our power to perform the inverse operation, and to utilize the whole of the heat in doing mechanical work. Thus we see that different forms of energy are not equally valuable for conversion into work. The energy of a system should be measured by the amount of work it can do under the most favourable conditions which can be imagined, though we are not necessarily capable of realizing them. The ratio of the portion of the energy of a system which can under given conditions be converted into work to the whole amount of energy present is called the *availability* of the energy. If a system be removed from all communication with anything outside of itself, the whole amount of energy possessed by it will remain the same, but will of its own accord tend to undergo such transformations as will diminish its availability; for since work is done only when energy undergoes transformation, every change which it is allowed to undergo of its own accord deprives us of one opportunity of deriving useful work, that is, of converting a portion of the energy into the particular form we desire. This principle, known as the principle of the dissipation of energy, was first pointed out by Sir William Thomson in the *Philosophical Magazine* for April 1852, and was applied by him to some of the principal problems of cosmical physics. Though controlling all phenomena of which we have any experience, the principle of the dissipation of energy rests on a very different foundation from that of the conservation of energy; for while we can conceive of no means of circumventing the latter principle, it seems that the actions of intelligent beings are subject to the former only in consequence of the rudeness of the machinery which they have at their disposal for controlling the behaviour of those portions of matter in virtue of the relative motions or positions of which the energy with which they have to deal exists. If we have a weight capable of falling through a certain distance, we can employ the system consisting of the earth and weight to do an amount of useful work which is less than the potential energy possessed by the system only in consequence of the friction of the constraints, so that the limit of availability in this case is determined only by the friction which is unavoidable. Here we have to deal with a system with which we can grapple, and whose motions can be controlled at will. If, on the other hand, we have to deal with a system of molecules of whose motions we become conscious only by indirect means, while we know absolutely nothing either of the motions or positions of any individual molecules, it is obvious that we cannot grasp single molecules and control their movements so as to derive work from the system. All we can do, then, is to place the system under certain conditions, and be content with the amount of work which it is, as it were, willing to do under those conditions. It is well known that a greater proportion of the heat possessed by a body at a high temperature can be converted into work than in the case of an equal quantity of heat possessed by a body at a low temperature, so that the availability of heat increases with the temperature.

Clerk Maxwell supposed two compartments, A and B, to be filled with gas at the same temperature, and to be separated by a partition containing a number of trap-doors, each of which could be opened or closed without any expenditure of energy. An intelligent creature, or "demon," possessed of unlimited powers of vision, is placed in charge of each door, with instructions to open the door whenever a particle in A comes towards it with more than a certain velocity V, and to keep it closed against all particles in A moving with less than this velocity, but, on the other hand, to open the door whenever a particle in B approaches it with less than a certain velocity v, which is not greater than V, and to keep it closed against all particles in B moving with a greater velocity than this. By continuing this process every unit of mass which enters B will carry with it more energy than each unit which leaves B, and hence the temperature of the gas in B will be raised and that of the gas in A lowered, while no heat is lost and no energy expended, so that by the application of intelligence alone a portion of gas of uniform pressure and temperature may be divided into two parts, in which both the temperature and the pressure are different, and from which, therefore, work can be obtained at the expense of heat. If the gas do not liquefy, there seems no limit to the extent to which this operation may be carried, by increasing V and diminishing v, except that v cannot be made less than zero, which corresponds to the whole of the energy being abstracted from the gas in A and given to that in B. This shows that the principle of the dissipation of energy has control over the actions of those agents only whose faculties are too gross to enable them to grapple with those portions of matter in virtue of the relative motions or relative positions of which the energy exists with which they are concerned.

In April 1875 Lord Rayleigh published a paper in the *Philosophical Magazine* on "the work which may be gained during the mixing of gases." In the preface to the paper Lord Rayleigh says, "Whenever, then, two gases are allowed to mix without the performance of work, there is dissipation of energy, and an opportunity of doing work at the expense of low temperature heat has been for ever lost." He then shows that the amount of work obtainable is equal to that which can be done by the first gas in expanding into the space occupied by the second (supposed vacuous) together with that done by the second in expanding into the space occupied by the first. In the experiment imagined by Lord Rayleigh a porous diaphragm takes the place of the partition and trap-doors imagined by Clerk Maxwell, and the gases sort themselves on account of the difference in the velocities of mean square of molecules of the different gases. When the pressure on one side of the diaphragm is greater than that on the other, work may be done at the expense of heat in pushing the diaphragm, and the operation continued until the gases are uniformly diffused. There is this difference, however, between this experiment and Clerk Maxwell's, that when the gases have diffused the experiment cannot be repeated, and it is no more contrary to the dissipation of energy than is the fact that work may be derived at the expense of heat when a gas expands into a vacuum, for the working substance is not finally restored to its original condition; while Clerk Maxwell's experiment may be supposed to be continued and work obtained till the whole of the gas has been reduced to the absolute zero of temperature, and the experiment may be repeated by again heating the gas. Independently of Lord Rayleigh, Mr S. Tolver Preston, in November 1877, called attention to the work which may be done at the expense of heat during the diffusion of gases, and the bearing of this upon the dissipation of energy (see *Nature*, Nov. 8, 1877).

In these experiments the molecular energy of a gas is converted into work only in virtue of the molecules being separated into classes in which their velocities are different, and these classes then allowed to act upon one another through the intervention of a suitable heat engine. If we could carry out this subdivision into classes as far as we pleased we might transform the whole of the heat of a body into work. The availability of heat is limited only by our power of bringing those particles whose motions constitute heat in bodies to rest relatively to one another; and we have precisely similar limits to the availability of the energy due to the motion of visible and tangible bodies.

If a battery of electromotive force E maintain a current C in a conductor, and no other electromotive force exist in the circuit, the whole of the work done will be converted into heat, and the amount of work done per second will be EC. If R denote the resistance of the whole circuit, $E = CR$, and the heat generated per second is C^2R. If the current drive an electromagnetic engine, the reaction of the engine will produce an electromotive force opposing the current. Suppose the current to be thus reduced to C'. Then the work done by the battery per second will be EC' or $CC'R$, while the heat generated per second will be C'^2R, so that we have the difference $(C - C')C'R$ for the energy consumed in driving the engine. The ratio of this to the whole work done by the battery is $\frac{C-C'}{C}$, so that the efficiency is increased by diminishing C'. If we could drive the engine so fast as to reduce C' to zero, the whole of the energy of the battery would be available, no heat being produced in the wires, but the horse-power of the engine would be indefinitely small. The reason why the whole of the energy of the current is not available is that heat must always be generated in a wire in which a finite current is flowing, so that, in the case of a battery in which the whole of the energy of chemical affinity is employed in producing a current, the availability of the energy is limited only on account of the resistance of the conductors, and may be increased by diminishing this resistance. The availability of the energy of electrical separation in a charged Leyden jar is also limited only by the resistance of conductors, in virtue of which an amount of heat is necessarily produced, which is greater the less the time occupied in discharging the jar. The availability of the energy of magnetization is limited by the coercive force of the magnetized material, in virtue of which any change in the intensity of magnetization is accompanied by the production of heat.

Since the motion of the centre of mass of a system is unaffected by any actions taking place between the parts of the system, it is plain that a system considered by itself cannot be said to possess energy in virtue of the motion of its centre of mass, and in estimating the energy of the system at any instant we may therefore treat this point as fixed, and consider only motions relative to it. Thus any motion of rotation we may consider to take place about an axis through the centre of mass. Now, if a system be not acted upon by any forces from without which have a moment about this axis, the product of the angular velocity of the system and of its moment of inertia about the axis of rotation will remain unchanged. Hence if we increase the moment of inertia we shall diminish the angular velocity in the inverse ratio, and therefore diminish the energy of rotation in this ratio, since the latter is proportional to the moment of inertia and the square of the angular velocity. If, then, we have a material system moving in the most general manner possible, we shall reduce its kinetic energy to a minimum by causing such actions to take place between the parts of the system as will make its moment of inertia about the invariable line as great as possible, and then changing the relative motions of the parts in such a manner that they move as if they were rigidly connected with one another. The motion of the system will then be a simple rotation with its kinetic energy as small as possible, and the greatest amount of energy will thus have been transformed.

In all the cases we have examined there is a general tendency for other forms of energy to be transformed into heat on account of the friction of rough surfaces, the resistance of conductors, or similar causes, and thus to lose availability. In some cases, as when heat is converted into the kinetic energy of moving machinery or the potential energy of raised weights, there seems to be an ascent of energy from the less available form of heat to the more available form of mechanical energy, but when this takes place there is always, accompanying it, a quantity of heat which passes from a body at a high temperature to one at a lower temperature, thus losing availability, so that on the whole there is a degradation of energy. Thus Thomson's second law of thermodynamics, which states that "it is impossible by means of inanimate material agency to obtain work by cooling matter below the temperature of the coldest body in the neighbourhood," appears to be generally true, except when this work is obtained at the expense of some other condition of advantage, as, for example, that possessed by air at a higher pressure than the surrounding atmosphere, or by different kinds of matter which are separate and tend to diffuse, and then the work having once been obtained, the system cannot be restored to its original condition without the degradation of energy from some other source, even though the heat converted into work be restored to the working bodies.

It is sometimes important to consider the rate at which energy may be transformed into useful work, or the horse-power of the agent. It generally happens that to obtain the greatest possible amount of work from a given supply of energy, and to obtain it at the greatest rate, are conflicting interests. We have seen that the *efficiency* of an electromagnetic engine is greatest when the current is indefinitely small, and then the rate at which it works is also indefinitely small. Jacobi showed that for a given electromotive force in the battery the horse-power is greatest when the current is reduced to one-half of what it would be if the engine were at rest. A similar condition obtains in the steam-engine, in which a great rate of working necessitates the dissipation of a large amount of energy through the resistance of the steam-pipes, &c. The only way to secure a high degree of efficiency with a great horse-power in the case of the steam-engine is by increasing the section of the steam-pipes and the areas of the steam ports. The efficiency of an electromagnetic engine cannot be greater than one-half when it is working at its maximum horse-power, but we may obtain any fixed rate of working we please with a given degree of efficiency by diminishing the resistance of the battery and conductors until the maximum horse-power of the engine exceeds that at which it is to be worked by a sufficient amount. (W. G.)

ENFANTIN, BARTHÉLEMY PROSPER [LE PÈRE ENFANTIN], (1796–1864), one of the founders of Saint-Simonism, was born at Paris, February 8, 1796. He was the son of a banker of Dauphiny, and after receiving his early education at a lyceum, was sent in 1813 to the École Polytechnique. In March 1814 he was one of the band of students who, on the heights of Montmartre and Saint-Chaumont, attempted resistance to the armies of the allies then engaged in the investment of Paris. In consequence of this outbreak of patriotic enthusiasm, the school was soon after closed by Louis XVIII., and the young student was compelled to seek some other career instead of that of the soldier. He first engaged himself to a country wine-merchant, for whom he travelled in Germany, Russia, and the Netherlands. In 1821 he entered a banking-house newly established at St Petersburg, but returned two years later to Paris, where he was appointed cashier to the Caisse Hypothécaire. At the same time he became a member of the secret society of the Carbonari. In 1825 a new turn was given to his thoughts and his life by the friendship which he formed with Olinde Rodriguez, the favoured disciple of Saint-Simon. Introduced by Rodriguez to the master, who was then near his end, he ardently embraced his doctrines and schemes of social, political, and religious reformation. With Rodriguez he received the last instructions of Saint-Simon, and the two were entrusted with the propagation and development of his system. Their first step was the establishment of a journal, entitled *Le Producteur*, and of a limited liability company for its support. This journal had for its motto "The Golden Age, hitherto placed by blind tradition in the past, is before us." Enfantin contributed largely to its pages; and setting forth in it not only the doctrines of his master, but also new views of his own, he gave offence to some of his supporters, and in the course of 1826 the journal was discontinued. He had now become known, and had found influential adherents in some members of the Liberal party, among them Blanqui, Bazard, Duveyrier, Pereire, Auguste Comte, Michel Chevalier, and Pierre Leroux. Before the close of 1828 they had their public meetings and lectures, not in Paris alone, but also in many provincial towns. The revolution of July (1830) brought a new freedom to the socialist reformers, and they did not fail to avail themselves of the occasion. A proclamation was issued demanding the community of goods, the abolition of the right of inheritance, and the enfranchisement of women. Enfantin now resigned his office of cashier, and devoted himself wholly to his cause. He obtained the support of the *Globe* newspaper, made appeals to the people by systematic preaching, and organized centres of action in some of the principal cities of France. The headquarters in Paris were removed from the modest rooms in the Rue Taranne, and established in large halls near the Boulevard Italien. Bazard and Enfantin were proclaimed "Pères Suprêmes." This union of the supreme fathers, however, was only nominal. A divergence was already manifest, which rapidly increased to serious difference and dissension. Bazard had devoted himself to political reform, Enfantin to social and moral change; Bazard was organizer and governor, Enfantin was teacher and consoler; the former attracted reverence, the latter love. A hopeless antagonism arose between them in reference to the proposal of Enfantin to supersede the formula of Saint-Simon, which was in substance "the greatest good of the greatest number," by another thus worded—"To each one according to his capacity, to each capacity according to its works." The breach was widened by Enfantin's announcement of his theory of the relation of man and woman, which would substitute for the "tyranny of marriage" a system of "free love." Bazard now separated from his colleague, and in his withdrawal was followed by all those whose chief aim was philosophical and political. Enfantin thus became sole "father," and the few who were chiefly attracted by his religious pretensions and aims still adhered to him. New converts joined them, and Enfantin assumed that his followers in France numbered 40,000. He wore on his breast a badge with his title of "Père," was spoken of by his preachers as "the living law," declared, and probably believed, himself to be the chosen of God, and sent out emissaries in quest of a woman predestined to be the "female Messiah," and the mother of a new Saviour. The quest was very costly and altogether fruitless. No such woman was discoverable. Meanwhile believers in Enfantin and his new religion were multiplying in all parts of Europe. His extravagances and success at length brought down upon him the hand of the law. Public morality was in peril, and in May 1832 the halls of the new sect were closed by the Government, and the father, with some of his followers, appeared before the tribunals. He now retired to his estate at Menilmontant, near Paris, where with forty disciples he continued to carry out his views. In August of he same year he was again arrested, and on his appearance n court he desired his defence to be undertaken by two women who were with him, alleging that the matter was of special concern to women. This was of course refused. The trial occupied two days and resulted in a verdict of guilty, and a sentence of imprisonment for a year with a small fine. This prosecution was the death-blow to the new society, which soon became extinct. Enfantin was released in a few months, and then, accompanied by some of his followers, he went to Egypt. He stayed there two years, and might have entered the service of the viceroy if he would have professed himelf, as a few of his friends did, a Mahometan. On his return to France, a sadder and practically a wiser man, he settled down to very prosaic work. He became first a postmaster near Lyons, and in 1841 was appointed, through the influence of some of his friends who had risen to posts of power, member of a scientific commission on Algeria, which led him to engage in researches concerning North Africa and colonization in general. In 1845 he was appointed director of the Paris and Lyons railway. Three years later he established, in conjunction with Duveyrier, a daily journal, entitled *Le Crédit*, which was discontinued in 1850. He was afterwards attached to the administration of the railway from Lyons to the Mediterranean. Father Enfantin held fast by his ideal to the end, but he had renounced the hope of giving it a local habitation and a name in the degenerate obstinate world. His personal influence over those who associated with him was immense. "He was a man of a noble presence, with finely formed and expressive features. He was gentle and insinuating in manner, and possessed a calm, graceful, and winning delivery" (*Gent. Mag.*, Jan. 1865). His evident sincerity, his genuine enthusiasm, gave him his marvellous ascendency. Not a few of his disciples have since ranked amongst the most distinguished men of France. He died suddenly at Paris, September 1, 1864.

Amongst his works are—*Doctrine de Saint-Simon* (written in conjunction with several of his followers), published in 1830, and several times republished; *Économie politique et Politique* (1831); *Correspondance politique* (1835–1840); *Correspondance philosophique et religieuse* (1843–1845); and *La Vie éternelle passée, présente, future* (1861). A large number of articles by his hand appeared in *Le Producteur*, *L'Organisateur*, *Le Globe*, and other periodicals. He also wrote in 1832 *Le Livre Nouveau*, intended as a substitute for the Christian Scriptures, but it was not published.

ENFIELD, a market town of Middlesex, is situated ten miles N.E. of London. A large number of its inhabitants are employed in the royal small arms factory at Enfield Lock, where the rifle now manufactured, however, is not the "Enfield," but the Martini-Henry. Enfield has the remains of an ancient royal palace, in which Edward VI. kept his court, and where Elizabeth rested on her way to London in order to assume the crown. Near to it is Enfield chase, disforested in 1799 and divided between various parishes and the Crown, and now occupied by several country seats of the more opulent traders of London. The population of Enfield in 1871 was 16,054.

ENFIELD, a town of the United States, in Hartford co., Connecticut, is situated on the Connecticut river, and on the railway from Hartford to Springfield, 14 miles N. of Hartford. It is connected by a bridge with Suffield, and two miles further down the river there is a bridge by which the railroad crosses to Windsor-Locks. Enfield has a large carpet factory and extensive powder mills. It contains a community of Shakers, who are noted for their stock-raising and their culture of seeds. The population in 1870 was 6322.

ENFIELD, William (1741–1797), a dissenting divine, noted for the number and variety of his literary works, was born at Sudbury in 1741. He received his education at the dissenting academy at Daventry, under the care of Dr Ashworth, where he passed through the usual curriculum of five years. Immediately afterwards he was chosen minister of the congregation of Benn's Garden, Liverpool, in 1763. During his residence in Liverpool he published two volumes of sermons (1768–1770), as well as a collection of hymns and family prayers, which met with a very favourable reception. In 1770 he was appointed tutor and lecturer on the belles-lettres at Warrington academy, an office which he held till the dissolution of the academy in 1783. On accepting it he obtained the degree of Doctor of Laws from the university of Edinburgh. Simultaneously with his tutorial appointment he held the pastoral charge of the dissenting congregation of Warrington. After an interval of two years spent in private tuition, he was chosen pastor of the dissenting (Unitarian) congregation of Octagon Street, Norwich, where he remained till his death, which took place November 3, 1797, in the 57th year of his age. Of the works of Dr Enfield a considerable number are mere compilations, in which no higher quality is displayed than the taste which dictated the selection. To this class belong the *Preacher's Directory* (1771), the *English Preacher* (1773–4), the *Speaker* (1775), and others. The last named work, an elocutionary manual, has passed through numerous editions, and Enfield's name is better known in connection with it than through any of his other works. Among his original works, however, and especially those published or written at the close of his life, there are some that display considerable powers of thought and great elegance of expression. His posthumous sermons on the principal characters of the Old and New Testaments not only evince the author's ability as a commentator, but show profound insight into the ethics of history. In theology he was a Socinian. At the recommendation of Dr Bagot, bishop of Norwich, he published an abridgment of Brucker's *History of Philosophy*, in 2 vols. 4to. He also wrote a work, entitled the *Institutes of Natural Philosophy, Theoretical and Experimental*, 4to, 1783, besides a variety of occasional pamphlets and sermons. His last literary employment was in writing for his friend Dr John Aikin's *Biographical Dictionary*. More than half the lives in the first volume of that work are from his pen.

ENGADINE (the ancient *Vallis Eniatina* or *Œnigadena*; German *Engadin*, Italian *Engadina*), the valley of the Inn from its source to the Austrian frontier at Martinsbruck, a distance (by road) of about 65 miles. It is divided politically into two districts, the Upper and Lower Engadine, and four circles, which form part of the Gotteshausbund, one of the three leagues comprised in canton of Grisons, Switzerland,

The Upper Engadine has only one circle, whose chief village is Samaden. It consists of the valley of the Inn with its tributaries. The river flows through a long and straight trough, about 30 miles in length, and varying from a mile to half a mile in breadth, lying between lofty mountains, at a mean height of 5500 feet above the sea, being, after the Avers and Spöl valleys, the highest inhabited region of central Europe. Unlike most Alpine valleys the Engadine is closed at its head only by a low bank. The Maloya Pass (5942 feet) is hardly 100 feet above the lake of Sils. The lakes of Silvaplana and St Moritz lie at nearly the same level. Samaden (ad summum Œni) stands at the junction of the Inn and its first considerable tributary the Flatzbach. This stream drains the principal glaciers of the Bernina chain, the largest glacier group in eastern Switzerland, remarkable for its closely-clustered summits, the highest of which, Piz Bernina, attains a height of 13,294 feet. Beside the Flatzbach runs the road to the Bernina Pass (7658 feet), leading into the Val Tellina. It passes Pontresina, a village of late years much frequented in summer by travellers of all nations. Its name has been assumed to be a trace of the presence of Saracens in this part of the Alps (Pons Saracenorum). Another and more plausible derivation (Pons Rhætiæ) has been suggested.

The valley below Samaden is for some distance level and uniform, and studded with flourishing hamlets. The boundary between the two Engadines lies between Scanfs and Zernetz, in an uninhabited part of the valley.

Owing to its great elevation, the scenery of the Upper Engadine has a bleak northern aspect. Pines and larches alone flourish, garden vegetables are grown only in sunny spots, and there is no tillage. The Alpine flora, however, is very rich and varied, and the Upper Engadine has been called "a paradise for the botanist." Snow always lies low on the mountain sides, and often falls even in the valley in the month of August. Hence the climate is described in the proverb—"Nine months winter and three months cold weather." The mean annual temperature is 36·5° Fahr., that of the summer months 50·8° Fahr., of the winter 17·5° Fahr. The villages are built entirely of stone. The houses are large and roomy, a cattle stable being often included under the same roof. The small deeply-set windows bear witness to the severity of the climate. Those of the lower story are protected with iron gratings, a precaution the character of the people does not justify. An abundant use of paint and whitewash gives many of the dwellings an almost Dutch air of cleanliness, and the window-sills are usually decorated with carnations and other bright flowers.

The Lower Engadine is divided into three circles. Schuls is the chief village; next in importance is Zernetz, which stands at the junction of the Inn and Spöl. The latter stream issues from Val di Livigno, the only inhabited valley north of the Alps belonging to Italy. At this point the Inn flows for a few miles due N. through a wooded defile before resuming its N.E. course. From Suss to Finstermunz it runs in a deep channel, while the villages lie high on terraces on the mountain sides, cut off from one another by deep ravines, through which descend streams from the glaciers of the Silvretta (Silva Rhætiæ) range on the N. and from the wild dolomite ridges of the Scarlthal on the S. In the recesses of the latter bears are still found. The villages of the Lower Engadine are not so well built as those of the upper valley, and the inhabitants are said to be less energetic and more ignorant than their neighbours.

Below the village of Schuls, on the left bank of the Inn, lie the baths of Tarasp, much resorted to by North Germans. The springs to which they chiefly owe their repute are saline-alkaline in character.

One of the highroads into Italy has since early times passed through the Upper Engadine. The Romans used the Bernina Pass in conjunction with the Julier. In the Middle Ages this route was the most frequented between the Mont Cenis and the Brenner, and was chosen by travellers who wished to avoid the Milanese territory and the Spanish troops. In recent years the old mule-track over the Bernina Pass has been converted into a military road, and the internal communications of the country have been opened up on all sides. Roads have been made over the Albula, Fluela, and Ofen Passes, and the villages of the Lower Engadine, previously almost inaccessible on wheels, have been united by a good road both to the upper valley and to Tyrol.

The population of the valley at the last census (1870) was 9756, of which 8402 are Protestants and 1335 Catholics. The Catholics are found chiefly at Tarasp and in the secluded glens of Samnaun and Sampnoir on the Tyrolese frontier. The people are industrious, frugal, and alive to their own interests, and at the same time more independent in manner, and less courteous to strangers than those of central Switzerland. With the exception of Tarasp, which is mostly German, the whole district is "Romantsch." The language is a dialect known as "Ladin," nearly allied to that spoken in the Tyrolese valleys of Groden, Abtei, and Enneberg. It has a scanty literature, consisting of a translation of the Bible, some prayer and hymn books, and one newspaper, the *Fögl d'Engiadina*, printed once a week at Samaden. German is now taught in all the schools of the valley. The wealth of the inhabitants consists in their hay meadows and pastures. The lower Alps feed large herds of cows, the upper are let to Bergamasque shepherds, who travel thither every summer with their flocks. A considerable trade is also carried on in Italian products and Val Tellina wines, in which the Engadiners serve as carriers. Formerly many of them used to emigrate to different parts of the world, where they found employment, especially as pastry-cooks. Of late years the sudden influx of strangers has changed the picturesque villages into groups of hotels, and diverted the inhabitants from their former pursuits. The iron springs of St Moritz, the cause and centre of the immigration of summer visitors from all parts of Europe, have been known since the 16th century. They had been steadily resorted to by Germans and Italians since the days of Paracelsus, though it was not till the present century that any bath-house was erected for the convenience of the guests, who found sufficient accommodation in the village. The waters are highly charged with alkaline salts and carbonate of iron, with a small proportion of phosphoric acid, and traces of iodine, bromine, &c. Their influence, in combination with mountain air, is extremely beneficial in cases requiring strong tonic treatment.

See Coxe, *Travels in Switzerland*; Theobald, *Naturbilde aus den Rhätischen Alpen*; Ball, *Central Alps*; Mrs H. Freshfield, *A Summer Tour in the Grisons*; Caviezel, *Engadine*; Lechner, *Piz Languard*; Dr Burney Yeo, *A Season at St Moritz* (for medical and botanical information); *Fortnightly Review*, No. cxi., new series. (D. W. F.)

ENGEL, Johanna Jakob (1741–1802), a German writer, chiefly distinguished as a dramatist, was born at Parchim, in Mecklenburg, on the 11th September 1741. His father was a clergyman, and he himself studied for the church, though he did not enter upon the clerical profession. He studied at Rostock and Bützow, and afterwards at Leipsic, where he took his doctor's degree in 1769. In the same year he produced his first drama, *Der dankbare Sohn*, which was received with marked approval. In 1776 he was appointed professor of moral philosophy and belles-lettres in the Joachimsthal gymnasium at Berlin, and a few years later he became tutor to the Prussian crown-prince, afterwards Frederick William III. The lessons which he gave his royal pupil in ethics and politics were published in 1798, with the title *Fürstenspiegel*, and furnish a favourable specimen of his powers as a popular philosophical writer. In 1787 he was admitted a member of the Academy of Sciences of Berlin, and in the same year he became director of the royal theatre. In the latter situation he was not successful, owing chiefly to an infirmity of temper, and he resigned it in 1794. For some time he resided at Schwerin, but on the accession of his former pupil Frederick William III. to the throne he was invited to return to Berlin, and received a pension. He died while on a visit to his native place on the 28th June, 1802.

Besides numerous dramas, some of which had a considerable success, Engel was the author of several valuable works on æsthetical subjects. His *Anfangsgründe einer Theorie der Dichtungsarten* (Leipsic, 1783) was one of the earliest works on the theory of poetry produced in Germany, and showed fine taste and acute critical faculty, if it lacked the loftier qualities of imagination and true poetic insight. The same excellences and the same defects were apparent in his *Ideen zu einer Mimik* (2 vols. Leipsic, 1785) written in the form of letters. His *Philosoph für die Welt* (Leipsic, 1788) consists chiefly of dialogues on men and morals, written in an attractive style, and containing much just reflection and criticism. His last work, a romance entitled *Lorenz Stark* (Leipsic, 1795), though its plot was weak, achieved a great success, in virtue of the purity of its style, the marked individuality of its characters, and the interest of its dialogues. Engel's *Sämmtliche Schriften* were published in 12 volumes at Berlin in 1801–6, and a new edition of them appeared at Frankfort in 1857.

ENGELBRECHTSDATTER, Dorthe (1634–1716), a Norwegian poetess, who enjoyed a very wide reputation throughout Scandinavia and over Germany during the first half of the 18th century. She was born at Bergen in January 1634; her father, Engelbrecht Jörgensen, was originally rector of the high school in that city, and afterwards dean of the cathedral. In 1652 she married Ambrosius Hardenbech, a theological writer famous for his flowery funeral sermons, who succeeded her father at the cathedral, when the latter died in 1659. By the poetess Hardenbech had five sons and four daughters. In 1678 her first volume appeared, *Sjælens aandelige Sangoffer* (The Soul's Spiritual Offering of Song), published at Copenhagen. This volume of hymns and devotional pieces, very modestly brought out, had an unparalleled success, and surpassed in popularity every similar collection of that age. The fortunate poetess was invited to Denmark, and on her arrival at Copenhagen was presented at court. She was also introduced to Thomas Kingo, the father of Danish poetry, and the eminent pair greeted one another with a brace of improvised couplets, which have been preserved, and of which the poetess's reply is incomparably the neater. The next fifteen years of her life were extremely unhappy. In 1683 her husband died, and before 1698 she had buried all her nine children. In the midst of her troubles appeared her second work, the *Taareoffer* (Sacrifice of Tears), which is a continuous religious poem in four books. This was combined with the *Sangoffer*, and no less than three editions of the united works were published before her death, and many after it. In 1698 she brought out a third volume of sacred verse, *Et kristeligt Valet fra Verden* (A Christian Rejection of the World), a very tame production. In her old age she was honoured by a visit from the great poet of her time, Petter Dass, who made the laborious journey to Bergen merely to see her. She died, aged eighty-two, in 1716. The first verses of Dorthe Engelbrechtsdatter are the best; her *Sangoffer* was dedicated to Jesus, the *Taareoffer* to Queen Charlotte Amalia; the change is significant of her different position in the eyes of the world. She is, all through, a dull and tiresome writer, but her immense fame among her contemporaries, and her merit as one of the earliest writers of verse in modern Norway, give her a position in literature.

ENGHIEN, Louis-Antoine-Henri de Bourbon-Condé, Duc d' (1772–1804), was the son of Henri-Louis-Joseph, prince of Condé, and of Louise-Marie-Thérèse-Bathilde d'Orleans, and was born at Chantilly on the 2nd August 1772. He was educated privately by the Abbé Millot, and was trained in the art of war by his grandfather the prince of Condé, with whom he was present at the battle of St Omer in 1788. In 1789 he, along with the other members of his family, went into exile. In 1792 he joined the royalist forces under his father in Flanders, and on the dissolution of this army he served under his grandfather, and specially distinguished himself at the battle of Berstheim in 1793. In 1794 he was made knight of the order of St Louis, and from 1796 to 1799 he commanded the vanguard of his grandfather's forces. When these were disbanded in 1801, he contracted a private marriage with the Princess Charlotte, niece of Cardinal de Rohan, and took up his residence near Ettenheim in Baden. Being suspected of concocting a plot against Napoleon Bonaparte,

spies were placed to watch his movements, who reported, it is said falsely, that he was in the habit of making frequent secret journeys along with General Dumouriez. Bonaparte therefore thought it necessary to seize his papers, and on the 14th March 1804 caused his château to be surrounded by 400 gendarmes, who took the duke prisoner, and conducted him to Strasburg. After being brought to Paris on the 20th March, he was conducted to Vincennes, where he was tried by court martial, and without being found guilty of any definite charges, was on the morning of the 21st at four o'clock condemned to death as a traitor. Half-an-hour afterwards he was led out to execution, and as soon as he was dead he was thrown into a grave, which, in anticipation of his sentence, had been prepared beforehand. Upon Napoleon's conduct in these arbitrary proceedings various interpretations have been put, but there are scarcely materials for forming a decisive judgment. It was in reference to the execution of the Duc d'Enghien that Fouché made the remark which has passed into a proverb: "It was worse than a crime; it was a blunder." After the Restoration the remains of the duke were removed to the chapel of the castle at Vincennes.

ENGINEERING—the art of designing and constructing works—embraces a very wide range of subjects, and the different departments into which the profession is now divided do not admit of very strict definition; but it may be mentioned that *civil engineering* includes the design and construction of canals, river navigations, harbours, docks, roads, bridges, railways, lighthouses, water supply, irrigation, sewerage, gas supply, telegraphs, &c.; *mechanical engineering* includes machinery, mill-work, steam-engines, iron shipbuilding, agricultural implements, &c.; *mining engineering* includes the working and raising of coal, iron, lead, copper, &c., and other minerals; and *military engineering* includes fortifications, gunnery, artillery, telegraphy, &c., as applied in warfare.

ENGLAND

PART I.—GEOGRAPHY AND STATISTICS.

I. *Situation.—Soil and Climate.—Political and Civil Divisions.*

Situation.

ENGLAND, comprising, with Wales, the southern portion of the island of Great Britain, extends from 49° 48′ to 55° 45′ N. lat., and from 1° 45′ E. to 5° 44′ W. long., and covers an area of 58,320 square miles. It corresponds in latitude with Northern Germany and the Netherlands. In shape it is nearly triangular; and owing to its being surrounded by the sea on all sides, except for a distance of about seventy miles on the Scottish border, it has a most extensive coast-line. The seas which encircle it are the German Ocean or North Sea on the E., and the Atlantic Ocean on the W. and S., the latter receiving in some of its parts the names of the Irish or St George's Channel, and of the English Channel. The coast is much indented, more particularly on the Atlantic side, the total length, following the indentations, being estimated at over 2000 miles.

Physical structure.

There are few countries more diversified in physical structure, or in soil, climate, and natural scenery, than England. As regards physical structure, it has been truly described to be in itself "an epitome of the geology of almost the whole of Europe." Nearly all the formations of the earth's crust, from the Silurian upwards to the most recent, are to be found, in layers more or less thick, in different parts of England. The lowest geological formations, known in general as Primary or Palæozoic, are met with principally in the north and north-west of England, in the counties of Cumberland and Westmoreland, and in North Wales. The rocks of Cumberland and North Wales, belonging to the Lower Silurian formation, consist mainly of slaty and gritty strata, interbedded with various kinds of felspathic lava and volcanic ashes, accompanied by numerous bosses and dykes of greenstone, quartz-porphyry, and other igneous rocks. These latter contribute greatly to give rise to that peculiar mountainous aspect which distinguishes these districts. The next geological formation, above that of the Silurian, is found in the Old Red Sandstone, and the so-called Devonian rocks, which occupy extensive tracts in Devonshire, Cornwall, South Wales, Herefordshire, and Worcestershire. Above these strata comes the Carboniferous Limestone, composed entirely of sea-shells, encrinites, and other organic remains, which formation, stretching from South Wales through the south-west of England into Derbyshire, attains in parts a thickness of 3000 feet and more. Next above the Carboniferous Limestone come the strata, all-important to England, known as the Coal Measures, a term originally used by the miners. The beds of coal, solid basis of England's modern supremacy in arts, manufactures, and, to some extent, political power, lie upon a peculiar stratum, which generally, but not always, is of the nature of fire-clay. Coal itself is well known to consist of mineralized vegetable matter, the intermingled shales and sandstones still showing the impressions of trunks of trees, ferns, and reed-like plants, and it is supposed that this fire-clay was the original soil upon which grew the priceless treasure.

Geological changes.

The Coal Measures are covered by the Permian rocks of England, which complete the geological formation to which the name of Palæozoic or Primary strata has been given. "During the time they were forming," says Professor Ramsay, "this part of the world suffered many ups and downs, accompanied by large denudations; but at the close of the Permian period, a disturbance of the strata on the greatest scale put an end to this great Palæozoic epoch over all our area, and much more besides, and from the Permian beds downwards to the Cambrian strata a large part of what is now England was heaved up and formed dry land, to be again wasted and worn away by sea-waves and rivers, and all the common atmospheric agencies. This old land in great part consisted of what we now know as Wales, and the adjacent counties of Herefordshire, Monmouthshire, and Shropshire, of part of Devon and Cornwall, and probably the Pennine chain, and all the mountainous parts of Scotland. Around old Wales, on three sides of Cumberland, and probably all round and over great part of Devon and Cornwall, the New Red Sandstone was deposited. Part at least of this oldest of the Secondary rocks was formed of the waste of the older Palæozoic strata that had then risen above the surface of the water."

Prehistoric England.

If, in the physical structure of England, the Primary strata form a highly important element as containing the Coal Measures, the more immediate nature of the soil is determined by the Secondary and Tertiary formations. Among the Secondary strata, none are more interesting than the so-called "Wealden series" of southern England. Geologists are agreed upon the fact that the Wealden and Purbeck beds represent the delta of an immense river, equal in size to the modern Ganges or the Mississippi, the waters of which carried down to its mouth the bodies of huge reptiles and mammalia now extinct, or the semblance