THURSDAY, MAY 9, 1889.

THE ESTATE OF HER MAJESTY'S COMMISSIONERS OF 1851.

UNDER this heading the *Times* has announced that "a Sub-Committee of the Commissioners, amongst the members of which are Lord Thring, Sir Lyon Playfair, Mr. Childers, M.P., and Mr. Mundella, M.P., held a meeting on Saturday last to adopt a final report upon the disposal of this Estate which should be submitted for the approval of the Royal Commissioners themselves." The Commissioners have determined to let out a considerable part of their Estate to house builders, and the Sub-Committee had before them, on Saturday last, tenders for building leases. If the Commissioners accept these tenders, they will add some £10,000 a year to their income. This notion of sacrificing the Estate to builders of private houses has been known for some months; and, with the view of demonstrating against so short-sighted, not to say utterly immoral, a policy, a Memorial has been framed and circulated. We have received a copy of it, and, entirely acquiescing in its object, we print it *in extenso*. It runs as follows:—

To His Royal Highness the Prince of Wales, K.G., &c., &c., President of Her Majesty's Commissioners for the Exhibition of 1851.

The Memorial from the undersigned on behalf of____________ [Here fill in name of Chamber of Commerce, Corporation, Guild or Educational Institution.

SHEWETH

(1) That in the year 1851 a large surplus profit accrued after the conclusion of the Exhibition of 1851.

(2) That this surplus profit was for the most part expended by Her Majesty's Commissioners for the Exhibition of 1851 in the purchase of a considerable Estate of land at Kensington, for the erection of public institutions, and generally to benefit the country's Arts, Sciences, Manufactures, and Commerce.

(3) That various public institutions, such as the South Kensington Museum, the Training School of Science and Art, the Natural History Museum, the Royal College of Music, the Royal Albert Hall, and the Imperial Institute, have been or are in course of being built upon this Estate.

(4) That fine open spaces intervene between the various institutions, to provide for further extensions of them, and give them proper light and air.

(5) That Sir Lyon Playfair, M.P., as Secretary to Her Majesty's Commissioners, recently stated in the House of Commons that a large portion of these fine open spaces between the public institutions already named was to be leased for the erection of private houses and mansions.

(6) That, in the opinion of Your Royal Highness's Memorialists, this crowding upon the public institutions of private houses and mansions is adverse to the interests of Arts, Sciences, Manufactures, and Commerce, and foreign to the intentions of Her Majesty's Commissioners, publicly announced, when they purchased the land, and also subsequently.

(7) That, in the opinion of Your Royal Highness's Memorialists, this crowding upon the public institutions to benefit Arts, Sciences, Manufactures, and Commerce, of private houses and mansions is in confiict with the last public announcement in respect of the future of the Estate which H.R.H. the late Prince Consort made within six months of his lamented death.

Your Memorialists, therefore, respectfully pray that Your Royal Highness, as President of Her Majesty's Commissioners, will prevent the public institutions on the Estate of Her Majesty's Commissioners from being crowded upon by private houses and mansions, and will induce Her Majesty's Commissioners to preserve intact those unalloted portions of their Estate in order that they may be placed to the great public uses for which the Estate was destined by Her Majesty's Commissioners and their President, Your Royal Highness's illustrious father, the lamented Prince Consort.

The *Times*, commenting upon the effect of the Commissioners' scheme for filling up their Estate with private houses, says that "the irregular blocks of variegated private houses" will more or less overwhelm and hedge in "such National Institutions for Science and Art as the Estate may ultimately contain."

From time to time the Commissioners' various proposals for dealing with their Estate have been publicly criticized, with the useful result that such of the proposals as were in the nature of distinct departures from the original intentions set forth at the time the Estate passed into their keeping, have been modified or dropped.

Twelve years or so ago, some representatives of the original subscribers, whose aid in 1851 virtually placed a large portion of the surplus funds at the disposal of the Commissioners, urged that unallotted portions of the Estate should be sold to meet expenses in founding provincial galleries or museums for science and art. For good reasons, the Commissioners did not give way to these plausible representations. They said at that time that, under the guidance of the Prince Consort, "we purchased the estate to provide an *extensive site for the development of great institutions for the promotion of industrial art and science amongst the manufacturing population*." At this very time, and, as was stated in NATURE of May 2, p. 3, the Commissioners proposed certain conditions to the Government, under which they (the Commissioners) would raise £100,000 as a contribution towards erecting a Museum of Scientific Instruments, a Science Library, and Laboratories of Scientific Research and Instruction. This proposal, which was not entertained however by the Government of the day, contained provisions for keeping the main parts of the Estate free for the development of national institutions. The reasons for keeping the main portions of the Estate at liberty in this way have since remained every whit as strong as they were then. Indeed they are stronger than ever, in the face of Government action now being taken in respect of the "National Science Museum." But a malign influence supervened. It was but a week before Christmas last year, when Mr. G. Samuelson asked a question in the House of Commons, that Sir Lyon Playfair stated that Her Majesty's Commissioners for the Exhibition of 1851 were arranging to dispose of considerable plots of land on their Estate to house builders, in order that the Commissioners might increase their income by obtaining ground-rents from private houses, and that the Commissioners did not intend to publish their reasons for this. Is Sir Lyon Playfair's assurance in thus apparently setting public opinion at defiance to be ascribed to a sense of relief from further responsibility which he may have derived from his resignation of the secretaryship to the Commissioners?

There is no ambiguity in his statement as to the choking up of the Kensington Estate with private houses and mansions. The sites to be occupied by private houses are bounded on the north by the Albert Hall and the adjoining semicircular arcades or quadrants, on the east and west by portions of the galleries containing the Museum of Science and the India Museum, and on the south by the Imperial Institute. They form the gardens and terraces so well known to the public who flocked to the evening *al fresco* entertainments which were given in connection with the series of International Exhibitions recently held at South Kensington. The various public announcements issued by Her Majesty's Commissioners during the last thirty-five years conclusively show that this land was acquired for more useful and comprehensive purposes than those of speculative house builders.

Let us briefly refer to those announcements. On the close of the Exhibition of 1851, H.M. Commissioners found themselves the possessors of some £200,000. They were impressed with the fact that many public institutions founded to promote science and art had been "subject to the disadvantages of being placed in such a situation from the crowding of surrounding houses that they were without light or air, and had no convenient access." They therefore determined to purchase a large estate of unoccupied land, and in 1852 became the landlords of what has since been commonly known as the South Kensington Estate. For the ultimate use of this large property they proposed to trust to the "voluntary efforts of individuals, corporations, and authorities, to carry out the promotion of the different interests with which they are themselves connected." In their Report for 1856, the Commissioners, alluding to "the question of the site that has been purchased by us," show that, during the intervening years, "the great natural capabilities of the site have been properly developed by means of the construction of important lines of communication and other improvements; and that we are still occupied in taking the remaining steps requisite for perfecting the estate, and rendering it in all respects fit for the great national objects to which it is to be applied." Very shortly afterwards a large area of the Estate was leased to the Royal Horticultural Society. This was laid out as an ornamental garden surrounded by arcades and galleries. The late Prince Consort opened this garden in 1861. His Royal Highness made a speech on the occasion, in the course of which he said, "We may hope that at no distant day this garden will form the inner court of a vast quadrangle of Public Buildings rendered easily accessible by the broad roads which will surround them, Buildings where Science and Art may find space for development, with that light and air which are well-nigh banished from this overgrown metropolis." This was but six months before the death of the Prince. For some years the Prince Consort's superior policy in dealing with the Estate was respected and followed by Her Majesty's Commissioners. The Natural History Museum arose on the land at the south of the Horticultural Gardens. Galleries were built above and at the side of the long eastern and western arcades of the gardens; other galleries were erected between these gardens and the Natural History Museum. The Government secured a tenure of all these galleries as a temporary home in which the Government has placed the National Science Museum, the Collections of Historic Machinery, the India Museum, and the Collections of Modern Industrial Art. On the far north of the Estate was built the Royal Albert Hall: then followed the Royal College of Music. Later still sprang up the Technological Schools of the City and Guilds of London Institute. But with all this steady realization of the Prince Consort's far-seeing policy the Commissioners were not satisfied. Pleading necessity to find money for defraying the expenses of certain not over-wise experiments undertaken by them, they began to let land on the margins of their Estate for the erection of private dwellings. And the more prominent result of this is the beetling mass of mansions opposite Hyde Park, overshadowing the Albert Hall on one side, and frowning ominously upon the "inner court of the vast quadrangle" of the Estate. Then came the movement for an Imperial Institute. A great slice out of the "inner court" was allocated for this mysterious Institute, which is rapidly asserting its architectural entity. At this point in the development of the Estate, the Commissioners, it would seem, succumbed to the hopeless temptation of washing their hands of further trouble. And, as we have already stated, their present intention is to block up the remaining portion of the "inner court" with private houses and mansions, and thus disencumber themselves of any responsibility for institutions for science and art.

Now, an explanation, which has been offered, of this *volte face* on the part of the Commissioners is this. The subscriptions for the Imperial Institute are insufficient for its endowment. It must be remembered that the Imperial Institute is the outcome of the "Jubilee" loyalty. The possible utility of this Institute has been debated without success. To lay the foundation-stone, and to pay for a staff of subscription-touters and what not, during two years, have exhausted some £25,000 of its capital, which does not reach £300,000. The ingenuity of Lord Thring and Sir Lyon Playfair has, it is said, been accordingly taxed. Their united wits are credited with having proposed the sale to private house builders of the unallotted land as well as of portions of land already occupied by galleries containing the Science Museum and India Museum. The money thus realized, or most of it, is to go into the coffers of the Imperial Institute. Such are the statements made. If they are wrong, they should be contradicted.

Another minor incident which further exemplifies the Commissioners' attitude is the projected removal of the monument raised twenty-five years ago on their estate to commemorate the Exhibition of 1851. This monument is surmounted by a statue of H.R.H. the late Prince Consort. This too is to be swept away to make room for private houses.

WARREN DE LA RUE.

A PROMINENT and representative figure has just disappeared from scientific circles, whose absence will be deeply felt by the many eminent men with whom, for a long time, he had been associated. In the

Councils of our great Societies he was a man invaluable for his intelligence, for his persevering energy, for his promptness of resource, and for a generosity, princely, but discriminating. These words will at once suggest the regretted decease of Warren de la Rue. At the age of seventy-four, he can hardly be said to have died full of years; but assuredly Warren de la Rue died full of honours. He was almost, but happily not quite, the last of a generation or two, of men who, possessing ample pecuniary means in middle or early life, devoted the means and the life to the search for truth in Nature, each in his own line. The two Herschels, Wollaston, Babbage, Gassiot, Spottiswoode, and De la Rue are gone, and but few like to them still survive, linking us with the past. "The old order changeth;" and now the endowed and professional student of Nature is fast displacing the amateur. Nor need we altogether deplore it; for, after all, the Professor and the amateur belong to the same race of Englishmen; they have the same love of the quest for truth ardent within them; and in the case of the Professor there is now superadded the spur that comes from a sense of duty.

Warren de la Rue was born in 1815, and was the son of Mr. Thomas de la Rue, the founder of that eminent firm of manufacturing stationers in Bunhill Row who have rendered well-known services to social life by the production of numerous articles, unsurpassed in excellence in their particular craft. He first became known to the world at large by his newly-invented machine for the manufacture of envelopes, which was placed in the Great Exhibition of 1851, and formed one of the chief objects of attraction there. Not far from it lay a small photograph of the moon, taken by Bond with the Harvard refractor of 15 inches. It was comparatively, and from the circumstances of the times necessarily, but a poor performance, yet it held out the promise of future possibilities, and it certainly fired the hopes of De la Rue. It was to him what the itinerant telescope in the streets of Bath became to the elder Herschel, viz. the determining point of a future and illustrious career. Accordingly, we soon find him engaged in the construction of, what in the sequel has become, his historic reflecting telescope, having an aperture of 13 inches and a focal length of 10 feet. The mirror was figured and polished by his own hands, and the equatorial mounting of the telescope was completed in his manufactory at Bunhill Row, from his own designs. Here again our thoughts revert to the elder Herschel; but that great astronomer never approached the perfection either of the De la Rue mirror, or of the mechanism by which it was mounted and by which it was moved. It is, however, only just to say that much of this notable improvement was the natural outcome of the lapse of time and of the progress that had been made in the working of metal. The instrument was mounted in the suburbs of London, at Canonbury, in a small garden surrounded by houses. It was hither, when the day's work was done at Bunhill Row, that De la Rue retired at night; and here, by patiently waiting for a clear and serene atmosphere, an event of rare occurrence, and then only during the small hours of the morning, he finally succeeded in taking telescopic pictures of the planets Jupiter and Saturn, which it may not be too much to say remain still the equals of any subsequent delineations of the same planets. Of the Saturn picture, John Herschel was heard to say that he could die content if he could but once see the planet itself as beautifully defined. This great success at once placed him among the chief amateur practical astronomers of the day.

It was about this time that he associated himself with Owen, Quekett, Bowerbank, and others, in the formation of the Microscopical Society; and such were the keenness and exactness of his eyes and hand, that he soon became a chief referee for the performance of the wonderful microscopic objectives which then for the first time were produced by the skill of Powell and Andrew Ross.

His first essays in lunar photography were not so successful as he had anticipated: the collodion plates were deficient in rapidity, and his telescope, not being as yet provided with a clock movement, he was unable to keep the moon motionless in the field, even for the short exposure requisite to secure a photographic image. All this, however, was soon rectified. For, about the year 1857, he removed his residence and his telescope from Canonbury to Cranford, a village distant from London by some twelve miles west. There he provided his instrument with an admirable driving-clock, and applied what leisure he could get, sedulously to celestial photography; and there he secured the earliest substantial results of a method, which, at present, bids fair to revolutionize the processes of the most exact and refined astronomy. The photographs of the moon which he now obtained still remain works of art, which even the most skilful of recent astronomers find it difficult to emulate with success. He also made many attempts to photograph the solar disk; but owing to mechanical difficulties, connected with the necessarily infinitesimal duration of the exposure of the plates, his success was not great. He had hoped that, by treating the photographs stereoscopically, he might decide the true nature of sun-spots in respect of their being depressions or the reverse; but, although the evidence seemed greatly in favour of depression, the question can hardly be considered as photographically settled. His efforts in this direction ended in the construction of a small telescope for the Royal Society, with an object-glass of 3½ inches aperture properly corrected; and, with this photo-heliograph, numberless pictures of the sun were successfully taken at the Kew Observatory. This instrument has proved the parent of many others established in various parts of the world, so that at present scarcely a day passes without a record of the condition of the sun's disk. The arrangements for these observations of sun-spots are now constituted under the advice of the Solar Committee at South Kensington, and in due time no doubt important facts will be brought to light. All this is traceable to the little inconspicuous photograph deposited not far from the envelope machine in 1851; and in this way De la Rue became, and will ever be remembered as, the Father of Lunar and Solar Photography.

In 1860, De la Rue took this photo-heliograph with him on board the *Himalaya*, in connection with the memorable expedition to the Spanish Pyrenees, for the purpose of observing the total eclipse of the sun. He posted himself, with his whole battery of implements, at Riva Bellosa, in the valley of the Ebro, not far from Vittoria. He was successful in obtaining several photographs of the eclipse during its totality, which gave the promise of settling, once for all, the hitherto much-mooted question as to whether the red prominences belonged to the sun, or were attributable to a different origin. On his return home he devised a micrometer for the due measurement of these remarkable phenomena, and in conjunction with other photographs taken by Padre Secchi, at a station some 250 miles distant from Riva Bellosa, he succeeded in allocating these singular fiery prominences beyond question, in the gaseous envelope which surrounds the sun. The results of his researches were embodied in the Bakerian Lecture delivered before the Royal Society in 1862. Perhaps it is not too much to say that these efforts laid the foundation of that wonderful structure of solar physics which is daily enlarging our knowledge of the true nature of the sidereal universe.

In 1873 the Observatory at Cranford was dismantled, on the occasion of De la Rue's removal from his comparative seclusion there to his residence in London. The reflector, with all its numerous and valuable accessories, was presented to the University of Oxford, and by this noble gift it was enabled at length to establish an efficient Astronomical Observatory at a place of learning where Halley and Bradley had flourished and taught nearly two centuries before. The instrument was erected in completeness at De la Rue's sole expense, and for several years he defrayed the cost of the additional assistant necessary for its utilization.

Oxford has at no time been backward in acknowledging with gratitude all efficient services rendered in behalf of the studies of the place. Accordingly, on De la Rue was conferred the rare honour of the full degree of M.A., by which he became a member of Convocation, while New College also incorporated him among her Society of Wykehamists, and made him a member of their common room.

We have occasion to know that it was a source of gratification to De la Rue to feel assured that his generous gift was utilized to the full by his old friend the present Professor of Astronomy, and specially in the direction which himself had inaugurated. Moreover, when a few months ago he saw the marvellous results produced by Mr. Roberts in his photographic pictures of nebulæ, secured by a four hours' exposure, he gave directions for the additional mechanism requisite for the production, as he hoped and believed, of similar pictures by his own now ancient instrument. Such is the solidity of the original mounting, that at this moment it is finally placed on a par, in respect of accurate movement, with any known instrument; but he did not live long enough to watch the progress of the experiment. Nor does this end the catalogue of his gifts to the University. When he heard of the projected scheme inaugurated by Admiral Mouchez, the Director of the Paris Observatory, for completing a photographic chart of the entire sidereal heavens, he placed a considerable sum of money in the hands of the Vice-Chancellor in order to defray the cost of the large photographic telescope necessary for taking a part in this great enterprise. The University of Oxford is not an ephemeral institution, and De la Rue's acts of generosity will remain inscribed upon her annals.

While he was thus watching with intense interest the uses made at Oxford of the work of his renovated instrument, he was himself engaged in a new enterprise of his own. Whether the recollection of what his friend Gassiot had done some twelve years before at Clapham—how, when he returned from his City work in the early evening, he retreated down to his laboratory, furnished at incredible labour and expense, and there tried to investigate the nature and origin of the electric discharge, and especially the strangely beautiful luminous striæ observed in tubes partially exhausted, visited now and then, while at work, by Faraday and other kindred spirits—whether or not this may have been the inducing cause, certain it is that De la Rue became fascinated by the same phenomena, and enamoured with the same pursuit. Possibly through a like scientific contagion, Spottiswoode also, in due course of time, endeavoured to wrest the same secret from Nature's hands. For years these three men worked and persevered in hope. None of them wholly succeeded, and yet none of them wholly failed; each and all left finger-posts to guide some future and more fortunate research.

The space which can be here afforded to the memoir even of an illustrious man precludes more than a passing allusion to the honours and social distinctions which always accompany the efforts of a life such as Warren de la Rue's; and upon him they were accumulated in abundance. The abiding honour lies in the contemplation of the man. A career like his dignifies the daily life of a manufacturer, giving it an aim and an object apart from the accumulation of wealth; it humanizes, warms, and illuminates the absorbing abstraction of the solitary student; and it illustrates the fact of an Aristocracy of Nature.

THE PHILOSOPHY OF MYSTICISM.

The Philosophy of Mysticism. By Carl du Prel, Dr. Phil. Translated from the German by C. C. Massey. 2 Vols. (London: George Redway, 1889.)

WE own to a certain mistrust when we are asked to accept goods under a trade-mark of mysticism; just as we have a most Levitical desire to pass by on the other side when we encounter the latest lucubrations of the circle-squarer, the absolute harmony of Genesis and geology, or when the last new theory of the soul is extended before us, "All Danaë to the stars." Now the philosophy of mysticism contains the latest of soul theories, or rather it is an old theory—a very old theory indeed—which has been newly adapted and furbished up and fitted with the very latest adjuncts which the outskirts of modern science can supply, so that it is to all intents and purposes just as good as if it were altogether new and original. Do not let us be misunderstood: both author and translator act in the strictest good faith. There is no false pretence about the matter. The whole work is perfectly ingenuous. The antiquity of the central idea is not in dispute, but it is claimed for the author that he has essentially modified our conception of that idea, that he presents his matter from a new stand-point, which is enough in all conscience nowadays, and that he is the first to show, by systematic analysis and comparison, that somnambulism and its cognate states are not essentially abnormal or morbid, but are in truth a mere exaltation of ordinary sleep, that the faculties evinced in those states are incipiently manifested also in dream, and are even indicated, though still more indefinitely, in waking life. It is contended that in this way the whole dream-life is reclaimed from its presumed worthlessness for scientific and philosophical purposes.

A duality of person with a unity of essence is the theory which commends itself to Baron du Prel, and he has worked out with much skill and acumen the details of an hypothesis to which his evident earnestness induces us to accord a hearing even when we are compelled to dissent from his conclusions. This hypothesis will have none of science, falsely so called; it sets at nought the accepted views of the physiologist and the materialist, and is a new, if nebulous, gospel of transcendental existence and apparently limitless progression. Man's life is moulded by his conception of his relation to the world, and that conception the present work is to radically revise. Who can tell if in the twentieth century the acceptance of these mystical views may not transform the present eager, struggling, money-grubbing crowd into a fraternity of peaceful philosophers finding in the placid pleasures of catalepsy an efficient substitute for the excitement of a boom in copper and for the fevered gambling of the Stock Exchange?

The author is very hard in his strictures upon the feeble physiologist, the wicked materialist, and indeed upon the modern professors of science generally, whom he abandons to their "exact amusements," whilst he seeks "the true theory in the bare analysis of the process which takes place in memory," and it is really wonderful what a superstructure he raises on the basis of that analysis. His preliminary dig at contemporary men of science he follows up with cuts and thrusts at intervals, but his salient grievance is that one and all fail to conceive progress otherwise than on their existing plane, whereas true progress must be inevitably vertical. With the advent of experimental methods, we learn, the world of science believed itself to have discovered a means for the attainment of all available knowledge, but the belief is erroneous. Not only is science still very far from its goal, but with the completion of its existing tasks, new prospects will be opened in the vertical direction. Should science succeed in explaining the whole visible world, that explanation is only as to a *represented* universe, a secondary phenomenon, a mere product of our sense and understanding, leaving the true world untouched. The quality of our consciousness in its relation to that world has still to be considered, and by such a method alone can its true nature be in any degree discovered. The visible world undergoes qualitative changes in the generation of consciousness, for, since the vibration of ether is in consciousness light and atmospheric vibration sound, it is evident that we are not truly cognizant of things, but only of the modes in which our senses react upon them. Taking all which and much more besides into consideration, the author sums up the result of human thought on the world-problem by saying that "consciousness does not exhaust its object, the world," a remark somewhat analogous to that of the Danish prince who observed that "there are more things in heaven and earth than are dreamt of in our philosophy."

As the world is the object of consciousness, so is the *Ego* that of self-consciousness; and here, says the Baron, materialism still flatters itself with the hope of reducing all psychology to physiology. It is deceived: self-consciousness does not exhaust its object, but is as inadequate to the *Ego* as consciousness is to the world, and the *Ego* may as much exceed self-consciousness as consciousness is exceeded by the world. The degree of the excess, is, however, not absolutely constant, since, by the rise of consciousness in the biological process, the boundary between the conscious and transcendental worlds has been and will be continually displaced. Of being, other than representation, we know nothing, and spirit is the primary and the real, for were its perceptive faculty changed, the whole material world of representation would be transformed; a clear demonstration that the represented world is a mere creature of the spirit. Behind consciousness is the ultimate being of which that consciousness is but the reflection, and as this ultimate being is beyond consciousness the Baron terms it the unconscious. This unconscious may either lie immediately behind the physically conditioned consciousness, or may be so indefinitely removed as to allow of an intermediate root of conscious individuality which is only relatively unconscious for the organism of sense. The author finds such an intermediary in his so-called psychophysical threshold of sensibility, which is the shifting barrier between the unconscious and self-consciousness. He conceives a dualism of consciousness, the division of two "persons" in one subject, but his conception differs from the popular conception of the dualism of soul and body, of matter and spirit, of Nature and supernatural. This dualism of consciousness is, with him, an intelligence which emerges with clearness and power just in proportion to the cessation of the organic functions with which the consciousness of waking life is associated; the two halves of our consciousness, divided by the movable threshold of sensibility, forming the subject which is an organizing as well as a thinking principle. The hypothesis of transcendental individuality co-existent with the earthly life and constructive of the organism by which consciousness is (from the earthly stand-point) dualized, necessitates the doctrine of pre-existence. Transcendental individuality implies a distinction from personal consciousness, and that the soul is not wholly plunged in the successive bodies which it constructs; the personal consciousness with its *Ego* being the mere partial and temporary limitation of a larger self, the growth of many seasons of earthly life.

The state of the individual after death is not precisely defined, but is suggested by the similitude of the smaller of two concentric circles expanding to the larger; the circumference of the inner circle being the organic threshold of sensibility, which death removes altogether, as it is already partially removed in such analogous states as sleep, somnambulism, &c. As in preoccupation the mind is concentrated to a focus, and subsequently expands to the limits of consciousness, so is earthly consciousness in death expanded to the boundary limits of the true *Ego*.

Transcendental subjectivity provides for continuity of consciousness, but the experience and whole activity of one of our objective life-times will be assimilated for results independent of those proposed by the contracted *Ego*, which bear but a minute proportion to the gradually accumulated content of the whole individual. The personal *Ego* must be brought to the point of view of the transcendental subject to which the mere happiness of that *Ego* is indifferent. What to us as persons are but high ideal motives may be alone of interest to the larger self which only maintains the organic personality for its own purposes. Such is Mr. Massey's analysis of the master's views, and it must be obvious that on this showing matters are decidedly in favour of the higher *Ego* which has, so to speak, got it all its own way. But since that exalted essence is, according to its moral nature, a product of development, the greater morality is not always on its side, for were that the case, terrestrial existence would have no educational value, and it is comfortable, therefore, to learn that our moral consciousness in earth-life can erect itself against its larger self, and may thus enrich the latter by the moral fruits of mundane existence; the struggle which takes place between the divisions of the subject being analogous to the process of Nature in its endeavour to expel disease, and drive whatever is morbid in an organism to the surface, or, to put it baldly, a species of spiritual measles. Such a theory, it is contended, fits the progress of the individual into the progress of the race, avoiding the waste of energy involved in the conception that the former is sacrificed to the latter, and supplies a wondrous harmony in which pessimism is subordinated to optimism.

The author is erudite, and he hails from the Fatherland; it is therefore not a matter for surprise that somewhat Shandean theories are exposed in sentences of wondrous construction. With these Mr. Massey has manfully wrestled; but, in his commendable desire to play the part of a faithful translator, he has at times given us such specimens of Teutonic English "as she is wrote" as render the good Baron's mysticism ten times more mysterious. We have read and re-read a passage, and a dozen perusals have left us still in doubt whether the meaning which the author and translator intended to convey were really grasped. Fidelity may be carried too far. At other times he who runs may read, and the author expresses his sentiments with an ingenuous frankness, as when he writes that "every criticism will be welcome which is adapted to advance the subject and myself."

Assuming that we have mastered the Baron's theory, an assumption we hesitate to make, we may place it before such of our readers as prefer à crude simile to the technicalities of metaphysics, in an illustration derived from natural history. Those who have visited the rock-pools of our coasts must have noticed the amusing little hermit crab (*Pagurus bernhardus*), who ensconces his soft unarmoured tail in the temporary shelter of an empty shell. He wriggles into his self-chosen habitation, and holds on to it with the pinchers with which his tail is provided, until he voluntarily leaves it before the approach of death. The hermit crab is the unconscious whole whose tail is tucked into the shell of self-conscious existence. As he emerges from it, or retires more completely, the amount of crab within the shell varies, the threshold of sensibility is shifted, and the shell benefits or suffers accordingly. The development of the moral nature of the subject, and its fitness for higher re-incarnation, are likewise shadowed forth in the fattening of the crab's tail, and his search for a roomy whelk-shell in place of the restricted covering of the modest periwinkle. Or, once again, the threshold of sensibility may be likened to the lid of the box from which the Jack of memory leaps, and upon the closure of which forgetfulness ensues.

It may be readily imagined that the author does not ask us to accept his theories unproven, and he has collected a mass of curious information from the most varied sources. Some of his anecdotes are oases of entertainment, which will, we fear, be missed by readers who do not, as we have done, peruse the volumes from cover to cover. As instances of our meaning, we may cite the case of a weak-minded youth upon whom all instruction in languages and science was thrown away, but who, after a fall on the head, became distinctly clever, intellectual, and highly cultivated, quickly seizing what he had been taught in vain before—a demonstration of the value of a box on the ears in the case of a stupid boy; the girl who, in her waking life, was reminded of her self-imposed somnambulistic treatment by the vision of a squirt; the military author who entered the barracks to take charge of the watch, in obedience to a dreamed order which he conceived to be a reality (had the case been one of neglect of a real order which he believed himself to have dreamt, we fear the court-martial would not have admitted the plea); or the wife who, subject to conditions of alternating consciousness, resented the presence of her husband, whom she treated with maidenly reserve. To prove the existence of a transcendental measure of time which is totally different from the normal, we are told of a flea-bite which occasioned a dream, concluding with a stab in the part of the body upon which the insect operated; of a pinch on the thigh, which caused the sleeper to imagine himself bitten by a wild beast; of De Quincey's opium dreams, which appeared to him to extend over vast periods of time; and of Mahomet, who, having knocked over a pitcher of water when translated by the Archangel Gabriel, viewed all things in heaven and hell, and held ninety thousand conferences with the Deity, returning to his still warm couch before the contents of the pitcher were expended. A somnambulistic girl exclaimed, "Where am I? I am not at home in the head. There is a strange struggle between the pit of the stomach and the head; both would prevail, both see and feel." So you see that "transcendental physiological functions seem to be parallel with corresponding changes in the ganglionic system." Authorities jostle in kaleidoscopic confusion; the "Novum Organum" standing cheek by jowl with the Bhagavadgita and the Vedas; whilst Aristotle and Proctor, Plato and Mrs. Crowe, Habakkuk, Galen, Plotinus, L. Oliphant, Daniel, Darwin, Kant, Olcott, and scores of others, jostle each other in ill-assorted series, but each with his contribution to the mosaic of marvels. On such a catena of evidence are based the two volumes; and, in spite of their waywardness, there is a thread of argument running through them which it would be unfair to the author to sunder by attempting an imperfect *précis* of his work, had we even the heart to impose it upon our readers. It has been said that, sooner or later, all books come into the hands of those for whom they were written, and there is no special reason for an exception in this case because the evidence for what is really a very beautiful theory fails to carry conviction to us. Doubtless our "threshold of sensibility" has gone wrong in some unaccountable way, and we have not enough of the Subject on this side of it to estimate the pearls of transcendentalism at their true worth. To the true adept, the work will doubtless prove wholly acceptable, and the author may take comfort in the reflection that "on this globe we serve an end, the attainment of which cannot be hindered, though all mankind conspired against it."

OUR BOOK SHELF.

A Treatise on Chemistry. By Sir H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. Vol. III. The Chemistry of the Hydrocarbons and their Derivatives; or, Organic Chemistry. Part V. (London: Macmillan and Co., 1889.)

THE present and fifth part of the "Treatise on Organic Chemistry" is devoted to an account of the benzenoid compounds containing eight or more than eight atoms of carbon, and brings the subject down to the group of the terpenes and camphors, including india-rubber and gutta-percha.

The various compounds are, as the title of the work denotes, grouped about the hydrocarbons from which they are derived. Thus we have the styrolene group, the cumene group, the cymene group, and so on.

The present instalment of the work also describes numerous instances of the interesting class of benzenoid compounds containing closed lateral chains in the ortho-position, *i.e.* with the two ends of the chain attached to carbon atoms which in their turn are directly united with one another. Such compounds are, for example, the indoles, the indazoles, isatin, carbostyril, and coumarin.

The subject of closed-chain compounds has of late years possessed a peculiar fascination for organic chemists, and the reason of this is not far to seek; for, apart from the fact that many of the closed-chain derivatives of benzene, such as coumarin, isatin, and indole, either occur in nature or are the immediate derivatives of naturally occurring compounds, many chemists believe that various important problems in chemical statics may ultimately be solved by the study of these compounds. At present chemists do not altogether know why, for example, closed lateral chains of carbon atoms should occur only in the ortho-position, and never in the meta- or para-position; why such closed lateral chains never contain less than five or more than six carbon atoms; and why it has never been found possible to unite any single polyad atom to two contiguous (ortho) carbon atoms in benzene, whilst in paraffinoid compounds such a union may be effected. But when these questions have been answered, something will be known concerning the local distribution of the affinities of the ultimate atoms; and meanwhile the ingenious hypothesis of Van 't Hoff with regard to the position of the affinities in the carbon atom is a step in the right direction, and affords what is possibly more than a merely provisional answer.

The authors have also given a very full account of Wallach's interesting researches on the terpenes, and here, as elsewhere, the information is thoroughly up to date.

The instructive historical introductions prefixed to the descriptions of important compounds and groups of compounds, referred to in our notices of previous portions of the work, are continued.

Solutions of the Examples in a Treatise on Algebra. By Charles Smith, M.A. (London: Macmillan, 1889.)

THE value of such a book is great both to teachers and students. The former, as we have often pointed out, have scant leisure for working out the more elaborate questions which nowadays have place even in elementary treatises, or scarcely care to refer to their notes, which are never, unless they are exceptionally methodical men, to be found when wanted; the latter are, by means of such a work as the one before us, in a great measure rendered independent of outside aid. Though Mr. Smith's solutions are marvels of compressed diction in many cases, they yet are, we can certify from an extended examination of all parts of the subject, expressed with all the clearness required. In a few cases two solutions are given; this is an advantage, for often we have found the second solution very suggestive. We have, then, here an excellent corpus of solutions of questions, which have been considered by many competent judges to be well arranged and well calculated to draw out a student's powers in this part of mathematics. We have come across a few typographical errors (there is one on the last page), but they are in most cases easily detected on following out the solution.

Applied Mechanics. By D. A. Low. (London: Blackie and Son, 1889.)

THIS is an excellent little text-book, treating of those parts of the subject which the Science and Art Department require for the elementary stage. There are, however, specially marked articles which may be read by advanced students.

The author has taken, as the ground-work of the book, the notes which he has used for many years in his classes with much success. Much care has been taken with those pages relating to mechanism. The diagrams are especially good, and the descriptive portions accompanying them are clear and concise. A striking and most useful feature will be found in the unusually large number of examples following each chapter, typical examples also being worked out between the articles.

The last half-dozen chapters are devoted to the nature, use, and strength of materials used for purposes of construction, and the different kinds of stress to which they may be subjected. The syllabus issued by the Department for teachers in this subject, followed by the examination papers of recent years, is appended. The book is one which can be recommended, and will no doubt be well received by teachers and students alike. G. A. B.

Northern Afghanistan. By Major C. E. Yate, C.S.I., C.M.G. (Edinburgh and London: Blackwood, 1888.)

IN this volume the author has brought together a number of letters written from the Afghan Boundary Commission, and he explains that they are now published in a connected form as a sequel to his brother Captain A. C. Yate's book, entitled "England and Russia Face to Face in Asia." A large part of the work relates chiefly to matters of political interest; but there are also excellent descriptions of the various places which Major Yate visited, and of the people with whom he came in contact. His account of Herat and the shrines in the neighbourhood is particularly good; and Balkh, of which he gives a plan, he depicts concisely and clearly. Of the desert from Andkhui to the Oxus he says it is about as hot and wretched a country as he ever saw. In this desert, wherever a few inches of mud and water were left, he used to see the white-breasted pintail sand-grouse coming to drink in small numbers; but with that exception he saw no sign of game. Lizards of all sizes and colours were to be seen. A lizard, some 2 or 3 feet long—"of a yellowish colour with red stripes"—seems to have especially attracted Major Yate's attention. This animal "never tries to run away, but stands and hisses, distending its stomach to an abnormal size." The dog hates it cordially; and very naturally, for, when the dog is approaching to the attack in front, "the lizard suddenly brings his tail round and gives the unwary dog a most tremendous wipe across the side of the head." "The first interview between a dog and one of these animals is very amusing—the dog is always so utterly astonished at this unexpected attack on the lizard's part, and also so hopelessly wroth." We may note that in a pocket at the end of the volume there are two maps—a map of the north-west frontier of Afghanistan, and a sketch-map showing the routes traversed by the Boundary Commission during 1884, 1885, and 1886.

By Leafy Ways. By Francis A. Knight. (London: Elliot Stock, 1889.)

THIS volume is made up of "brief studies," which originally appeared as articles in the *Daily News*. The author's object is not to present scientific conclusions about Nature, but to convey some idea of the impressions which have been produced upon him by various elements of the external world. He is an ardent lover of everything in Nature that appeals to what may be called the artistic sense; and he has the secret of suggesting, by means of brief and simple descriptions, very vivid pictures of scenes in which he himself has found delight. No one who wants to be intellectually instructed should trouble himself to read the volume; but it will give much pleasure to persons who like to be reminded of some of the innumerable aspects in which the country reveals itself to sympathetic observers. The volume is prettily illustrated by E. T. Compton.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On an Electro-magnetic Interpretation of Turbulent Liquid Motion.

THE equations of rate of increase of momentum F, components X, Y, Z, per unit volume of a liquid (density = 1) are—

$$X = \frac{du}{dt} + u\frac{du}{dx} + v\frac{du}{dy} + w\frac{du}{dz} + \frac{dp}{dx},$$

and corresponding terms for Y and Z. If the liquid be incompressible,

$$\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} = 0.$$

Mulip ying this by u, and adding to X, we get—

$$X = \frac{du}{dt} + \frac{d}{dx}(u^2) + \frac{d}{dy}(uv) + \frac{d}{dz}(uw) + \frac{dp}{dx},$$

and similar ones for Y and Z.

It is at once obvious that these could be written down at once, for u^2, uv, and uw are the momenta per second carried into the element through its faces as in the kinetic theory of gases; and it is evident that the equation is the same as for a strained solid where these are the superficial normal and tangential forces.

If we now take the average values of these throughout any small region, and write for the average of $\frac{du^2}{dx} = \frac{\overline{du^2}}{dx}$, we have—

$$\overline{X} = \frac{du}{dt} + \frac{\overline{du^2}}{dx} + \frac{\overline{duv}}{dy} + \frac{\overline{duw}}{dz} + \frac{dp}{dx}.$$

Comparing this with Maxwell's stress in the ether, we must take ("Electricity and Magnetism," vol. i. § 105)—

$$\frac{\overline{du^2}}{dx} = \frac{d}{dx}\cdot\left(\frac{d\psi}{dx}\right)^2 - \frac{d}{dx}(Q^2 + R^2 - P^2) - \frac{d}{dx}(\beta^2 + \gamma^2 - \alpha^2),$$

$$\frac{\overline{duv}}{dy} = \frac{d}{dy}\left(\frac{d\psi}{dx}\cdot\frac{d\psi}{dy}\right) + \frac{d}{dy}PQ + \frac{d}{dy}\cdot\alpha\beta,$$

$$\frac{\overline{duw}}{dz} = \frac{d}{dz}\left(\frac{d\psi}{dx}\cdot\frac{d\psi}{dz}\right) + \frac{d}{dz}PR + \frac{d}{dz}\cdot\alpha\gamma;$$

adding these together, and comparing with the equation for X, we get—

$$\overline{X} - \frac{\overline{du}}{dt} - \frac{dp}{dx}$$

$$= \tfrac{1}{2}\frac{d}{dx}\left\{\left(\frac{d\psi}{dx}\right)^2 + \left(\frac{d\psi}{dy}\right)^2 + \left(\frac{d\psi}{dz}\right)^2\right\} + \frac{d\psi}{dx}\left\{\frac{d^2\psi}{dx^2} + \frac{d^2\psi}{dy^2} + \frac{d^2\psi}{az^2}\right\}$$

$$+ P\left(\frac{dP}{dx} + \frac{dQ}{dy} + \frac{dR}{dz}\right) - Q\left(\frac{dQ}{dx} - \frac{dP}{dy}\right) + R\left(\frac{dP}{dz} + \frac{dR}{dx}\right)$$

$$+ \alpha\left(\frac{d\alpha}{dx} + \frac{d\beta}{dy} + \frac{d\gamma}{az}\right) - \beta\left(\frac{d\beta}{dx} - \frac{d\alpha}{dy}\right) + \gamma\left(\frac{d\alpha}{dz} - \frac{d\gamma}{dx}\right),$$

and two similar ones involving Y and Z.

Now, assuming

$$-p = \tfrac{1}{2}\left\{\left(\frac{d\psi}{dx}\right)^2 + \left(\frac{d\psi}{dy}\right)^2 + \left(\frac{d\psi}{dz}\right)^2\right\},$$

and

$$\frac{d^2\psi}{dx^2} + \frac{d^2\psi}{dy^2} + \frac{d^2\psi}{dz^2} = 0,$$

$$\frac{dP}{dx} + \frac{dQ}{dy} + \frac{dR}{dz} = e,$$

$$\frac{d\alpha}{dx} + \frac{d\beta}{dy} + \frac{d\gamma}{dz} = m,$$

we get—

$$X - \frac{\overline{du}}{dt} = Pe + \alpha m - Q\left(\frac{dQ}{dx} - \frac{dP}{dy}\right) + R\left(\frac{dP}{dz} - \frac{dR}{dy}\right)$$

$$- \beta\left(\frac{d\beta}{dx} - \frac{d\alpha}{dy}\right) + \gamma\left(\frac{d\alpha}{dz} - \frac{d\gamma}{dy}\right),$$

and two other similar ones.

If we now *assume* as the relations connecting P, Q, R and α, β, γ with a velocity V—

$$V\left(\frac{dR}{dy} - \frac{dQ}{dz}\right) = \frac{d\alpha}{dt} \text{ and } V\left(\frac{d\gamma}{dy} - \frac{d\beta}{dz}\right) - -\frac{dP}{dt},$$

and the corresponding others, we get—

$$X - \frac{\overline{du}}{dt} = Pe + \alpha m + \frac{1}{V}\cdot\frac{d}{dt}(Q\gamma - R\beta),$$

which, if we suppose the motion steady, so that $\frac{du}{dt} = 0$ gives exactly the right expression for the mechanical force due to an electric charge, e, and a magnetic charge, m, and to an electric current with components $\frac{dP}{dt}, \frac{dQ}{dt}, \frac{dR}{dt}$.

In order to justify the assumed relation between α, β, γ and P, Q, R, compare with Sir William Thomson's equations of propagation of disturbance in a turbulent liquid (*Phil. Mag.*, October 1887, p. 342).

In his case everything is a function of y only, and in that case my equations become, when there is no mechanical force—

$$\frac{\overline{du}}{dt} = \frac{1}{V}\frac{d}{dt}(R\beta - Q\gamma),$$

$$= Q\frac{dP}{dy} - R\frac{dR}{dy} + \beta\frac{d\alpha}{dy} - \gamma\frac{d\gamma}{dy}.$$

Now under the circumstances contemplated, R and γ are not functions of y—

$$\therefore \frac{\overline{du}}{dt} = Q\frac{dP}{dy} + \beta\frac{d\alpha}{dy}.$$

If we now assume that during the passage of a disturbance of the kind $Q = \beta =$ constant, and they must be if

$$\frac{dP}{dx} + \frac{dQ}{dy} + \frac{dR}{dz} = \frac{d\alpha}{dx} + \frac{d\beta}{dy} + \frac{d\gamma}{dz} = 0,$$

we get—

$$\frac{du}{dt} = \frac{d}{dy}(PQ) + \frac{d}{dy}(\alpha\beta) = \frac{d}{dy}(PQ + \alpha\beta),$$

and consequently—

$$\frac{d}{dt}(R\beta - Q\gamma) = V\frac{d}{dy}(PQ + \alpha\beta).$$

Comparing this with Sir William Thomson's equation (34) we see that—

$$f = -\frac{R\beta - Q\gamma}{V},\ xzav(uv) = PQ + \alpha\beta).$$

Similarly, by calculating

$$\frac{d}{dt}(PQ + \alpha\beta) = Q\frac{dP}{dt} + \beta\frac{d\alpha}{dt}$$

$$= -QV.\frac{d\gamma}{dy} + \beta V\frac{dR}{dy} = +V\frac{d}{dy}(R\beta - Q\gamma),$$

we reproduce Sir William Thomson's equation (49), if $V^2 = \frac{2}{3}R^2$, *i.e.* be $\frac{2}{3}$ of the average square of velocity of turbulency. This V is the velocity of propagation of the disturbance.

If we wish to identify this laminar motion of Sir William Thomson's with a simple wave propagation such as light consists of, we must take $Q = \beta =$ constant, and then the two equations are satisfied by—

$$\frac{dP}{dt} = -V\frac{d\gamma}{dy} \text{ and } \frac{d\gamma}{dt} = -V\frac{dP}{dy},$$

and

$$\frac{dR}{dt} = V\frac{d\alpha}{dy} \text{ and } \frac{d\alpha}{dt} = V\frac{dR}{dy},$$

no matter what Q and β are, and these are, of course, Maxwell's equations. There is nothing to settle which is the electric and which the magnetic disturbance, nor even which, f or $xzav(uv)$, is proportional to $R\beta - Q\gamma$, and which to $PQ + \alpha\beta$, but the consideration that electric currents and electrification are possible while magnetic currents do not exist, will probably decide a question of this kind. In Maxwell's simplest wave, P and γ only exist, and in this case, as I have assumed above, $xzav(uv)$ would correspond to electric, and f to magnetic disturbance. In Sir William Thomson's representation, $xzav(uv)$ is of the nature of a twist, and f of a flow, contrary to the usual notion that magnetic force is twisty. However, a flow cannot take place outwards continuously from a body, so that there seems a reasonableness in likening electrification to a twist. The fact that magnetism in matter rotates the plane of polarization sometimes to one side and sometimes to the other does not prove conclusively that it is a rotation : a flow might confer that property on matter.

In order to include the general case of a variable state, an interpretation of X, Y, Z, is required. Where no matter is present, we must assume—

$$-X = \frac{dp_1}{dx} + \frac{1}{2}\frac{d}{dx}(P^2 + Q^2 + R^2 + \alpha^2 + \beta^2 + \gamma^2), \text{ \&c.},$$

and in the steady state—

$$p_1 = -\tfrac{1}{2}(P^2 + Q^2 + R^2 + \alpha^2 + \beta^2 + \gamma^2).$$

When the state is not steady, we have, if

$$\frac{dP}{dx} + \frac{dQ}{dy} + \frac{dR}{dz} = e,\quad \frac{d\alpha}{dx} + \frac{d\beta}{dy} + \frac{d\gamma}{dz} = m,$$

$$X - \frac{d\bar{u}}{dt} = +Pe + \alpha m + \frac{d}{dt}\frac{(Q\gamma - R\beta)}{V}, \text{ \&c.}$$

We must assume that p_1 has no longer the above value ; but by differentiating the first of these with respect to x, the second with respect to y, and the third with respect to z, we get—

$$\frac{dX}{dx} + \frac{dY}{dy} + \frac{dZ}{dz} - \frac{d}{dt}\left(\frac{d\bar{u}}{dx} + \frac{d\bar{v}}{dy} + \frac{d\bar{w}}{dz}\right)$$

$$= +\left(e^2 + P\frac{de}{dx} + Q\frac{de}{dy} + R\frac{de}{dz}\right) + \left(m^2 + \alpha\frac{dm}{dx} + \beta\frac{dm}{dy} + \gamma\frac{dm}{dz}\right)$$

$$-\frac{1}{2}\frac{1}{V^2}\frac{d^2}{dt^2}(P^2 + Q^2 + R^2 + \alpha^2 + \beta^2 + \gamma^2),$$

which is satisfied by $e = 0$, $m = 0$; or if e and m exist, by—

$$e^2 + P\frac{de}{dx} + Q\frac{de}{dy} + R\frac{de}{dz} = 0;$$

and

$$m^2 + \alpha\frac{dm}{dx} + \beta\frac{dm}{dy} + \gamma\frac{dm}{dz} = 0;$$

and

$$\frac{d\bar{u}}{dx} + \frac{d\bar{v}}{dy} + \frac{d\bar{w}}{dz} = 0,\quad \frac{d^2p_1}{dx^2} + \frac{d^2p_1}{dy^2} + \frac{d^2p_1}{dz^2} = 0;$$

and

$$\left(\frac{d^2}{dx^2} + \frac{d^2}{dy^2} + \frac{d^2}{dz^2} - \frac{1}{V^2}\frac{d^2}{dt^2}\right)(P^2 + Q^2 + R^2 + \alpha^2 + \beta^2 + \gamma^2) = 0,$$

which means that energy is propagated with a velocity = V, and so the assumed relations connecting P, Q, R, and α, β, γ, mean little more than that the initial state is stable.

This, I think, shows that, so far, the ether may be a turbulent liquid.

If we compare the dimensions of the quantities involved in the theory of motion of a turbulent liquid with those in the electro-magnetic theory, we find it convenient to put these latter dimensions into the following forms, as they are the same on the electro-magnetic and electrostatic systems.

Calling $[K^{\frac{1}{2}}\mu^{\frac{1}{2}}] = [V^{-1}]$, and density $[\rho] = [ML^{-3}]$, we can write—

Electric displacement $= [K^{\frac{1}{2}}\rho^{\frac{1}{2}}V]$
Electric force $= [K^{-\frac{1}{2}}\rho^{\frac{1}{2}}V]$
Magnetic displacement $= [\mu^{\frac{1}{2}}\rho^{\frac{1}{2}}V]$
Magnetic force $= [\mu^{-\frac{1}{2}}\rho^{\frac{1}{2}}V]$.

It is at once evident that the products of the force and displacement are, in each case, of the dimensions of the P^2, Q^2, R^2, α^2, β^2, γ^2, involved in the theory I have already given.

I think it would be well, perhaps, to introduce some new quantities of zero dimensions to define the polarization of the medium. It seems likely that the velocity involved in P must depend on how intensely the turbulency is polarized, and could therefore be measured by a quantity of zero dimensions multiplied by a measure of the turbulency. This measure would be $\rho^{\frac{1}{2}}V$, so that, for electrostatic energy—

$$P^2 = P_0^2(\rho V^2),$$

and for electro-magnetic—

$$\alpha^2 = \alpha_0^2(\rho V^2),$$

where P_0 and α_0 were of zero dimensions.

In order to introduce the effect of alterations in material, we may put these in the form—

$$P^2 = \frac{\rho P_0^2}{K\mu},\quad \alpha^2 = \frac{\rho\alpha_0^2}{K\mu},$$

and then the electric displacement will be—

$$= \sqrt{\frac{\rho}{\mu}}.P_0,$$

and the electric force—

$$= \sqrt{\frac{\rho}{\mu}}.\frac{P_0}{K};$$

while the magnetic displacement will be—

$$= \sqrt{\frac{\rho}{K}}.\alpha_0,$$

and the magnetic force will be—

$$= \sqrt{\frac{\rho}{K}}.\frac{\alpha_0}{\mu}.$$

If we call the six quantities $\bar{u}^2$, $\bar{v}^2$, $\bar{w}^2$, $\overline{vw}$, $\overline{wu}$, $\overline{uv}$, a, b, c, f, g, h, they are connected with the six quantities P, Q, R, α, β, γ, and the three undisturbed values of $\bar{u}^2 = A$, $\bar{v}^2 = B$, $\bar{w}^2 = C$, by the equations—

$$a = A + P^2 + \alpha^2, \text{ \&c.},\ f = QR + \beta\gamma, \text{ \&c.}$$

In order to examine how these are related, take an ellipsoid defined by—

$$ax^2 + by^2 + cz^2 + 2fyz + 2gzx + 2hxy = d,$$

and we see that, if A = B = C = R, as is the case except in a crystalline medium, the ellipsoid is—

$$R(x^2 + y^2 + z^2) + (Px + Qy + Rz)^2 + (\alpha x + \beta y + \gamma z)^2 = d;$$

so that, if $Px + Qy + Rz = L$, $\alpha x + \beta y + \gamma z = \lambda$.

$L + i\lambda$ and $L - i\lambda$ are the imaginary circular reactions of the ellipsoid,[1] and consequently the intersection of L and λ, whose direction cosines are proportional to $Q\gamma - R\beta$, &c., is the major axis of the ellipsoid, when the above signs are attributed to L^2 and λ^2. As any ellipsoid can be expressed in this form by referring it to its circumscribing sphere and the corresponding planes of circular section, it is apparent that any polarized state of the turbulent motion can be built up of P, Q, R, and α, β, γ, polarizations. The axis of the ellipsoid mentioned above represents the flow of energy in the medium during the propagation of a disturbance.

I am inclined to think that Sir William Thomson's fear that diffusion would vitiate these investigations would be avoided either by supposing the turbulent liquid to consist of interlocked vortex rings, or of infinite intercrossing lines; and in either case a natural hypothesis would be that matter consisted of free vortex rings. GEO. FRAS. FITZGERALD.

Trinity College, Dublin, April 26.

[1] This was remarked to me by Prof. Lyle, of Melbourne, while I was recently speaking to him upon this subject.

The New Eruption of Vesuvius.

ON April 29, 30, and May 1, a constant series of explosions (*boati*) and rumblings accompanied by earthquakes, which shook the southern foot of Vesuvius, were very noticeable at Resina. About 2 a.m., on May 2, part of the new cone of eruption (formed during the last ten months) fell in, showing that the internal support of the lava column had been removed, in consequence of this filling the new dyke, the formation of which had given origin to the preceding sonorous and mechanical disturbances. On the same day at 3 p.m. the lava sank still lower in the conduit on account of the dyke reaching the surface at the upper part of the great cone. More of the eruptive cone crumbled in, and of course simultaneously a considerable outpour of lava took place from the dyke fissure which is situated on the south-east side of the great cone. This outflow soon formed a long tongue of lava reaching to the Pedimentina or lower.

My friend Mr. George Bidder, Jun., who is studying at the Zoological Station here, was fortunately able to visit the mountain yesterday (May 3), and much of the information in this letter I have to thank him for. Unfortunately the extremely bad weather has prevented the upper part of the mountain being examined, so that accurate information as to the position and length of the fissure has not been obtainable; I hope, however, to make the ascent to-morrow, and will then send a more detailed account for your next issue. So far as the facts at hand are available, it would appear that this eruption is of small importance, being an analogue of that of May 2, 1885, and that, therefore, the lava will hardly reach cultivated ground.

A short glimpse of the summit of the mountain this evening shows that much of the eruptive cone still exists, whilst the reflection from the flowing lava is much feebler than yesterday evening. Lastly, a single faint glimmer this evening at the vent demonstrates the fact that the lava has not sunk very deep in the chimney. The eruption, or more properly *disruption*, was coincident with a marked barometric depression.

Naples, May 4. H. J. JOHNSTON-LAVIS.

The Sailing Flight of the Albatross.

I have been much interested by the letter of Mr. A. C. Baines (NATURE, May 2, p. 9) upon this subject. In the year 1883 ("The Soaring of Birds," NATURE, vol. xxvii. p. 534) I suggested that the explanation of these puzzling performances might be found in the increase of wind with height. To take advantage of this, the bird must rise against the wind and fall with it; but, at the time referred to, I had before me only the observations of Mr. Peal, in Assam, on the flight of pelicans, in which this feature is not alluded to. In Mr. Baines's observations, the omission is supplied, and there seems little reason to doubt that the true explanation of the flight of the albatross has been arrived at. In the case of the pelican soaring to a great elevation, it is less easy to understand how the differences of horizontal velocity can be sufficient.

Reference may be made to a paper by Mr. H. Airy (NATURE, vol. xxvii. p. 590), in which the matter is further discussed. Similar views have also been put forward more recently by an American author, whose name I have, unfortunately, forgotten.

Terling Place, Witham, May 6. RAYLEIGH.

"Giphantia."

IN a curious little work, entitled "Giphantia," the full title of which I subjoin, there is, at pp. 95–98, a passage that may have some interest in connection with the early history of photography, and of which I therefore subjoin a copy.

The Camp, Sunningdale, April 29. J. D. HOOKER.

"Giphantia: or, a View of what has passed, what is now passing, and, during the Present Century, what will pass, in the World." Translated from the Original French, with Explanatory Notes. (London: Printed for Robert Horsfield, in Ludgate Street, 1761.)

"Thou knowest that the rays of light, reflected from different bodies, make a picture and paint the bodies upon all polished surfaces, on the retina of the eye, for instance, on water, on glass. The elementary spirits have studied to fix these transient images: they have composed a most subtile matter, very viscous, and proper to harden and dry, by the help of which a picture is made in the twinkle of an eye. They do over with this matter a piece of canvas, and hold it before the objects they have a mind to paint. The first effect of the canvas is that of a mirrour; there are seen upon it all the bodies far and near, whose image the light can transmit. But what the glass cannot do, the canvas, by means of the viscous matter, retains the images. The mirrour shows the objects exactly; but keeps none; our canvases show them with the same exactness, and retains them all. This impression of the images is made the first instant they are received on the canvas, which is immediately carried away into some dark place; an hour after, the subtile matter dries, and you have a picture so much the more valuable, as it cannot be imitated by art nor damaged by time. We take, in their purest source, in the luminous bodies, the colours which painters extract from different materials, and which time never fails to alter. The justness of the design, the truth of the expression, the gradation of the shades, the stronger or weaker strokes, the rules of perspective, all these we leave to nature, who, with a sure and never-erring hand, draws upon our canvases images which deceive the eye and make reason to doubt, whether, what are called real objects, are not phantoms which impose upon the sight, the hearing, the feeling, and all the senses at once.

"The Prefect then entered into some physical discussions, first, on the nature of the glutinous substance which intercepted and retained the rays; secondly, upon the difficulties of preparing and using it; thirdly, upon the struggle between the rays of light and the dried substance, three problems, which I propose to the naturalists of our days, and leave to their sagacity."

Geological Photography.

IN the report of the Annual Conference of Delegates of Corresponding Societies of the British Association (*vide* NATURE, vol. xxxix. p. 187), reference is made to the proposed appointment of a Committee to collect and register photographs of localities, sections, or other features of geological interest in the United Kingdom. Several Societies have already attempted local photographic surveys, but the need is felt to secure uniformity of action by all the Societies interested, and to arrange for the photographs to be available for teaching and other purposes when needed. In order that steps may be taken to arrange for the practical working of the proposed scheme at the forthcoming meeting of the British Association at Newcastle, I am desirous of invoking the kind aid of those of your readers who have interested themselves in the photography of local geological features (especially of typical and temporary sections) in favouring me with the following information:—

(1) A list of photographs already taken, illustrating given localities or sections; and

(2) The names of local Societies, or persons who are willing to arrange for a photographic survey for geological purposes in their district.

The information afforded me will be placed before the Geological Section of the British Association at their next meeting, and I trust to receive many offers of valuable assistance from different parts of the country. If copies of photographs are sent me they will be carefully kept for exhibition at the meeting. Several geological friends have favoured me with suggestions in regard to size of photograph, scales of height, length, and other details, which will all be carefully considered. Photography is now so popular and easy of accomplishment that there should be no difficulty in organizing local photographic surveys for the purpose I have indicated.

It was arranged at Bath that the delegates should get their Societies to think the matter over, and that I should meanwhile endeavour to prepare a list of local geological photographs already available for study. I am communicating with the Societies with this object, but your insertion of this letter will further aid me in directing attention to the subject over a wider circle than I am able to reach. OSMUND W. JEFFS.

12 Queen's Road, Rock Ferry, Cheshire, April 23.

Columnar Structure in Ice.

I HAVE just read Mr. James McConnel's interesting and important paper on the plasticity of ice (NATURE, vol. xxxix. p. 203), and as he remarks that it would be interesting to know whether the columnar structure he describes as occurring in the ice of the St. Moritz Lake has been observed in England, I venture to ask you to record the fact that I recollect seeing a precisely similar structure in the ice of the lake in Kew Gardens in February 1880. The phenomenon occurred *during a thaw* that preceded by a day or two the memorable snowstorm of that month, and the aspect of the ice, where it had been broken through, recalled to my mind that of the well-known fossil *Lithostrotion basaltiforme*, as it was built up of vertical columns, irregularly hexagonal in section, about a quarter of an inch in diameter and of equal length with the thickness of the ice, about 4 or 5 inches. If I remember aright, bright sunshine had been thawing the ice during the day. I made a note on the occurrence at the time, but as I came to India shortly after I do not know what has become of it.

T. D. LA TOUCHE,
Geological Survey of India.

Camp near Cherrapunji, Assam, March 4.

Brilliant Meteor.

I SEND you an account of a meteor I saw on Saturday evening last, thinking it may interest others as much as it has myself. I was lamp-signalling at the time (8.55 p.m.), and saw far the largest meteor I have ever seen. It was far brighter than any planet, or even than a good rocket. It seemed to start from the Great Bear, and fall in a north-east direction half-way to the horizon. I immediately stopped my message, and asked my companion (a mile distant) if he had seen the meteor. He replied he had not, which surprised me, though he had the town lights not far behind him, and he was looking away from the north-east. I had not finished asking him about the meteor, when I heard a loud but distant report, which I can only put down to the same source. It sounded like distant artillery, or more particularly like a six-pounder at six miles distance on a still evening. The interval of time between the sight and the sound I should estimate at a minute. T. HERBERT CLARK.

Wingfield, Trowbridge, April 30.

A New Mountain of the Bell.

HAVE the kindness to correct two typographical errors in my communication describing the "New Mountain of the Bell," printed in your issue of April 25. On p. 607, col. 2, line 7, an unfortunate superfluous comma after the word quartz should be expunged, so as to read quartz pebbles and veins.

Near the bottom of the same column "modern gong" should read "wooden gong." As a matter of fact the *Nagous* is far from "modern." It consists of a heavy plank nearly 2 inches thick, 14 feet long, and suspended by ropes at two points 4 feet from either end. When struck with a wooden mallet, this primitive gong emits a loud sound. At the Monastery of St. Catherine, three of these are in use, one small one to call to their noonday meal the numerous *cats* which inhabit the rambling old building. H. CARRINGTON BOLTON.

London, May 1.

KLEIN'S "IKOSAHEDRON."[1]

IT has recently been said, with great truth, that pure mathematics is at the present moment the most progressive of all the sciences. It is, we must confess with sorrow, equally true, that the means at the disposal of English pure mathematical students for making themselves familiar with the recent advances in their science are deplorably scanty. This is not the place to discuss the reasons why it has so long been the case in this island that the stars of our mathematical firmament have been

"*Étoiles qui filent, filent et disparaient !*"

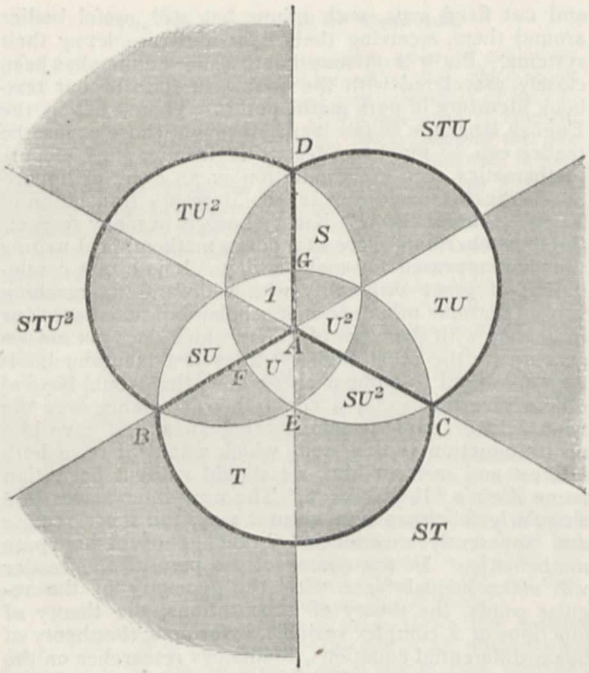
and not fixed suns, with minor but still useful bodies around them, receiving their light and completing their systems. But it is obvious that this shortcoming has been closely associated with the backward state of our text-book literature in pure mathematics. There exist in the English language so few books through whose pages the reader can so much as descry the frontier land of pure mathematics that every addition is an event of importance. Such an addition is Mr. Morrice's translation of Klein's "Ikosahedron." Klein's book is in many respects the most charming piece of modern mathematical writing that has appeared for many a day. It is a rare combination of great originality with wide and far-reaching views, Teutonic minuteness of scholarship, and a candour in dealing with the work of others which does not always accompany the other high qualities just mentioned. If we were asked to name a single book that would beyond others give the reader a comprehensive glance over the wide field of modern pure mathematics, and give him an introduction to this study which would at once both interest and instruct him, we should without hesitation name Klein's "Ikosahedron." The work interweaves, in a singularly felicitous and natural way, the most remote and apparently unconnected branches of higher pure mathematics. In the course of its perusal the reader will make acquaintance with the geometry of the regular solids, the theory of substitutions, the theory of functions of a complex variable, invariants, the theory of linear differential equations, Riemann's researches on the hypergeometric series, Galois's theory of the resolution of algebraic equations, elliptic functions, Plücker's line geometry, and the special theory of quintic equations. This enumeration will sufficiently indicate the wide sweep of the work; but let not the reader be alarmed. If he is ignorant of all these subjects, so much the more will he enjoy the pleasure of Prof. Klein's introduction to them. He will find that he is led, by easy and pleasant ways, first to see the interest and importance of these subjects, then to panoramic aspects of them, and finally to just so much detail as will make him (if he be right-minded) thirst for more. Speaking from past experience, we should say that one of the greatest disadvantages of modern specialism is the repulsive force which it establishes at every point to the entrant. Let an English student sit down, for example, to Jordan's "Théorie des Substitutions." He is at once plunged into a sea of new terms and definitions. He is baffled by a kaleidoscopic array of subtle distinctions between con-

[1] "Lectures on the Ikosahedron, and the Solution of Equations of the Fifth Degree." By Felix Klein. Translated by George Gavin Morrice, M.A., M.B. (London: Trübner and Co., 1888.)

ceptions that are unfamiliar to him. He toils through the solution of abstract problems whose formulation he imperfectly grasps, and whose interest and importance he has not been permitted to see beforehand. The very beauty and logical rigour of the work is a hindrance to him; it entangles and suffocates him at the outset. And yet M. Jordan's work could not be otherwise, could not be better for its purpose, could not be dispensed with. But let the learner first read Klein's "Ikosahedron." He will there see the substitution theory first applied in simple cases with concrete illustration, and will then be led by degrees to see its all-embracing character. Then let him return to Jordan, and he will say of the theory of substitution,

> "Her loveliness I never knew,
> Until she smiled on me."

Under ordinary circumstances, any detailed analysis of a mathematical work would be out of place in the pages of NATURE. The appearance of the "Ikosahedron" in English is, however, an event of such importance that it would be wrong to miss the opportunity of giving the



English mathematical world some account, however imperfect, of its contents.

The proper subject of the work may be said to be the general theory and applications of functions which are transformable into themselves (*i.e.* are unaltered) by a finite group of substitutions. By a *group* of substitutions, or indeed of any operations whatsoever, is meant a complete set of operations of such a nature that the combination of any two or more of them is equivalent to some one of the set. The number of operations in a group is called its order, and the order may in general be finite or infinite. A leading feature of Klein's work, indicated by its title, is the geometrical connection which he establishes between certain groups of substitutions, and the rotations which cause a regular solid to return into itself. It is obvious beforehand that the totality of such rotations for any given regular solid forms a group of finite order, for any two successive rotations of the kind may be replaced by a single one. The accompanying figure will make the connection plain. It represents the stereographic projection of the traces on a circumscribed sphere made by the planes of symmetry of a regular tetrahedron, A B C D, the vertex of projection being the antipodal point to A, and the plane of projection the diametral plane of which A is the pole. The spherical surface is obviously divided by the planes of symmetry into twelve (non-shaded) congruent triangles, and twelve other (shaded) congruent triangles, each of which is the image of one of the former in a plane of symmetry. These triangles lie in sets of $\nu_2 = 2$ about points such as F, which correspond to mid-edges of the tetrahedron, in sets of $\nu_2 = 3$ about points such as E, which correspond to centroids of the faces, and in sets of $\nu_3 = 3$ about the points which correspond to vertices of the tetrahedron. It is farther obvious that any one of the unshaded triangles can be transformed into each of the other twelve unshaded triangles by one of the group of N = 12 rotations which cause the tetrahedron to return into itself. If we mark one of these by inscribing 1, and if S denote a rotation of period 2 (*i.e.* of angular magnitude $2\pi/2$) about G, T a rotation of period 2 about F, and U a rotation of period 3 about A, then the rotations by which the region 1 is transformed into the other twelve are—

$$1, U, U^2, S, SU, SU^2, T, TU, TU^2, ST, STU, STU^2;$$

and these give the twelve rotations of the tetrahedral group expressed succinctly in terms of three of them.

The same holds for the shaded triangles. Hence, if we pair each non-shaded triangle with a shaded one, and thus form a *fundamental domain*, then we see that any point within such a domain (boundary and summit points excepted) is transformed by the N tetrahedral rotations into N other points, one of which lies in each of the N domains. (Here we count the transformation of the point into itself, viz. the rotation represented by the identical symbol 1.) We pass over the questions that arise regarding the composition of a group and the conception of the extended group which embraces reflections in the planes of symmetry as well as rotations, and merely mention that a similar theory is established for the dihedron, *i.e.*, the figure composed of a great circle of the sphere divided into *n* equal parts, the octahedron, and the ikosahedron, the characteristic numbers being given by the following table:—

	ν_1	ν_2	ν_2	N
Dihedron ...	2 ...	2 ...	n ...	$2n$
Tetrahedron ...	2 ...	3 ...	3 ...	12
Octahedron ...	2 ...	3 ...	4 ...	24
Ikosahedron ...	2 ...	3 ...	5 ...	60

The next step is to connect each point on the sphere with the value of a complex variable z, or with the ratio of two complex variables $z = z_1/z_2$. This is done, after the manner of Riemann, by representing $z = x + yi$ in an Argand-diagram on the diametral plane of the sphere, and then projecting the point (x, y) stereographically upon the sphere. The point on the sphere is then spoken of as the point (z) or (z_1, z_2).

It is next shown that every dihedral, tetrahedral, octahedral, or ikosahedral rotation is equivalent to a nonhomogeneous linear substitution of the form—

$$z' = (Az + B)/(Cz + D),$$

or to one or other of two pairs of homogeneous substitutions of the form—

$$z_1' = Az_1 + Bz_2, \; z_2' = Cz_1 + Dz_2;$$

and the proper values of A, B, C, D are calculated for each case.

If we consider the values of z corresponding to a point, and the N − 1 other points into which it is transformed by the N polyhedral rotations, we see that they are the roots of an algebraical equation of the Nth degree, say $Z \equiv f(z) = c$, the characteristic Z of which must have the property of remaining unaltered by every one of the N non-homogeneous substitutions. And there must likewise exist homogeneous integral functions of $F(z_1, z_2)$ of the Nth degree in the two variables z_1, z_2, containing one arbitrary parameter, which remain unaltered, to a factor *près*, for each of the group of 2N homogeneous polyhedral substitutions. The functions of the latter kind ("ground forms") are first determined. First, a special function F_1 (of degree N/ν_1 is determined, such that $F_1 = 0$ gives one of the ν_1 summits on the sphere, and the $N/\nu_1 - 1$ other points into which it is transformed by the polyhedral rotations. Then $F_1^{\nu_1}$ is a particular function having the property sought for. By an elegant application of the theory of invariants, two other functions, F_2 and F_3, corresponding respectively to the ν_2 and ν_3 summits, are derived from F_1. We then have for the general invariant function required—

$$\lambda_1 F_1^{\nu_1} + \lambda_2 F_2^{\nu_2} + \lambda_3 F_3^{\nu_3},$$

which contains only one arbitrary parameter, since there is in each case an identity of the form—

$$\lambda_1^{(0)} F_1^{\nu_1} + \lambda_2^{(0)} F_2^{\nu_2} + \lambda_3^{(0)} F_3^{\nu_3} = 0,$$

connecting F_1, F_2, F_3. In the particular case of the ikosahedron we have—

$$F_1 \equiv z_1^{30} + z_2^{30} + 522(z_1^{25} z_2^{5} - z_1^{5} z_2^{25}) - 10005(z_1^{20} z_2^{10} + z_1^{10} z_2^{20});$$

$$F_2 \equiv -(z_1^{20} + z_2^{20}) + 228(z_1^{15} z_2^{5} - z_1^{5} z_2^{15}) - 494 z_1^{10} z_2^{10};$$

$$F_3 \equiv z_1 z_2 (z_1^{10} + 11 z_1^{5} z_2^{5} - z_2^{10});$$

and $F_1^2 + F_2^3 - 1728 F_3^5 \equiv 0$.

The non-homogeneous function Z is next discussed. It is shown that any form of Z, whatever, is a linear rational function, $(\alpha Z' + \beta)/(\gamma Z' + \delta)$ say, of any particular form Z^1; so that it is sufficient to determine a special form Z subject to the conditions that Z assumes the values $1, 0, \infty$, for the ν_1, ν_2, ν_3 summits respectively. It is found that $Z = c F_2^{\nu_2} / F_3^{\nu_3}$, and thus the synthesis of the polyhedral functions is completed.

In Chapters III. and IV. of his first part, Klein discusses the inversion of the polyhedral functions. If, in the polyhedral equation $c F_2^{\nu_2} / F_3^{\nu_3} = Z$, we suppose Z given and z required, z appears as an N-valued function of Z, whose properties it becomes our business to discuss. Parallel to this problem we have a "form-problem." There are for each of the five polyhedra a set of three forms which are *absolutely* invariant for the 2N homogeneous polyhedral substitutions; thus, for the ikosahedron, these are the special forms F_1, F_2, F_3, themselves. We may then suppose the values of these absolutely invariant forms given, subject to the identical relation which in all cases connects them; and require the values of Z_1 and Z_2. There are in each case 2N solutions of this "form-problem," and it is shown that these can all be obtained from the N solutions of the corresponding polyhedral equation by adjoining an accessory square root. It is, of course, obvious that the N solutions of the polyhedral equation and the 2N solutions of the corresponding form-problem can all be derived from any one of them by the N non-homogeneous and the 2N homogeneous polyhedral substitutions respectively.

A brief graphical discussion is given of the functions Z, Z_1, Z_2; and it is shown that Z satisfies the differential equation—

$$\frac{Z'''}{Z'} - \frac{3}{2}\left(\frac{Z''}{Z'}\right)^2 = \frac{\nu_1^2 - 1}{2\nu_1^2 (Z-1)^2} + \frac{\nu_2^2 - 1}{2\nu_2^2 Z^2} + \frac{1/\nu_1^2 + 1/\nu_2^2 - 1/\nu_3^2 - 1}{2(Z-1)Z} \quad \ldots \text{(A)}$$

the left-hand side of which is the differential invariant which Cayley has called the Schwarzian derivative of z with respect to Z (see Forsyth's "Differential Equations," § 61 and chapter vi.); and that Z_1 and Z_2 each satisfy the linear differential equation—

$$y'' + \frac{y'}{Z} + \frac{y}{4(Z-1)^2 Z^2}\left\{-\frac{1}{\nu_2^2} + Z\left(\frac{1}{\nu_2^2} + \frac{1}{\nu_3^2} - \frac{1}{\nu_1^2} + 1\right) - \frac{Z^2}{\nu_3^2}\right\} = 0.$$

Through the latter equations z_1 and z_2 are identified as particular cases of the Riemannian P-function, and thus connected with the theory of the hypergeometric series. Here Klein's work comes in contact with the well-known researches of Schwarz—"Ueber diejenigen Fälle, in welchen die Gaussische Hypergeometrische Reihe eine Algebraische Function ihres vierten Elementes darstellt" (*Crelle*, Bd. 75).

The inversion of the polyhedral functions is next considered from the standpoint of Galois's theory of the resolution of an algebraical equation. An attractive outline of this theory is given, so far as it concerns the problem on hand. The starting-point may be said to be the famous theorem of Lagrange, which, in a generalized form, runs as follows: If R, R_1, R_2, ... be rational functions of the variables $x_1, x_2, \ldots x_n$, and if R remain unchanged by all the substitutions of the x's which leave $R_1, R_2, \ldots$ simultaneously unaltered, then R can be expressed as a rational function of $R_1, R_2, \ldots$ and of the elementary symmetric functions of the x's. In particular, if we characterize all the functions which admit (*i.e.* are unaltered by) a given group of substitutions, G, as belonging to the family G, we see that all the functions of any family are rationally expressible in terms of one another.

Suppose now that we have any algebraical equations, $f(x) = 0$, whose roots are $x_1, x_2, \ldots x_n$, and we "adjoin" thereto a group of asymmetric functions, $K_1, K_2, \ldots$, of its roots, whose values along with the coefficients of $f(x)$ are supposed to be "known," then there exists a group of substitutions, G, that, viz., for which K_1, $K_2, \ldots$ are unaltered, such that all functions of the family G and no others are rationally expressible in terms of the "known quantities." If R be a function of $x_1, x_2, \ldots x_n$, not belonging to the family, but say to the family g where g is a sub-group in G of the order $\nu = N/n^1$, then we can form an equation for R, viz.,

$$(R - R_1)(R - R_2) \ldots (R - R_{n^1}) = 0,$$

whose coefficients are rational functions of the known quantities. Such an equation is called a resolvent of $f(x) = 0$. All the resolvents constructed by means of functions R which belong to the same family g_1 are identical in the sense that they are rationally transformable into each other, and with these are also identical all resolvents arising from functions belonging to the families $g_2, g_3, \ldots$, where $g_2, g_3, \ldots$ are the sub-groups "associated with g_1" in the main group G of the original equation. There are therefore as many different kinds of resolvents, as there are different sets of associated sub-groups in G. The group Γ of every resolvent is isomorphous with the original group G; that is to say, we can order the two groups so that to every substitution S in G corresponds one S^1 in Γ, and to every combination of substitutions STU .... in G corresponds $S^1T^1U^1$ .... in Γ. If this correspondence be holohedric (one S for every S^1), then the resolvent and the original equation are equivalent in the sense that every root of the one is rationally expressible in terms of the roots of the other and of the known quantities; each is in fact a resolvent of the other. Pre-eminent among this species of resolvents stands the Galois resolvent, whose R is a perfectly asymmetric function as regards the substitutions G. The degree of this resolvent is the highest possible, viz. N. Since the sub-group g_1 belonging to any root R_1 of this equation reduces to the identical substitution, it follows that we can express each of the x's in terms of R_1. In fact, all the roots of the Galois resolvent are rational functions of any one of them; and it has the remarkable property of being transformable into itself by a group of N rational transformations, which stands in holohedric isomorphism with the group Γ. It is also established that an irreducible equation of the Nth degree which is transformable into itself by a group of N rational transformations is its own Galois resolvent; and its group is holohedrically isomorphous with the group of the N transformations. We are now enabled to perceive a very important property of the polyhedral equations, viz. each of them is its own Galois resolvent; the N rational transformations in question being simply the N linear polyhedral transformations. Every polyhedral equation therefore stands in a fundamentally simple relation to any equation of which it can be shown to be a resolvent.

If we consider the case where the isomorphism of the groups G and Γ is not holohedric—that is, where to each of the S^1's corresponds a group of the S's, we see that this necessitates the existence of a self-conjugate (*sibi*-associate) group γ in G to which belong the whole of the R's. If to the other known quantities we now adjoin the R's, the solution of the original equation $f(x) = 0$ will be simplified, because its group is now γ, which is smaller than G. Moreover, the R's themselves are calculable in terms of the known quantities by means of an equation whose group Γ is also smaller than G. In this case, therefore, an essential simplification in the formal solution of the equation $f(x) = 0$ can be effected. If the group γ be either intransitive or composite, a further simplification would ensue, in the one case by the "reduction" of $f(x) = 0$, in the other by the construction of another resolvent having a smaller group than γ.

The application of the latter part of the general theory in combination with the data regarding the groups of the polyhedral substitutions obtained in the earlier chapters, leads at once to important conclusions regarding the polyhedral equations. It is found that the octahedral equation can be solved by extracting in succession a square root, a cube root, and finally two square roots; the tetrahedral equation by the same series of operations, if we omit the first, and the dihedral equation by extracting a square root and then an nth root. All these equations are therefore soluble by means of the ordinary *elementary* algebraical irrationalities.

The ikosahedral equation stands by itself because the ikosahedral substitutions form a "simple" group; its lowest resolvents correspond to the five associate tetrahedral and the six associate dihedral sub-groups of the ikosahedral main group, and are of the fifth and sixth degrees respectively. This is, from one point of view, the main part of the theory, for it leads us to see that the solution of the ikosahedral equation involves an irrationality which exists independently of the ordinary algebraical irrationalities.

Since Abel demonstrated the impossibility of solving general equations whose degree exceeds the fourth by means of elementary algebraical irrationalities, two, or perhaps we should say three, great classes of problems in the higher theory of equations have arisen: (1) to characterize and classify all those exceptional cases of equations of a degree exceeding the fourth which can be solved by elementary irrational operations; (2) to circumscribe the domain of the higher algebraic irrationalities—that is, to characterize and exhaustively classify all the essentially distinct irrational operations which are required for the solution of any algebraical equation of finite order,—this is not to be confounded with the interesting and practically important, but perfectly distinct, question regarding the solution of such equations by means of transcendental irrationalities, such as circular and elliptic functions; (3) in connection with each distinct higher irrationality, there arises, of course, the question as to the characteristics of the various equations which can be solved by means of this irrationality and others of a lower order.

Much has been done in the working out of the first problem by Abel, Kronecker, and others; but comparatively little progress has been made with the second class of problems. In Klein's work we have an important contribution to this new branch of the theory of equations; and a sketch of a general method which seems to promise farther advance in the immediate future. The latter part of the book under review is almost entirely occupied with this subject. He there shows by two different methods that the solution of the general quintic equation can be effected by means of the ikosahedral irrationality combined with an accessory square root. A brief sketch of his first method will enable the reader to understand the general march of the investigation. If to the rational coefficients of the quintic equation we adjoin the square root of its discriminant, its Galois group becomes the 60 even permutations of its roots. Now this is isomorphous with the group of the ikosahedral equation, and therefore (since that group is simple) with the group of any of its resolvents. But it is shown that one of the ikosahedral resolvents ("the principal resolvent") is an equation of the fifth degree of the form $y^5 + 5Qy^3 + 5Ry + S$, where Q, R, S are rational functions of three arbitrary parameters m, n, Z. The question then naturally arises, Can we rationally connect the roots of this resolvent with the roots of the general quintic by properly determining the parameters m, n, Z? By means of a Tchirnhausian transformation, we can reduce the general quintic to a "principal equation" of the form $y^5 + 5\alpha y^2 + 5\beta y + \gamma = 0$; and it is shown that the necessary operations become rational after the adjunction of the square root of the discriminant of the quintic. We have thus two equations, each involving three arbitrary parameters; and it is shown that the determination of m, n, Z in terms of α, β, γ so as to satisfy the equations $Q = \alpha$, $R = \beta$, $S = \gamma$ involve no farther irrational operations. The calculations in both methods are full of beautiful details, partly geometrical and partly analytical in character.

In the last chapter of the first part a general survey of the theory of the polyhedral functions is given, wherein their relation to a variety of other functions is pointed out. In particular it is shown that the polyhedral functions virtually embrace all functions that "admit" a *finite* group of linear transformations. The proof of this depends essentially on the fact that the diophantine equation, $\Sigma(1 - 1/\nu_i) = 2 - 2/N$, where the ν_i's and N are all finite and positive, has only four solutions, viz. the values of ν_1, ν_2, ν_3, N (given in the above table), which characterize the polyhedral functions. In these four cases $1/\nu_1 + 1/\nu_2 + 1/\nu_3 > 1$. If in the differential equation (A) we give to ν_1, ν_2, ν_3 other integral values for which $1/\nu_1 + 1/\nu_2 + 1/\nu_3 =$ or < 1, we get the Schwarzian functions, which are transcendents admitting infinite groups of linear substitutions. Among these, as a limiting case corresponding to $\nu_1 = 2$, $\nu_2 = 3$, $\nu_3 = \infty$, are found the elliptic modular functions. This fact naturally leads to the attempt to solve the polyhedral equations by means of transcendentally irrational functions; and it is shown that, just as the binomial equation, $Z^n = A$, can be solved by means of logarithms, and the dihedral equation, $z^n + z^{-n} = -4Z_1 + 2$, by means of circular functions, so the tetrahedral, octahedral, and ikosahedral equations can be solved by means of elliptic modular functions.

The above imperfect sketch of Klein's "Ikosahedron" will, we trust, be held sufficient to justify us in saying that Mr. Morris's hope that his translation "may contribute towards supplying the pressing need of text-books upon the higher branches of mathematic" is not a vain hope. He could not, in our opinion, have made a better beginning. If our critical responsibility compels us to point out some defects in the execution of the work, we trust that this will be understood as indicating our desire to see the book made perfect; and not construed into depreciation of a valuable service to the cause of pure mathematics.

We strongly advise the author to have the translation read by some one who is familiar with both English and German idioms, and who possesses also some familiarity with the departments of mathematics concerned. In proof of the necessity for such a revision, we draw the author's attention to the following points, which are merely a few of those that have attracted our attention. When Klein says (Pt. I. chap. iii., § 7), "Die Lineare Differentialgleichung zweiter Ordnung, verlangt also, . . ., zu ihrer Lösung nur noch eine einzige Quadratur;" he does *not* mean, "The linear differential equation of the second order, therefore, requires, . . . , only a single *square root* besides in order to solve it." *Quadratur* means simply *quadrature* (*i.e.*, direct integration), it never means *square root*. Here a knowledge of the properties of the Schwarzian derivative might have helped the translator to divine the meaning of the German technical term. On p. 96, "But *for this* the determination of the R's themselves is more easy to carry out," is not a good, but in fact a misleading translation of the German "Dafür aber ist die Bestimmung . . ." *Dafür* here means "in compensation for this." At the foot of the same page occurs a very common confusion between *wenn eben* and *wenn gleich*, which has the effect of exactly reversing the meaning of the note. "Hierdurch kann $f(x) = 0$ (wenn eben γ, in den x geschrieben, nicht transitive ist) möglicherweise reducibel geworden sein," means, "Hereby $f(x) = 0$ may possibly have become reducible (namely if (or precisely if) γ, when expressed in terms of the x's, is intransitive)" for, of course, an equation is reducible if, and not unless, its group be intransitive. A still more important error occurs on the following page, where, in the definition of the Galois resolvent, "ihre einzelne Wurzel bei jeder in G enthaltenen Vertauschung der x umgeändert wird" is translated "its individual roots are *unaltered*, &c." First of all, this makes nonsense of the definition, as definite knowledge of the subject would have shown; and farther, supposing the translator to have read *un-* by mistake for *um-*, a knowledge of German idiom would have shown him that "ungeändert *wird*" makes nonsense of the German. The error is deliberately repeated on the following page, where "in umgeänderter Reihenfolge" is translated in "unaltered sequence," instead of "in altered sequence." These are vital errors, which should at once be corrected by means of an "errata-slip"; for they would be a serious rock of offence for a tyro in reading the passages where they occur. There are many other cases, however, where loose translation somewhat obscures the crisp and lucid exposition of Klein, which is a pity, for this quality is not all too common among Klein's countrymen. There are a considerable number of misprints, many of them copied from the original. An amusing instance of this occurs in the first footnote on p. 73, where the title of Schwarz's well-known memoir begins "Ueber *dienigen* Fälle, &c."; this is in the original, but the transcriber should have known that *dienigen* is impossible German. Nevertheless, we declare, with all the sanction of our critical stool of infallibility, that Mr. Morris's translation is a notable piece of good work; and he did well to publish it without waiting to perfect his knowledge of German idiom or of Galois's theory. The blemishes alluded to can be easily amended when another edition is called for, which will be speedily, if our good wishes avail.

G. CH.

THE NORTHFLEET SERIES ELECTRIC TRAMWAY.

ON Monday, April 29, there was opened for regular passenger traffic an electric tramway at Northfleet, near Gravesend, which marks an era in the history of electric traction. This line has been run experimentally for the last month, but the seven years Board of Trade certificate having been received, this line now enters on the commercial stage of its existence. Four tramways on which electricity is the motive power have been in regular use for the last few years in Great Britain: it is not, therefore, because the Northfleet line is the first electric tramway in this country that it has attracted considerable attention; nor is it because it is the longest electric tramway, for two of the other four are of much greater length; but it is because this Northfleet line has been constructed on a totally different principle from that hitherto adopted on this side of the Atlantic that it is worthy of special consideration.

When a number of electric lamps or motors have to be supplied with power from a common centre, there are two well-known methods by which this can be done. They can either be joined "in parallel," as it is technically called, or they can be coupled up "in series." In the parallel system, the one generally adopted with electric lighting, and hitherto the only method that has been employed with the electric tramways in Europe, the electric current that passes through any lamp or motor does not pass through any other, and the dynamo produces a large current equal to the sum of all the currents passing through all the lamps or motors. In proceeding, therefore, from the dynamo end of the circuit to the distant end, there is a steady falling off in the current, but the electric pressure remains, or may remain, nearly constant. In the series system, on the other hand, the whole current produced by the dynamo passes through all the lamps or motors in succession, and therefore this current can be small. The initial electric pressure, on the other hand, must be large, since the energy imparted by the current to each lamp or motor is represented by a drop in the electric pressure. Since the energy furnished by the dynamo depends on the product of the current into the electric pressure it produces, while the waste of power in heating the conductor depends on the square of the current flowing through the conductor, it is clear that while any amount of energy can be supplied by either system, the use of high pressure and small current is by far the more economical as regards the power wasted in heating the conductor, this economy being the greater the greater the number of lamps or motors on the circuit.

Until a few years ago, however, it was not clear how it was possible to run motors electrically in series when the motors were themselves in bodily motion, as they must be when employed to propel tramcars. In 1881, Profs. Ayrton and Perry, for the purpose of diminishing the loss of power through the leakage of the current that occurs from the insulated rail of an electric railway to the earth, and which becomes serious when the line is long, proposed a plan of electrically subdividing the railway track into sections so arranged that the electric current was only supplied to that section of the track on which a train happened to be at any moment. This system was described and shown in action at a lecture given by one of the inventors at the Royal Institution in 1882, and the late Prof. Fleeming Jenkin, on reading the account of this lecture, saw that the device of employing an electrically subdivided conductor supplied the means of running electrical trains *in series*. A combination was, therefore, brought about between these three Professors to develop electric traction. This combination resulted in the formation of the Telpherage Syndicate, and lastly in the Series Electrical Traction Syndicate, to whom is due the construction of the first series line in Europe, the one that was opened for public traffic at Northfleet, on April 29.

The track itself does not at first sight appear to differ from an ordinary horse tramway track, there being no overhead wires as in the American electric tramways, nor auxiliary raised insulated rail, as at Portrush, nor central trough, as at Blackpool. A closer inspection, however, shows that one of the rails at Northfleet, instead of being simply grooved, is a double rail with a cavity or slot between the two portions. Fig. 1 shows the general cross-section of the line, the upper portion only of which is of course visible to the passer-by. In the cavity "the arrow," as it is called, glides, being drawn along by the moving car, the function of the arrow being to open the electrical

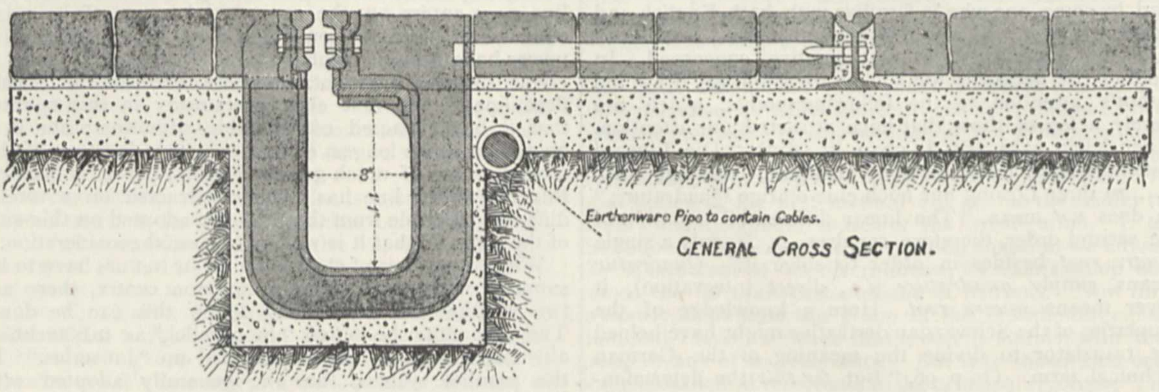


Fig. 1.

conductor at successive points, and insert the electric motor carried by the moving car in the electrical circuit. This arrow is made of flexible leather with a kind of steel spear-head at each end; it is coated with two flexible conducting strips, 1, 2 (Fig. 2), insulated from one another and permanently connected respectively with the two terminals of the motor. As this arrow glides along, it passes, as seen in Fig. 3, between the two portions of each spring-jack, the spring-jack being shown in detail in Fig. 4. The arrow keeps open two spring-jacks at any one time, the portion of the cable joining them being either cut out of circuit or short-circuited, its place in the electric circuit being temporarily occupied by the motor on the car. This result is attained by the con-

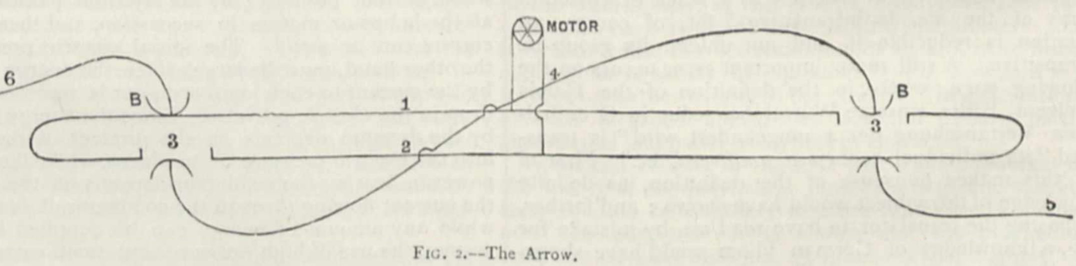


Fig. 2.—The Arrow.

ducting-strips 1, 2 (Fig. 2) on the arrow, being each wrapped round one end, and by an insulated space, 3, 3, being left on each side, slightly longer than the surface of contact B of the spring-jack. When the sceptical Englishman, who, in the past, could not realize that railways could ever succeed if the carriages were not shaped and painted like mail-coaches, reads a description of the Northfleet series tramway, he at once jumps to the conclusion that stones must necessarily get wedged in the slot; that the cavity will get filled up with mud; that the arrow must stick; and that the method is impossible in practice, though very pretty in theory. When he is told that a *series* electric tramway has been running successfully for some time in Denver, Colorado, and that

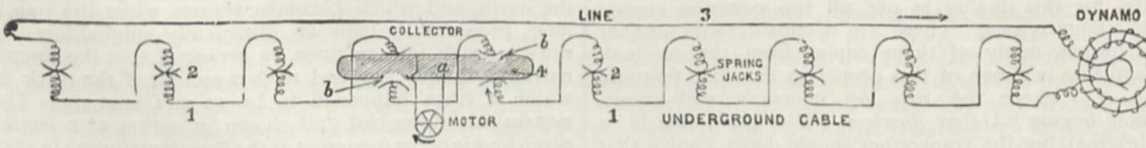


Fig. 3.—Diagrammatical Illustration of Series Line.

another *series* line, twelve miles long, with forty cars on it, is completed, or on the verge of completion, in Columbus, Ohio, he merely shrugs his shoulders and implies that such crude ideas may do for America, but that in this country we want time-honoured well-tried methods, and not new-fangled notions. The Northfleet cars, however, seem to have a marked disregard for conservative prejudices, since the arrow, with an ease and lofty contempt that makes one respect the silent power of the electric current, simply whisks out of its way any stone that has been intentionally jammed into the slot as tightly as any mischievous London urchin can fix it.

The spring-jack (Fig. 4) consists of a pair of glazed earthenware blocks, 14 × 3 × 4 inches. To each block is attached, by means of a double spiral spring, a gun-metal casting, curved at its ends to allow of the easy entrance of the arrow. The spring-jacks are arranged so that they can be taken out or replaced in the conduit in a few minutes in case of any failure. The electric resistance that they offer is much smaller than would have been anticipated, the total measured resistance of the entire line being but little higher than the calculated resistance of the insulated cable. This is probably due to the surfaces of the spring-jacks being kept bright and clean by the arrow constantly running through them.

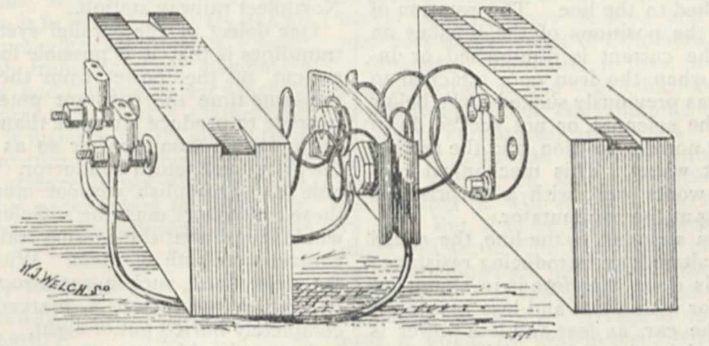


FIG. 4.—The Spring Jack.

In order that the speed of any one car shall not be affected by the starting or stopping of any other, it is necessary, with series working, that a *constant current* should be supplied to the circuit. Now while it is possible, by winding the field-magnets of a dynamo in a particular way, known as "compounding," to cause it, when running at a fixed speed, to supply perfectly constant pressure to a circuit, no matter how the resistance of the circuit may vary, no such solution has yet been practically attained when the supply conditions are *constant current*. Hence some mechanical device is necessary in the latter case, and the one employed with the Northfleet dynamo is that due to Messrs. Statter, and

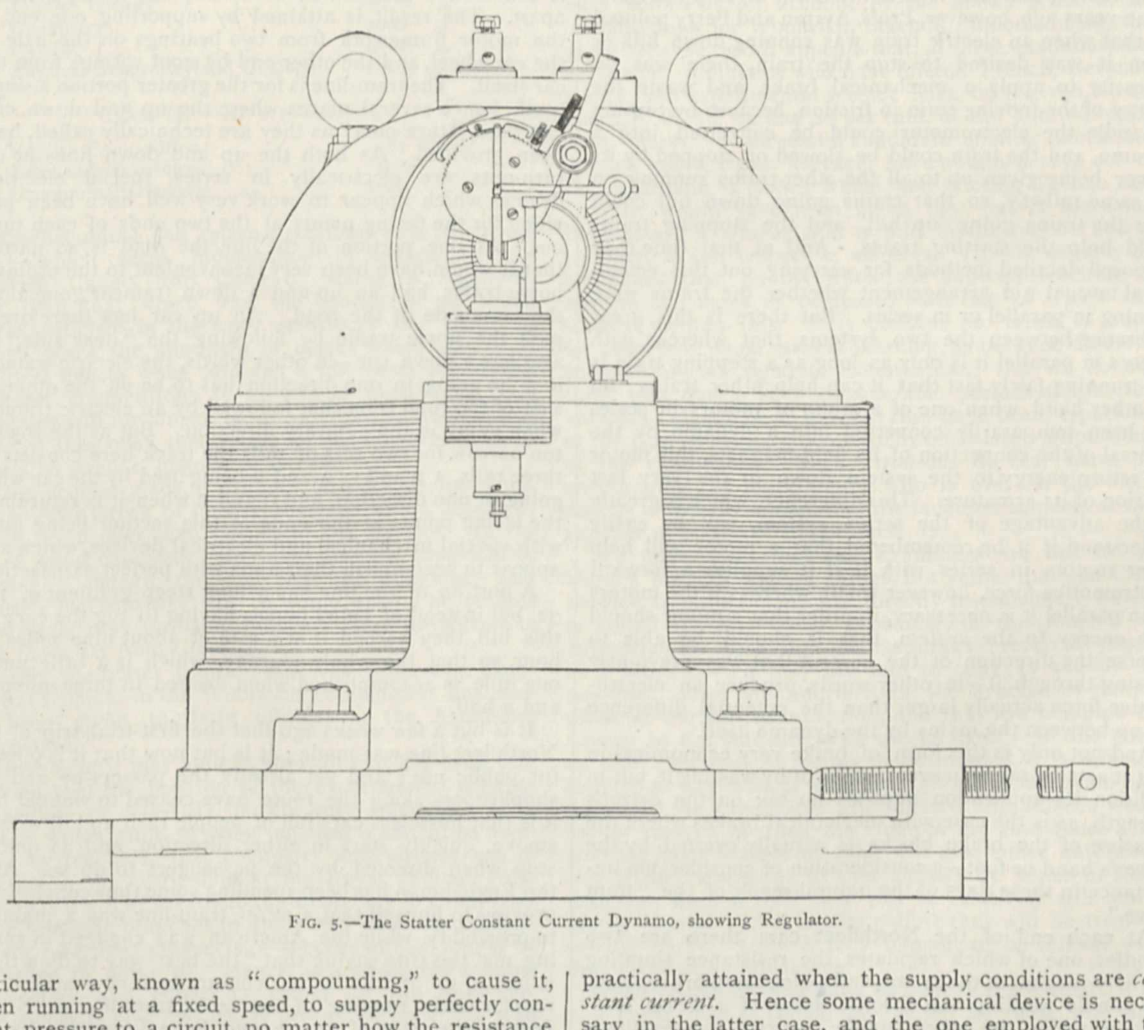


FIG. 5.—The Statter Constant Current Dynamo, showing Regulator.

seen in Fig. 5. A small pinion rotated by the dynamo shaft rocks a double ratchet by means of an eccentric. One or other of the ends of this ratchet is pulled down and made to engage with the ratchet wheel depending on whether the current is greater or less than 50 amperes, the normal current supplied to the line. The rotation of the ratchet wheel alters the positions of the brushes on the commutator, until the current is diminished or increased to 50 amperes, when the iron core attached to the ratchet, and which was previously sucked down below its normal position by the solenoid, or not sucked down so far, is now held in its normal position, and the ratchet kept free of the ratchet wheel. This mechanical constant current regulator works well, with a surprisingly small amount of sparking at the commutator.

As constant current is supplied to the line, the speed of the car could not be altered by introducing resistance into the circuit; what is done therefore is to shunt the field magnets of the motor with a less and less resistance by moving a lever on the car, as less and less power is required to be developed by the motor. When the car is at rest at the end of the journey, the motor is entirely cut out of the circuit by the handle being pushed full home. With horse tramcars a mechanical brake must be employed, and the energy of the moving car wasted in friction; indeed with the continuous vacuum brakes on the modern railway trains, not merely is the energy of the train wasted, but coal is actually burnt to stop the train. Some years ago, however, Profs. Ayrton and Perry pointed out that when an electric train was running down hill, or when it was desired to stop the train, there was no necessity to apply a mechanical brake and waste the energy of the moving train in friction, because by turning a handle the electromotor could be converted into a dynamo, and the train could be slowed or stopped by its energy being given up to all the other trains running on the same railway, so that trains going down hill could help the trains going up hill, and the stopping trains could help the starting trains. And at that time they proposed detailed methods for carrying out this economical mutual aid arrangement whether the trains were running in parallel or in series. But there is this great difference between the two systems, that whereas with motors in parallel it is only as long as a stopping train is still running fairly fast that it can help other trains; on the other hand, when one of a group of motors in series has been temporarily converted into a dynamo by the reversal of the connection of its field-magnets, this motor can return energy to the system down to the very last rotation of its armature. This difference, which is greatly to the advantage of the series system, will be easily understood if it be remembered that a motor will help other motors in series with it if it supplies a forward electromotive force, however small, whereas if the motors be in parallel it is necessary, in order that a motor should give energy to the system, that it should be able to reverse the direction of the current that was previously passing through it—in other words, produce an electromotive force actually larger than the potential difference set up between the mains by the dynamo itself.

And not only is this form of brake very economical in that it acts by saving power instead of by wasting it, but in addition its application imposes no tax on the driver's strength, as is the case with mechanical brakes where the pressure of the brake blocks is actually exerted by the driver's hand or foot—a consideration of considerable importance in these days of the natural revolt of the "tram slave."

At each end of the Northfleet cars there are two handles, one of which regulates the resistance shunting the field-magnet of the motor, and which therefore replaces the handle working the throttle valve of a steam locomotive, while the other handle reverses the terminals of the field-magnet, or short-circuits them when it is in its middle position, and therefore replaces the handle which operates the link motion in the locomotive. During the several journeys we made in the cars, we had frequent opportunity of seeing how perfectly they were under control, even when descending the steep hill near the Northfleet railway station.

One defect of the parallel system of working electric tram-lines is that it is possible for a mischievous person to cut off the power from the whole line, while at the same time the constant potential difference dynamo is made to produce far more than its normal current, by his laying an iron crowbar so as to electrically connect the going and return conductor. This result he may be able to accomplish without much difficulty, since both these conductors must be sufficiently exposed along their whole length that the passing train can maintain electrical contact with both of them. With the series system, on the other hand, such a catastrophe is impossible, since the return conductor, 3, marked "line" in Fig. 3, is completely buried out of sight.

A considerable amount of ingenuity has been displayed in the mechanical details both on the cars themselves and on the track at Northfleet. The motor, for example, is geared directly to a spur wheel on the car wheel shaft by double helical gearing, which runs without biting, and at the same time without any chance of slip, since the axle of the motor and the axle of the car wheel driven by it are always maintained at exactly the same distance apart. The result is attained by supporting one end of the motor framework from two bearings on the axle of the car wheel, and the other end by stout springs from the car itself. The tram-line is for the greater portion a single track, hence several places where the up and down cars can pass, "turn-outs" as they are technically called, have been provided. As both the up and down lines at the turn-outs are electrically in series, special electrical devices which appear to work very well have been provided for the facing points at the two ends of each turn-out. At one portion of the line the road is so narrow that it would have been very inconvenient to the ordinary horse traffic, had an up and a down tramcar gone along the same side of the road. An up car has therefore to pass the horse traffic by following the "near side," so also has a down car—in other words, the electric tramcar if it be going in one direction has to be on the opposite side of the road from that followed by an electric tramcar when going in the contrary direction. But as the road is too narrow for two sets of rails the track here consists of three rails, A B and C, A and B being used by the car when going in one direction, and C and B when it is returning: the facing points at the ends of this section being fitted with special mechanical and electrical devices, which also appear to accomplish their aims with perfect satisfaction.

A portion of the line has a long steep gradient of 1 in 32, but instead of jaded horses having to tug the cars up this hill, they ascend it at a rate of about nine miles an hour, so that the whole journey, which is a little under one mile, is accomplished when desired in three minutes and a half.

It is but a few weeks ago that the first trial trip of the Northfleet line was made; it is but now that it is opened for public use; and yet already the passers-by and the shopkeepers along the route have ceased to wonder how it is that horseless cars full of people rush up hill without smoke, quickly start in either direction, and as quickly stop when directed by the passengers to do so. After the Englishman has been spending some time conclusively proving to himself that a *series* tram-line was a practical impossibility, while the American was engaged in carrying out the trite saying that "the best way to do a thing is just to go and do it," our countrymen now accept the regular daily running of the *series* tram-line at Northfleet as a matter of course, and have forgotten that its very marked success ought to astonish them.

THE EXAMINATIONS FOR WOOLWICH AND SANDHURST.

THE revised Code for these examinations has at length been published. It is to come into force after January 1, 1891. There is to be a preliminary examination in elementary Arithmetic, Euclid, Algebra, French or German, writing English from dictation, elementary Latin, Geometrical Drawing, and Geography, for which no marks are given. We regret that as this examination has now been extended till it includes nearly all the main subjects of a modern education, an elementary knowledge of some branch of science is not also required. There is also to be a further examination for those who pass the preliminary, for which the following Code has been adopted:—

CLASS I.—*Obligatory.*

Mathematics (for Woolwich) ...	3000 Marks
,, (for Sandhurst) ...	2500 ,,
Latin	2000 ,,
French or German	2000 ,,

CLASS II.—*Any two Subjects may be taken up.*

Higher Mathematics	2000 Marks
German or French	2000 ,,
Greek	2000 ,,
English History	2000 ,,
Chemistry	2000 ,,
Physics	2000 ,,
Physical Geography and Geology	2000 ,,

CLASS III.—*All may be taken.*

English Composition	500 Marks
Freehand Drawing	500 ,,
Geometrical Drawing	1000 ,,

Notwithstanding the relative positions of science and Latin—which seem indefensible in regard to the Woolwich Cadets—this Code of marks is decidedly better than that which was the subject of so much adverse criticism in the early months of last year. In the first place, the allotment of marks which had such disastrous effects when adopted a few years ago in the Sandhurst competitions is at length abandoned, and candidates will no longer be at any disadvantage in this respect if they offer themselves for examination in such subjects as science, history, or Greek.

In the second place, it will now be possible for candidates to offer Greek or history, together with a branch of science, or to offer both chemistry and physics. In the case of some candidates this may prove a considerable advantage; though the fact that the obligatory and advanced mathematics can to some extent be studied concurrently may probably induce a large proportion to select the latter from Class II.

Thirdly, the better position that was claimed for experimental sciences in the Woolwich competition has now also been given to these subjects in the Sandhurst examination.

At first sight it may appear, after all that has been said and done, that the position of the experimental sciences as members of Class II. is not very splendid. It is therefore worth while to point out, lest it should be overlooked by teachers, that chemistry and physics are so important in the curriculum at the Royal Military Academy, that it will be greatly to the advantage of candidates for the scientific branches to study and offer one of these subjects, now their prospects of success will no longer be diminished by doing so. Hence, as a whole, the scheme for selecting and educating cadets for the Engineers and Artillery is now reasonably favourable for those who exhibit an aptitude for the experimental branches of science. We think this will soon be recognized by the candidates themselves, and that those who are interested in the science of our public schools will also quickly perceive the importance of the changes that have been secured in the face of very considerable difficulties by the action of Sir Henry Roscoe and the other scientific members of the House of Commons.

Altogether, therefore, it may decidedly be said that the authorities at the War Office are to be congratulated on the result of their consultations with Sir Henry Roscoe and other educational authorities. The new Code is not ideal. It does not fully recognize the importance of natural science in modern education, and it is to be feared that it will lengthen the examination to some extent. But, if it be fairly carried out, scientific candidates will not in future be placed at any great disadvantage, as compared with those who have studied other subjects, in the examinations for admission to either branch of the Army. In regard to this last point, however, it would be well if the Civil Service Commission took steps to remove the blot in their system of conducting public competitive examinations to which attention was called, some years ago, by Sir Lyon Playfair, in his Presidential Address to the British Association. We allude to the irregularity with which marks are awarded for the various subjects at more than one of these examinations. These irregularities are still unduly large. We have before us an account of the marks given in six examinations for Woolwich, taken at random during the years 1884–88, and it appears that, at these examinations, successful candidates who have offered French, German, Greek, and experimental science have been given, on an average, 38, 35, 29, and 28 per cent. of the allotted maximum marks. A successful candidate offering Greek and science would, on an average, have obtained 1154 out of the maximum of 2000; whilst one offering French and German would have been given 1491 out of the same maximum. A similar tale is told by the highest marks awarded in the respective subjects. It will scarcely be contended that, on the whole, the superior teaching of modern languages, as compared with that of Greek and science, justifies this. It is perhaps too much to hope for absolutely equal rates of marking, as between different subjects at each separate examination. But we do not think that during such considerable periods of time the variations should be so great as they have been, especially in the case of subjects taken up by fairly large proportions of the candidates. Such variations do real harm by encouraging the mark-hunter, who is ever on the alert, and by artificially stimulating the favoured subjects at the expense of others of importance.

We understand that the examiners are not to be blamed for this state of things, but rather that the Civil Service Commissioners are directly responsible. For it is stated by Mr. Oscar Browning, in the *Journal of Education* for April, that the examiners "receive a paper as a model which they are told to copy as exactly as possible. They are informed of the average of marks given at the last examination, and they are enjoined to adhere to the standard with special care." If this goes on year after year, as seems to be implied, it is difficult to see how any code of marks can secure a fair examination. If the candidates who offered any subject were hardly treated in 1888, the chances are that those who offer the same subject in 1889 will also suffer hardness. For if the candidates in that subject be better in 1889 than they were in 1888 they will be relatively still more hardly treated. If of similar calibre they will be treated equally badly. Only if they happen to be inferior will they stand at an advantage.

If the system of examining be as it is represented, it is high time that it should be revised by those who are responsible for it.

NOTES.

We regret to announce the death of Mr. Robert Damon, of Weymouth, the well-known naturalist and geologist. He died suddenly on Saturday, the 4th instant, from heart disease. Mr. Damon was the author of an excellent work on the "Geology of Weymouth and the Isle of Portland," now in its second edition. He was a most extensive traveller and an assiduous collector. He obtained a marvellous series of fossil fishes from the Cretaceous beds of the Lebanon, Syria, now in the British Natural History Museum, also the most complete skeleton of that rare and extinct Sirenian, "Steller's Sea-cow," from Behring Island. Although in his seventy-fifth year, he contemplated another trip to Siberia to procure an entire Mammoth's skeleton for the National Museum. Only a few years ago he took passage from Nijni Novgorod, down the Volga to Astrakhan, for the purpose of collecting a complete series of the fishes of the Caspian Sea, in which he was most successful. He lately purchased the celebrated zoological collections forming the "Godeffroy Museum" in Hamburg, and he had perhaps the largest collection of recent shells in this country. Mr. Damon's loss will be long felt by a wide circle of scientific friends in all parts of the world, by whom he was warmly esteemed and respected.

The Paris Exhibition was opened on Monday by the President of the French Republic. As usual on such occasions, there was a great display of empty spaces which ought to have been, and soon will be, filled with exhibits. The British Section was greatly in advance of the others. M. Carnot, in speaking of the general character of the Exhibition, referred emphatically to "the surprises reserved for our generation by the marvellous progress of science."

At the Royal Academy banquet, on Saturday last, Sir Henry Roscoe responded to the toast for "Science." He spoke of the intimate relations between science and art, and, as an illustration of the services rendered by the former to the latter, referred to the fact that this year we celebrate the jubilee of the discovery of photography. "In 1839," he said, "the power of the sun to draw in black and white was first indicated by Daguerre and Fox Talbot. In her infancy exhibiting but slight promise of artistic life, Photography, in her maturity, has developed true artistic power, so that she has now grown to be a trusted and valued helpmate to the artist, while she can produce effects and catch expressions which might defy the brush of a Turner or a Reynolds."

An International Congress of Photography will be held in Paris from August 6 to 17. If we may judge from the programme, which has been issued by the Organizing Committee, the proceedings are likely to be of great interest. Anyone may suggest subjects of discussion on condition that the suggestions are sent to the secretary (M. S. Pector, 9 rue Lincoln, Paris) at least fifteen days before the opening of the Congress. On August 20 there will be a public conference on the labours of the Congress.

The third of the series of One-Man Photographic Exhibitions at the Camera Club is now open to visitors on presentation of card. The Exhibition will continue for about two months. The object of this series of exhibitions is to bring together, in turn, representative collections of the work of the best photographic artists. The photographs shown on the present occasion are by Mr. J. Gale. They are chiefly photographs of landscape, and landscape with figure, and are printed in platinum and in silver processes.

Science gives the following as a complete list of the papers presented and read to the American National Academy of Science, at its meeting in April: on composite coronagraphy, by D. P. Todd; additional experimental proof that the relative coefficient of expansion between Baily's metal and steel is constant between the limits zero and 95° F. (read by title), by W. A. Rogers; notice on the method and results of a systematic study of the action of definitely related chemical compounds upon animals, by Wolcott Gibbs and Hobart Hare; on sensations of colour, and determinations of gravity, by C. S. Peirce; on the Pliocene Vertebrate fauna of Western North America, and on the North American *Proboscidea*, by E. D. Cope; on the mass of Saturn, by A. Hall, Jun.; on the nature and composition of double halides (read by title); on the rate of reduction of nitro-compounds, and on some connection between taste and chemical composition, by Ira Remsen; recent researches in atmospheric electricity, by T. C. Mendenhall; measurement by light-waves, by A. A. Michelson; on the feasibility of the establishment of a light-wave as the ultimate standard of length, by A. A. Michelson and E. W. Morley; on the general laws pertaining to stellar variation, by S. C. Chandler; review of the trivial names in Piazzi's Star Catalogue, by C. H. F. Peters; on Cretaceous flora of North America, by J. S. Newberry; terrestrial magnetism (read by title), Cleveland Abbe; spectrum photography in the ultra-violet, by Romyn Hitchcock; North American *Pelagidæ* (read by title), and development of Crustacea (read by title), by W. K. Brooks; the plane of demarcation between the Cambrian and pre-Cambrian rocks, by C. D. Walcott; report of the American Eclipse Expedition to Japan, 1887, by D. P. Todd.

It is reported from India that Mr. Blanford, Meteorological Reporter to the Government of India, who retires at the end of his furlough, has been recommended for the special pension of 6000 rupees per annum.

The following "resolution" of the Government of Bombay, which has just been published, tells its own story, and adds another to the already numerous examples of the well-judged munificence of the Parsee community of Bombay. The resolution is entitled "Scientific Medical Research." "(1) The sum of Rs. 75,000 having been placed at the disposal of his Excellency the Governor by Mr. Framjee Dinshaw Petit, for the purpose of erecting and fitting a laboratory for scientific medical research, on a site which has been approved by the donor, in the immediate vicinity of the Grant Medical College, the Governor in Council has much pleasure in accepting the offer, and, in doing so, desires publicly to thank Mr. Framjee Dinshaw Petit for his munificence in supplying an institution, the want of which has long been felt by those most interested in promoting the cause of higher medical education in this Presidency. (2) The Governor in Council is pleased to direct that the institution shall be called 'The Framjee Dinshaw Petit Laboratory for Scientific Research.' (3) Instructions for the preparation of the necessary plans and estimates for the proposed building have already been given."

The native population of Benares cannot be said to have very advanced ideas as to the importance of sanitary science. The other day a monster meeting was held in that city to protest against certain proposed drainage and water supply schemes, and a petition to the Government condemning the entire action of the municipality in the matter is said to bear 100,000 signatures. According to the Calcutta Correspondent of the *Times*, the petitioners emphatically decline to pay by increased taxation for any new system.

Last winter the Vienna Medical School was attended by 150 British and American medical graduates, among whom were many Edinburgh men. As many medical students, on their arrival at Vienna, do not know German, the Vienna *Weekly News* has opened a special "medical inquiry office" near the hospital, where information as to lectures, lodgings, &c., is given without charge to British and American medical men.

The same journal publishes weekly a list of forthcoming courses of lectures at the Universities of Vienna and Berlin.

THE *Times of Colombo* announces the arrival in Ceylon of two naturalists, Herr Frühstorfer and Herr Kannegieter, the former a German, the latter a native of Amsterdam. Herr Frühstorfer has already travelled over a great part of the world making natural history collections, while his companion is travelling on behalf of the collection of Herr Van de Poll. Both were about to proceed to the southern part of Ceylon, and after a few weeks' exploration they intended going, one to Malacca and Borneo, the other to Sumatra and Java, for scientific purposes.

A SEVERE earthquake lasting four seconds occurred at Agram on April 27 at 8.35 p.m.

A NEW stalactite cave has been found at Hönnethal, in Sauerland, not far from the village of Sanssouci. It is not very large, but has many beautiful stalactites.

COMPLAINTS having, on several occasions, been made to the Fishery Board for Scotland that salmon smolts are exposed for sale and sold, the Board have issued a notice to the effect that such sale, or exposing for sale, is illegal, and renders the seller or exposer liable to severe pecuniary penalties. The word "salmon" in the Salmon Fishery Acts of 1862 and 1868 means and includes "salmon, grilse, sea trout, bull trout, smolts, parr, and other migratory fish of the salmon kind." All offences under the Salmon Fishery Acts of 1862 and 1868 may be prosecuted, and all penalties incurred may be recovered, "before any sheriff or any two or more justices acting together, and having jurisdiction in the place where the offence was committed, at the instance of the clerk of any District Board, or of any other person."

WITH regard to Prof. Harker's article on a new farm pest, printed in NATURE last week, Miss Ormerod writes that, "if, by any accident, readers should think that what her valued friend Prof. Harker meant only as a courteous acknowledgment of specimens was an expression of belief in the injurious powers of this worm, she would in such case like to be able to mention that up to the present time she sees no reason for alarm."

A SERIES of experiments upon combustions in nitric acid vapour have been made by Dr. P. T. Austen, of Rutger's College, U.S. The gaseous nitric acid is most conveniently obtained in the following manner. Into a large flask, whose neck is sufficiently wide to admit a good-sized deflagrating spoon, a quantity of sulphuric acid is poured, so as to form a layer about half an inch deep. About ten to twenty grammes of potassium nitrate, in crystals averaging a quarter of an inch in size, are then added. On careful heating, the air is rapidly expelled, and the flask becomes filled with the clear vapour of nitric acid. A glowing chip of wood held in this vapour inflames and burns energetically, something after the manner of combustion in oxygen; but, as the red tetroxide of nitrogen, N_2O_4, is formed by the reduction of the nitric acid, a ruddy halo is seen to play around the flame. Charcoal, especially bark-charcoal, burns brilliantly, the scintillations in the red tetroxide gas producing an unusually fine effect. In a similar manner a steel watch-spring may be burnt as in oxygen, the combustion being started with a little sulphur; the effect, however, is quite different from that in oxygen, owing to the formation of a red halo around each melted globule of iron as it falls. A layer of sand should be placed in the bottom of the flask in this experiment, in order to prevent fracture. Phosphorus burns with great beauty, the dazzling white flame passing into a deep red at the edges. By far the most beautiful effects, however, are obtained by the combustion of readily oxidizable gases from jets suspended in the nitric acid vapour. Hydrogen burns with an intensely white flame, totally unlike that in oxygen, surrounded by a deep red envelope. Coal gas continues to burn with a white centre, enveloped as in case of hydrogen by a red halo; when first introduced the flame becomes musical, then degenerates into a series of rapid slight explosions; at length, after a certain amount of nitrogen tetroxide has formed, it burns quietly. Sulphuretted hydrogen gas burns with a bright yellow flame, and the flask becomes filled with a cloud of minute chamber-crystals, resulting from the action of the sulphur dioxide and water formed upon the tetroxide of nitrogen simultaneously produced. Ammonia gas burning in nitric acid vapour is perhaps the most beautiful case of simple combustion yet investigated. Success in this experiment appears to depend entirely upon the size of the orifice of the jet, which should not be less than an eighth of an inch in diameter. As soon as the jet, which of course should be turned upwards, from which a good stream of ammonia is issuing, is lowered to a level with the mouth of the flask, it may be readily ignited. On lowering it into the centre of the flask, the flame is seen to consist of a bright yellow nucleus surrounded by a greenish-yellow envelope; this, in turn, passes into an outer envelope of a carmine-red colour, which deepens as the amount of nitrogen tetroxide increases.

ACCORDING to the *Manchester Guardian*, a technical school has lately been added to the ancient Chetham College, "the most unique piece of antiquity" left in Manchester. It seems that a well-known employer of labour in Salford, and a strong supporter of technical education in Manchester and the neighbourhood, generously offered to fit up a workshop and supply it with all necessary tools for the use of Chetham College. The offer, which was regarded both as a very generous and a very happy one, was accepted by the authorities. The result was the erection of a building at the north-east rear of the College dormitories. The building, which is very well lighted and comfortably heated, has been fitted up with lathes (for wood and iron) driven by a steam-engine; also benches, drilling machines, grindstones, blacksmith's forge, vices, &c. The results so far are regarded as highly satisfactory. Some forty-five of the boys are now regularly engaged in the shop; fifteen working in the morning, fifteen in the afternoon, another batch of fifteen the next morning, and so on. Each boy works nine hours in the shop every week.

MR. ROWLAND WARD writes to the *Times* that on Saturday, April 27, one of the keepers on the estate of Mr. Farnal Watson, in Surrey, trapped a fine specimen of the kite (*Falco milvus*)—"a grand bird," says Mr. Ward, "at one time common on our moors before men became so many in the land, and their hospitality, even to such visitors, so scant." Mr. Ward notes that these birds are still sometimes encountered in Wales.

MR. ALLAN HUME proposes to issue a second edition of his "Nests and Eggs of Indian Birds." It will be edited by Mr. E. W. Oates, author of a "Hand-book to the Birds of British Burmah," and will incorporate all the notes which Mr. Hume's numerous correspondents in all parts of India have sent to him since 1873, as well as some notes from other sources. The work will be published in three volumes, 8vo, of 500 pages each; but for the convenience of subscribers it will be issued in six parts, one of which will be completed every three months, beginning from an early date. The publisher will be Mr. R. H. Porter, 18 Princes Street, Cavendish Square, London, W.

A COLLECTION of Prof. Weismann's essays on heredity has been translated under the care of Mr. E. B. Poulton, of Oxford, and will form the second volume of the series of translations of foreign biological memoirs which the Clarendon Press are publishing. The volume is nearly ready, and may be expected shortly.

MESSRS. CROSBY LOCKWOOD AND SON have published a second edition of M. Eissler's "Metallurgy of Gold." The work has been enlarged by about 150 pages and 40 additional illustrations.

WE have received the seventh part of Cassell's "New Popular Educator," which will be completed in forty-eight parts. This part contains a lithograph presenting the constellations visible in Britain.

MESSRS. C. GRIFFIN AND CO. have published the sixth annual issue of the "Year-book of the Scientific and Learned Societies of Great Britain and Ireland." The work, which is compiled from official sources, comprises lists of the papers read during 1888 before Societies engaged in fourteen departments of research.

THE additions to the Zoological Society's Gardens during the past week include an Indian Wolf (*Canis pallipes* ♀) from India, presented by Major C. S. Skipton, R.A.; two Stone Curlews (*Œdicnemus scolopax*), British, presented by Mr. Brunsden; a Golden Eagle (*Aquila chrysaëtus*) from Inverness-shire, presented by Mr. Thomas G. Henderson; a Cape Mole-rat (*Georychus capensis*), a Geometric Tortoise (*Testudo geometrica*), four Tuberculated Tortoises (*Homopus femoralis*), six Narrow-headed Toads (*Bufo angusticeps*), thirty-four Gray's Frogs (*Rana grayi*), a Spotted Slowworm (*Acontias meleagris*), from Cape Colony, South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Puff Adder (*Vipera arietans*) from the Cape of Good Hope, presented by Mr. F. Streatfield; six European Tree Frogs (*Hyla arborea*), European, presented Mr. H. Bendelack Hewetson, F.Z.S.; a Rhesus Monkey (*Macacus rhesus* ♀) rom India, deposited; two White-eyed Ducks (*Nyroca ferruginea*), European, two Black-necked Swans (*Cygnus nigricollis*) from Antarctic America, two Lineated Kaleege (*Euplocamus lineatus*) from Tenasserim, a Brazilian Tortoise (*Testudo tabulata*) from South America, a Blackish Sternothere (*Sternothœrus subniger*) from Madagascar, purchased; a Persian Gazelle (*Gazella subgutterosa*), two Chinchillas (*Chinchilla lanigera*), four Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *MAY* 12–18.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 12

Sun rises, 4h. 15m.; souths, 11h. 56m. 10·1s.; daily decrease of southing, 1·2s.; sets, 19h. 38m.: right asc. on meridian, 3h. 17·9m.; decl. 18° 15′ N. Sidereal Time at Sunset, 11h. 1m.

Moon (Full on May 15, 7h.) rises, 15h. 55m.; souths, 21h. 57m.; sets, 3h. 45m.*: right asc. on meridian, 13h. 20·1m.; decl. 2° 58′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury..	4 48 ...	13 10 ...	21 32 ...	4 32·4 ...	24 8 N.
Venus.....	3 21 ...	10 45 ...	18 9 ...	2 6·3 ...	15 16 N.
Mars	4 38 ...	12 37 ...	20 36 ...	3 58·6 ...	20 55 N.
Jupiter....	23 18*...	3 14 ...	7 10 ...	18 34·0 ...	22 58 S.
Saturn....	10 7 ...	17 45 ...	1 23*...	9 7·8 ...	17 42 N.
Uranus ...	16 17 ...	21 46 ...	3 15*...	13 9·8 ...	6 42 S.
Neptune..	4 50 ...	12 37 ...	20 24 ...	3 59·4 ...	18 56 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

May.	h.	
18 ...	3 ...	Jupiter in conjunction with and 0° 15′ south of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·5 ...	81 17 N. ...	May 16,	1 11	*m*
R Aurigæ	5 8·3 ...	53 28 N. ...	,, 13,		*M*
W Leonis	10 47·8 ...	14 18 N. ...	,, 13,		*M*
T Ursæ Majoris ...	12 31·3 ...	60 6 N. ...	,, 15,		*m*
δ Libræ	14 55·1 ...	8 5 S. ...	,, 13,	23 25	*m*
U Ophiuchi... ...	17 10·9 ...	1 20 N. ...	,, 17,	0 10	*m*
R Scuti	18 41·6 ...	5 50 S. ...	,, 13,		*M*
β Lyræ...	18 46·0 ...	13 14 N. ...	,, 14,	22 30	*M*
U Aquilæ	19 23·4 ...	7 16 S. ...	,, 18,	1 0	*M*
R Capricorni ...	20 5·1 ...	14 36 S. ...	,, 17,		*M*
X Cygni	20 39·1 ...	35 11 N. ...	,, 17,	2 0	*m*
T Vulpeculæ ...	20 46·8 ...	27 50 N. ...	,, 13,	1 0	*M*
δ Cephei	22 25·1 ...	57 51 N. ...	,, 15,	21 0	*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Near α Coronæ	232° ...	27 N. ...	Faint. Rather slow.
,, η Aquilæ	295 ...	0 ...	May 15. Very slow.
From Delphinus	313 ...	15 N. ...	Swift. Streaks.

GEOGRAPHICAL NOTES.

DR. H. MEYER, in a paper read before the Geographical Society of Leipzig, deals with the snowfall on the summit of Kilimanjaro. Having shown that the southern and south-eastern slopes of the mountain are exposed during summer to the south-eastern trade winds, while the summit rises into the region of the anti-trades, and that local winds, sometimes of considerable force, ascend the mountain slope during the day, and descend during the night, he explains how these winds produce rain and snow. Dr. Meyer looks upon the wall of ice which stopped his further progress as the edge of a cap of *névé* which covers the summit, and which, owing to the combined influence of the wind and radiation, has melted away on its northern side. On the south, however, it seems to form a true glacier, which issues from the ancient crater-trough of Kibo.

SOME of the conclusions come to by Dr. K. W. Schmidt, in his paper on the soil and climate of German East Africa, in the current number of *Petermann's Mitteilungen*, are worth giving in detail. The wooded and mountainous region of Usambara and the western part of Bondei, in consequence of the favourable character of the soil, the copious rainfall, and extensive irrigation, may be truly described as fertile, and in the opinion of the author these countries have a great future before them. West of Usambara extend vast steppes, utterly unfit for cultivation. The mountain mass of Kilimanjaro, composed of recent, volcanic, basaltic, and trachytic rocks, and clothed with a wealth of forests, should become of great importance. The physical condition of the country between the Pangani and the Wami are apparently not very favourable. Westwards the country of Nguru, in its geological formation, its magnificent forests, its numerous streams, and its meteorological conditions, resembles Usambara. Southern Useguha, as far as the Kingani and Gerengere, including the districts of Udoe and Ukewere, is nothing but a vast waterless steppe. Ukami, in its western part, abounds in lofty forest-clad mountains and rushing streams, and its soil is well adapted for cultivation; the soil of the eastern part of Ukami is, on the other hand, composed almost exclusively of quartz pebbles and gravel. Immediately to the west of Ukami stretches the vast desolate Mkata steppe, beyond which rises the mountainous country of Usagara, divided by the Mukondokwa River. The plain of Farhani, traversed by the river, is fertile and well populated. The mountainous district of Usagara itself suffers from a lack of streams, and also from the sparsely wooded character of its mountain slopes, at least in the eastern part. The country of Khutu, in its various river valleys, might furnish soil suitable for extensive cultivation. The general results of Dr. Schmidt's observations is to show that there is a great difference in the fertility and consequent value of the various countries comprised within the German protectorate in East Equatorial Africa, and that while there is a considerable extent of extremely fertile territory, the greater part does not appear to be capable of remunerative cultivation.

THE LIVERPOOL MARINE BIOLOGY COMMITTEE'S EASTER DREDGING CRUISE.

THE Liverpool Salvage Association's s.s. *Hyæna* left the Mersey on Thursday, April 18, on her fifth scientific cruise under the direction of the Liverpool Marine Biology Committee. The old gunboat had been generously placed at the disposal of the L.M.B.C. for five days, and the proposed course was to cross to Port Erin, at the south end of the Isle of Man, and then dredge southwards to Holyhead through the deepest water to be found in this district; then to work along the coast of Anglesey to Puffin Island, and from that back to Liverpool. Besides the ordinary dredging and tow-netting operations, it was hoped that two interesting new methods of collecting would be tried on this cruise: (1) the submarine electric light, which gave such good results in the *Hyæna* expedition of last summer, was to be used as an attraction in the nets let down to the bottom at considerably greater depths than was the case in last year's experiments at Ramsey and Port Erin; (2) Mr. W. E. Hoyle's new tow-net (recently described in the Proc. Biol. Soc. Liverpool, vol. iii.), which can be opened and closed at any required depth, so as to insure that the contents were captured in a particular stratum of water, was to be taken with the view of trying how it worked.

After the first day, however, the weather although fine on land became very unfavourable for marine work, and the programme had to be considerably altered. Thursday was spent in crossing to Port Erin. On Friday morning we steamed south-west towards the deep water, but a strong wind was blowing, and after a haul of the dredge in 27 fathoms, about five miles out, some bottom and surface tow-netting, a sounding in 50 fathoms, and a further run to about nine miles from land, it was found that the heavy rolling of the vessel rendered dredging operations impossible out in the open sea; so the *Hyæna* was put about and returned to Port Erin, where tow-netting and other work was carried on in the bay. The following day the wind was still stronger, so it was decided to give up the Anglesey part of the cruise and devote the remaining days to shore and shallow-water work round the south end of the Isle of Man. Accordingly the rocks at Port Erin, Port St. Mary, Poyllvaaish Bay, and Fleshwick Bay were explored on the third day, while on the fourth most of the day was spent on board the *Hyæna*, at anchor in Port Erin Bay. Tow-nets were let down, both on the surface and weighted so as to reach the bottom, and a small dredge with a long canvas net was taken out in a boat and used for obtaining samples of mud and sand to examine for small animals, such as Foraminifera, Copepoda, and Ostracoda. The strong wind blowing was utilized by Captain Young, who suggested floating tow-nets across the bay with life-buoys, and devised a sailing apparatus, consisting of an old life-buoy rigged up with a mast and sail, and having a tow-net suspended from it, which was let out carrying a long line to leeward and was then hauled in, the net keeping distended and working well during both the outward and the return journeys. Another surface-net was even rigged up attached to a large kite, but this did not work satisfactorily.

In the afternoon the *Hyæna* made two runs from Port Erin southwards to the Calf, dredging homewards with the wind, and got two excellent hauls, which contained amongst other things: *Sarcodictyon catenata*, *Stichaster roseus*, *Palmipes membranaceus*, *Porania pulvillus*, *Adamsia palliata*, and *Pagurus prideauxii*, *Ebalia* sp., *Lyonsia norvegica*, *Pectunculus glycimeris*, and *Ascidia venosa*.

After dark on two consecutive nights the electric light was used for a couple of hours in collecting bottom and surface free-swimming animals round the ship, in much the same way as during last summer's cruise. A pair of large arc lamps of 2000 candle-power each were hoisted up in such a position as to illuminate the deck and cast a bright light on the water for some distance on each side of the ship. Three submarine incandescent lamps of 50 candle-power each were then fitted in the mouths of tow-nets and were let down, two of them to the bottom at a depth of 5 fathoms, and the third to a foot or so below the surface of the sea. Each of these nets was put out twice, so that we got four bottom hauls and two surface hauls with the electric light tow-nets. Another tow-net, without any lamp, was let over the side of the *Hyæna*, and lay in the brightly illuminated surface water. All these nets were stationary, but were kept fairly distended by the tide. At the same time Mr. I. C. Thompson was rowed round and round the ship dragging an ordinary tow-net in the bright area. Consequently all the nets were, on this occasion, used in water lighted up, the surface nets being in the glare of the 4000 candle-power lamps, while the bottom nets were further from this bright light, but had each their own smaller lamps. All gave, so far as we yet know, from a cursory examination, practically similar results which are markedly different from both the bottom and surface gatherings taken at the same place during the previous day. The electric light gatherings contain chiefly Schizopoda, Cumacea, Amphipoda, and a few Copepoda. The Cumacea are the most marked feature, they are very abundant, and form a conspicuous characteristic in the gathering whenever it is transferred from the net into a glass jar. In none of the daylight tow-nettings, either bottom or surface during the cruise, was a single Cumacean obtained, while every gathering on the two nights when we had the electric light going contained Cumacea in abundance. I think there can be little doubt that those captured in the surface-nets had been attracted from the bottom by our brilliant deck-lights, which had been shining for fully half an hour before the nets were put over.

On the fifth day the *Hyæna* started in the morning from Port Erin and arrived at Liverpool at midnight. A little dredging and tow-netting was done on the way. A good haul was obtained from a stony and shelly bottom, at about 15 miles south-east of the Chicken Rock, depth 30 fathoms, which yielded large numbers of Polyzoa, chiefly incrusting forms. At this spot also, it being the deepest water on our track from Port Erin to Liverpool, we let the electric lamp down to the bottom in a tow-net twice, and got gatherings consisting mainly of Copepoda, *Sagitta*, Amphipoda, Zoëas, and other larval forms.

That free-swimming Crustaceans are attracted to a stationary net by the electric light may now be considered established beyond doubt; and that the illuminated tow-net can be used in, at least, such moderately deep water as is commonly met with in dredging round our coasts was evident to all who saw the success with which the net was worked on board the *Hyæna* in 30 fathoms.

The various tow-net gatherings and dredged collections were as usual preserved and brought home, and are now in the hands of the specialists who are working at the different groups of animals for the Liverpool Bay "Fauna."

W. A. HERDMAN.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, May 2.—Mr. C. B. Clarke, F.R.S., in the chair.—With reference to a recent exhibition, by Mr. D. Morris, of leaves of different species, or varieties, of plants included under *Erythroxylon Coca*, Lamarck, Mr. Thomas Christy made some remarks on the leaves of a variety from Japan. These he described as brittle and thin, with hardly any trace of cocaine, though yielding 8 per cent. of crystallizable substance. The thicker leaves of the Peruvian plant yielded more cocaine, though at first rejected on account of their more glutinous nature.—Mr. John Carruthers read a short paper on the Cystocarps, hitherto undescribed, of a well-known seaweed, *Rhodymenia palmata*, upon which remarks were made by Mr. G. Murray and Mr. A. W. Bennett.—The second part of a monograph of the *Thelephoreæ* was communicated by Mr. G. Massee.—Mr. Mitten contributed a paper on all the known species of *Musci* and *Hepaticæ* recorded from Japan. An interesting discussion followed on the character of the Japanese flora, in which Mr. J. G. Baker, Dr. Braithwaite, and Mr. G. Murray took part.

Geological Society, April 17.—W. T. Blanford, F.R.S., President, in the chair.—The following communications were read:—On the production of secondary minerals at shear-zones in the crystalline rocks of the Malvern Hills, by Charles Callaway. In a previous communication the author had contended that many of the schists of the Malvern Hills were of igneous origin. Thus, mica-gneiss had been formed from granite, hornblende-gneiss from diorite, mica-schist from felsite, and injection-schists from veined complexes which had been subjected to compression. As a further instalment towards the elucidation of the genesis of the Malvern schists, he discussed the changes which the respective minerals of the massive rocks had undergone in the process of schist-making.—The northern slopes of Cader Idris, by Grenville A. J. Cole and A. V. Jennings. From the publication of Mr. Aikin's paper in the Transactions of the Geological Society in 1829 to the second edition of the

Survey Memoir on North Wales, the relations of the geological and physical features of Cader Idris have been pointed out in some detail. The present paper dealt with the nature of the eruptions that took place in this area, and the characters of their products at successive stratigraphical horizons.—Discussions followed the reading of both of these papers.

PARIS.

Academy of Sciences, April 29.—M. Hermite in the chair.—On a means of obtaining photographs of true chromatic value by the use of coloured glasses, by M. G. Lippmann. By the judicious employment of green, yellow, and red glass in the way here explained, excellent results have been obtained even with present plates, notwithstanding their greater sensitiveness to blue. The impressions are described as clear and free from brown patches, the green foliage, the red or yellow draperies, instead of yielding brown tints, being reproduced in delicately modelled design as in a well-executed engraving.—Loss and gain of nitrogen as determined by the experiments carried on at Grignon from 1875–89, by M. P. P. Dehérain. A general survey of the results of these experiments leads to the conclusion that all soils containing considerable quantities of nitrogen in combination, say two grammes to the kilogramme, lose, if cultivated without manure, far more nitrogen than is absorbed by the crops, but in proportions varying according to the nature of those crops—more with beetroot, less with maize grown for fodder, still less with potatoes and wheat. But when the ground has thus been impoverished, no longer containing more than 1·45 or 1·50 grammes to the kilogramme, the losses ceases and the ground begins, on the contrary, to recover a certain proportion of nitrogen, the gain being much greater on grass-grown than on tilled lands.—Underground growth, seed, and affinities of the Sigillaria, by M. Grand'Eury. The author, who has had a favourable opportunity of studying these fossil plants in the Carboniferous formations of the Gard, confirms the view always held by Prof. Williamson, that they are true Cryptogams of the vascular order, despite the radiated structure of the wood. But they are not directly connected with any living type, and form a family of fossil plants which entirely disappeared towards the close of the Palæozoic period.—Two eruptions observed on the sun in September 1888, by le Père Jules Fényi. These eruptions, observed on September 5 and 6, are described as of an extremely violent character, and as all the more remarkable because occurring at the epoch of minimum intensity. Both appear to have taken place about the same region of the solar disk, and the protuberance accompanying the first contained the vapours of several metals, such as sodium, barium, and iron, besides two very bright red rays of an unknown element, one between B and C, the other between B and *a*.—On the alloy of the standard international kilogramme, by M. J. Violle. The alloy of platinum and iridium in the proportion of 10 per 100, prepared with the greatest care by M. Matthey, is here found to be still somewhat defective. M. Violle's researches show that an alloy of 9 parts platinum and 1 iridium yields more uniform and accurate results both as regards density and specific heat. The density thus obtained is an absolute constant, incapable of further modification under cold-hammering, annealing, or any other severe test.—Dilatation and compression of carbonic acid, by M. Ch. Antoine. In a previous note (January 21, 1889), the author showed that the reciprocal β of the coefficient of dilatation under constant pressure is given by the relation—

$$\beta = \frac{pv_s}{\delta} - t_s,$$

δ being a constant coefficient, t_s and v_s the temperature and volume at saturation under the pressure p. Here he finds that more simple values may be obtained both for pv_s and β.—On electrolytic polarization by metals, by M. N. Piltschikoff. A general result of these researches is that one metal may be polarized by another.—On the formation of earths containing nitrogen, by MM. A. Müntz and V. Marcano. The authors describe numerous caves in Venezuela, both on the coast ranges and on the slopes of the Andes, which contain vast deposits richly charged with nitrates and interspersed with the remains of large extinct animals. The bones are so friable that they crumble to dust at contact of the finger; hence the difficulty of determining the species. They consist almost exclusively of phosphate of lime; carbonate of lime is entirely absent, and there are but slight traces of organic matter. In these caves, sheltered from the action of rain-water, the nitrogen yielded by the nitrified organic remains was gradually accumulated. In some places the beds are over 30 feet thick, containing from 4 to 30 per 100 of nitrate of calcium, and from 5 to 60 of phosphate of calcium.—On the art of utilizing statistics, by M. Delauney. With a view to the better utilization of statistical returns, especially in the sphere of meteorology, the author here proposes a solution of the problem: Given the statistics of a phenomenon, to find a certain method by means of which the laws controlling that phenomenon may be discovered.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Sylvan Folk: J. Watson (Unwin).—Moral Order and Progress: S. Alexander (Trübner).—Physiological Notes on Primary Education: M. P. Jacobi (Putnam).—Die Meteorologie Ihrem Neuesten Standpunkte Gemäss und Mit Besonderer Berücksichtigung Geographischer Fragen: Dr. S. Günther (München, Ackermann).—Report of Rainfall in Washington Territory, &c., for two to forty years (Washington).—Haunts of Nature: H. W. S. Worsley-Benison (Stock).—A Table of Specific Gravity for Solids and Liquids (Constants of Nature, Part 1): F. W. Clarke (Macmillan).—Half a Century of Australian Progress: W. Westgarth (Low).—Electric Light for the Million: A. F. Guy (Simpkin).—A Syllabus of Modern Plane Geometry: (Macmillan).—Geological Magazine, May (Trübner).—Annalen der Physik und Chemie, 1889, No. 5 (Leipzig, Barth).—Quarterly Journal of Microscopical Science, May (Churchill).—Proceedings of the Royal Society of Edinburgh, vol. xv. No. 128.—Proceedings of the Royal Society of Edinburgh, Session 1888–89, vol. xvi. pp. 65-128.—Journal of Physiology, April (Cambridge).—Meteorological Record, vol. viii. No. 31 (Stanford).—Quarterly Journal of the Royal Meteorological Society, January (Stanford).—Quarterly Weather Report, Part 4, October–December, 1879 (Eyre and Spottiswoode).—Hourly Readings, 1886 (Eyre and Spottiswoode).

CONTENTS.