenal (founded 1783), cannon foundry, shipbuilding yards (for river navigation); grain, salt, and wood trade. Cathedral of B.V.M., built 1526, and restored end of 17th century. Pop. 24,000.

Brianza, a highly-favoured dist. of Italy, called 'the Garden of Lombardy,' thickly dotted over

with the country seats of the Milanese, and celebrated by poets and painters alike. It lies between the two southern arms of the Lake of Como, and stretches from Bellagio southwards to Mariano.

Briare, tn., dep. Loiret, France, on r. bk. of Loire, 39 m. by rail S.E. of Orleans; gives its name to the first canal (connecting the Loire and Seine) made in France, begun 1604, finished 1642. Important manufactures of buttons. Pop. 5,200.

Briareus, or ÆGÆON, son of Uranus and Gæa, a giant with a hundred hands and fifty heads who helped Zeus to conquer the Titans, and guarded them when imprisoned in Tartarus.

Briar-root is the name given to the roots and knots of the tree-heath *Erica arborea*, a plant belonging to the Ericaceæ; it abounds in countries bordering on the Mediterranean. Pipes made from these roots and knots are sold as briar pipes, the word briar being a corruption of the French *bruyère*, 'heath.'

Bribery. In Great Britain, the offer to or acceptance by a public official of a bribe is a common law misdemeanour. By the Sale of Offices Act, 1809, the sale of offices is a misdemeanour, and their advertisement for sale punishable by fine. By the Public Bodies Corrupt Practices Act, 1889, the giving or offering or promising of a bribe to any member, officer, or servant of a public body (such as a county or borough council or other local authority) in respect of any matter in which that body is concerned, and the soliciting and receiving of such a bribe, are statutory misdemeanours punishable at the suit of the attorney-general by imprisonment for two years, or fine not exceeding £500, or both, and by disqualification for public office for seven years, or, in the case of a second offence, for life. Customs and inland revenue officers receiving bribes are liable to a fine of £500, and disqualification for service under the crown; and persons offering bribes to such officers are liable to a fine of £500 (Customs Consolidation Act, 1876; Inland Revenue Regulation Act, 1890). As to bribery at elections, see ELECTIONS, and of jurymen, see EMBRACERY; also COMMISSIONS.

Brice, ST., bishop of Tours (5th century). He was brought up in the monastery of St. Martin, near Tours, and succeeded St. Martin as bishop. His life was somewhat irregular. On his day, Nov. 13, 1002, by the orders of Ethelred the Unready, a great massacre of the Danes occurred, a treacherous act which cost Ethelred his throne.

Brickfielders, a hot wind of Australia, blowing from the north, is of the sirocco class. During November, December, and January it is very severe, the temperature at Sydney under its influence having been known to rise as high as 107° F. In Central Australia still higher readings have been registered, a shade temperature of 131° having been recorded; and at Melbourne apples have been said to be literally roasted on the trees.

Bricklaying. See BRICKWORK.

Brickmaking. The use of bricks dates from an early age. The dwellings of the ancient Egyptians consisted chiefly of sun-dried bricks, remains of which may still be seen.

In England there are valuable brickfields—in Stafford, Essex, Kent, Northampton, and Suffolk. The first-mentioned county produces a blue variety; from the last we get the 'Suffolk whites.' In Scotland, Whitehill and Newhailes produce good red stocks, and the Wishaw fire-brick is quite equal to those from Wales and Stourbridge.

A good clay ought to contain about 20 per cent. of alumina, 60 per cent. of silica, and 20 per cent. of other salts, such as iron, lime, and manganese. When alumina is in excess there will be considerable shrinkage in the burning, and the bricks may crack; a sandy clay produces porous and brittle bricks. The colour depends partly on the amount of iron present, and partly on the temperature during the burning. On the London brickfields chalk is mixed with the clay, producing a material similar to 'malm,' a bright yellow brick earth now scarce.

The earth is dug in autumn, and allowed to weather till spring. After being moistened and well worked ('tempered') with a spade, it is then carried to the pug-mill. Here it is further worked and mixed by an arrangement of knives, ultimately coming out in a solid mass. This, in the case of hand-made bricks, is cut in pieces and passed along to the moulder, who packs it well into the mould, a case of hardwood or metal, open at the top and bottom, and slightly larger than the finished brick, to allow for shrinkage in burning. To remove the surplus clay, a straight-edge, called the 'strike,' is passed across the top of the mould. Each time the mould is filled, it, as well as the table on which it rests, must be sprinkled with sand or with water: the former is called 'sand-moulding,' the latter 'slop-moulding.'

The moulded green bricks are now stacked on the hacks to dry, and are generally built eight courses high, and so arranged that the air has free access all round them. This takes from six to eight days, after which the bricks are ready for the fire. They are burned in one of two ways—by clamp or by kiln. In the first method the bricks are stacked to form a clamp on the highest part of the field, and so arranged as to give the walls a considerable batter. Layers of cinders ('breeze'), from one to two inches in depth, are placed between the courses, spaces being left for the kindling material—generally coal, breeze, and wood—while flues are carried through the mass. In order to keep in the heat and regulate it, the clamp is plastered over with clay; and when the fire is burning briskly, the furnace holes are similarly closed. After from twenty to forty days, depending on the number of the flues, the clamp is 'drawn'—*i.e.* the mass is broken open, and the finished bricks removed. In the second method some form of built kiln is employed. These structures are various in design, the Hoffman being one of the best. It consists of a series of chambers, so built that in some the full heat from the furnace is obtained, while in others the waste gases afford sufficient heat to dry the freshly-moulded bricks. The fuel, consisting of small coal, is fed in at the top. Most modern kilns, though not of the exact Hoffman type, are designed on the same principle.

The Scotch kiln is a common type—brick built, rectangular on plane, and open at the top. The Suffolk or Sussex kilns are varieties of this.

The ordinary kiln is a conical brick structure, in which the damp bricks are first dried by a gentle heat; the furnace is then fully charged, and, when thoroughly alight, its mouth is plugged with a mass of clay and broken bricks. During the burning the temperature is not kept constant, but is successively raised and lowered. After about forty-eight hours the bricks are ready, and may be then sorted into 'stocks,' 'burrs' or 'clinkers,' and 'place bricks;' these terms are applied respect-

ively to well and evenly fired, overburnt, and underburnt bricks.

There are two classes of machines by which bricks may be moulded. In one the pressure employed is moderate, and the clay is worked wet; in the other the pressure is greater, and the clay supplied is dry and powdered. In the wet-process machine the arrangement is such that the clay, after being well mixed, is forced out between rollers and through a die in a compact stream of the desired dimensions. By means of wires the mass is cut up into separate bricks. In the dry-process machine the clay is fed into the pug-mill from a mixer, and forced by the knife-blades into moulds on a revolving table. As this table revolves, the bricks are forced up, and then slid under a steam-heated press. After pressing, the bricks are ready for the kiln.

Bricks made from brick earths or clay with the admixture of other substances are moulded to the required shape, dried, and burnt either in kilns or clamps. They are described as 'hand made,' 'machine made,' 'clamp burnt,' or 'kiln burnt,' according to the methods employed in making them. 'Pressed bricks' and 'wire cuts' are names given to bricks made by special machines, in which the bricks are pressed or cut off to length by stretched wires respectively. 'Salt-glazed bricks' are those which have a thin glass-like glaze on the exposed surfaces, formed by throwing salt on them whilst being burnt in the kiln. 'Enamelled bricks' have a china-like surface of various tints by dipping the partly-burnt brick into a specially-prepared 'slip' and reburning them. The size of bricks is not uniform, although the general building brick is approximately $8\frac{3}{4}$ in. long, $4\frac{1}{4}$ in. wide, and $2\frac{3}{4}$ in. thick.

The manufacture of stoneware pipes differs from the above in respect to the mould employed. Like bricks, they may be worked by hand or by machinery. In the former case the clay is beaten out flat to the required size and thickness, then well wetted, and wrapped round a cylinder, its edges being well pressed together. In pipe-moulding machinery the clay is forced through an annular space of the required dimensions. After moulding, the pipes are gently dried, and then burned in special kilns. See also POTTERY.

Brickwork. The art of brickwork may be divided into two great classes: (1) bricklaying; (2) brickcutting. In building, the work of the bricklayer is chiefly confined to the former, which provides for the arrangement of bricks in such a manner as to secure the maximum strength. This is termed the bonding of bricks, of which there are several methods, varying with circumstances. The average size of the general building brick used in and about London is $8\frac{3}{4}$ in. long by $4\frac{1}{4}$ in. wide by $2\frac{3}{4}$ in. thick, though in the north of England they are slightly larger. The long face of the brick is known as a 'stretcher,' and the end as a 'header.'

Bonds in brickwork. — The chief of these is 'English bond,' which consists of alternate courses of headers and stretchers. This is generally considered the strongest of all the bonds. 'Flemish bond' consists of alternate headers and stretchers in the same course, and is sometimes preferred to English bond on account of (1) the appearance, (2) the fact that any want of uniformity in the proportion between the headers and stretchers is equalized. 'Single Flemish bond' consists of English bond backing with a facing of Flemish

bond. 'Sussex' or 'garden wall bond' is a bond used principally for 9-in. walls, and admits of keeping a 'fair' or regular face on both sides of the wall, hence the name garden wall bond. The bricks are laid to show three stretchers and a header alternately on the same course. 'English garden wall bond' is used for the same purpose as the above, and consists of three courses of stretchers and one of headers alternately. 'Diagonal bond' and 'herring-bone bond' are used in thick walls to act as a tie and increase the strength. In the former the bricks in the heart of the wall are laid at an angle of 45° with the face. In the latter the bricks, again in the heart of the wall, are laid at an angle of 45° with a centre line, but in opposite directions.

Hollow or cavity walls are used in exposed positions, or where the outer face of the wall is in contact with damp earth. Usually a half-brick or 4½-in. wall is built on the outside, then, leaving a space of 2¼ in. or 3 in., the inner wall is built, which may be 9 in., 13½ in., etc., according to the height. The two walls are tied together at intervals by bonding bricks, or bonding ties of wrought iron. In good construction it is essential that such cavities should be ventilated.

In ordinary bricklaying the 'footings' (*i.e.* the base of the wall) having been put in, the 'quoins' or corners are first built up for a few courses perfectly 'plumb' and 'square,' the work usually rising four courses to the foot. A line is stretched across the intermediate space, level with the top of each course, and to this line the bricks of the face work are laid, the inside work or 'backing in' being done by a less skilled operator. In thick walls, such as retaining or embankment walls, the inside bricks are sometimes laid dry, and a thin mortar spread over each course so as to run between the joints. This is known as 'grouting' or 'larrying.' The joints of the face brickwork may be struck off as the work proceeds, or raked out and filled in with a specially-prepared stopping. This operation is known as 'pointing,' and is frequently employed to renovate old brickwork. Whichever method is employed, the best joint is known as the 'weathered joint,' in which the mortar is struck by means of the trowel so as to form a surface sloping outwards from the top of joint. The mortar used is known as cement mortar or lime mortar, according to whether Portland cement or lime is mixed with the sand. For ordinary work above ground proportions may be one part lime, three parts sand; for work in damp situations and below ground, one part Portland cement to five parts sand.

Brickwork is generally measured by the rod of reduced work. A rod = 272 superficial feet, and reduced work is brickwork 1½ bricks thick. All work is brought to this common thickness.

Gauged brickwork is a variety of brickwork in which special bricks are used, known as 'rubbers' or 'cutters.' Such bricks are very soft and uniform, one of the best-known varieties being the T.L.B. rubber. The joints in this kind of brickwork are exceedingly thin, usually about $\frac{1}{32}$ in. The work being set out, the bricks are rubbed perfectly square on a circular bed of stone, and afterwards reduced—*i.e.* cut to size in a wooden box by means of a wire bow-saw. The use of this type of brickwork seems to have been introduced by Sir Christopher Wren in the 17th cent.

Brick arches are divided into three classes:—(1) Rough, in which the bricks are not cut to

shape, the joints radiating according to the curve of the arch; (2) axed arches, in which the bricks are approximately cut to a radial shape by means of a tool known as the 'scotch' or 'scutch'; (3) gauged arches, in which special bricks described above are used, and cut exactly to the required size and shape of specially-prepared templates fixed in wooden boxes. See Richards's *Bricklaying and Brickcutting* (1901); Hammond's *Practical Bricklaying* (1903); and Mitchell's *Brickwork and Masonry* (1908).

Bride, BRIDEGROOM, and BRIDAL. See MARRIAGE.

Bride, ST. See BRIGIT, ST.

Bridel, PHILIPPE CYRIAQUE (1757–1845), Swiss Protestant pastor, elected (1786) pastor of the French church at Basel, in 1796 was called to the cure of Château d'Oex, and in 1805 to that of Montreux. He set himself to stir up the patriotism of the French-speaking Swiss for the Confederation. His *Etrennes Helvétiques* appeared annually from 1782 to 1816, and from 1816 to 1831 bore the name of the *Conservateur Suisse* (best ed. 1855-8). It treats of all subjects relating to Switzerland, and is much valued. His *Course de Bâle à Bienne par les Vallées du Jura* appeared in 1789 (enlarged ed. in 1802), and his *Histoire du Comte de Gruyère* in 1838, but his *Glossaire du Patois de la Suisse Romande* not till 1866. See *Life* by Vulliemin (1855).

Bridewell, par., City of London, Middlesex, England; once contained a famous prison or house of correction, so named from St. Bride's Well, a spring of reputed healing power. It was burned during the great fire of 1666, and was finally demolished in 1863. The name has now become a general term for establishments of a similar nature.

Bridge. At a remote period of antiquity the Chinese crossed openings or spans of great width by means of suspension bridges. In Europe, the Romans were the greatest of ancient bridge builders. The invention of the masonry arch has usually been attributed to them; and though traces of an arched construction are occasionally found in earlier architecture, yet the Romans were the first to employ it upon a bold scale for the construction of great bridges and aqueducts.

Until the 19th century a bridge was generally understood to be a structure for carrying a road across a river; but now that roads, railways, and canals are laid out upon lines which cross over and under each other, any structure which carries these lines of communication may be considered as a bridge, although it would sometimes be otherwise designated. The words 'aqueduct' and 'viaduct' are often applied to special forms of bridge, but they define only the nature of the *carried* line of communication. The viaduct is a structure carrying a line of way, which may be either a road, railway, or footway; and such a structure would be called a bridge if it were built over a road, railway, river, or arm of the sea.

A bridge crosses one or more 'spans,' and the structure must include two or more supports, with some kind of superstructure built over the intervening openings. For a single span the supports consist of a pair of abutments, whose form will depend on the superstructure; but whether they receive the abutting thrust of an arch or the dead-weight of a girder, they are commonly called by the same name. For a bridge of several consecutive spans, the intermediate supports are called the piers. The flooring is so arranged as to consti-

tute a platform adapted to the character of the traffic carried over it, and forms a subsidiary part of the superstructure; but the main superstructure is that which carries the distributed weight of the floor and its load, transferring it to the supports on either side.

Bridges are designated according to the character of the main superstructure, whose design in modern examples exhibits great variety. They may, however, all be classed under three principal types—the beam, the suspension bridge, and the arch, which, in their turn, have been dictated by the physical properties of three classes of building material.

1. The transverse stiffness exhibited by every piece of timber suggests its employment in the form of a beam laid horizontally across an opening. Iron girders are modifications of the beam, fulfilling the same functions.

2. A flexible rope or chain possesses no transverse stiffness, but offers a high resistance to a direct pull or tensile stress. The rope can easily be hauled across an opening too wide to be spanned by a piece of timber; and when the ends are made fast, the rope is capable of carrying a suspended load, as in Fig. 1, or several loads, as in Fig. 2, or the weight of a continuous floor, as in Fig. 3. With each new distribution of the load the rope will find for itself a new position of equilibrium, falling into a certain curve or polygonal line, the so-called 'funicular polygon.' The study of this figure is a branch of graphic statics; it serves to illustrate the principles concerned in the equilibrium of arches and in the construction of girders, as well as the actual form of an equilibrated chain. When the load is *uniformly* distributed along the floor, as in Fig. 3, the figure becomes a parabolic curve. It is a catenary when the rope or chain (of uniform section) has nothing but its own weight to carry. If the funicular polygon is inverted, it becomes a 'linear arch,' or a line of struts equilibrated under the given load. The 'line of tension' in the curved chain becomes a curved line of pressure in the arch.

3. A mass of brickwork or masonry held together by mortar joints possesses neither the transverse strength of the beam nor the tensile strength of the rope, but is well adapted for sustaining a direct pressure. It can be used in the straight vertical piers of a tall viaduct, transmitting the line of pressure from summit to base; but if such a material is employed for the superstructure, it can only be in the form of an arch. When the arch is carefully designed on the curve indicated by the flexible chain, the line of pressure will be transmitted through it without subjecting the masonry to any bending or tearing stress. Thus, an arch of uniform section, if it has nothing to carry but its own weight, should be built in the form of an inverted catenary; while a parabolic arch would be exactly suited for carrying a load which is uniformly distributed along the horizontal floor. Usually the load is not quite uniform, and the line of pressure often approximates to a short arc of a circle. The principle is applicable to arched ribs of iron and steel, while in masonry structures it governs the design of the 'free arch,' or that portion of the arch which maintains its equilibrium under vertical forces, like the free chain of the suspension bridge in Fig. 3.

Masonry arches.—The outline of a segmental arch is shown in Fig. 4, its figure being the segment of a circle. The arch springs from the abutments A and B, and at the 'springing' it rests upon the 'skewbacks,' which are special

courses of stonework dressed back to the proper inclination. At the crown C the arch rises above the chord line to a certain height CD, which is called the 'rise' of the arch; it is measured from the chord to the soffit. The 'extrados' and 'intrados' are the external and internal surfaces, or the lines which define them; and the soffit is the under side of the arch. The constituent stones of the arch are termed 'voussoirs;' they are dressed to a tapered form, the beds being plane radial surfaces.

A small segmental arch may sometimes be built as a free arch from A to B; but if the span is a large one, the masonry of each abutment is generally carried up above the skewback, so as to enclose the lower portion in masonry backing.

The reaction of the backing, in a horizontal or in a normal direction upon the arch, is essential to its stability whenever the elliptical or the semicircular form is adopted; for it is impossible that the line of pressure can follow either of these curves if the arch receives only the action of parallel vertical forces or loads. The elliptical arch has been chosen for many large river-bridges, such as those crossing the Thames; and the usual disposition of the backing is sufficiently illustrated in Fig. 5. It encloses the arch up to certain points E and F, so that the free arch is only the intervening length EF.

The Romans invariably adopted the semicircular form, carrying the backing always to the requisite height. The pointed arch was used by the Gothic architects as an aperture in a masonry wall; it is not suitable for bridge construction.

Oblique arches are often employed where the carried line of communication crosses obliquely over a lower one, as sketched in the ground plan of Fig. 6, where the line RR crosses over the line CC at an angle of about 60°, so that the 'angle of skew' is then $30° = 90° - 60°$. The arch crosses from the abutment AA_1 to the abutment BB_1, and is generally cylindrical in form; so that a section at right angles to CC_1 would be either a semicircle or a segment, while the face AB, or A_1B_1, would be elliptical. The arch is generally built in spiral courses, so that each course of voussoirs winds over the cylindrical intrados like the twisting bands and grooves of rifled ordnance. In this way the beds can be placed *nearly* at right angles to the line of pressure; and they are not plane but helical surfaces.

Brick arches are occasionally, but not usually, built with tapering voussoirs. In using the ordinary bricks, they are laid in concentric rings, with the object of ensuring a nearly uniform distribution of the pressure, and avoiding the occurrence of widely-tapering mortar joints. Thus, an arch eighteen inches in thickness would consist of four such concentric rings, one over the other, and the joints would be equally fine in each ring.

Concrete arches have been often used in modern times, and frequently with the object of dispensing with the employment of skilled labour. The liquid Portland cement concrete is filled behind or between temporary moulds, and becomes a monolithic mass on the setting of the cement. In 1902 a bridge was built at Sutton Drain, Hull, consisting of concrete poured over a frame of steel bars.

The *inverted arch* is employed in engineering construction wherever the conditions are the opposite of those presented in the upright arch. It usually forms the floor of tunnels, culverts, graving docks, and lock entrances. In

Fig. 1

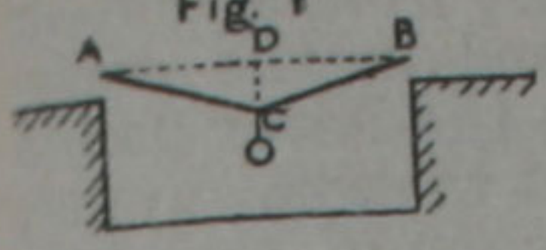


Fig. 2

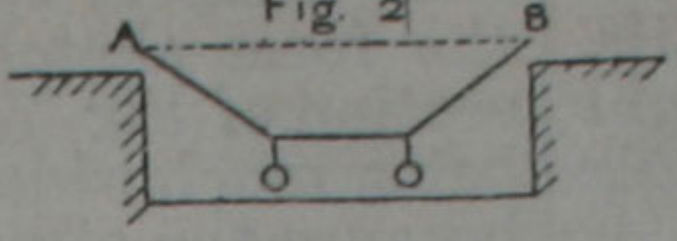


Fig. 3

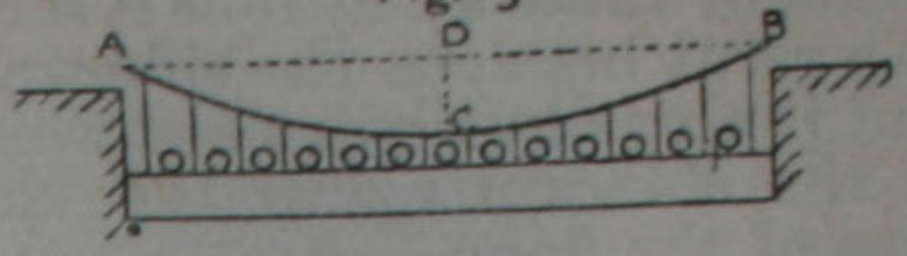
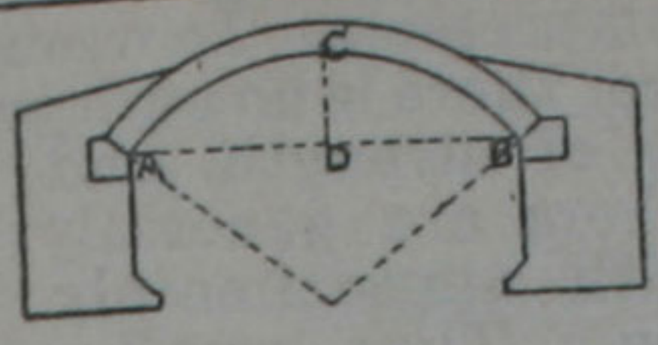


Fig. 4



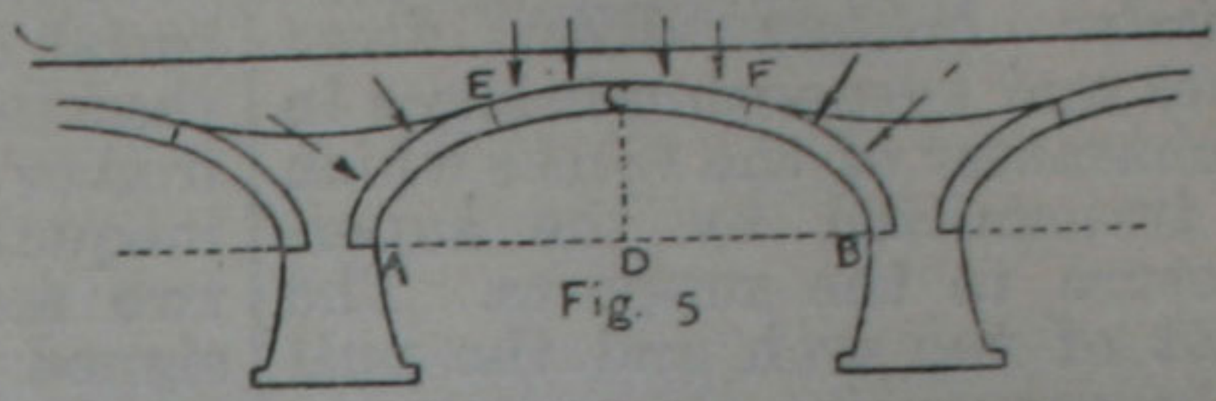


Fig. 5

Fig. 6

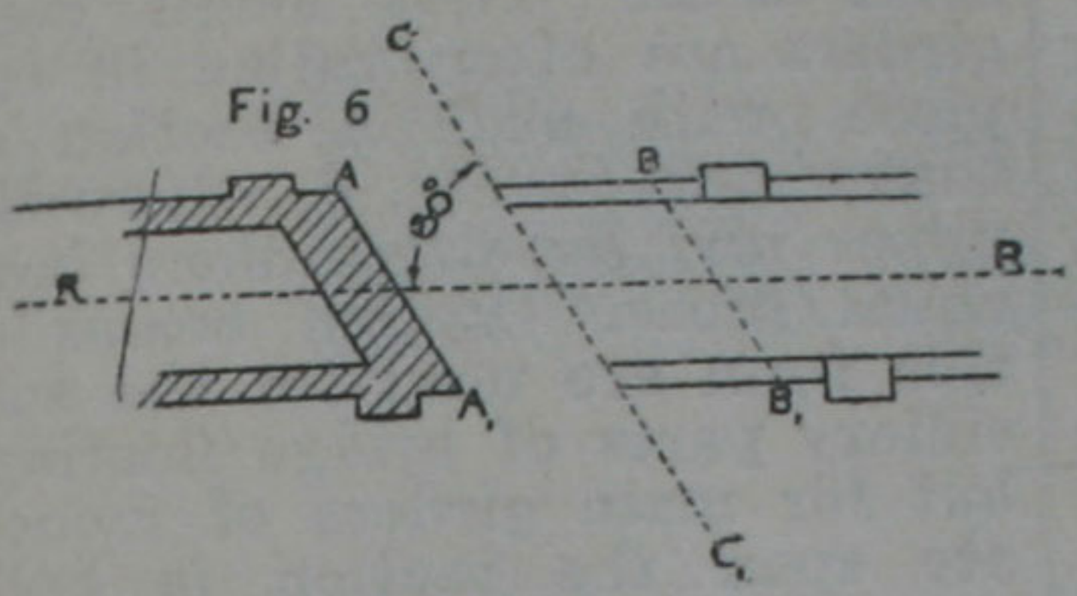


Fig. 7

Fig. 8

Fig. 9

Fig. 10

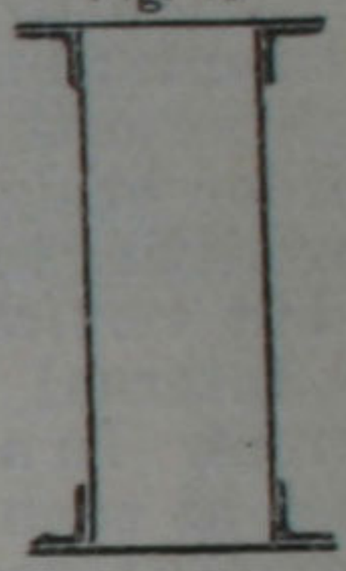


Fig. 11

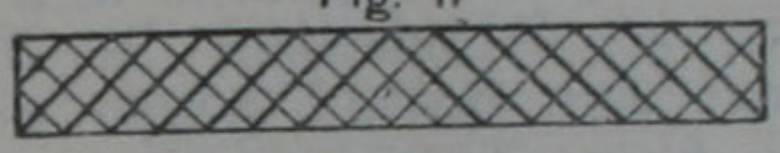


Fig. 12

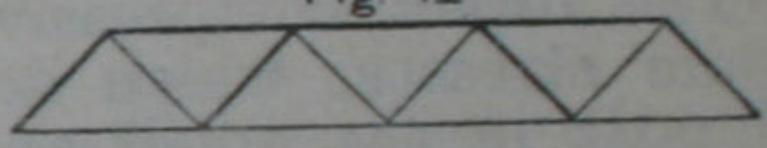


Fig. 13

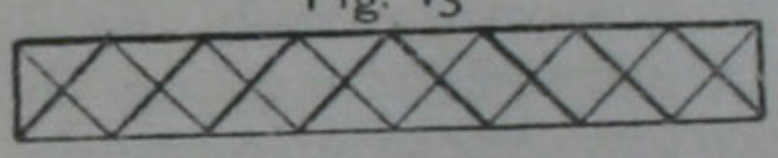


Fig. 14

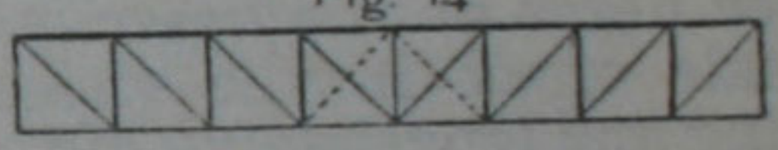


Fig. 15

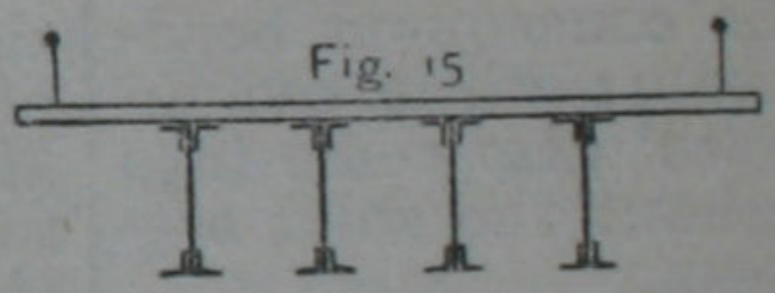


Fig. 16

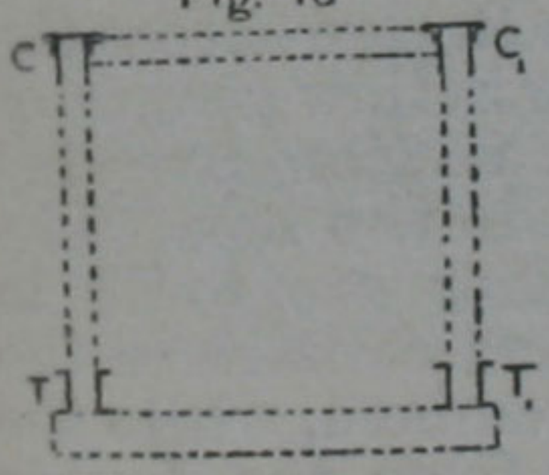


Fig. 17

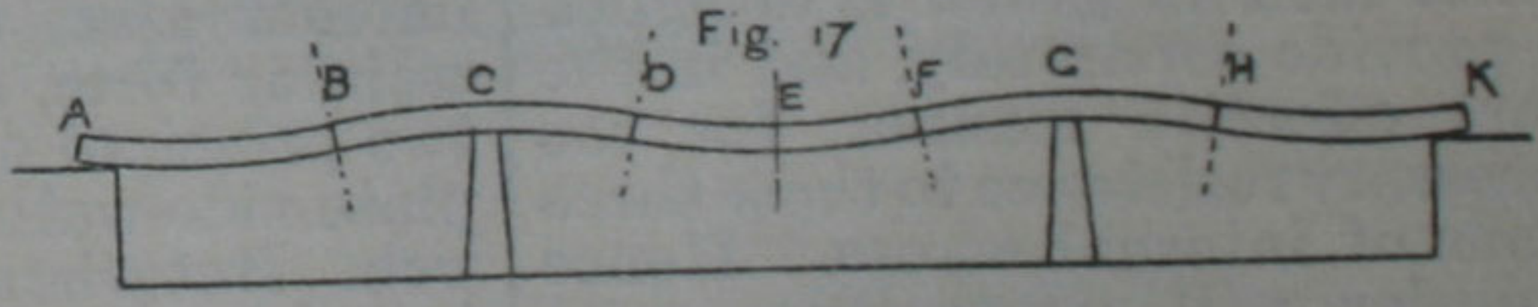


Fig. 18

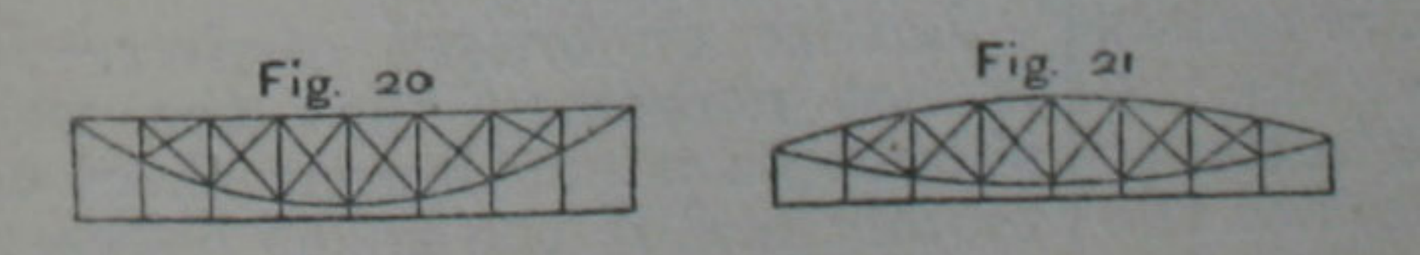


Fig. 19

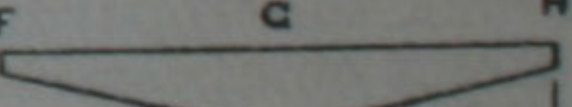


Fig. 20

Fig. 21

Fig. 22

Fig. 23

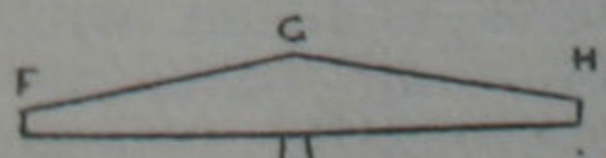
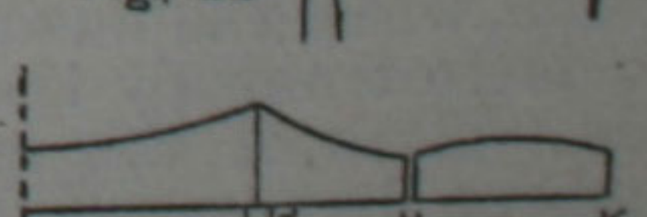


Fig. 24

Fig. 25



Bridges.

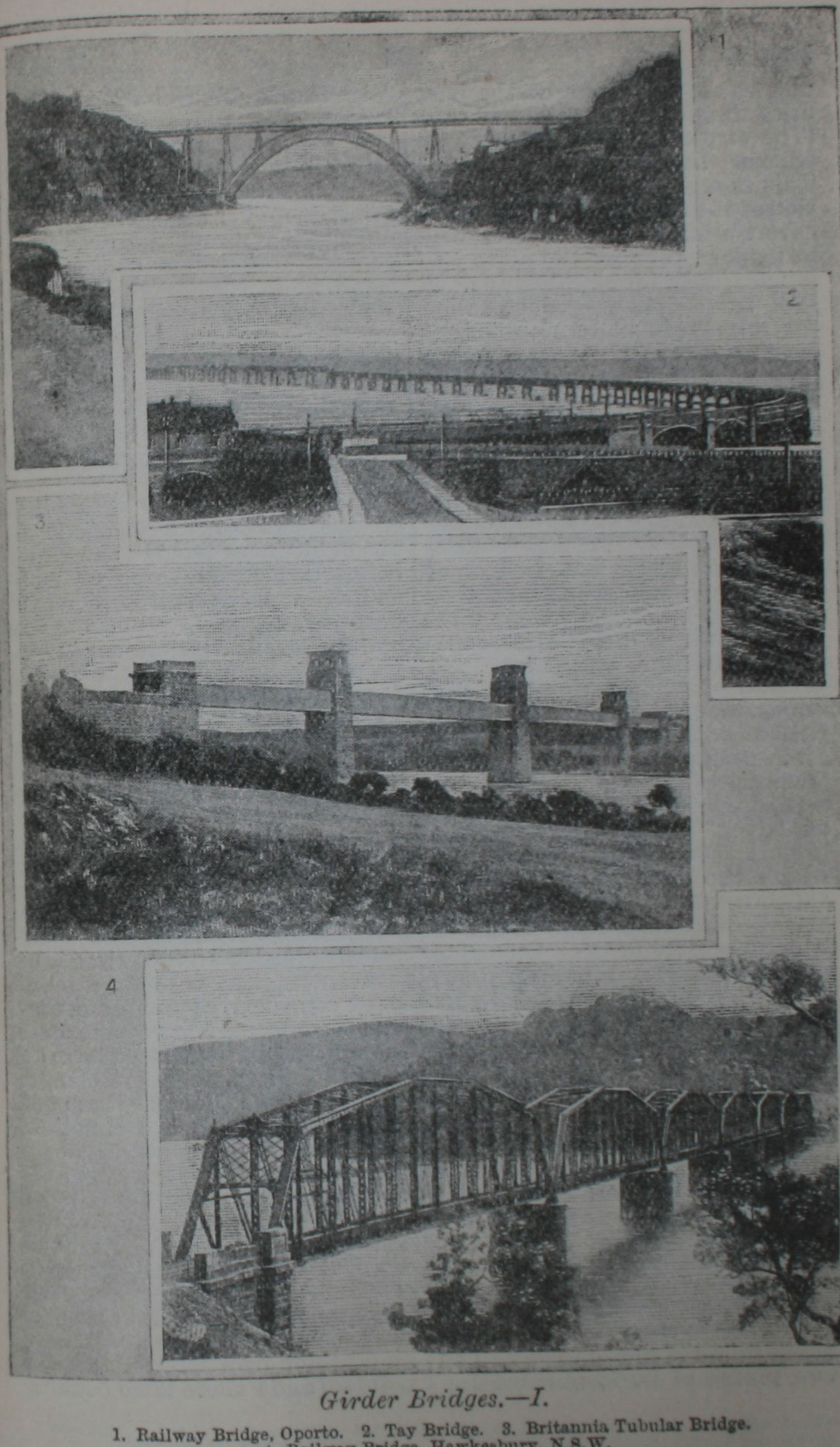
Diagrams referred to by numbers in the text.

either of these situations it serves as a strut between the side-walls, and it also distributes the weight of the side-walls over the whole area of the floor.

Girder bridges differ from arches and suspension bridges in the character of the forces which are transmitted by the superstructure to the supports. The thrust of the arch and the pull of the suspension-chain have to be resisted by heavy and strong abutments; but the main girders, which form the superstructure of a girder bridge, act like beams, transmitting to the supports nothing but *vertical* forces or loads. The internal stresses are also different. In a loaded beam, supported at each end, the material undergoes three different kinds of stress. The direct compressive and tensile stresses, which act longitudinally in the upper and the lower fibres of the beam, exhibit their effect in the visible shortening and lengthening of the fibres, and the consequent bending of the beam; while certain 'shearing forces' also come into action throughout the solid section of the beam.

The modern girder is designed to provide separately, and in the most effective manner, for the necessary resistance to these three kinds of internal stress. Hence a girder will generally consist of three essential members—an 'upper flange,' a 'lower flange,' and an intervening 'web.' When the loaded girder is supported at each end, the upper flange resists the direct compressive stress, the lower flange acts as a tie in direct tension, while the business of the web is to transmit the shearing force. Each of the constituent members, however, has received different names according to the various structural forms that have been chosen for it, while the essential functions have remained the same. The earliest girders were made of cast iron, and took the form sketched in the cross-section of Fig. 7, the lower flange being much wider than the upper, because the strength of that material is so much less in tension than in compression. In wrought iron or steel there is no such great inequality of strength, and the two members are generally designed with approximately the same area. Thus small steel girders are often rolled in one piece, with such a section as that shown in Fig. 8, where the upper and lower members have equal areas. Rolled beams of this form are used for the subsidiary parts of bridge flooring; but for main girders of moderate span the section is built up of separate plates and angle bars, as illustrated in Fig. 9. These are called plate girders, and they frequently are built with a double web, as in Fig. 10, where the section becomes a hollow rectangle or box section. The great tubular girders of the Britannia Bridge across the Menai Strait are hollow girders of rectangular box section, carrying the railway inside the box. The flatroof and floor are built in cellular form, and constitute the two principal members, while the plate side-walls form the double web. But when the bridge is subjected to a violent side-wind, the plate walls assume the function of flanges, while the roof and floor become the double web of the wind-girders.

Lattice or braced girders.—It is not necessary that the web should be a continuous sheet of metal; and if the space between the two flanges is filled with a lattice of crossing bars, as in Fig. 11, the essential functions of the web will be performed equally well. The web-stresses are then resolved into direct pulls and thrusts passing in a zigzag direction towards the abut-



Girder Bridges.—I.

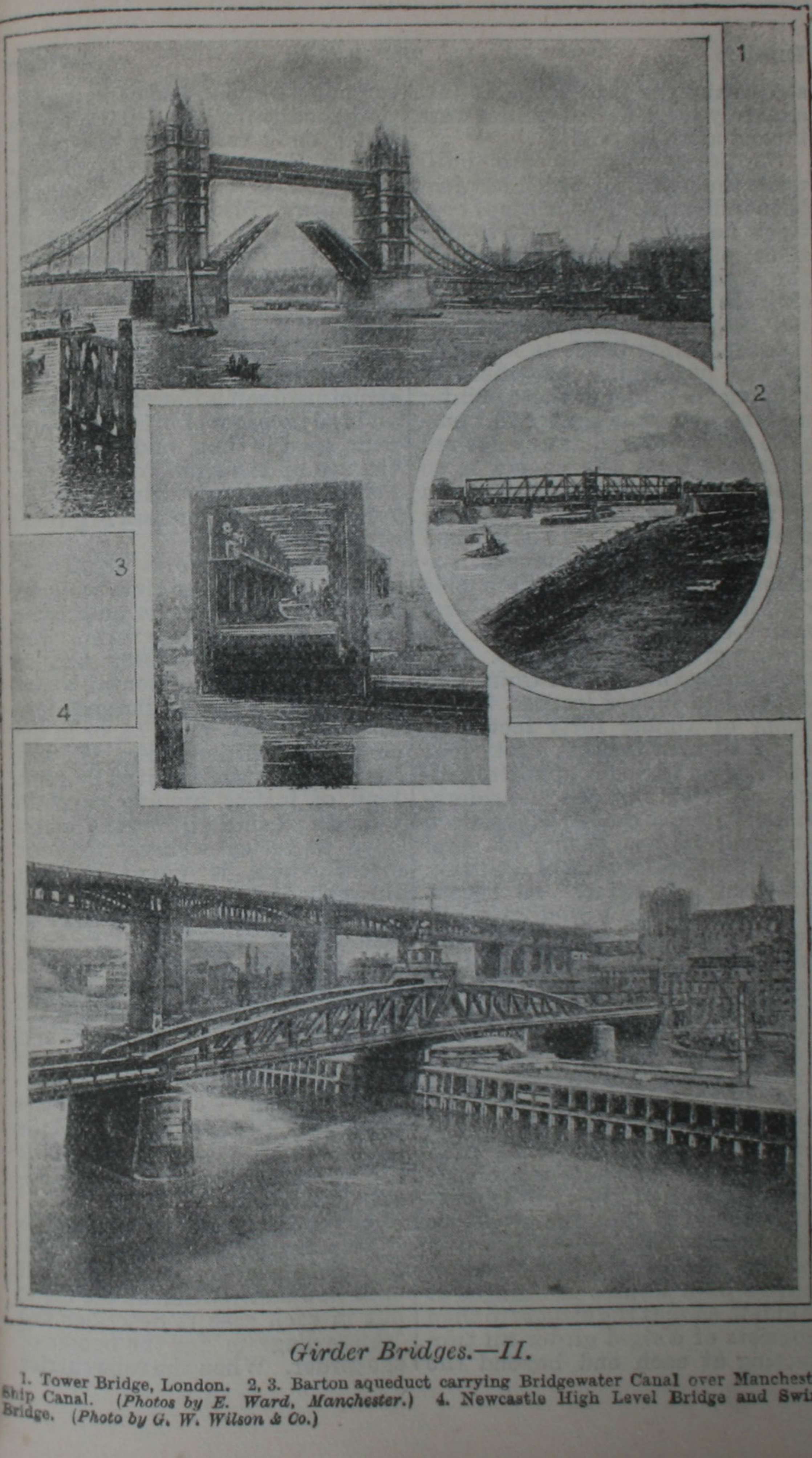
1. Railway Bridge, Oporto. 2. Tay Bridge. 3. Britannia Tubular Bridge.
4. Railway Bridge, Hawkesbury, N.S.W.

ments, so that some of the bars are struts and others act as ties. (The struts are distinguished by thicker lines in the diagram.) This is a more effective disposition of the material in a web which covers a large and deep area, and in modern practice the plate web is used only for small spans. A still more effective construction for large bridges is obtained by leaving out some of the lattice bars, and thereby concentrating the stress upon a smaller number of members. Thus, the close lattice may be reduced to the open lattice of Fig. 13, or to a single triangulated system of bracing, as in Figs. 12 and 14; and in either case the web system may consist of inclined struts and ties, or of vertical struts and inclined ties, as in Fig. 14. The girder thus becomes an assemblage of separate bars acting either in direct tension or compression, and the two principal members are often called 'booms' instead of flanges. In America they are designated 'chords.'

Girder bridges are distinguished as 'deck bridges' or 'through bridges,' according to the position which the floor occupies in the superstructure. Fig. 15 is the cross-section of a deck bridge, in which the floor or deck is carried upon the top of four main girders; while in the larger bridge of Fig. 16 the traffic goes 'through' the bridge, as it does in the Britannia rectangular tubes. The through bridge consists of the two main girders, in which C and T are the principal members of one girder, and C_1 and T_1 of the other; the vertical planes CT and C_1T_1 are occupied by the bracing of the web system; the floor TT_1 is carried by cross girders braced together by diagonals like a horizontal web; while the horizontal plane CC_1 is filled in like manner by an overhead system of wind-bracing. The two planes of horizontal bracing form the double web of the wind-girder.

A *cantilever* is a girder which projects beyond its support, and carries a load upon the projecting arm. It may have to carry a load distributed along the arm, or a concentrated weight at the outer end, and in cantilever bridges it generally carries both. The bending stress in the cantilever is the reverse of that which takes effect in a beam supported at the ends, and the cantilever is therefore bent in the reverse direction, with a curvature convex upwards, like a fishing rod.

A *continuous girder* is one that crosses two or more spans in one continuous length, the girder being laid upon three or more supports. Such a girder bends in both directions, as illustrated in a very exaggerated manner in Fig. 17, where the beam AK is laid upon four supports at A, C, G, and K. The portions BCD and FGH are bent like cantilevers, while the portions AB, DF, and HK lie in a sagging curve, like beams supported at their ends. The points B, D, F, and H, where one kind of bending ends and the other begins, are called the 'points of contrary flexure.' Their exact position in a continuous beam can be determined beforehand, though only by a mathematical investigation of much complexity; but when they have been located, it becomes easy to trace the internal stresses in all parts of the structure. The length DF undergoes all the stresses and also performs all the functions of the girder supported at each end, transferring its load to the points D and F, where it is carried upon the projecting ends of the cantilevers CD and GF. And this defines exactly the load which the cantilevers have to carry at their extreme ends, while they also bear the loads which may be distributed along their own length. At the points D and F there is no bending



Girder Bridges.—II.

1. Tower Bridge, London. 2, 3. Barton aqueduct carrying Bridgewater Canal over Manchester Ship Canal. (*Photos by E. Ward, Manchester.*) 4. Newcastle High Level Bridge and Swing Bridge. (*Photo by G. W. Wilson & Co.*)

stress, and the load would be just as safely carried if the girder were hinged at these points.

Cantilever bridges are built upon the principle which has just been indicated. The points of contrary flexure are not left to find their places in accordance with the laws of elastic deflection, as they do in the continuous beam, but they are located at a pair of definite points (such as D and F) by the mechanical expedient of hinging the girder at these points; and the points chosen for this purpose can be located at any desired distances from the centre E, so that the supported span DF can be made of any length less than the total span CG. This method of construction offers many advantages for the bridging of very wide openings, and it received its first and greatest application in the girders of the Forth Bridge. The early bridge builders of China and Japan had indeed learned that a beam of timber forty feet long might be used to cross a fifty-foot opening by laying it upon projecting corbels; but the considerations that have guided the modern engineer in the design of steel cantilever bridges are of a totally different character. In recent times the hinged girder, or cantilever, has frequently been employed in large bridges *of three spans*, for which, indeed, it is specially well adapted; and the design of such bridges has followed two different types. The first of these is illustrated in the Niagara and the St. John River (New Brunswick) bridges, where the central detached girder DF (Fig. 17) is carried between the two overhanging ends of the rigid girders AD and KF, so that the structure is virtually hinged at the two points D and F; while the alternative plan locates the hinges at B and H, so that the structure then consists of a rigid girder BH projecting at each end beyond the supports C and G, and carrying the detached girders AB and HK, whose outer ends rest upon the abutments. This latter type of construction is exemplified in the Kentucky Bridge, and also in the great bridge recently erected across the Danube at Cernavoda, in Roumania. In either of these types the bending stress at the centre of the great span CG is very much less than it would be in a simple independent girder; the structure itself is therefore lighter, and the problem of bridging a very wide span is thus made easier by the use of the cantilever. These points are clearly illustrated by reference to the stresses in girders of uniform depth.

Girders of uniform depth constitute a particular class which is marked by certain characteristics besides those of mere form. The two principal members are, of course, a pair of horizontal booms or chords, as in the independent girders of Figs. 11 to 14, or in the continuous girder of Fig. 17; and the two booms are united by some kind of lattice bracing or plate web. In all such girders the booms have to resist a direct force or stress which is never uniform throughout the span, but much greater at some points than at others. If the girder is merely supported at each end, without being strained over the supports, the boom stress will depend upon the distribution of the load, and will be represented in the simplest manner by the form of the 'funicular polygon,' so that a flexible rope carrying a similar load might be used as an instrument by which the stress diagram is automatically described.

At the beginning of this article it was remarked that the rope falls into a different shape with each new distribution of the load; but in each case it describes the 'stress diagram' for the booms of the girder. When the rope carries

nothing but a single weight in the centre of the span, it is pulled into lines which form the sides of the triangle ABC in Fig. 1, and the height of that triangle is everywhere a measure of the boom-stress in a girder carrying the same central load. At the centre the boom-stress is represented by the height DC, and from this point the stress dies away regularly in each direction until it vanishes at each end of the span. Again, the varying magnitude of the boom-stress will follow a different law when the load is uniformly distributed along the girder. Under such a load it was observed that the flexible rope falls into the parabolic curve ABC of Fig. 3; and the height of that figure, measured from the chord line, will everywhere represent the varying stress in the booms of the girder—a compressive stress in the upper, and a tensile stress in the lower boom. In the same way, for any other disposition of loads between the supports, the funicular polygon becomes the stress diagram; and the stress vanishes at the points of support, where the polygonal line joins the chord.

The same method might be applied to the span CG in Fig. 17, if the girder were subject to no other forces outside the span. For any given loading between the points C and G, the curve ce_2g in Fig. 18, representing the funicular polygon for that load, would serve as before to measure the boom-stress. At the centre of the span the booms would have to be made strong enough to bear the great stress ee_2, while the stress would die away to nothing at the points c and g. But the conditions are greatly altered when the girder is made to project beyond the supports C and G, and to carry any load upon the projecting ends B and H outside the span. The effect of such extraneous loading is felt not only upon the projecting arms, but throughout the length CG, reducing, annulling, or reversing the stresses that have been previously described. The stress diagram will therefore be greatly changed when the span CG forms one of the openings in a continuous girder bridge. The curve ce_2g will remain unaltered; but if D and F are the points of contrary flexure, the base line of the diagram will be the straight line CDFG in Fig. 18, instead of the straight line cg, the new line being drawn through the points D and F upon the curve. At the centre of the span the compressive stress in the upper boom will now be measured by the comparatively small height Ee_2, dying away to nothing at D and F, where the boom suffers no stress of either kind. From D to C the stress will be reversed in character, and the tensile stress in the upper boom will reach its greatest magnitude Cc at the point of support. In cantilever bridges of either class, the diagram of bending stress will have the general form indicated in Fig. 18, consisting of a curved line, such as ce_2g, intersected by a straight base line. The form of the curve depends only upon the distribution of the load; while the base line may lie at different levels, its position depending upon the points D and F, which are fixed by the arbitrary location of the hinges.

Girders of varying depth.—If the depth of the girder is increased at any point, the boom-stress at that point will be proportionately reduced; and the stress diagrams for girders of uniform depth serve to indicate the points where an increased depth is desirable, and to indicate other points where the stress is very small, and where the depth might profitably be reduced. Thus, each of the diagrams which have been traced for girders of uniform depth suggests an altered form of girder, in which the depth shall vary, while the boom-stress

shall either be uniform or approximately uniform; and, with this object, the diagram itself may be taken as a model for the design. Girders that are supported at each end may be built to either of the polygonal or parabolic outlines sketched in Figs. 1 to 3; and if the load were wholly concentrated at one central point, the triangular form suggested by Fig. 1 would be eminently suitable. If the triangle were turned upside down, the required variations of depth would still be preserved, and the figure would represent in outline the 'King post truss'—familiar in timber construction. In general the load is disposed in a manner which approximates more nearly to the uniform distribution assumed in Fig. 3; and for such a load the girder of varying depth may take the parabolic form of the bowstring girder, as in Fig. 19, or the inverted bowstring, as in Fig. 20; or both the members may be curved, as in Fig. 21, which represents the outline of the Saltash bow-and-chain bridge. In each case the lower member is a tie or chain subjected to a nearly uniform pull throughout, while the upper member is either a straight horizontal strut or an arched compression member under nearly uniform stress.

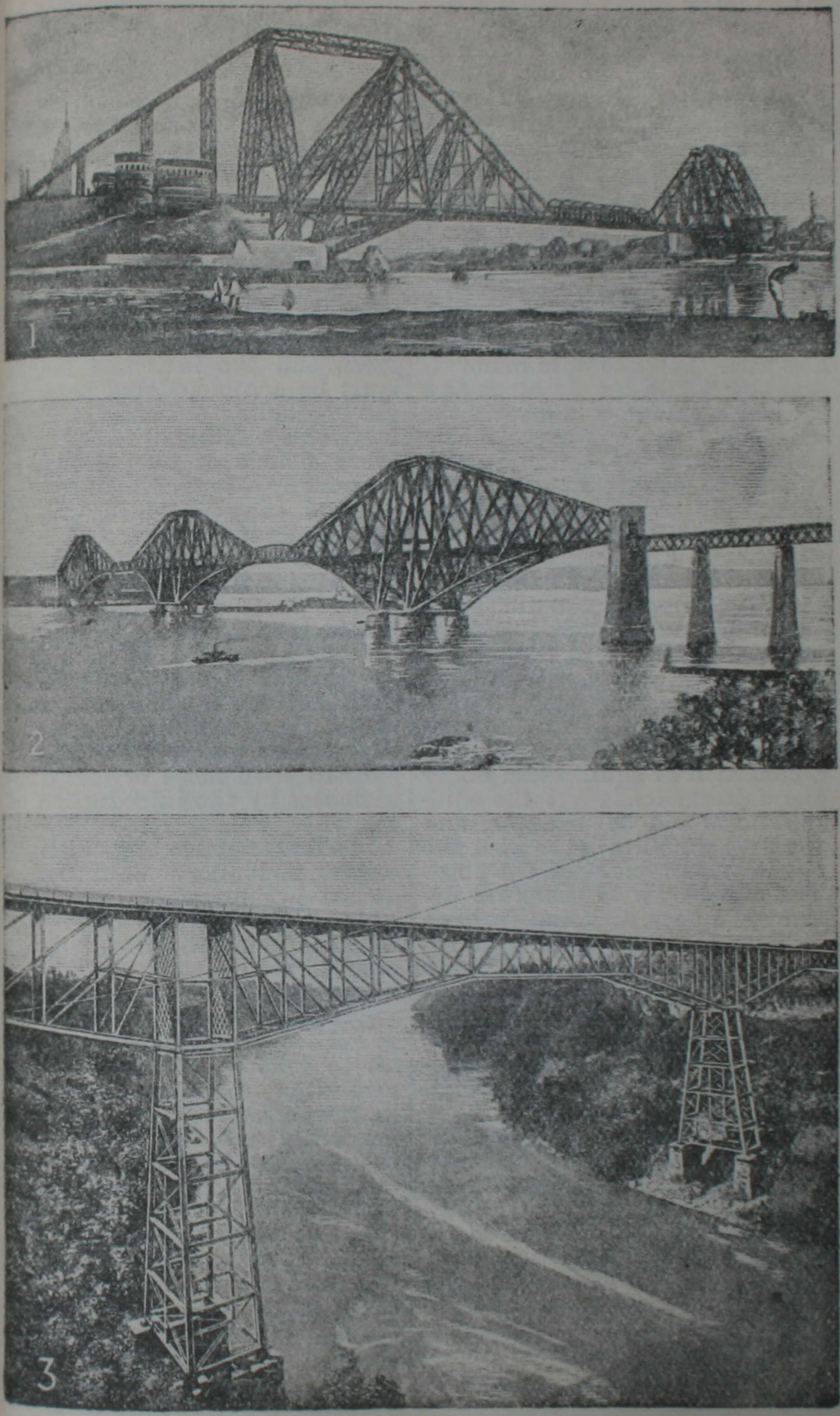
In the same way, the diagram of Fig. 18 suggests an improved form of cantilever, in which the varying depth may follow approximately the proportions of the figure F*g*H contained between the rising curves F*g* and H*g* and the straight line FH. Thus, the cantilever would have an apex at the point of support, while the depth tapers away in hollow curves towards the ends. The altered configuration is illustrated in Figs. 22, 23, and 24, which represent the mere outlines of the cantilevers used in the Niagara, the St. John River, and the Forth Bridges respectively.

In each of these examples the bridge terminates at the point H, so that the arm GH does not carry the weight of a beam HK, as in Fig. 17, but the rear end of the cantilever is held down at the point H by anchoring it to the masonry abutments. The bending, therefore, is of one kind throughout the length FH; the upper member is in tension, and the lower member in compression, so long as the bridge is fully loaded. In American examples the tension member is a linked chain of long bars. The compression member in the Forth Bridge is a pair of hollow steel tubes. The outline of the Danube cantilever bridge is sketched in Fig. 25. Here the point H is one of the virtual hinges, carrying the end of the girder HK.

Lastly, it may be remarked that in large girder bridges of every kind it is necessary to provide for those changes of length which result from changes of temperature. Independent girders are generally held at one end and supported by rollers at the other end. Continuous girders are fixed to one support, and allowed to expand in both directions; while the detached span in a cantilever bridge is hinged to one cantilever, and is free to travel upon the other.

The short line of railway from Edinburgh to Dundee crosses two of the most remarkable of existing girder bridges. The Tay Bridge, consisting of a large number of independent spans, has a total length of two miles, which is greater than in any other example. The Forth Bridge contains two great cantilever spans of 1,710 ft., which is the greatest width that has yet been spanned by any form of bridge construction.

Arched ribs of iron and steel.—In a preceding paragraph it was remarked that the curved parabolic member of the bow-



Cantilever Bridges.

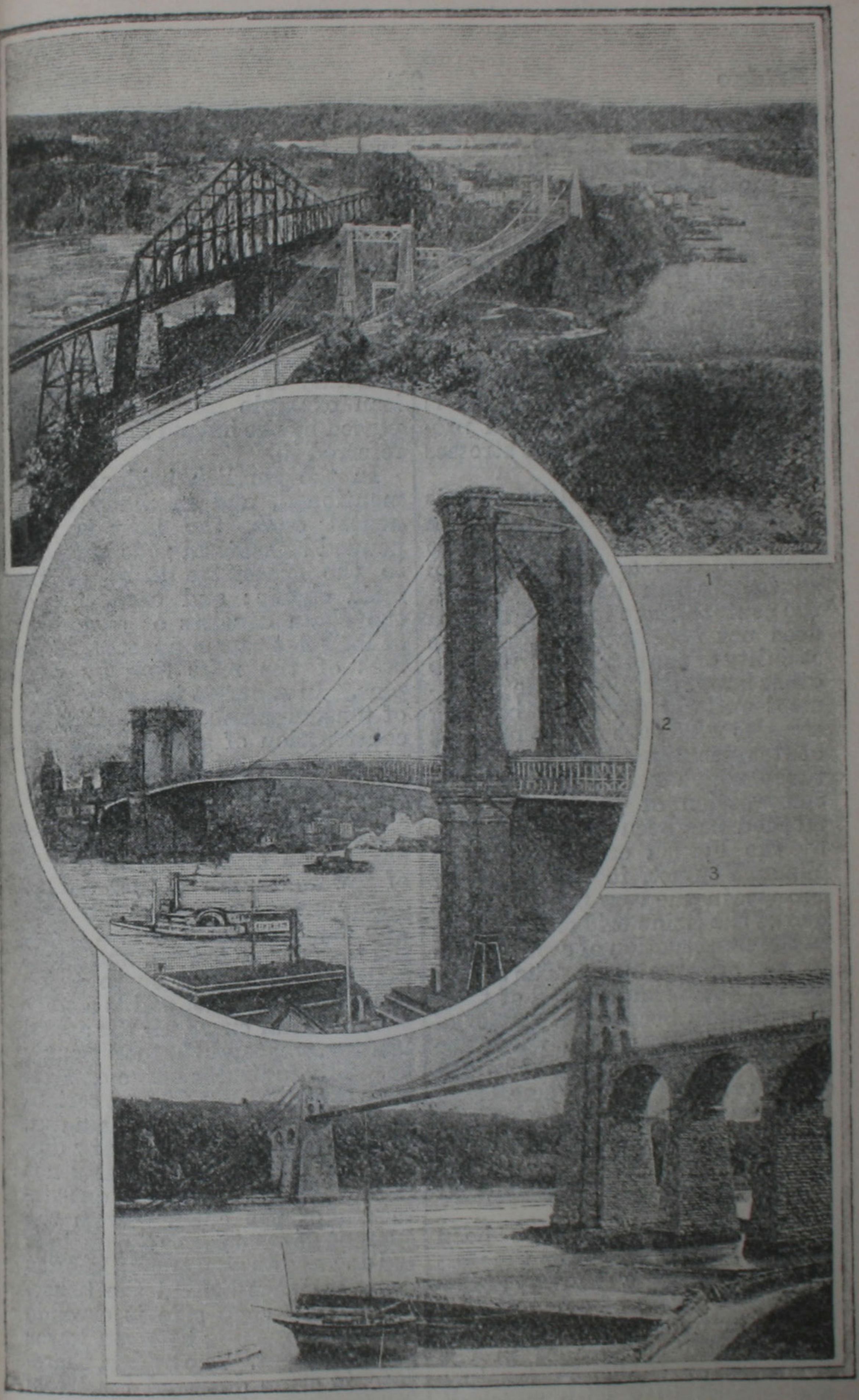
1. Lansdowne Bridge over the Indus, Sukkur, India (Sir A. M. Rendel). 2. Forth Bridge.
3. Niagara River Cantilever Bridge.

string girder in Fig. 19 takes the character of a linear arch, transmitting a thrust through its entire length, while the lower member of the girder is simply a straight tie uniting the ends of the bow. If the bow could be made to spring from a pair of unyielding abutments, there would remain no measurable stress in the tie or in the diagonals of the web. If these were removed, the bow would remain alone as a slender arch, and would carry the same load without experiencing any greater stress than that which it had to endure as a member of the girder. There are many situations in which solid masonry abutments can readily be constructed of sufficient strength and stability to resist the thrust of the arch, and in such situations the arch offers great advantages as compared with the girder.

If the arch were merely a line or slender rod bent to the parabolic curve, it might still be in a condition of equilibrium under the uniform load; but the equilibrium would be unstable, and the arch would collapse with the slightest movement of the load. The arched rib is therefore designed in such sectional form as to ensure a considerable transverse stiffness—sufficient to resist the distorting effect of an irregular load. With this object the curved rib is generally designed with a section like that of a shallow girder, its depth being a small fraction of the rise of the arch. In small bridges the rib is often formed with a plate web, the sections being similar to that of the plate girder in Fig. 9; while in very large bridges the curved rib resembles a curved lattice girder consisting of two concentric members braced together: the arch-thrust is then divided between the two members, though it cannot always be equally shared by both.

By either form of construction it is easy to ensure a sufficient degree of transverse stiffness; but the stiffness of the arched rib may act prejudicially when the structure is subjected to changes of temperature. When the temperature rises, the expansion of the curved rib compels it to bend upwards at the crown, because it cannot extend the width of its span, and the increased length must be accommodated between the unyielding abutments. This inevitable bending of the rib with every change of temperature is necessarily attended with certain bending stresses which will be very severe if the rib is very stiff, and they can only be moderated by reducing the stiffness. To reconcile these conflicting requirements, it is necessary to provide for the expansion of the arch by mechanical expedients which shall not weaken the resistance of the rib to the bending effects of irregular loading; and this is effected with more or less completeness by the introduction of hinges.

In a large number of modern examples, including some of the fine arched bridges which cross the Rhine and the North Sea-Baltic Canal in Schleswig-Holstein, the arched rib is hinged at the two extremities. These hinges permit a freedom of angular movement at each abutment, enabling the rib to take a continuous curvature in one direction throughout its length, and to accomplish the inevitable bending more easily, so that the resulting stress is much less severe than it would have been if the rib were fixed to the skewback. The stress which still has to be endured is chiefly felt at the crown, and it becomes a matter of small importance when the arch is designed with a great rise and a moderate depth of rib. Thus, by way of example, the French engineers found no great



Suspension Bridges.

1. Suspension Bridge, St. John, N.B. (Cantilever Bridge alongside). 2. Brooklyn Bridge, New York. 3. Menai Suspension Bridge.

difficulty here in carrying out their bold plan for the very tall arches of the Douro Bridge and of the Garabit Viaduct, near St. Flour, in the French department of Cantal. The largest steel arch that has yet been constructed is to be found, however, in the new bridge which crosses the Niagara in a single span of 840 ft. The arch is hinged at each end, and has a rise of 150 ft., while the depth of the open lattice rib is only 15 ft., and with such proportions the temperature stresses are not at all severe.

But the mechanical purpose is more perfectly carried out when a third hinge is introduced at the crown of the arch; and if the abutments can be relied upon, the central hinge in a single span does not necessarily impair the stability of the structure. On the other hand, it relieves the rib almost entirely from the bending stresses which are due to changes of temperature, and also from those which result from elastic compression of the arch. This method has been boldly applied by the French engineers in the Viaur Viaduct, in the south of France, in the very flat arches of one of the Seine bridges, and also in the construction of arched roof-trusses of large span. The stability of the abutments and of their foundations becomes a matter of increasing importance when the arch is designed with a great width of span and a relatively small rise. The choice between the arch and the girder is therefore very much influenced, in many cases, by the natural character of the foundations.

Suspension bridges have been used in all countries for the purpose of carrying a roadway at low level over rivers of great width; and in many situations they present certain advantages in the lightness of the superstructure and the facility with which it can be erected. The most notable of English examples are, perhaps, the Menai Strait Bridge, the Victoria Bridge at Battersea Park, London, and the Clifton Suspension Bridge over the Avon at Bristol. The last-named structure, like the Clifton Suspension Bridge in America, crosses a deep ravine, where an arch might have been preferred but for the greater difficulty of erection. The American example has now been replaced by the hinged arch already referred to.

In the English bridges above mentioned, and in many continental ones, the floor is suspended by vertical rods attached to the successive links of the main chains; and each link of the chain consists of a number of long flat bars connected to the bars of the next link by steel pins. In America the same form of tension-member is used in the construction of girders, but wire cables are generally employed for the principal member of a suspension bridge.

The main span of the bridge is flanked on either side by a pair of towers which rise to a considerable height above the roadway. The chain or cable is laid across the tops of the towers, and hangs between them in a curve which is nearly parabolic, and is always the funicular curve for the actual loading, whatever the loading may be. The funicular curve ce_2g has been drawn in Fig. 18 to a certain vertical scale; but the chain can, of course, be adjusted to any dip, and the dip ee_2 is generally not more than one-twelfth to one-sixteenth of the span. From the summit of each tower the chain is led down to an abutment placed at some distance behind the tower, so that on each side it extends across an opening between tower and abutment. The bridge, therefore, is often designed for crossing three openings; and the road-

way is suspended from the chain across the side spans, the chain falling into parabolic arcs like the curves CBA and *g*HK in Fig. 18. The Victoria Bridge, the great Brooklyn Bridge at New York, and the Cincinnati Bridge are examples of this kind. In other cases the object has been simply the bridging of a single wide opening from tower to tower, and the chain is then stretched, in a nearly straight line, from tower to abutment. These portions of the chain, carrying no load beyond their own weight, are called 'backstays.' In either case the two ends of the chain are securely anchored into solid and heavy abutments. The Clifton Suspension Bridge is an example of the single span, and here the anchorage for the backstays is obtained by tunnelling into the natural rock.

The towers are always designed to act merely as vertical pillars. The chains are not attached to them, but are carried in some kind of saddle or carriage which is free to travel longitudinally upon the top of the tower. When the temperature rises, the curved chain finds accommodation for its expanded length by assuming a greater dip (corresponding to the increased rise in the heated arch). The expansion of the straight backstay is allowed for by a movement of the saddle upon its rollers. When the disposition of the load is in any way altered, the chain finds for itself a new position of equilibrium, letting down the more heavily loaded parts of the roadway, and raising those which are more lightly loaded. The equilibrium is always stable, but the vertical movement will often develop oscillations of considerable amplitude. The vibrations are kept within narrower limits when the chain is subjected to a severer pull and stretched in a flatter curve. But the chain bridge can hardly be used for railway traffic without some kind of stiffening. With this object, the floor is often stiffened by roadway girders, and the girders are sometimes hinged in the centre to avoid the incidence of severe temperature stresses; while American cable bridges are further stiffened by a series of radiating straight ties extending from the top of each tower to a number of points along the roadway. In some cases the main superstructure has consisted of straight radiating links, and their weight has been supported by an auxiliary overhead cable. All these expedients afford in some degree a remedy for the flexibility of the chain; but although this flexibility is precisely what has given shape and being to the suspension bridge, yet it does not constitute an essential feature of the system, nor a necessary accompaniment. In the suspension bridge flexibility is less harmful, but not more desirable, than in the arch; and the conflicting requirements being the same in both, they can be met by similar expedients. This has been accomplished to some extent in the design of a few hinged suspension ribs.

Movable bridges have long been used in fortification with the object of intercepting communications; but in civil engineering they are used for maintaining the traffic on two crossing lines of communication. Thus, a bridge which carries a road or a railway across a navigable channel at low level must occasionally be opened for the passage of shipping; while the Manchester Ship Canal is crossed by a movable bridge which carries another canal over it. Such bridges may be classed under different heads, according to the movement which is imparted to the girder super-

structure in order to open the way for navigation, or to close the bridge for restoring the upper line of traffic.

Roller bridges are those in which the girder is carried upon wheels or rollers, and travels in a straight line across the waterway. In general the weight of the moving girder is supported upon the fixed portions of the structure. The caissons which are used for closing the entrance of graving docks, and which carry a line of roadway across the top, are sometimes made to travel on rollers across the floor of the dock, and may be included among roller bridges.

Bascule bridges are those which rotate upon a horizontal axis, as in some of the drawbridges of mediæval castles. The roadway platform may be compared to a hinged flap which is drawn up to allow the passage of vessels; and the navigable opening may be spanned by one or by a pair of such flaps meeting in the middle. A new form of bascule bridge, operated electrically, was erected over the Chicago R. at Ashland Avenue in 1903.

Swing bridges are easily distinguished from either of these types, and for many reasons they are generally preferred by engineers for the movable spans of large railway bridges. They are made to rotate about a vertical axis, the weight of the swing-span being carried upon a turntable. The live-ring of the turntable contains a number of conical steel rollers, which turn upon radial axles and travel round a circular roller-path. An upper inverted roller-path travels in the same way upon the rollers, and carries the main girders of the swing bridge. In a few examples the navigable opening is spanned by two swinging cantilevers which meet in the middle; more frequently by a single arm which rotates upon a turntable placed on one side of the opening, the arm being duly counterbalanced at the rear end. When the navigable channel is very wide, it may conveniently be divided into two openings, spanned by a double-armed swing bridge rotating upon a central tower which stands between the two openings. In this case the girder becomes a balanced cantilever with two equal arms, supported upon the turntable in the middle of its length. When the bridge is closed by turning it into the line of the railway, the girder is made to take a bearing upon the two abutments, and is converted into a continuous beam of two spans. This is effected by the employment of mechanical appliances for the due adjustment of the three supports. The form of the elastic girder is thus changed from that of a drooping cantilever to that of a continuous beam, having a point of contrary flexure in each span. In some examples the weight of the swinging cantilever has been carried upon the head of a hydraulic ram, which becomes the central pivot of the turntable, and the load is wholly supported by the pressure of the fluid on which the ram rests and turns. The adjustment above referred to can then be made by the hydraulic raising or lowering of the ram. For all operations connected with the working of movable bridges hydraulic power is the most convenient, and is generally employed.

Military bridges.—Military bridging differs from other kinds in that (1) speed in construction is generally essential; (2) the materials must be so light as to be easily transported, or else must be rapidly extemporized locally; (3) time does not usually admit of very much calculation. The bridging duties of the British

army are carried out by the bridging battalion and field companies of the Royal Engineers. Rivers are crossed by laying the roadway of the bridge on pontoons, on rafts of casks and timbers, or on ordinary boats. In every case the floating pier is anchored on the up-stream side, or on both. At each end of the bridge one or more piers of piles or trestles are usually built, to allow for the rise and fall of the tide. If the river is sufficiently shallow, and more time is available, bridges resting on trestles or crib-piers are constructed. Where good holding ground exists on both sides of a small stream or ravine, the gap is spanned by a bridge built on spar-frames resting on each bank and locking in the centre. In this way a single lock bridge will span a thirty-foot opening, a double lock forty-five, a single sling sixty, and a treble sling eighty feet. Wide and very deep chasms are crossed by suspension bridges, the materials used including iron chains, steel-wire ropes, hemp ropes, and even, in emergency, hide thongs and ropes of grass or creepers twisted together. A flying bridge is one in which the action of the current is made to move a boat or a raft—anchored by a long rope to the bank or to the centre of the river—across the stream by acting obliquely against its side. Another way is to stretch across the river a stout cable on which hangs a pulley, to which are attached the floating platform and two lines for hauling it from bank to bank.

See J. C. Fidler's *Bridge Construction* (3rd ed. 1901), and W. Humber's *Iron Bridge Construction* (3rd ed. 1870); *Modern Road and Railway Bridges*, by W. Maw and J. Dredge (1872); Baker's *Strength of Beams, Columns, and Arches* (1870), and *Long Span Railway Bridges* (new ed. 1873). Numerous examples are illustrated in the *Trans. Inst. C.E.* For legal questions in respect of bridges, see HIGHWAYS.

Bridge, a game at cards. The origin of bridge is uncertain. A hybrid form of it was played in Constantinople as far back as 1860. A variation has long been popular in Holland, and another in Russia, where it is known as *yeralash*. From Constantinople it made its way to Alexandria, and into the French clubs of the Riviera. In its present form and name it first appeared in Paris about 1892, and from thence was taken to America. In 1894 Lord Brougham gave it its first introduction into London at the Portland Club, and in the course of the next year or two it had won its way into general favour.

Bridge is a game for four persons, two being partners against the other two, and an ordinary pack of fifty-two cards is used. Only three persons actually engage in playing the cards, for the dealer's partner always stands out, his cards being exposed as a dummy hand, and played by the dealer in partnership with his own. The game then resolves itself into one of single dummy whist (see WHIST). Outside the active play of the hands, bridge differs *in toto* from dummy whist.

The dealer serves out the whole fifty-two cards singly, without turning up the last one of the pack. The four players examine their hands, and the dealer then has the privilege of determining what suit shall be trumps, or whether he shall declare 'no trumps,' and has to announce it. Should he consider it undesirable to exercise the option, he passes the selection on to his partner; and the latter is then bound to name a suit, which becomes the trump suit for that deal.

As in whist, every trick over six taken by one side is scored as an overtrick, but in bridge its scoring value is regulated by the suit that is made trumps, on the basis tabulated further on. When the trump suit has been named, it is at the option of either adversary —the one to the dealer's left having priority—to double its scoring value by saying, 'I double;' so that each overtrick in spades would now be 4, in clubs 8, and so on. The dealer who declared trumps, or, failing him, his partner, may now redouble, and the other side can redouble again, until 100 points—the usual limit—on each overtrick is reached. The question of doubling or not doubling having been settled, the player on the dealer's left leads out a card to the first trick, and the dealer's partner then, and not till then, spreads out his thirteen cards in their suits face upwards on the table, and, as far as he is personally concerned, takes no further part in that game except (1) to assist his partner by drawing a card from the dummy as he names it, or (2) should his partner renounce, to ask him if he has no more of the suit.

A game consists of 30 points, made up exclusively of overtrick scoring, whether on 'doubles' or otherwise. Should a win carry the score over 30, the surplus points are taken into account when the score is settled at the end of the rubber. Every deal must therefore be played out, whether the game be won before its conclusion or not. The best two games out of three win the rubber, and for that a score of 100 points is taken.

There are five honours in bridge —the ace, king, queen, knave, and ten of the trump suit. In a 'no trump' declaration (termed 'sans atout' in some card circles) the four aces are the only honours. Any three trump honours held singly or conjointly by one side score twice the single value of a trick in the suit. Four honours held between partners score four times the trick value; but held by one player, they score twice as much, or eight times the trick value. There are three ways of scoring five honours: held in one hand, they count ten times the trick value; held between partners, four in one hand and one in the other, they count nine times the trick value—eight times for four in one hand, and once for the fifth honour with the partner; or divided, three and two, they score five times the trick value. In 'no trumps,' three aces, held either conjointly or by one player, count 30; four aces between partners score 40; four aces held in one hand score 100. When each side has two aces there is no honour score. When, on a trump declaration, a player has none of the trump suit, he has 'chicane,' and adds to his honour score twice the value of the trick. For a 'grand slam' by one side—making the whole thirteen tricks—40 points are placed to the honour score; for making a 'little slam,' or twelve tricks, 20 points. The honour score is in no way affected by doubling, which applies to the trick score only. Honours are not added up till the finish of the rubber.

The score is generally kept on a sheet of paper ruled in the form of a long cross, with the horizontal line a little above the centre. This admits of the trick and honour scores being kept separate, and ultimately added up together in one sum. It is usual to keep the score of your own side in the longitudinal division on the left, and the adversaries' score in the division on the right. The honours are recorded in the top division, be-

ginning from the cross line, and are continued upwards; while the overtricks are registered immediately below the line, and are scored downwards.

The declaring hand should hold not less than four reasonably certain tricks. The trump suit should be sufficiently strong either to capture the adverse

The Trick Score.

Each trick above six counts—

When spades are trumps	2 points.
When clubs are trumps	4 ,,
When diamonds are trumps	6 ,,
When hearts are trumps	8 ,,
When there are no trumps ('sans atout')	12 ,,

The Honour Score.

	In Spades.	In Clubs.	In Diamonds.	In Hearts.
Three honours in one hand or between partners count	4	8	12	16
Four honours between partners	8	16	24	32
Four honours in one hand	16	32	48	64
Five honours—three with one partner, two with the other	10	20	30	40
Five honours—four with one partner, one with the other	18	36	54	72
Five honours in one hand	20	40	60	80
Chicane counts	4	8	12	16

When there are no trumps—

Three aces held in one hand or between partners count	30
Four aces held between two partners	40
Four aces held in one hand	100

Grand slam counts 40; little slam counts 20.

As regards the stakes, it is estimated that half a crown per 100 at bridge is equivalent to shilling points at short whist. The best plan is to fix the price at an amount per hundred easily divisible into ten, such as tenpence, half a crown, or five shillings. Any odd excess points under 5 are not taken into account, but over 5 they count as a full 10. Bridge is looked upon as rather a gambling game, but as the stakes can be set as low as a farthing for 10 points, it is not so necessarily.

In 1895 a set of laws was drawn up by a special committee of the Portland Club, which has been revised and generally adopted.

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With three aces and other probable tricks declare 'no trumps' (on a passed call dummy should declare 'no trumps' with three aces and no other likely trick). Always declare 'no trumps' with four aces, even if there is not the smallest prospect of making another trick. At the worst

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you can only score three by tricks, which, doubled, would only lose 72, against which you are compensated in advance by an honour score of 100; and the prospects of finding your partner with a hand sufficiently good, when supported by your four aces, to enable you to conjointly make the odd trick or more, are distinctly in your favour.

Do not double unless you are practically sure of making the overtrick, or your chances of doing so are promising, and the double is necessary to put you to game. Never redouble unless your prospect of winning is almost certain. It is always safer to double when you sit over the trump-making hand—*i.e.* to his left—than when he sits over you. Beware of doubling spades unless you have practical control of the suit, for the caller may have extreme length and strength in them; and should he redouble, the overtricks are 8 each, the same value as hearts. Beware of doubling on a questionable hand if the adversaries need a doubled or a redoubled odd trick to win, more especially if the double or redouble cannot put you to game if you get the odd trick.

Always consider the state of the score before declaring or doubling; and as dealer, always summarize your own and dummy's best chance of getting to game before following to the first lead. Never take unnecessary risks. When you have a strong black suit that will carry you out, do not chance a doubtful red or 'no trump' declaration; but when the opponents are almost certain to win the game on the next deal if you fail to do so on the current one, take any reasonable risk that may be likely to attain the desired result.

A popular variety of the game is auction bridge, which is after all a sort of mixture of bridge and nap; each player bidding against the other in value of suits, and the highest bidder taking the deal.

See Badsworth on Bridge, 'Hellespont' on Bridge, Dalton's *Saturday Bridge*, Doe's *Bridge Manual*, Dunn's *The Bridge Book*, Elwell's *Advanced Bridge*, Foster's *Bridge Tactics* and *Complete Bridge*, E. Anthony's *The Complete Bridge Player* (1905), and W. Dalton's *Auction Bridge* (1908).

Bridge, Sir Cyprian Arthur George, G.C.B. (1839), British admiral; served in the Crimea, in the Indian mutiny, and on the Burmese frontier. From 1889 to 1894 he was director of naval intelligence, and from June 1901 to 1904 he was commander-in-chief on the China station. In 1904, with Mr. Aspinall, K.C., he held an inquiry at Hull on the Dogger Bank incident. He has published *The Art of Naval Warfare* (1907); and *Sea Power, and Other Studies* (1910).

Bridge, Sir Frederick (1844), organist of Westminster Abbey since 1875, was born at Oldbury, Worcestershire; studied music under Sir John Goss; organist, Trinity Church, Windsor (1865–9); and organist, Manchester Cathedral (1869–75). He has since been professor of harmony at Owens College and Royal College of Music, and has been Gresham professor of music since 1890, conductor of the Royal Choral Society since 1896, and since 1902 King Edward professor of music in University of London. His principal works are *Counterpoint* (1877), *Musical Gestures* (1894), *Rudiments in Rhyme* (1896), *Mount Moriah* (1874), *Boadicea* (1882), *Rock of Ages* (1886), and *The Inchcape Rock* (1891). He was knighted in 1897.

Bridgend, mrkt. tn., Wales, in Glamorganshire, 20 m. w. of Car-

diff; has two lunatic asylums, steam joinery works, tanneries, blast-furnaces, coal mines, and stone quarries. Pop. 6,000.

Bridgenorth. See BRIDGNORTH.

Bridge of Allan, par., tn., and health resort, par. of Logie, Stirlingshire, Scotland, on Allan Water, trib. of river Forth; on C.R., 2 m. N. of Stirling; mild climate; hydropathic, baths and mineral well; has paper mills and dyeworks; also an annual Highland gathering in August. Pop. 3,300.

Bridge of Weir, tn., Renfrewshire, Scotland, 13 m. W. of Glasgow; has calico printing. Here are Quarrier's Orphan Homes. Pop. 2,300.

Bridgeport, city and seapt., Connecticut, U.S.A., co. seat of Fairfield co., 18 m. S.W. of New Haven, on an inlet of Long Island Sound. It is connected with New York city by daily steamers. It is a great manufacturing centre, the most important branches being corsets, sewing-machines, carriages, and firearms. Pop. 102,000.

Bridges, ROBERT SEYMOUR (1844), English poet and critic, was born at Walmer, Kent. He studied medicine at St. Bartholomew's, London, and practised in London until 1882. While in London, Mr. Bridges had become known to a small circle as a fine writer of delicate lyric poems in the Elizabethan manner. Since 1882 he has devoted himself seriously to literature; writing, besides lyrics, narrative poems, sonnets, and a series of interesting plays in various experimental manners. The following are some of his works:—Poems: *The Growth of Love* (1876; enlarged 1890); *Eros and Psyche* (1885; revised 1894); *Eden: an Oratorio* (1891); *Purcell Commemoration Ode*, etc. (1896). Plays: *Prometheus the Fire-giver* (1883, 1884); *Nero* (two parts, 1885); *Feast of Bacchus* (1889); *Christian Captives* (1890); *Humours of the Court* (1893); *Demeter: a Mask* (1905). Poetical works: Complete edition (1898–1905); Criticism, etc.; *Milton's Prosody* (new ed. 1893); *John Keats* (1895, 1896), in Muses' Library. See Dowden's *The Poetry of Robert Bridges* (1894).

Bridget, ST. (1302–73), was born near Upsala, Sweden; after a pilgrimage to St. James of Compostela in Spain, retired (1344) to a convent, where the rule of 'the Saviour's Order after the reformed rule of Augustine' was revealed to her, and she built the first monastery of the order at Vadstena, in E. Gothland—a monastery which flourished until its suppression in 1595. Bridget repaired in the jubilee year 1350 to Rome, where she lived till her death. Her body was conveyed to the monastery of Vadstena. She was canonized in 1391. Her day is October 8.

Bridget, ST., of Ireland. See BRIGIT.

Bridgeton, city, New Jersey, U.S.A., the co. seat of Cumberland co., 37 m. S. of Philadelphia, on both sides of the Cohansey R. It has a large trade in pig iron and ore, lumber, lime, and coal, and manufactures nails, glass, woollens, flour, and canned goods. Pop. 14,000.

Bridgetown, seapt. and cap. of Barbados, W. Indies, on the N.E. shore of Carlisle Bay, a fine spacious roadstead affording safe anchorage for the largest ships, and situated on the W. coast of the island. It is a port of call for steamers, and the headquarters of the Royal Mail Steamship Company. The exports include sugar, molasses, aloes, and mineral oil. The total trade is valued at about two millions sterling annually. It is the seat of the bishop of Barbados. Pop. 35,000.

Bridgewater, tn., Plymouth co., Massachusetts, U.S.A., 26 m. S. by E. of Boston; manufactures cottons, shoes, bricks, and paper. Pop. 7,000.

Bridgewater, FRANCIS EGERTON, THIRD DUKE OF (1736–1803), succeeded to the title on the death of his elder brother (1748). On the advice of James Brindley (see BRINDLEY, JAMES) he constructed a canal (1758–71) which was 77½ m. long, and spanned the Irwell from Worsley to Manchester (afterwards extended to the Mersey), at an expenditure of £220,000. In 1887 the canal was sold to the Manchester Ship Canal Company.

Bridgewater, FRANCIS HENRY EGERTON, EIGHTH EARL OF (1756–1829), son of John Egerton, bishop of Durham (1721–87), succeeded his brother in 1823. He lived for years at Paris, where the Hôtel Egerton was notorious for its swarm of cats and dogs dressed as human beings, and the flocks of birds with clipped wings in its gardens. In addition to bequeathing £12,000 to the British Museum to buy MSS., he left £8,000 to be given for the best work 'On the Power, Wisdom, and Goodness of God, as manifested in the Creation,' to be awarded at the discretion of the president of the Royal Society, and by him allocated to—(1) Dr. Chalmers, *The Adaptation of External Nature to the Moral and Intellectual Constitution of Man*, 1834; (2) Dr. William Prout, *Chemistry, Meteorology, and the Function of Digestion, considered with reference to Natural Theology*, 1833; (3) Rev. William Kirby, *On the History, Habits, and Instincts of Animals*, 1833; (4) Dr. Kidd, *The Adaptation of External Nature to the Physical Condition of Man*, 1833; (5) Sir Charles Bell, *The Hand, its Mechanism and Vital Endowments, as evincing Design*, 1834; (6) Dean Buckland, *On Geology and Mineralogy*, 1836; (7) Dr. Whewell, *Astronomy and General Physics, considered with reference to Natural Theology*, 1833; (8) Dr. P. M. Roget, *Animal and Vegetable Physiology, considered with reference to Natural Theology*, 1834. These form the *Bridgewater Treatises.*

Bridgewater Canal, the first in England, runs from Manchester to Runcorn on the Mersey, with a branch to Leigh. It is carried across the Manchester Ship Canal by a swing aqueduct.

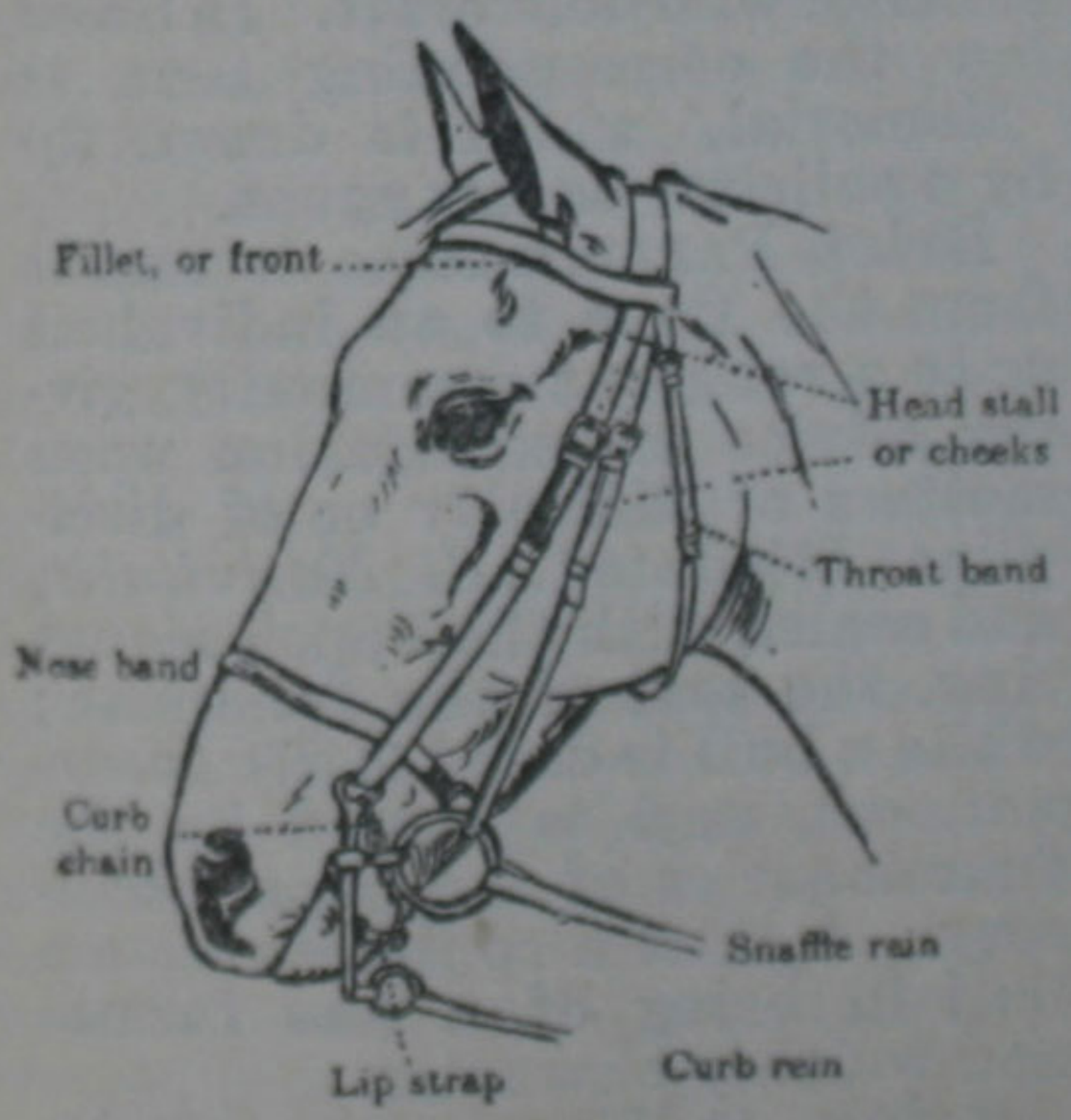
Bridgewater Treatises. See BRIDGEWATER, EIGHTH EARL OF.

Bridgman, LAURA DEWEY (1829–89), a native of Hanover, New Hampshire, U.S.A. At the age of two, as the result of an attack of fever, she lost sight, hearing, smell, and (partly) taste, and, along with these, the power of speech. From the age of eight years and onwards, under the tuition of Dr. Howe of Boston, she acquired the power of reading and speaking with her fingers; and subsequently she learned geography, history, algebra, and even acquired proficiency in needlework and household duties; while she was an adept at teaching others similarly afflicted. An exactly analogous case is that of Helen Keller, another American residing in Alabama, who, in spite of infirmities like Laura Bridgman's, has been taught English, French, German, Latin, and Greek; to speak, to write, and to typewrite. See *Life and Education of Laura Dewey Bridgman*, by Miss Lampson (1878), and *The Story of my Life*, by Miss Keller (1903).

Bridgnorth, munic. bor. and mrkt. tn., Shropshire, England, on Severn, 18 m. S.E. of Shrewsbury; has industries of carpet-weaving, worsted-spinning, tanning, and malting. Thomas Percy, author of *Reliques of Ancient English Poetry*, was born here in 1728. Pop. 6,000.

Bridgwater, munic. bor., seapt., and mrkt. tn., Somersetshire, England, on the Parret, on G.W.R., 12 m. N.N.E. of Taunton; trades with the United States, W. Indies, Canada, etc.; exports bath-bricks, earthenware, cement, and bricks. The town existed in Saxon times. Monmouth was proclaimed king in the old castle in 1685. Admiral Blake was born here in 1598. Pop. 15,000. See Powell's *Bridgwater* (1908).

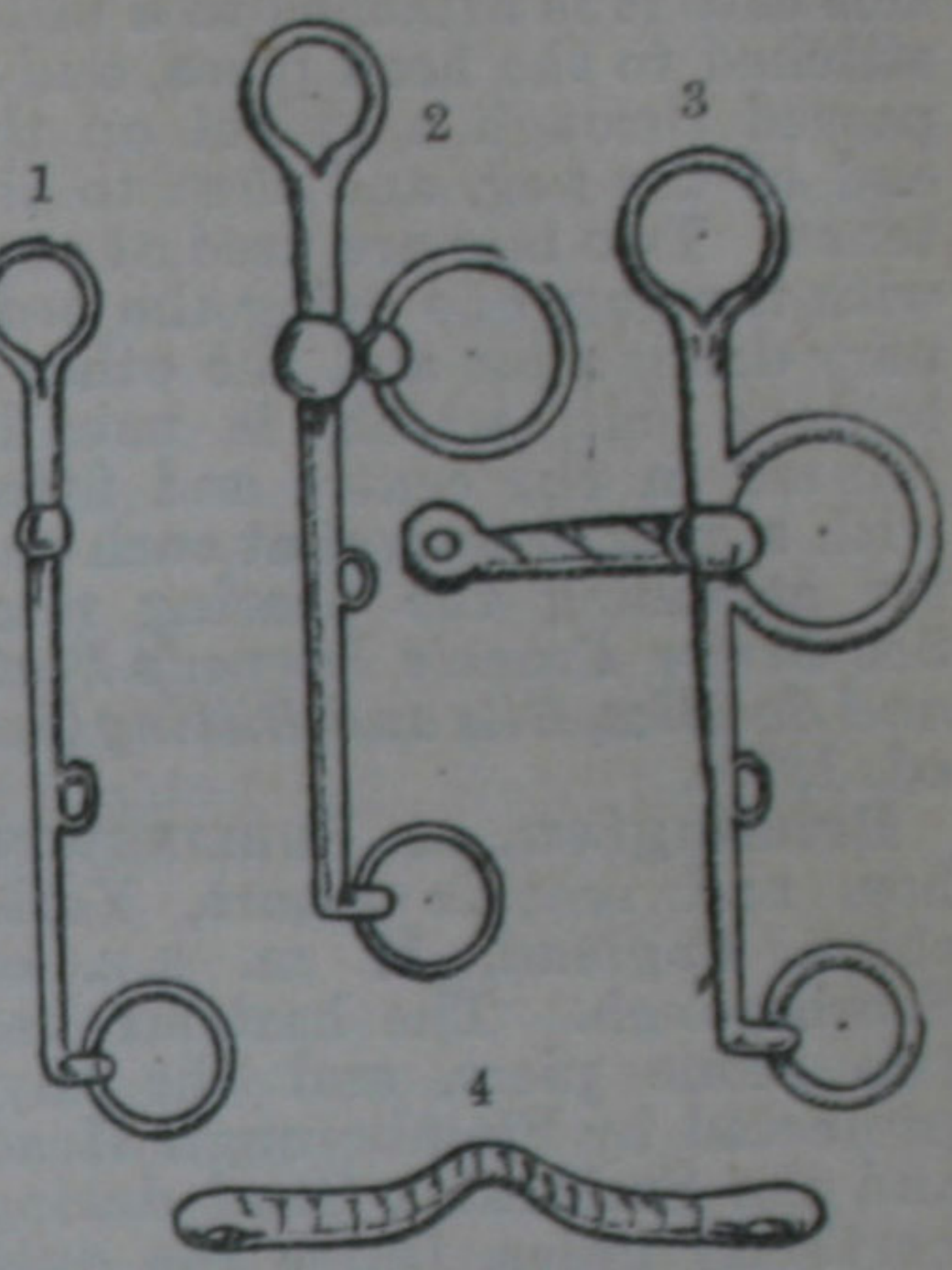
Bridle, the head harness of a horse or other beast of burden. Bridle bits are of three kinds—snaffles, curb bits, and stiff bits. The snaffle has two bars, jointed together in the middle, with rings at the ends for the reins. It sometimes has cheek pieces to prevent the ring pulling into the horse's mouth. The curb bit comprises cheek pieces or branches with eyes for the cheek straps and the reins, and holes for the curb-chain; a mouth piece, uniting the cheek pieces and forming the bit proper, sometimes a bar uniting the lower ends of the branches;



Parts of Bridle.

and a curb-chain. The elastic bit consists of a chain covered by closely-coiled wire between the bit rings. Another form of elastic bit is made of twisted wire with a soft rubber covering.

A double-ringed snaffle will suit almost any horse; and if a little



Forms of Bridle.

1. Kent Weymouth. 2. Princess Weymouth. 3. Pelham. 4. Bit, showing the 'port.'

extra power is needed, a jointed or twisted snaffle may be used. In particular cases, the sliding mouth bits and those having small ports may be resorted to; but they are frequently used when there is no need for them, and when the simple bits, if properly placed on the bridle, would be sufficient. If a bit is very tight, a horse cannot be expected to obey his driver, as it deprives the mouth of feeling.

The two most popular forms of bridle are the double or Weymouth bridle, and the Pelham bridle, a modification of the former.

Bearing reins—to which many are opposed—are used for supporting the horse's head, and in the simple form are attached to a loop in the bit, from which they are carried through a loop or

swivel attached to the throat, and then to the tenet on the pad. In its more powerful form the bearing rein is known as the gag. In this case it is attached to a billet stitched to the head piece, and is passed through a swivel on the end of the gag, and then to the tenet. Two bits are used at once with the gag, one being the ordinary driving bit and the other a bridoon bit, which is usually jointed in the centre and fitted with a ring or swivel at each end for attaching the bearing rein. See Major Francis Dwyer's *Seats and Saddles, Bits and Bitting* (3rd ed. 1879).

Bridlington, or BURLINGTON, bor. and seaside resort, Yorkshire, England, 17 m. S.E. of Scarborough. The harbour has two stone piers, and the bay, protected by Flamborough Head and the Smithwick Sand during northerly gales, forms the only safe anchorage on the east coast of Britain between Harwich and Leith. Pop. 12,000. See J. Thompson's *Hist. Sketches of Bridlington* (1821).

Bridport (656 ac.), seapt., munic. bor., and par., Dorsetshire, England, on the Brit, 18 m. W. of Dorchester; manufactures cordage, ropes, and sailcloth, and has flax mills. Pop. 5,700.

Bridport, SIR ALEXANDER HOOD, FIRST VISCOUNT (1727–1814), English admiral, son of a Devonshire clergyman, and the younger brother of Admiral Viscount Hood. He was in charge of the *Minerva* at Hawke's action in Quiberon Bay in 1759, and in the same frigate he captured the *Warwick* in 1761. In 1777 he commanded the *Robust* in the action off Ushant. In 1780 he became rear-admiral, and two years later led a division of Lord Howe's fleet to the relief of Gibraltar. He was second to Lord Howe in the victory of June 1, 1794, and for his services received an Irish peerage, as Baron Bridport. In 1795 he defeated the French off L'Orient, capturing three 74's. In 1796 he was made vice-admiral and a peer of the realm, and was placed in command of the Channel fleet on Lord Howe's retirement—a position he held till 1800. In 1801 he was further rewarded with a viscounty and the generalship of marines. By the seamen he was known as 'Lord Breadbags.'

Brief, in English law, is a memorandum of instructions, concisely expressed, drawn up by an attorney for the guidance of the barrister, containing a statement of the facts, points of law, etc., to be developed and expanded before the court, or to be used in the cross-examination of witnesses. As soon as counsel is briefed he has authority to act as his client's representative in all matters involved in the litigation. The brief is always endorsed with the title of the court and of the action, and with the names of the counsel and of the solicitor who delivers it. In Scots law the corresponding term is 'Memorial,' which is drawn up by a solicitor or law agent.

Brief, PAPAL, a state document from the Pope to an individual or to a religious community, giving advice or exhortation upon matters of difficulty or of discipline. It is dated *A die Nativitatis*, and sealed with the Pope's signet ring, the seal of the fisherman; while a bull is dated *A die Incarnationis*, and is signed by the functionaries of the papal chancery. A brief also differs from a bull in being of a less formal and weighty character.

Brieg. (1.) Town, prov. Silesia, Prussia, on high ground on the l. bk. of the Oder, 26 m. by rail S.E. of Breslau, cap. of the former duchy of Brieg (1348–1675). The castle (1544) of the former dukes, with a fine façade, is now a store-

house. The town was taken by the Prussians in 1741, and by the Bavarians in 1807. Pop. 28,000. (2.) Also called BRIG and BRIGUE, small and picturesque tn., canton Valais, Switzerland, at beginning of ascent to the Simplon Pass, and at Swiss mouth of the tunnel, 90 m. by rail E. of Lausanne, and 15 m. below the hospice on the summit of the Simplon. Alt. 2,244 ft. Pop. 2,200.

Briel, or BRIELLE, fort. seapt. tn., prov. S. Holland, Netherlands, at the mouth (s. bank) of the New Maas, and on the island of Voorne, 14 m. w. of Rotterdam. It is the birthplace of Admiral M. Tromp. Its capture by the patriotic Beggars of the Sea (Gueux) in 1572 marked the beginning of the war of independence against Spain. Pop. 4,000.

Brienne, JOHN I., COUNT OF (1148–1237), king of Jerusalem and emperor of the Latin empire of Constantinople, in 1212 became king-regent for his daughter Yolande. In 1218 he took part in the fifth crusade, led by Andrew, king of Hungary, and besieged Damietta, which capitulated in 1219. In 1225 he married his daughter to the German emperor Frederick II., with the condition that he should remain king of Jerusalem for life. But as Frederick did not observe this condition, John was driven to seek refuge at the papal court. In the quarrel between Pope Gregory IX. and the Emperor Frederick, John commanded the papal forces, but was defeated in 1229. In the same year the barons of Constantinople elected him emperor, during the minority of Baldwin II. In this capacity he defeated the united forces of the Greeks and Bulgarians (1236). See E. Georges' *Jean de Brienne* (1858).

Brienz, a considerable village in the Swiss canton of Bern, and the centre of the wood-carving industry. It is the starting-point of the railway up the Brienzer Rothhorn. Brienz is built at the N.E. extremity of the lake of the same name (11½ sq. m. in area, 1,857 ft. above the sea-level, and 853 ft. in depth), opposite Giessbach waterfall. Pop. 2,600.

Brierley, BENJAMIN (1825–96), writer and poet in the Lancashire dialect, was born at Failsworth, near Manchester. In 1863 he became sub-editor of the *Oldham Times*, and in 1864 his first story, *The Layrock of Langley-side*, appeared. In 1869 he started the publication of *Ben Brierley's Journal*, first as a monthly and then as a weekly magazine, and continued to edit it until 1891. He also published *Irkdale* (1865), *Marlocks of Merriton* (1867), *Red Windows Hall* (1867), *Ab-o'-th'-Yate in London* (1868), *Cotters of Mossburn* (1871), *Home Memories* (1886), *Cast upon the World* (1887), and *Spring Blossoms and Autumn Leaves* (1893).

Brierley Hill, eccles. par. and mrkt. tn., Staffordshire, England, on Stour R., 2 m. N.E. of Stourbridge; has coal and ironstone mines, and deposits of fireclay, which have been worked for centuries. The industries are glass-bottle-making, brick and earthenware manufacturing, chain, nail, and spade making. Pop. 12,000.

Brierly, SIR OSWALD WALTERS, (1817–94), English marine painter, born at Chester. In 1850, with the Hon. Henry Keppel, he visited New Zealand, the Society Is. and the Friendly Is., crossed the Pacific to Valparaiso, returning to England by the Strait of Magellan, and illustrated Keppel's account of the voyage. During the Crimean war he published a series of lithographs, *The English and French Fleets in the Baltic, 1854.* He took sketches for Queen Victoria of the naval review at Spithead (1856). He accompanied the

Duke of Edinburgh round the world (1867–8), and the Prince (King Edward VII.) and Princess of Wales on their tour to the Crimea, Constantinople, and Egypt (1868). After being appointed marine painter to Queen Victoria (1874), he was knighted (1885). Among his well-known works are *The Retreat of the Spanish Armada* (1871), *Drake taking the 'Capitana' to Torbay* (1872), *The Loss of the 'Revenge'* (1877), and *The Decisive Battle off Gravelines* (1881).

Briesen, tn., W. Prussia, Germany, 40 m. E. by N. of Bromberg. Pop. 7,500.

Brieux, EUGÈNE (1858), French dramatic author, born at Paris. He wrote his first play, *Bernard Palissy*, in 1879, but only became known in 1890, when his *Ménages d'Artistes* was represented at the Théâtre Libre in Paris; two years later he won even greater success with *Blanchette* at the same theatre. Since then he has produced several plays, mostly dealing with some social injustice or abuse, some of which have been interdicted by the authorities. Brieux's characters are drawn with power and dramatic effect. Among his latest pieces are *Les Bienfaiteurs* (1896); *L'Evasion* (Comédie Française, 1896); *Les Remplaçantes* (1901); *Les Avariés* (1901); *La Robe Rouge* (1900), produced at the Garrick Theatre, London (1904), as *The Arm of the Law*, which called attention to abuses (now altered) connected with the preliminary inquiry of the *juge d'instruction*, and stirred up a violent controversy; *Petite Amie* (1902); *La Couvée* (1904); *Maternité* (1904); *L'Armature* (1905); *Les Hannetons* (1906); *La Française* (1907); and *Simone* (1908).

Brig, a sailing vessel with two masts, both square-rigged. A *brigantine* or *hermaphrodite brig* has also two masts, but has square sails on the foremast only, the mainmast being fore-and-aft rigged.

Brig. See BRIEG.

Brigade, a number of military units assembled for convenience of supply and tactical control. A cavalry brigade consists of headquarters and 3 regiments, or 80 officers, 1,617 men, 1,805 horses, and 58 vehicles. A mounted brigade consists of headquarters, 2 or 1 cavalry regiments, 1 or 2 mounted infantry battalions, a horse artillery battery, an ammunition column, a transport and supply column, and a cavalry field ambulance. Its strength is, in either case, about 100 officers, 2,200 men, 2,360 horses, and 120 vehicles. By reason of its infantry, a mounted brigade is capable of especially tenacious resistance. It thus forms a solid *point d'appui* for a cavalry division. It is usually employed as protective cavalry (see CAVALRY). An infantry brigade consists of headquarters and 4 battalions, or 120 officers, 4,023 men, 311 horses, and 67 vehicles. An artillery brigade consists of headquarters and 2 batteries of horse artillery, or 3 batteries of Q.F. field or howitzer artillery; in each case with an ammunition column. (See AMMUNITION SUPPLY.) It will be noticed that cavalry and infantry brigades are not provided with supply and medical services. The reason is that their respective divisions possess sufficient to equip them should it be necessary to detach them. See DIVISION.

Brigade-major, the staff officer of the officer commanding a cavalry or infantry brigade; as a rule, a captain or major. His chief duty lies in drafting and issuing the brigadier's orders to the various commanding officers in the brigade, and he is responsible for the safe delivery of these orders. Much of his work is necessarily in the office in time of peace. On manœuvres and active

service, besides the drafting, etc., of orders, his duties include the arrangement of many details of administration.

Brigadier-general, the temporary or local rank granted to a colonel on his appointment to the command of a cavalry or infantry brigade or of the artillery of a division. He directs all brigade operations, but, within reasonable limits, gives the officers commanding his units a free hand in the training of their commands.

Brigandine (Low Lat. *brigans*, 'a light-armed soldier'), a mediæval (15th–16th century) coat of mail composed of light, thin, jointed scales, or a coat of thin, pliant plate armour. The term is also applied to a jacket quilted with iron, worn by archers in the reigns of Elizabeth and James I.

Brigands, or BANDITTI, organized bands who practise robbery, making their headquarters in fastnesses in forests or mountains. Brigandage had its origin in Greece and Italy, and soon spread to France and Germany. Perhaps the most noted brigand in history was Fra Diavolo, who played an important part in the revolution of Naples in 1799, and was received with extraordinary favour at the court of Queen Caroline. Spain, also, has been one of the happy hunting-grounds of the brigand, and in that country, as in Italy, popular sympathy has been frequently extended to the robbers rather than the robbed. Sicilian, Turkish, and Bulgarian brigands are now the most notorious. The most recent case of note was the seizure of Miss Stone, an American missionary, and Mrs. Tsilka, a Bulgarian nurse, who were captured by Macedonian brigands on Sept. 3, 1901, and kept for six months, when they were released on the payment by the American government of a ransom of 25,000 Turkish pounds. See Sir R. Church's *Chapters in an Adventurous Life in Italy and Greece* (1895). E. About's *Le Roi des Montagnes*, Moens's *English Travellers and Italian Brigands* (1866), and Macfarlane's *Lives and Exploits of Banditti* (1837).

Brigantine. See BRIG.

Briggs, CHARLES AUGUSTUS (1841), American theologian, was born in New York city. He was ordained (1870) minister of the Presbyterian church at Roselle, New Jersey; in 1874 became professor of Hebrew at Union Theological Seminary, and professor of Biblical theology, 1891-1904. In 1893 he was suspended for heresy. His works include *American Presbyterianism* (1885), *The Messianic Prophecy* (1886), *The Higher Criticism of the Hexteuch* (1893), *The Messiah of the Gospels* (1894), *New Light on the Life of Jesus* (1904), *Commentary on the Psalms* (1904–7), *Church Unity* (1909), etc.

Briggs, HENRY (1561–1630), English mathematician, was professor of geometry at Gresham College, London (1596–1619), and Savilian professor of astronomy at Oxford, in succession to the founder, Sir Henry Savile. He was among the first to recognize the importance of Napier's discovery of logarithms, and originated the use of the number 10 as the best base for tables. Chief works: *Arithmetica Logarithmica* (1624); *Trigonometrica Britannica* (1633).

Brighella, a personage in the Italian popular comedy. He is represented as a servant who is always ready to lie, to play tricks, and plot, but leaves the execution of his plots to Arlecchino, another comic character. His livery is white, with green trimmings.

Brighouse, munic. bor., incorporated in 1893 with Brighouse Rastrick and Hove Edge, on the

riv. Calder, W. Riding, Yorkshire, England, 3 m. S.E. of Halifax, with stn. on L. & Y.R. It has woollen and cotton factories, silk and wire works, flour mills, and flagstone quarries. Pop. 23,000.

Bright, SIR CHARLES TILSTON (1832–88), English telegraph engineer, was born at Wanstead, in Essex. As engineer of the Magnetic Company (1852–60) he erected lines in various parts of Great Britain, and laid (1853) the first deep-water cable between Portpatrick, Scotland, and Donaghadee, Ireland. His experiments in long-distance electric signalling resulted in the formation, with Brett and Cyrus Field, of the Atlantic Cable Company, of which Bright was appointed engineer. The first cable (1857–58), after working sixty-eight days, proved a failure. Bright subsequently laid cables in the Mediterranean, the Persian Gulf (1864), and the W. Indies (1871). He was knighted in 1858, and from 1865 to 1868 represented Greenwich in Parliament. See *Life* by his brother, E. B. Bright, and his son, Charles Bright (1898).

Bright, JOHN (1811–89), English orator and statesman, the son of Jacob Bright, a Quaker cotton spinner, was born at Greenbank, near Rochdale, in Lancashire. His friendship with Richard Cobden began over the question of national education; but it was in 1839 that they were drawn closely together, on the formation of the National Anti-Corn-Law League, when Bright began to devote himself heart and soul to the movement for the repeal of the Corn Laws, and from this time forward was the most eloquent advocate of the cause. In 1843 he was returned to the House of Commons for the city of Durham, and speedily made his mark; and at length, in 1846, Sir Robert Peel's measure for repealing the obnoxious laws was carried. Bright incurred much unpopularity for his resistance to Lord Ashley's factory legislation; he held that workmen and employers should be left free to regulate their mutual relations. In 1847 he was returned for Manchester, and again in 1852. He advocated remedial legislation for Ireland, including disestablishment of the church, free trade in land, and a liberal policy towards India.

The Crimean war found a strong opponent in Bright, and some of his finest speeches in Parliament were delivered in connection with this subject—*e.g.* that on Feb. 23, 1855. At the spring election of 1857 he lost his seat for Manchester, owing to his attitude on China and the Crimean war; but in the following August he was returned for Birmingham, and he ever afterwards remained one of its representatives.

Bright supported the bill (1858) carried by Lord Derby's government for the abolition of the E. India Company and the transfer of the government of India to the crown. In 1859–60 he was one of the principal leaders in the great reform agitation; and when the civil war broke out in the United States he ardently supported the cause of the North, though his own trade was most seriously affected by the continuance of the war. The Russell-Gladstone Reform Bill of 1866 he also supported, and when it was defeated by a combination of discontented Liberals ('Adullamites') and the Tories, he took the foremost part in the reform campaign in London, Birmingham, Leeds, Edinburgh, and Glasgow.

When Gladstone came into office in 1868, Bright accepted the presidency of the Board of Trade. He gave powerful support at all stages to the Irish Church Disestablishment Act, the Irish Land Act, and the Elementary Educa-

tion Act. Resigning office in December 1870, in consequence of ill-health, he did not appear again in Parliament until April 1872. He was appointed Chancellor of the Duchy of Lancaster in August 1873, and held this office until the resignation of the Gladstone ministry in February 1874. In 1879 he declined an invitation from President Hayes to visit the United States, where he was held in high honour. When the Liberals returned to office in May 1880, Bright again became Chancellor of the Duchy of Lancaster; but he retired from the cabinet in 1882, on the ground that he could not support the policy of his colleagues in Egypt—a policy which led to the bombardment of Alexandria. When Gladstone introduced the Home Rule Bill for Ireland in 1886, Bright separated himself with pain from his old leader and attached himself to the Liberal-Unionist party. From May 1888 Bright suffered almost continuously from illness until his death, on March 27, 1889. He was a strong, manly Englishman, fearless but just in his political contests, and with a power of simple, nervous eloquence which placed him in the front rank of parliamentary orators. See Bright's *Life and Speeches*, by G. Barnett Smith (2 vols. 1881); Robertson's *Life* (new ed. 1884); *Speeches* (published in 1866 and 1868); *Public Letters* (ed. by H. J. Leech, 1895); Vince's *John Bright* (1897); and *John Bright: A Monograph*, by R. Barry O'Brien (1910). A biography of Bright, by Mr. G. M. Trevelyan, is now in preparation.

Bright, RICHARD (1789–1858), English physician, was born at Bristol, and received his medical education in Edinburgh and London. In 1820 he settled in London. His *Reports of Medical Cases* (1827), studies in morbid anatomy, contain the first statement of the association of general dropsy and albuminuria with a morbid condition of the kidneys, and the name 'Bright's disease' has been given to non-suppurative nephritis. He was physician-extraordinary to Queen Victoria (1837).

Bright, TIMOTHY (?1551–1615), English inventor of shorthand, was presented by Queen Elizabeth to the livings of Methley (1591) and Barwick-in-Elmet (1594), both in Yorkshire. His *Treatise of Melancholie* (1586) is credited with having suggested Burton's *Anatomy*. Bright's *Characterie*, a method of 'short, swift, and secret writing' (1588), is only partly alphabetical, and therefore vastly inferior to Willis's *Stenography* (1602), which is the real forerunner of the modern systems. See *Shorthand*, May 1884; J. H. Lewis's *Hist. of Shorthand* (1815).

Bright, WILLIAM (1824–1901), canon of Christ Church, Oxford, born at Doncaster; theological tutor in Trinity College, Glenalmond (1850–9), and tutor of University College, Oxford (1859–68), when he was made regius professor of ecclesiastical history at Oxford, and canon of Christ Church. Canon Bright was a voluminous writer, his works including *Ancient Collects and Prayers* (1857), *Hist. of the Church* (1860), *Faith and Life* (1864), *Chapters of Early Eng. Church Hist.* (1878), and *Iona and other Verses* (1895). He also edited Eusebius's *Eccles. Hist.* (1872), St. Athanasius's *Against the Arians* (1873) and *Historical Writings* (1878), and St. Augustine's *Anti-Pelagian Treatises* (1880).

Brightlingsea, par. and seapt., Essex, England, on the estuary of the Colne, 10 m. S.E. of Colchester. Fishing and boat-building. Yacht crews are largely drawn from Brightlingsea and neighbouring villages. Pop. 4,500.

Brighton, formerly BRIGHTHELMSTONE, parl. (1832), munic. (1854), co. bor. (1888), and wat.-pl., Sussex, England, on English Channel, 50 m. S.E. of London, on L.B. & S.C.R. Brighton's great popularity as a fashionable resort arose from the writings of Dr. Russell in the 18th century, the discovery of a chalybeate spring, the residence of George IV., and the facilities afforded to Londoners, especially by the opening in 1841 of the L.B. & S.C.Ry. The corporation has constructed a massive sea front 3 m. long (protected against the sea by a system of groynes), the West Pier (1,115 ft.), and the New Pier (1,700 ft.). The old Chain Pier was washed away in 1896. The Royal Pavilion, a fine though bizarre structure of Oriental aspect, now the property of the corporation, was acquired in 1849 from the crown at a cost of £53,000. The Dome, formerly the royal stables, is now an assembly room accommodating 3,000 people. In connection with this property there are pleasure grounds, a library, a reading room, an art gallery, and a museum. Among other fine parks are the Preston (72 ac.) and the Queen's (17 ac.), presented to the corporation by the race stand trustees. There are well-equipped public baths; and the Aquarium, purchased in 1901, is the property of the corporation.

The munic. bor. of HOVE, or W. Brighton (1,694 ac.; pop. 38,000), adjoins Brighton, and the par. of Hove forms part of the parl. bor. Preston, to the N., has since 1873 been included in the munic. and parl. bor. of Brighton.

Brighton has always been connected with the fishing industry, and its boats still bring in large numbers of herring and mackerel. Pop. 130,000. See Sicklemore's *History of Brighton* (1827), and Melville's *Brighton* (1909).

Brighton, tn. and wat.-pl., Bourke co., Victoria, Australia, on Port Philip Bay, 8 m. S.E. of Melbourne. Pop, 10,000.

Bright's Disease. See NEPHRITIS.

Brigit, BRIDGET, or BRIDE, ST. (453–523), of Kildare, founded the church of Kildare. Her day is February 1. From the frequent references to fire in her history, it has been suggested that the saint has been partly confounded with Brigit, the old goddess of smiths. See Todd's *St. Patrick* (1844).

Brignoles, dist. tn., dep. Var, France, 36 m. by rail N.N.E. of Toulon, with mineral springs, marble quarry, and some trade in olives, wines, and fruits. It occupies a beautiful situation at an altitude of 750 ft. Pop. 4,400.

Brigue. See BRIEG.

Bril, MATTIJS (1550–84), Flemish painter, born in Antwerp, went while a youth to Rome, where he executed frescoes at the Vatican for Pope Gregory XIII. His *Jesus Healing the Paralytic* is in the Naples Museum, and his *Virgin* and *The Infant Jesus and the Two Angels* are in the Dresden Gallery.

Bril, PAULUS (1554–1626), the earliest of the great 17th century Flemish landscape painters. He went to Rome with his brother Mattijs, and created a style at once grand, simple, and poetic. Annibale Carracci occasionally painted the figures in his pictures. His works include *Martyrdom of St. Clement* (Vatican), and landscapes in most European galleries. See F. T. Kugler's *Handbook of Painting: German, Flemish, and Dutch Schools* (1879).

Brill, a fish belonging to the same genus (*Rhombus*) as the turbot, from which it is distinguished by its smooth skin, smaller size, and glistening spots. It is widely distributed in the seas of Europe, but is less prized than the turbot.

Brillat-Savarin, ANTHELME (1755–1826), French writer and magistrate, born at Belley, is known by his *Physiologie du Goût* (1825; Eng. trans. 1884, as *A Handbook of Gastronomy*), the code of gastronomers, written in a humorous vein. He resided in Switzerland and America (1793–96), and after his return became a member of the Court of Cassation.

Brilon, tn., dist. Arnsberg, prov. Westphalia, Prussia, 27 m. E. of Arnsberg; has calamine, lead, and iron mines, and makes tobacco pipes. It was for some time capital of Westphalia. Pop. 5,000.

Brimstone. See SULPHUR.

Brin, BENEDETTO (1833–98), an Italian naval engineer and administrator, was born at Turin, and after service as an engineer in the navy, he was appointed under-secretary of state to the Italian minister of marine in 1873. In 1876 he was promoted to be minister of marine, an office he held with short interruptions down to 1891, and during that time distinguished himself by the rapid manner in which he developed the Italian navy, especially by the construction of the armoured cruisers *Dandolo*, 12,265 tons (built 1878, reconstructed 1897), and the *Italia*, 15,654 tons (built 1880), both designed by himself, and the establishment of shipyards and shops for the construction of engines and munitions of war. In 1892 Brin became minister for foreign affairs, but in 1896 returned to his old position as minister of marine.

Brinckman, JOHN (1814–70), writer in Low German (Platt-Deutsch), was a schoolmaster most of his life, and wrote popular stories—*e.g. Kaspar Ohm un ik* (1854—the best edition), *Peter Lurenz bi Abukir* (1868), and *Uns' Hergot up Reisen* (1869)—and a volume of poems, *Vagel Grip* (1859). See *Life* by W. S. (1900).

Brindaban, or BINDRABAN, munic. tn. on the r. bk. of the Jumna, 6 m. N. of Muttra, United Provs., India; one of the holy cities of the Hindus, visited by large numbers of pilgrims. Pop. 22,000.

Brindisi (anc. *Brundusium*), seapt. tn. and archiepisc. see, prov. Lecce, Italy, the only really good harbour between Venice and the S.E. extremity of Italy, stands on the Adriatic, 472 m. by rail S.E. of Bologna. It acquired renewed importance after the opening of the Suez Canal, as the land terminus of the 'overland' route to India. But in 1898 the P. & O. main line steamers made Marseilles their base instead of Brindisi, though a branch line of boats for the mails still runs from the last named to Port Said. Brindisi is also the shipping port for mails to Turkey, Greece, and Albania. The harbour encloses the town with two arms, and is reached by a channel from the outer harbour, which is itself sheltered by some small islands. Vessels of 525 to 550 ft., drawing 25 ft., can now enter and turn without hindrance. The trade aggregates nearly a million sterling annually, and is about equally divided between exports (chiefly figs, wine, olive oil, coral, and silk) and imports (mostly coal). This town was an important shipping centre under the Romans, when, being the sea terminus of the Appian Way, it was the chief port for Greece (Dyrrhachium was only 70 m. distant across the Adriatic); and again in the period of the crusades. The town has a cathedral, rebuilt in 1150; a castle, built by the Emperor Frederick II., and now used as a prison; and a museum, in the ancient 11th-century baptistery of St. John. Here the Roman poet Pacuvius was born, and here

the poet Virgil died in 19 B.C. The town was besieged by Cæsar in 49 B.C., was destroyed by King Louis of Hungary in 1348, and suffered from an earthquake in 1458. Pop. 25,000.

Brindley, JAMES (1716–72), English engineer, planned (1758) a canal from Worsley to Manchester for the Duke of Bridgewater, from which dates the commencement of English inland navigation. In all he superintended the construction of over 365 miles of canal, the most important being the Grand Trunk, between the Trent and the Mersey. See Smiles's *Lives of the Engineers*, vol. i. (new ed. 1874).

Brine-shrimps (*Artemia*), small crustaceans found in the water of salt lakes, and of interest because the naturalist Schimkewitsch succeeded in transforming one so-called species into another by altering the salinity of the water. For discussions of the significance of the experiment, see *Darwinism*, by A. R. Wallace (1889), and *Materials for the Study of Variation*, by W. J. Bateson (1894).

Brink, BERNARD TEN (1841–92), philologist, born at Amsterdam, and died at Strassburg. He was successively professor of modern languages at Marburg (1870) and at Strassburg (1873), and specially distinguished himself as a student of English literature. His principal books were *Geschichte der Englischen Literatur* (1877–93; Eng. trans. 1883), and studies of Chaucer (2 vols. 1870 and 1884), Beowulf (1888), and Shakespeare (1893).

Brink, JAN TEN (1834–1901), Dutch critic and novelist, born at Appingadam; taught for a time (1860) at Batavia, Java, then (1862) at the Hague, and in 1884 became professor of Dutch literature at Leyden. In the field of criticism he wrote (in Dutch) *History of North Dutch Letters in the 19th Century* (new ed. 1902); *Talks about Modern Novels* (1884); studies of Bulwer Lytton (1873), Zola (1879), etc. Of his novels it may suffice to mention *Het verloren Kind* (1879), *De Schoonzoon van Mevrouw de Roggeveen* (1872–73), and *De Brederos* (1891). His *Literary Sketches* (Dutch) were collected in 17 vols. in 1882–8, and his *Novels* in 13 vols. in 1885.

Brinvilliers, MARIE MADELEINE DREUX D'AUBRAY, MARQUISE DE (*c.* 1630–76), French poisoner, was married to the Marquis de Brinvilliers in 1651. Conceiving a passion for a young officer, Jean Baptiste Sainte-Croix, and having learned from him the secrets of poisoning, she in 1670 poisoned her father, two brothers, and sisters. Her guilt was discovered on the sudden death of Sainte-Croix (1672). She fled, but was arrested in a convent at Liège, and beheaded and burned at Paris, July 16, 1676. See Bauplein's *La Marquise de Brinvilliers* (1871), *Lettres* of Madame de Sévigné (1818–19); Funck-Brentano's *Le Drame des Poisons* (4th ed. 1900); and Roullier's *La Marquise de Brinvilliers* (1883).

Brionian Islands, in the Adriatic, opposite to the harbour of Pola in Istria, belong to Austria. Here are the sandstone quarries whence the stone was obtained for building the palaces of Venice. Here, too, the Genoese defeated the Venetians in a naval battle in 1379.

Brioude, tn., dep. of Haute-Loire, France, 30 m. by rail N.W. of Le Puy, near riv. Allier; has an interesting church, founded in 4th century, and finished in 11th and 13th centuries. Trades in wine and corn. Pop. 4,800.

Briquette, a fuel composed of coal-dust incorporated with pitch, tar, asphalt, or other combustible cementing material. The dust is

washed, dried, and mixed with pitch in a disintegrator. The mixture is then introduced into a pugmill, in which the pitch is rendered viscid by steam; it is pressed into moulds, and allowed to cool. Briquettes are usually made in two sizes, about 10 lbs. and about 5. Other substances, such as peat, charcoal, and coke, have been used in the making of briquettes. Their heating power, however, is not equal to that of good coal, and they leave a large amount of ash. Certain kinds of iron ore have to be briquetted for smelting in the blast furnace.

Brisbane, cap. of Queensland, Australia, at the S.E. corner, about 500 m. N. of Sydney, on river of same name, 25 m. from its mouth in Moreton Bay. It is built on a series of hills, but some parts are low-lying, and have been the scene of disastrous floods. The river is navigable up to the city for ocean-going steamers. Canadian-Australian mail-boats running monthly between Sydney and Vancouver call (Brisbane to Vancouver, 20 days); the British India Line (London and Brisbane *viâ* Torres Straits) dispatches steamers at intervals. Mean temp.: summer, 75·2°; winter, 64·3°. Rainfall: average for ten years, 58 in. Among the prominent buildings are the Houses of Parliament, the Treasury Buildings, the Custom House, the General Post Office, and the R.C. Cathedral. There are fine botanic gardens, and numerous parks. Brisbane is a great trading and manufacturing centre. Preserved and frozen meats, hides and skins, wool, tallow, and pastoral produce, are the chief exports; cereals, hardware, and soft goods are the principal imports. Brisbane was founded in 1825 as a penal settlement, and was named after the then governor of New South Wales. In 1859 it was made the capital of Queensland. South Brisbane became a separate city in 1903. Pop. 30,000; including S. Brisbane and suburbs, 140,000.

SOUTH BRISBANE lies on the south side of the Brisbane R. It has an important shipping trade, and has a dry dock which can accommodate vessels up to 420 ft. in length. Pop. 26,000.

Brisbane, SIR CHARLES (?1769–1829), British rear-admiral, was a midshipman at the battle of Dominica (1782). In 1793 he was present at the occupation of Toulon, and in 1794 at the operations under Nelson in Corsica. In command of the *Arethusa*, in company with the *Anson*, he fought and destroyed the *Pomona* and several gunboats under the guns of Havana (1806). Brisbane was severely wounded. In 1807 he carried out his finest exploit—the capture of Curaçao and several Dutch vessels with a force of four frigates only. He received a K.C.B. in 1815, and attained the rank of rear-admiral in 1819.

Brisbane, SIR JAMES (1774–1826), British naval officer, a younger brother of Sir Charles Brisbane, was a midshipman in the *Queen Charlotte* at the battle of 'the glorious First of June,' 1794. In 1809, in the *Belle Poule*, he captured the *Var* under the batteries of Valona, and in 1816 commanded Lord Exmouth's flagship, the *Queen Charlotte*, at the bombardment of Algiers, and was knighted. In the first Burmese war (1825) he commanded the naval forces.

Brisbane, SIR T. MAKDOUGALL (1773–1860), astronomer and colonial governor, served in Flanders, W. Indies, and the Peninsula. Appointed governor of New South Wales (1821), he gave a rather unwise encouragement to indiscriminate immigration, and was recalled in 1825 in consequence of the confusion in the affairs of the