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Broadcasting and Wireless Licences.

THE wireless licence problem has for some time been engaging the attention of the Post Office authorities, and acute differences appear now to have arisen between the Postmaster-General and the British Broadcasting Company as to the conditions under which licences may be issued to amateurs who either own home-made wireless sets or desire to build up such sets. Matters have been brought to a head by the present Postmaster-General refusing to impose upon amateurs restrictions which the British Broadcasting Company claims it has a right, under its agreement with the Post Office, to insist upon. The Postmaster-General made a statement in the House of Commons on April 19 on the situation that has, in consequence, come to pass: he then informed the House that negotiations had taken place on the licence question between himself and the Company, and that the latter had suggested that the Post Office issue to the home-constructor a licence, without any clog, at 20*s.*, of which 15*s.* was to go to the Company. This proposal was promptly declined by the Postmaster-General. Then, in the course of further negotiations, the Company expressed its willingness to permit the Post Office to issue to amateurs a licence at 10*s.*, of which one-half was to go to the Company, but such licence was to be subject to the clogging provision that it should alone be issued to those home-constructors who either own, or propose to build up, listening-in sets with parts of "B.B.C." manufacture. This proposal has also proved unacceptable to the Postmaster-General.

It was perhaps inevitable, in view of the terms and conditions contained in the agreement entered into between the Post Office and the British Broadcasting Company, and of the provisions in the articles of association of the Company, that the present trouble should have arisen. Neither the Post Office authorities nor those responsible for the promotion of the British Broadcasting Company appear to have appreciated correctly certain psychological aspects of the wireless situation from the point of view of a large and important section of those interested in that field. The subject, it may be remembered, was well ventilated at the time that the provisional committee representing the promoters of the British Broadcasting Company was carrying on its preliminary negotiations in the autumn of last year. It should, therefore, have been clear to the Postmaster-General of the day, his advisers, and the promoters of the Company, that many conflicting interests were involved and that the greatest caution was needed in handling what was undoubtedly a difficult problem (see NATURE for August 19 and

October 7, 1922—vol. 110 at p. 237 and p. 469). The situation actually created by the agreement between the Post Office and the British Broadcasting Company has been such that, almost from the very beginning, two important classes—the small manufacturer and salesman of wireless apparatus and the amateur experimenter—in the wireless field have felt themselves seriously aggrieved by the policy adopted by the parties to the agreement in relation to wireless licences, owing to the deliberate attempt made to fetter their freedom of action, each in his own particular field.

As regards the small manufacturer, it is argued that he has no real cause of complaint, since by subscribing but for a single one-pound share he can at once avail himself of all the benefits secured by the British Broadcasting Company from the Post Office under its concession. However, there is a not unnatural objection and disinclination on the part of small manufacturers to join a combine in which their most powerful competitors have a preponderating influence and voice. Further, an impression prevails, rightly or wrongly, that the inquisitorial powers which the British Broadcasting Company appears to have acquired under its articles of association may be, and are being, used to the detriment of the smaller shareholding companies: for example, a suspicion exists that the organisation of the Company is being made use of by the powerful shareholding companies, to some extent, as a sort of intelligence department for the purpose of obtaining information likely to be useful in connexion with the protection of their patent rights and interests. In all the circumstances, then, it would obviously be wrong for the Post Office to take any action with the view of compelling any British manufacturer to join the Broadcasting Company: in this view the present Postmaster-General has expressed his concurrence.

One of the chief arguments used in favour of broadcasting services being provided alone by a single company, and of the present rule that only apparatus bearing the "B.B.C." mark shall be used for broadcasting purposes, is that the British market is being flooded with wireless apparatus manufactured in countries with depreciated currencies; and, therefore, without safeguards of the nature indicated here, the broadcasting industry would be destroyed. It may, of course, be of vital importance, as the British Broadcasting Company alleges to be the case, to protect from unfair foreign competition, at the present time, the industry in question. Should any protective measures be desirable, the proper method of dealing with this aspect of the situation is surely by the direct and open one of imposing on foreign telephone apparatus and parts an import duty to be collected in the ordinary way by the Customs authorities, and not by the indirect, clumsy, and, what must prove to be, ineffective method of attempting to prevent the use for a specific purpose, by means of ministerial regulations and articles of association of a trading company, of some particular material after its unrestricted importation.

As regards the other class the rights of which appear to be seriously infringed under the broadcasting agreement, that is to say, the amateurs, a misapprehension seems to exist in the minds of some of the promoters of the British Broadcasting Company as to the nature of the bargain made by them with the Post Office. Owing to the great and rapid increase in the so-called "experimental licences" issued since the advent of broadcasting—the actual increase is from about 10,000 in the summer of last year to 35,380 at the present date—the Company seems to have taken alarm at the construction placed by the Postmaster-General on the language of Section 2 (1) of the Wireless Telegraphy Act, 1904 (4 Edw. 7, c. 24), which authorises the issue on special terms of a licence to an applicant who "proves to the satisfaction of the Postmaster-General that the sole object of obtaining the licence is to enable him to conduct experiments in wireless telegraphy." Certain of the promoters of the Company appear to think that, in view of the terms and conditions of the agreement negotiated by them with the Post Office, they are to be the judges as to the meaning to be placed on the provisions of the Section of the Act referred to. They are inclined to put an exceedingly narrow construction on the language of the statute, and seem to claim that the issue of the "experimental licence"—the rights of the Postmaster-General in relation to the granting of which are in no way abrogated or restricted under the Company's broadcasting agreement—shall alone be to actual research students and those in a strictly analogous position: that is to say, they wish to see the ordinary amateur deprived of his right to an "experimental licence." Owing to the attitude taken up by the British Broadcasting Company, the issue of licences other than those in respect of the listening-in sets bearing the "B.B.C." mark has been suspended since January 1 last, and, in consequence, some 33,000 applications for "experimental licences" were waiting to be dealt with on April 19.

When addressing the House of Commons on April 19, the Postmaster-General announced that, in the opinion of the Law Officers of the Crown, if he is satisfied that the object of an applicant for a licence is to experiment in wireless telegraphy, not only may he issue an "experimental licence" to him, but also he is bound to do so. Accordingly, he has referred the outstanding applications in question to some expert members of his staff in order that they may advise him as to the cases in which the licences are being honestly sought for the purpose of conducting experiments in wireless telegraphy, and on this advice he intends forthwith to act. It would, indeed, be exceedingly mischievous if the narrow construction sought to be placed on the language of the statute as it affects "experimental licences" were to be accepted by the Postmaster-General. It is to be hoped that his expert advisers will deal with the question submitted to them in the light of the plain language of the Act of 1904 and in accordance with the well-known principles relating to the interpretation of the provisions of statutes which affect private rights. The expert advisers will, no doubt, bear in mind that in the case of any particular amateur the dominant reason prompting him to apply for a licence may well be, and often is, that he desires to conduct experiments, and, therefore, in his case as in that of the research student, the listening-in to broadcasting services is altogether a secondary consideration, although the existence of such services is possibly of some assistance to him in connexion with his experiments, and for this use he will, under the Postmaster-General's proposal, be contributing his 5*s.* a year.

The Postmaster-General made the further important announcement on April 19 that he proposed immediately to set up a committee consisting of members of Parliament, expert members of his staff, a member of the British Radio Society, and a director or other official of the British Broadcasting Company, if possible, to consider the whole future of broadcasting. The members of this committee have now been appointed and their names appear in another part of this issue. It is eminently desirable that a thorough inquiry should take place; in this way the various issues which have been raised can most satisfactorily be separated out, in order that each may be dealt with on a practical basis on its own merits. One of the most important of the questions upon which a sound decision is required is that relating to the position of the amateur worker in the wireless field: there are to-day thousands of young fellows who are induced to take up as a hobby some technical or scientific subject, owing almost entirely to the pleasure they derive in carrying out practical work with a view of obtaining a clear understanding of some of the mysteries of Nature. It is desirable that the committee which the Postmaster-General has now appointed should make a definite pronouncement on this particular point: it cannot fail fully to recognise the importance of seeing that nothing is done unreasonably to hamper the activities of this particular class of workers in the wireless field; indeed, it is likely to appreciate the value of encouraging them, both with the view of benefiting science by their work and by their inventive faculty, should they possess any, as well as of assisting the industries of the country by the trade in the sale of the materials they may require for the purposes of their experiments.

History teaches that there are certain directions in which an attempt to impose statutory restrictions prompts people alone to measures of evasion, and on so wholesale a scale as practically to paralyse the arm of the law: to mention but a single example, the legislature, with doubtful wisdom, endeavoured at the beginning of the eighteenth century to suppress the so-called "Common-law Companies," and passed the famous Bubble Act, 1718 (6 Geo. I. c. 18), with this object in view. The Act, as is well known, proved a dead letter and was, a century later, repealed; the legislature, finding that it must tolerate the joint-stock company, set accordingly to work to regulate what it could not suppress, and to-day the whole country is reaping benefit from the facilities which were created to permit the incorporation of commercial and industrial undertakings. The present situation in relation to the amateur worker in the wireless field is almost identical with that which existed a couple of centuries ago in relation to the joint-stock company. It behoves those, then, who may be called upon to deal with the wireless licence problem to bear steadily in mind the teachings of history of the kind to which this allusion refers.

Biology in Utopia.

Men Like Gods. By H. G. Wells. Pp. viii+304. (London, New York, Toronto and Melbourne: Cassell and Co., Ltd., 1923.) 7*s.* 6*d.* net.

THE columns of NATURE are not the place to discuss the literary merits of Mr. Wells's new book—although, for the matter of that, good style or artistic capacity and appreciation are qualities as natural as any others. Suffice it to say that he has achieved a Utopian tale which is not only interesting but also extremely readable. Most readable Utopias are in reality satires, such as "Gulliver's Travels," and the no less immortal "Erewhon." Mr. Wells has attempted the genuine or idealistic Utopia, after the example of Plato, Sir Thomas More, and William Morris; and, by the ingenious idea of introducing not a solitary visitor from the present, but a whole party of visitors (including some entertaining and not-at-all-disguised portraits of various living personages) has provided a good story to vivify his reflections.

However, since Mr. Wells is giving us not only a story, but his idea of what a properly-used human faculty might make of humanity in the space of a hundred generations, his romance has become a fit subject for biological dissection in these pages.

Mr. Wells pictures a world where, in the first place, the advance of physico-chemical science and its application, to which we are already accustomed, has attained a far higher pitch of perfection. Further, machinery has become so self-regulating that it does not make man captive, as Samuel Butler prophesied, but is a real servant. Also, instead of machinery and mechanism occupying the foremost place in the life of the majority of men, as Bergson laments that they are tending to do to-day, they have apparently been rendered not only more efficient, but also more self-regulating, and are as subservient to the will of the community as a motor-car that never gets out of order is to its owner.

In the second place, life has been subjected to a similar control. This is a process which the biologist sees so obviously on its way that it should excite no surprise. As our knowledge of genetics increases, our application of it must outstrip the past achievements of empirical breeding as much as the application of scientific knowledge of principle in chemistry, say, or electricity, has outstripped the achievements of empiricism in those fields. Mr. Wells's wonderful flowers and trees are almost there already: we will not worry about them. Even his domestic-minded leopards and tigers, more "kittenish and mild" even than Mr. Belloc's, should not be lightly dismissed after recent experiments on the inheritance of tameness and wildness in rats—not to mention our knowledge of many breeds of dog.

Meanwhile, Mr. Wells also imagines a purging of the organic world. The triumphs of parasitology and the rise of ecology have set him thinking; and he believes that, given real knowledge of the life-histories and inter-relations of organisms, man could proceed successfully to wholesale elimination of a multitude of noxious bacteria, parasitic worms, insects, and carnivores. Here again we have no right to quarrel. Mr. Wells does not need to be reminded of the thistle in California or the rabbits in Australia: his Utopians proceed with exemplary precautions. All this is but an extension of what has already been begun.

In the third place, however, human as well as non-human life has been subjected to this control; and this in two ways. First, by an extension of the methods previously used. The accidents and circumstances of life have been altered—there has been a further control of external machinery. This has been, of course, chiefly in the fields of social and political institutions. A great part of such change is only intelligible as a corollary of the other supposed change. But we may here direct attention to one idea which is imagined as at the root of much of it—the idea that man is master in his own house of Earth, as opposed to the idea which, with few exceptions, has until now dominated his history—the idea that he is the slave, sport, or servant of an arbitrary personal Power or Powers.

Finally, we come to the most radical and inevitably the most provocative of our author's imaginings—that which concerns not the alteration of things in relation to a constant human nature, but the alteration of that human nature itself. Here Mr. Wells is extremely interesting. He reduces the rôle of eugenics to a minimum, exalts that of education, or, if you prefer it, environment, to a maximum. Eugenic change has been restricted to "breeding out" (Mr. Wells does not initiate us into methods) certain temperamental qualities—habitual gloominess, petty inefficiency, excess of that "sacrificial pity" Mr. Wells dislikes so much, and so forth.

The rest has been accomplished by proper education, and, above all, by a "change of heart" as regards the essential aims of life. Mr. Wells sums this up in a phrase (in which one recognises his devotion to the late headmaster of Oundle) as the substitution of the ideal of creative service for that of competition.

The realisation of this ideal is made possible in the first instance by a proper application of psychology to early life, so that painful repression and stupid suppression shall not occur, and men and women shall grow up unridden by hags of sex or fear, and yet without separation of any important fragment of their mental organism from the rest. Education *sensu restricto* then steps in, and enlarges the capacities of the unhampered growing mind, while the substitution of a form of telepathy for speech reduces the time and energy needed for communication. Meanwhile, a rational birth-control provides a world not overcrowded and overstrained.

By these means, Mr. Wells imagines, a race has been produced of great beauty and physical strength, great intellectual and artistic capacities, interested primarily in two things—the understanding of Nature for its own sake, and its control for the sake of humanity. By control Mr. Wells means not only utilitarian control, but that which, as in a garden, is to please and delight, and that highest control of material—artistic and scientific creation.

The Utopians, owing to their upbringing and social environment, come to think and act so that they need no central government, no law-courts, no police, no contracts. In this Mr. Wells is only telling us what we all knew already, that in most men it seems theoretically possible to produce a "change of heart"—*i.e.* substitute new dominant ideas for old—and that if this is effected, restrictive measures gradually become unnecessary. He is careful not to make his Utopia too ideal. It is as ideal compared with this world as would be Olympus: but as short of perfection as Olympus seems to have been. The men and women there are often discontented and restless; criticism is abundant. Mr. Wells knows that intellectual and æsthetic achievement opens the door to the highest known happiness of the present; he keeps them so, with all conditions and limitations of their being, in Utopia.

Let us go back and try to see how much of Mr. Wells's speculations fall within the bounds of possibility. All Utopias must suffer from lack of familiar associations, for it is by familiar associations, especially with things of youth and childhood, that emotional appeal is made and real assent gained. Thus, whatever stores of loved memories a Utopian may have, whatever driving force he may draw from the sight of familiar places and objects, we can only see his emotional life from outside, as an Englishman on his first visit to the United States notices the differences from England rather than the resemblances. But if we remember that they must have each their private growth of life, and that this must be in many ways like ours, we get over the first stile.

We have already dealt with Mr. Wells's applied physics and chemistry and his applied biology of lower organisms. That in a sense is commonplace—commonplace made surprising; none the less, it is good to have it so well done, to have people reminded that the rate of this sort of change not only need not slow down, but can continue, and continue to be accelerated, for a very long time. What of his applied biology of man? Minor criticisms are easy to make. The Utopians, for example, go either almost naked, or else clothed in garb of the indeterminate simplicity that seems to be fashionable in all Utopias. Mr. Wells is perhaps so revolted by the dulness of modern male attire that he underestimates the amount by which dress enlarges the human horizon, giving us a hundred extra variations of personality, raising the possibilities realised in the courtship-decorations of lower animals to an infinitude of permutations.

With the rediscovery of Mendel's laws and their recent working out, we are introduced to the theoretical possibility of an analysis of the hereditary constitution similar to the chemist's analysis of a compound; and so, presumably, in the long run to its control. There are great technical difficulties in higher organisms, and application to man presents yet further difficulties. Still, the fact remains that the theoretical possibility exists for us to-day, and did not exist twenty-five years ago. We must further remember that all discoveries concerning the history of man remind us that we must think, not in centuries as heretofore, but in ten-thousand-year periods when envisaging stages in human development.

We must further recall the lessons of evolutionary biology. These teach us that, however ignorant we may be regarding the details of the process, life is essentially plastic and has in the past been moulded into an extraordinary variety of forms. Further, that the attributes of living things have almost all been developed in relation to the environment—even their mental attributes. There is a causal relation between the absence of X-rays in the normal environment and the absence in organisms of sense-organs capable of detecting X-rays, between the habits of lions and their fierceness, of doves and their timidity. There is, thirdly, no reason whatever to suppose that the mind of man represents the highest development possible to mind, any more than there was to suppose it of the mind of monkeys when they were the highest organisms. We must squarely recognise that, in spite of proverbs to the contrary, it is probable that "human nature" could be considerably changed and improved.

Next, we have the recent rise of psychology. Much nonsense doubtless masquerades under the name of psycho-analysis or "modern" psychology. None the less, as so shrewd a critic as the late W. H. R. Rivers at once saw, and as has been put to such practical uses in therapeutic treatment, there is not only something in it, but a great deal. Repression, suppression, sublimation, and the rest are realities; and we are finding out how our minds do work, ought not to work, and might be made to work. It is clear that the average mind is as distorted and stunted as a much-below-average body; and that, by just so much as a great mind is more different from an average one than great from average bodily capacity, by so much would proper training be more efficient with mind than even with bodies. Here the extravagances of some eugenists find their corrective; Mr. Wells's imagination is pursuing to its logical end the line taken by such authorities as Mr. Carr Saunders in his "Population Problem."

Again, Mr. Wells, being a major prophet, perceives without difficulty that the substitution of some new dominant idea for the current ideas of commercialism, nationalism, and sectarianism (better not beg the question by saying *industry*, *patriotism*, and *religion*) is the most needed change of all. Here, again, he is in reality only adopting the method of Lyell and Darwin—uniformitarianism—and seeking the key of the future, as of the past, in the present. There is to-day a slowly growing minority of people who not only profoundly disbelieve in the current conceptions *and valuations* of the world and human life, but also, however gropingly, are trying to put scientifically-grounded ideas in their place.

Belief is the parent of action; and so long as the majority of men refuse to believe that they need not remain the slave of the transcendental, whether in the shape of an imaginary Being, of the Absolute, or Transcendental Morality, they cannot reap the fruits of reason. If the minority became the majority, society and all its institutions and codes would be radically altered.

Take but one example, and a current one—birth-control. When Mr. Wells's "Father Amerton" finds that it is the basis of Utopian civilisation he exclaims in horror: "Refusing to create souls! The *wickedness* of it! Oh, my God!"

. . . .

This is the great enemy of true progress—this belief that things have been already settled for us, and the consequent result of considering proposals not on their merits, but in reference to a system of principles which is for the most part a survival from primitive civilisations.

Mr. Wells may often be disagreed with in detail: he is at least right in his premises. A perusal of his novel in conjunction with a commentary would be useful. "Men Like Gods" taken *en sandviche* with, say, Punnett's "Mendelism," Trotter's "Instincts of the Herd," Thouless's "Psychology of Religion," Carr-Saunders's "Population Problem," Whetham on eugenics, and a good compendium of recent psychology, would be a very wholesome employment of the scientific imagination. J. S. H.

Linnean Correspondence.

Bref och Skrifvelser af och till Carl von Linné med understöd af Svenska Staten utgifna af Uppsala Universitet. Första Afdelningen, Del 8: Bref till och från Svenska enskilda personer Kalm-Laxman. Utgifna och med upplysande noter försedda af J. M. Hulth. Pp. v+200. 6 kroner. Andra Afdelningen, Utländska brefväxlingen; Del 1: Adanson-Brünnich. Utgifven och med upplysande noter försedd af J. M. Hulth. Pp. viii+430. 12 kroner. (Uppsala: A.-B. Akademiska Bokhandeln, 1916 and 1922.)

SINCE the death of Carl von Linné, better known in this country under his Latinised name of Linnæus, nearly a score of works have been issued containing selections of his letters, many of them restricted to his relations with a single person, as Jacquin, B. de Jussieu, or Sauvages. But these only dipped into the extensive correspondence which is available, and the Swedish Government has aided the University, of which Linnæus was so distinguished a professor, to bring out a complete issue of all the letters known to be in existence, as part of the publications commemorating the bicentenary of the birth of the great naturalist in 1907. The editor was, naturally, Emeritus Professor T. M. Fries, who, four years earlier, had produced his monumental life of Linné and was steeped in Linnean lore and knowledge of his contemporaries. Six volumes had been brought out under his editorship when his death, early in 1913, closed his industrious career, and left the series of volumes less than half finished. These six belonged to the first section, devoted to letters to and from Swedes; a seventh was partly prepared, and the first volume of the second section, devoted to foreigners, was in course of preparation when the editor's life closed. The successor to Fries was Dr. J. M. Hulth, chief librarian of the University of Uppsala, but the time available for the subject so essential was obtained with difficulty by a very busy man. Nevertheless, we have here two volumes for a brief survey—volume 8 of the first section, extending from Kalm to Laxman, and a first volume of the second section, embracing the letters from Adanson to Brünnich.

Naturally, the latter volume attracts the non-Swedish reader, nearly the whole being in Latin, and the forty-nine writers include Francis Calvert, sixth and last Lord Baltimore (the owner of Maryland), Sir Joseph Banks, John Bartram, the early North American botanist of Philadelphia, Johann Bartsch, the close friend of Linnæus, who fell a victim to the climate of Surinam, Anna Blackburne, Herman Boerhaave, the celebrated Dutch physician, whose pathetic farewell to Linnæus is one of the most touching episodes in the Swede's career, and Patrick Browne, whose volume on Jamaica plants incited Linnæus to buy his herbarium for himself. Much might be extracted from these letters, but their comparative accessibility prompts our passing on to the other volume before us.

The forty-one letters from Pehr Kalm to his former teacher extend over 118 pages, more than half the volume, and are especially interesting. Kalm had travelled in Russia, whence the first letters were sent, but having undertaken a journey to North America, he, with an assistant, reached London in February 1748, and hastened the same day to report his arrival. His letters, written in Swedish, are couched in a fresh and lively style, and convey his first impressions. He hesitated to call upon the persons to whom he had been recommended till he should have acquired a better command of English, for though many wrote and spoke Latin, it was differently pronounced, and thus difficult to understand. In this he succeeded, as he was obliged to stay six months in London, waiting for a ship to America. He remarked on the milder winter of England compared with that of Sweden, and of the many plants which could stand out of doors unharmed. Soon we find him telling about his acquaintances. Philip Miller of Chelsea Physic Garden, and a special friend Richard Warner of Woodford (1711–1775), whose splendid garden yielded many seeds for Uppsala, John Ellis, Ehret the botanical artist, Dr. John Mitchell, and others were among the earliest of his acquaintances in London. Then the scene shifts to Philadelphia, where he was often with Bartram: "he lives about five miles from Philadelphia, a thoroughly good fellow and a strong Linnean; we have botanised a good deal round the country, and he has promised to send a quantity of rare seeds to Uppsala if he can manage to do so with the next ship." Kalm then turned his steps to Canada, and returned to Pennsylvania at the end of the year, again reaching London in the spring of 1751, and Stockholm a month later, passing on to Åbo; in that University he had been appointed professor of economy, and on his return he took up the duties of his chair until his death in 1779, the year after the death of his old teacher. There are but few letters here from Linnæus, the reason no doubt being that, the recipient having sewn these letters into a volume, they probably perished in the fire of 1827, which destroyed the town and University of Åbo.

Martin Kähler (1728–1773), another of the Linnean pupils, had intended to travel to the Cape, but that intention was hindered by the Dutch. He therefore travelled in France and Italy, whence he returned in 1757. Magnus Lagerström (1691–1759) was a director of the East India Company of Göteborg (Gottenburg), and in that capacity was able to supply novelties to Linnæus; thirteen letters are here printed, but the letters to Lagerström are unknown. The last writer in the volume is Erik Laxman (1737?–1796), whose name is well known for his work amongst Siberian plants.

B. D. J.

Technology of Oils and Fats.

Chemical Technology and Analysis of Oils, Fats, and Waxes. By Dr. J. Lewkowitsch. Sixth edition, entirely revised by George H. Warburton. (In 3 vols.) Vol. 3. Pp. viii+508. (London: Macmillan and Co., Ltd., 1923.) 36*s.* net.

THE third and final volume of this well-known book deals principally with the technology of manufactured oils, fats, and waxes, as, for example, the refining of edible oils, the making of soap and candles, the purification of glycerine, oil hardening, and the preparation of polymerised, boiled, and oxidised oils. In appraising the value of these sections it must be remembered that the book deals essentially with the chemical aspect of these industries, and that in the few pages which can be spared to each it is impossible to attempt more than a general outline of the processes in common practice.

In particular, it is not part of the author's scheme to indicate on the more mechanical side of the industry which type of plant or process is at the moment generally in use in an up-to-date factory. One consequence of this treatment is that the accounts of the manufactures appear antiquated when read by one acquainted with practice, and the student of chemical technology trained on this book would justly be accused in the works of being too theoretical. On the other hand, it will be said there are numerous highly specialised text-books devoted to each of these subjects, and a brief summary of them from the more purely chemical point of view is quite enough to attempt. In this connexion it may be suggested that the book is rather overburdened with statistics.

An important section is that devoted to waste oils and fats: it may be defined as an essential function of the chemist in any industry to eliminate waste and to utilise the so-called waste products. In oil-refining, for example, much depends, from the economic point of view, on obtaining both a high yield of the refined product and the retention of the foots in a form in which they can be utilised. The respective values of soap stock, or soap stock fatty acids, often make all the difference in the refiner's profit. Latterly a number of alternative processes have been tried in this connexion, and some reference to them might well have been included in this volume.

The subject of hydrogenated fats is dealt with very adequately in the well-known book of Carleton Ellis, so that the author may be excused for devoting only ten pages to it. Of some interest is a paragraph referring to the use of such fats in the edible-fat industry, particularly on the Continent, and indicating doubt as to their suitability. Actually to-day hardened fats, particularly whale oil, are the most popular materials for edible fats on the Continent, and the refiners are willing to pay a price for the raw oil which puts it beyond the reach of the soap-maker, at whose instance, it may be remembered, the hydrogenation process was invented. The refined product, which is absolutely free from nickel and of a high standard of purity, has many desirable qualities, though from the most modern point of view the absence of vitamins must be held to be a disadvantage. Very little hardened fat, however, is used in margarine made in Britain.

Probably no section of the industries based on oils and fats has developed more in this country than the manufacture of margarine, owing in the main to the abnormal conditions imposed during the War. The advance in the technology of this industry has been enormous, both in the methods of refining the crude fats, in their selection and blending, and in the actual manufacture of the margarine, including the bacteriological processes of imparting the special butter flavour. The new factories are models of their kind, and triumphs of cleanliness and organisation. Unfortunately, the difficulties of distribution are such that the consumer cannot with certainty buy his pound of margarine in perfect condition unless his retailer is certain of a quick sale; and although the same difficulty applies to butter, more tolerance is extended to the older commodity.

A problem which is engaging an increasing amount of attention in the fat industry is that of texture. A fat, that is to say, a triglyceride, may either contain three of the same acid radicles or two or more different acid radicles, in which case it is spoken of as a mixed glyceride. A mixed glyceride has properties very different in regard to melting-point, consistency, etc., from a mixture of glycerides. Again, fats which, when separate, have similar properties which are satisfactory from the technical point of view, may have altogether different and far less satisfactory properties when mixed. Such theoretical considerations have an important practical bearing in the chocolate and biscuit industries.

Sufficient has perhaps been said to indicate how diverse are the problems to be found within the industries of the fats and oils, and how wide must be the scope of a work dealing with their chemical technology. Dr. Lewkowitsch's book has played no small part in aiding many an investigator to do his share in advancing the knowledge of them, and each new edition has reflected in turn the new information acquired. The newest edition is no exception to this and is replete with information, and it is with no wish to detract from its value that it is suggested that when the time comes for it again to be revised it may be advisable largely to remodel the plan on which it is built.

E. F. A.

Our Bookshelf.

(1) *Steam Turbines.* By Prof. W. J. Goudie. Second edition, rewritten and enlarged. Pp. xviii + 804. (London: Longmans, Green and Co., 1922.) 30*s.* net.

(2) *Modern Practice in Heat Engines.* By T. Petrie. Pp. xi + 264. (London: Longmans, Green and Co., 1922.) 15*s.* net.

(3) *Notes and Examples on the Theory of Heat and Heat Engines.* By John Case. Second edition, revised and enlarged. Pp. vi + 138. (First issued in 1913 as "A Synopsis of the Elementary Theory of Heat and Heat Engines.") (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1922.) 7*s.* 6*d.* net.

(1) PROF. GOUDIE's treatise was first issued in 1917, and the volume has become a standard work. Its value has been proved by teachers, students, and professional men engaged in practice. The book has been out of print for some time, owing to the author's desire to bring it up-to-date, and this has meant the formidable task of rewriting practically the whole work. To those acquainted with the first edition, the result will be found extremely serviceable, inasmuch as not only recent designs are included, but also additional matter is given bringing the theory up-to-date. The thoroughness with which the task of revision has been carried out is evidenced even in the numerical examples. The volume is now one which cannot be dispensed with by any one engaged in steam engineering.

(2) This book is divided into three sections dealing with steam boilers, steam prime movers (including steam turbines), and internal-combustion engines respectively. Some of the descriptive parts of the section on steam turbines are taken from the article written by Prof. Gerald Stoney and the author for the "Dictionary of Applied Physics" (Macmillan). The field covered is wide, and the book contains a large number of illustrations descriptive of the details of modern plants. Despite this, the author has succeeded in presenting as much of the theory as the average student requires in his college course. Students require a general treatment such as is contained in the present work, and they will also appreciate the fact that it contains no very difficult mathematics. There are a number of worked examples in the text, but it would be an improvement if some exercises were included for the purpose of enabling the student to test his knowledge.

(3) Mr. Case's volume of notes, worked examples, and exercises on the theory of heat engines will be helpful to many students. Most parts of the subject are covered, and those omitted do not present any particular difficulties.

The Pageant of Nature: British Wild Life and its Wonders. Edited by Dr. P. Chalmers Mitchell. (Complete in about 36 fortnightly parts.) Part 1. Pp. 72. Part 2. Pp. 73–144. Part 3. Pp. 145–216. (London: Cassell and Co., Ltd., 1923.) 1*s.* 3*d.* net each part.

THE avowed object of this new publication is to provide the libretto to the play of Nature in Britain, and, by describing in clear and accurate language the varied phenomena which can be observed at all seasons of the year during almost any country ramble, to stimulate observation, to foster a love of Nature and, perhaps, to spur on to further independent discovery the keener and more gifted of its readers. It is essentially a book of Nature study, of observation in the field, of animals and plants in their natural surroundings. All the authors who have contributed to its pages—and there are no fewer than twenty in the three parts under notice—are well known for their admirable first-hand studies of wild Nature, in one or other of its many branches, with eye, field-glass, and camera and, may we add, with pen, and their articles are illustrated with original photographs taken either by themselves or by other equally skilled and enthusiastic Nature photographers.

It is perhaps invidious to make a selection from a number of articles all of which reach a high level of charm, accuracy, and simplicity; but special mention should be made of Dr. Francis Ward's delightful studies of otters and fishes, illustrated by a unique series of remarkable photographs of these animals taken under water, Mr. Edgar Chance's account of the egg-laying habits of the cuckoo, and Dr. Landsborough Thomson's articles on birds. The illustrations, in colour, photogravure and half-tone, are excellent on the whole. Particularly charming are four studies of the feeding of a cuckoo by its foster-parent, a meadow pipit, the work of Mr. T. M. Blackman. The reproductions of the photographs illustrating Mr. Chance's article, however, scarcely do justice to the originals.

The general editor, Dr. P. Chalmers Mitchell, in a short introduction, makes a strong appeal for the wider study of Nature in the field. This publication should go far to stimulate such study and to fulfil his hopes "to turn all our readers into watchful lovers of Nature."

Chambers's Encyclopædia: a Dictionary of Universal Knowledge. New edition, edited by Dr. David Patrick and William Geddie. Vol. 1: A to Beatty. Pp. vi+824. (London and Edinburgh: W. and R. Chambers, Ltd.; Philadelphia: J. B. Lippincott Co., 1923.) 20*s.* net.

A NEW edition of this work is welcome, for in spite of the many encyclopædias now available, Chambers's still holds its place. It is not exhaustive and does not claim to be a compendium of all knowledge, but at the same time it would be difficult to find any subject of general interest that finds no place in its volumes. The work has the further merit of easy reference, the subdivisions of the larger subjects being arranged in their respective places in the alphabet. The form and appearance of the pages which have been familiar to several generations are unchanged, but the matter has been revised, new articles being given where necessary and others brought up-to-date. New coloured maps, mostly by Bartholomew, have been added. That of North America needs a little revision in the north of Greenland, but for all general purposes they are excellent. The illustrations would appear to be mainly the woodcuts of earlier editions.

In one respect we might suggest an improvement in this useful work. Some geographical articles still contain descriptive matter that is unworthy of the advances in modern geography. Without any greater demands on space the descriptions of many countries could be made far more explanatory and graphic than is the case. Thus, in the article on the Balkans certain striking features, such as the central plateau, the fold ranges parallel to the sea, the two great corridors, and the gateways to the sea should be emphasised as being keys to many Balkan problems. The article as it stands is full of accurate information which might be better displayed. The same criticism is applicable to Albania and other articles. The low price of the encyclopædia is noteworthy.

Wind and Weather. By Prof. Alexander McAdie. Pp. 82. (New York: The Macmillan Company, 1922.) 1.25 dollars.

PROF. MCADIE's little work is more historical than a current discussion of wind and weather. Much of the work is a dissertation on "The tower of the winds," which has been standing at Athens for the past twenty-two centuries. The allegorical figures of the winds given are reproductions copied from the frieze of the tower and the author has extemporised on them. Boreas, the north wind, is referred to as a cold and boisterous wind from the mountains of Thrace; Kaikias, the north-east wind, who carries in his shield an ample supply of hailstones, is supposed to be ready to spill them on defenceless humanity; Apheliotes, the east wind, is styled a graceful youth, with arms full of fruit and wheat; Euros, the south-east wind, is depicted as a cross old fellow, intent on the business of cloud making; Notos, the south wind, is the master of the warm rain; Lips, the mariners' wind, the south-west, said to be favourable for bringing the ships speedily into harbour; Zephyros, the west wind, is represented as a graceful youth, scantily clad, with his arms filled with flowers, while Skiron, styled lord of gusty north-west gales, carries with him a brazen fire bucket and is said to spill a generous stream of hot air on all below.

The latter part of the book is more practical and deals with the weather map and current meteorology, although in an elementary way, and this part seems to suggest that the author had American weather in mind rather than the weather in other parts of the world. C. H.

Text-Book on Wireless Telegraphy. By Dr. Rupert Stanley. Vol. 2: Valves and Valve Apparatus. Second edition. Pp. xi+394. (London: Longmans, Green and Co., 1923.) 15*s.* net.

IN this edition a new chapter has been added describing high-speed signalling, recorder reception, short-wave signalling, and directional apparatus. In the author's opinion the two outstanding problems for research work are the elimination of atmospherics and the invention of a cheap system of high-speed reception able to withstand ordinary wear and tear. We agree with him that the well-established term "valves" should be used to designate the special vacuum tubes used in radio signalling.

In his preface the author points out that the development of radio signalling since 1918 has been much hampered owing to doubts about the validity of the patents of many of the methods and types of apparatus which were used in the War. The tedious delay in the establishment of broadcasting stations in Britain was largely due to disagreements between manufacturing firms on this question.

The Year-Book of Wireless Telegraphy and Telephony, 1923. (Edition for Amateurs.) Pp. xcv+824. (London: The Wireless Press, Ltd., 1923.) 6*s.* net.

THE progress in the art of radio communication is so rapid that a new "Year-Book" is a necessity for all who wish to keep abreast of the times. We learn that in the United States nearly two hundred broadcasting transmitting stations are now in practically continuous operation and that the number of listeners is nearly a million. Canada comes next with fifty-three broadcasting stations, twelve of which are in Toronto alone. In France great progress has been made in perfecting high-frequency alternators. It is now possible to get a 500-Kilowatt 15000-frequency alternator which will have an over-all efficiency of 85 per cent. Latour has also shown how, by means of a 100,000-volt transformer and using two electrode valves as rectifiers, a pressure of 200,000 volts direct current can be easily and comparatively cheaply obtained. These high pressures are of great value as they open up new fields for physical research.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Hafnium and New Zealand Sand.

THE account which was given in NATURE of February 10 (p. 195) of the very refractory substance which I obtained from a black titaniferous iron sand from New Zealand and believed to be the oxide of the newly discovered element, hafnium, requires now to be brought up-to-date. In that account it was mentioned that I had sent to Copenhagen practically all my purified material for X-ray examination and comparison with the preparations and specimens of the discoverers. Three specimens were sent: (*a*) the sand itself, (*b*) the cream-coloured substance labelled in 1918 "New Oxide," (*c*) the cinnamon-coloured oxide which resulted from the atomic weight determinations (Chem. Soc. Jour. for February, p. 312). The total amount of (*b*) and (*c*) was between 0·3 and 0·4 gram each and was all I had. The result of the first examination by Drs. Coster and Hevesy was to the effect that they were unable by X-ray spectral analysis to detect hafnium in any of the three specimens, and this I announced at the meeting of the Chemical Society on February 15.

Drs. Coster and Hevesy very kindly undertook a much more thorough and laborious examination, both by X-ray and by optical spectral analysis, especially of (*c*), which was naturally regarded as the purest sample of the oxide. They did this in the hope of finding some evidence of the presence of some of the other elements still missing, and in particular element No. 75, but in this they were unsuccessful. Their final report is that "The chief components are undoubtedly iron and titanium" with traces of manganese, aluminium and magnesium. As soon as I received this statement on March 19 I set to work on what remained of (*b*) and (*c*) to try to unravel the mystery of the high atomic weight which had seemed to prove conclusively that the oxide was that of an element with an atomic weight at least one and a half to two times that of zirconium (90·6). As the full analytical details and the steps by which the explanation was arrived at are given in the Journal of the Chemical Society for April, p. 881, I need not do more here than give the general conclusions. My further chemical examination of the cinnamon-coloured powder (*c*) agrees entirely with that of Drs. Coster and Hevesy in proving that it consists practically of oxides of titanium and iron, the latter only to the extent of about half a per cent. It is to the presence of this iron oxide that the cinnamon colour is undoubtedly due.

The "New Oxide" (*b*), however, seems to be a new oxide so far as chemical literature is concerned, but not the oxide of a new element. Further investigation showed it to contain a large percentage of silicon and that, so far as could be ascertained with the small quantity which I had, there seems to be but little doubt that it is a form of titanium dioxide in which part of the titanium is replaced by silicon. It is due in all probability to this replacement of titanium by silicon that the "New Oxide" owes its resistance to the attack of sodium bisulphate on one hand and caustic soda on the other.

The substance extracted from a New Zealand sand (while my specimens were in Copenhagen) by Dr. C. J. Smithells and Mr. F. S. Goucher (NATURE, March 24, p. 397) in the Research Laboratories of the General Electric Company, is entirely different from my "New Oxide." This is clearly proved by their own statements; hence their experiments with it have no bearing on the composition and properties of the substance isolated by me.

I gladly avail myself of this opportunity of acknowledging and thanking Prof. Bohr and Drs. Coster and Hevesy for all their courtesy and for the very great trouble they have taken to assist me in the elucidation of what seemed to be a real mystery. It is with sincere pleasure that I have just learned that they have succeeded in the difficult task of preparing hafnium compounds in a state of purity sufficient to enable them to locate its atomic weight between 179 and 181.

ALEXANDER SCOTT.

34 Upper Hamilton Terrace,
London, N.W.8,
April 25.

A Meteorological Disturbance of an Oscillatory Character.

A DISTURBANCE possessing a pronounced oscillatory character swept across the Gulf of St. Vincent, South Australia, on the morning of February 24. It may be of interest to put upon record its chief features.

At 5.10 A.M. those who were sleeping out of doors were rudely awakened after a stifling airless night (wind N.N.E., strength 0 – 1) by a sharp westerly squall. A lull was succeeded by a second squall about 7 minutes after the first; a well-marked line-cloud accompanied it, but no rain fell. The wind then dropped to a gentle S. breeze for a few minutes, but the approach of another splendidly developed line-cloud arching the horizon from S.S.E. to N.N.W. heralded another squall from the west. The upper atmosphere was almost cloudless, save on the western horizon, where an alto-cumulus layer drifted slowly from a northerly point. Again the wind went round to the S. and dropped, but a third line-cloud brought a fresh squall from the west.

The writer, observing from Glenelg, faced forty miles of sea stretching out to the westward, and it was a very fine sight to watch the unbroken lines of cloud, 2000 to 3000 feet up, approaching at a very great speed and stirring up an almost calm sea into momentary activity. The three clouds passed over within the space of a quarter of an hour, and were separated by approximately equal intervals of time. The wind which accompanied them was not very violent, probably between 30 and 40 miles an hour, but strong enough to cause the anchored yachts to swing round through 90° from S. to W. in a few seconds.

Though no further line-clouds were observed, the oscillatory character of the disturbance continued, and at two further intervals of 8 and 7 minutes respectively the squalls and vagaries of the shipping were noted. Eye observations were then suspended, but the writer is indebted to Mr. Bromley, Commonwealth Meteorologist for the State of South Australia, for traces of the automatic records obtained at Adelaide, 6 miles inland and E. of Glenelg, which show that the pulsations continued for about an hour altogether. The periodicity is especially well-marked in the barograph and wind velocity curves reproduced below; at first they keep remarkably in step, each rise in the barometer coinciding with an increase in wind velocity and vice versa, but there is some confusion in the velocity graph towards the end of the disturbance. The anemo-biagraph has been under suspicion of furnishing low readings, but it is also probable that the squalls lost something in intensity in travelling inland.

From the accompanying graphs (Fig. 1), the average period appears to be about 7·5 minutes; from the times of observation of the pulsations at Glenelg and Adelaide we calculate that they were travelling inland at approximately 30 miles an hour, and that they were between $3\frac{1}{2}$ and 4 miles apart.

The wind direction graph shows that, except for the initial squall, the changes in direction were neither so regular nor so pronounced in Adelaide as they were on the coast; as would be expected, the changes generally, but not invariably, coincided with the rise of the barometer. This graph records a series of small abrupt changes in direction, leading from W.S.W. to S.S.E., each pulsation, except the third, sending the wind round some 15°. This is very different from what was observed at Glenelg, where,

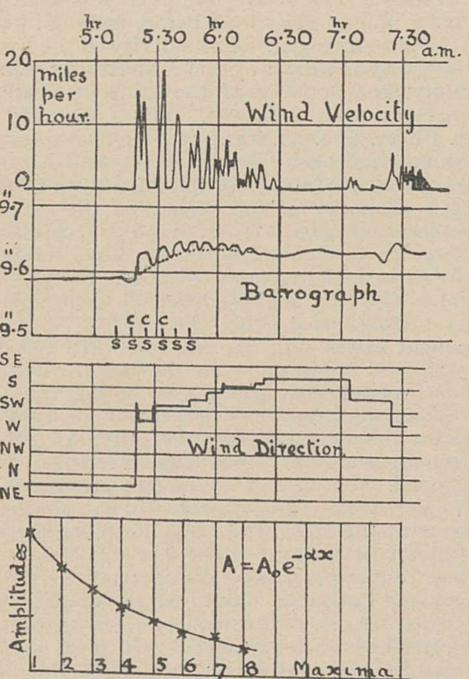

FIG. 1.—Records of an oscillatory meteorological disturbance at Glenelg on February 24. The times at which squalls and line-clouds were observed at Glenelg are marked S and C respectively. The autographic instruments were at Adelaide.

at any rate for the first 6 pulsations, the wind was S. during the lulls and W. during the squalls, rather as though there were intrusions of westerly air from above into a gentle S. current in the lower levels. It is difficult to account for these differences because the intervening country is flat, and both Glenelg and Adelaide are on the direct line of advance of the disturbance.

The barograph record shows first a slight depression and then a sudden rise of about 0·04 inch, something like half the amount observed in the case of some famous line-squalls. Later oscillations are less intense, the average of all being 0·02 inch from hollow to crest. From the original barogram I have measured the amplitudes of the successive oscillations, taking the dotted line drawn through the minima as datum line. Except for the last oscillation, which shows some irregularity, the amplitudes closely follow an exponential law. This is indicated in the final graph, where the abscissæ represent equal time intervals between successive maxima, and the ordinates the amplitudes, A. The full line represents the curve $A = A_0 e^{-ax}$, where x is the time between maxima; the crosses mark the measured amplitudes on an appropriate scale. The logarithmic decay of the amplitudes suggests that viscous forces are involved in the phenomenon, though whether they act by diminishing the forces which occasion the pulsations, assuming that they are formed successively, or by diminishing the oscillations in their transmission, we have no means of ascertaining.

As regards the general meteorological conditions, the barometer had been falling for some time and the disturbance marked the beginning of a rise which continued for some hours. The Commonwealth weather-map compiled at 8.30 A.M. indicates that a shallow V-shaped depression, probably part of a monsoonal system, had recently passed across Adelaide from W. to E.; the axis then lay along a S.S.E.-N.N.W. line, which is rather curiously the direction along which the axis of the lines of cloud extended. Mr. Bromley kindly gave me access to a large number of weather charts and barograms, from which it appears that though unstable conditions are liable to arise with the passage of depressions, no evidence of regular pulsations occur except that above described and, also rather curiously, a comparatively feeble example on the previous day (11 A.M. February 23). In this case the oscillations increased in intensity as time went on. There were 5 pulsations with an average period of about 7 minutes, but the maximum amplitude was not more than 0·01 inch. Seven well-marked pulsations are shown upon the wind velocity graph, reaching 10 miles per hour.

W. G. DUFFIELD.

Dundrennan, Glenelg, South Australia,
March 3.

Phosphorescence caused by Active Nitrogen.

IN 1904, in the *Astrophysical Journal*, the present writer described the spectrum of the afterglow of active nitrogen, and showed that the vapours of mercury and other metals present in the tube participated in the afterglow. Some years later the present Lord Rayleigh showed that luminosity of the vapours of many substances is excited by active nitrogen.

Recently I have found that it also excites phosphorescence in a number of solid compounds. By opening a stopcock between the discharge tube and the pump, a jet of active nitrogen could be directed against a small quantity of the substance. In a number of cases phosphorescence was produced, which lasted for several seconds. The colour was green or bluish green, and the spectra all appeared to be continuous, except in the case of the first two substances named below, which showed characteristic bands. The results were as follows:

Strong.—Uranium nitrate, uranium-ammonium fluoride, zinc sulphide, barium chloride, strontium chloride, calcium chloride, cæsium chloride. These are arranged in the order of brightness.

Weak.—Lithium chloride, sodium chloride, potassium chloride, sodium iodide, potassium iodide, sodium carbonate, strontium bromide.

No effect.—Potassium sulphate, potassium nitrate, potassium hydroxide, mercurous bromide, calcium carbonate, calcium sulphate, calcium sulphide, lead chloride, cadmium iodide, magnesium nitrate, zinc chloride, manganese chloride, thorium oxide, chalk sugar, sulphate of quinine.

With the exception of the first three, the excited substances are little or not at all affected by light, but most of them are excited by cathode rays. It is remarkable that a specimen of calcium sulphide very sensitive to light was not at all affected. With the same exceptions, the effect was obtained only after partial drying, but appeared to be destroyed by complete calcination. Some of the substances did not always respond, even when taken from the same bottles as portions that did. None were chemically pure.

It seems possible that the phenomenon is due to chemical reactions with the active nitrogen, or it may be due to the presence of free electrons. An insulated electrode was sealed into the exhaust tube about a metre from the discharge tube and connected with an electroscope. When the latter was negatively charged little effect was produced by a stream of active nitrogen just past the stage of luminosity. When it was positively charged, it was rapidly discharged. When an uncondensed discharge was used with the same nitrogen, or the condensed discharge through inactive nitrogen, little effect was produced in either case. Recombination was apparently complete before the gas reached the electrode. As there must have been equal numbers of positive and negative ions, the loss of the positive charge must have been due to the greater mobility of the negative ions, and presumably they were free electrons. An attempt to measure the specific ionic velocities of the ions failed, on account of the electrostatic disturbances due to the disruptive discharge.

Under the conditions of these experiments, the line spectrum of nitrogen was not given by the light in the discharge tube. This indicates that molecular dissociation was small. The ions were probably for the most part molecular ions and electrons. The isolated bands in the first group which are the most characteristic feature of the spectrum of the active nitrogen afterglow must, of course, be due to molecular radiators. The afterglow depends upon the presence of a trace of oxygen (or some electronegative element) and is destroyed by the presence of more than a trace. It may be that in pure nitrogen there is no appreciable afterglow, because the great electron density favours rapid recombination. When there is an excess of oxygen, the electrons may all attach themselves to oxygen, and the final step may be the formation of nitric oxide, with the emission of Deslandres' third group of bands. If there is enough oxygen to remove most but not all of the electrons, recombination may go on slowly, the afterglow continuing while it lasts, the spectrum being due to the recombination of electrons with positive molecular ions. Of course the alternative is not excluded that active nitrogen may be monatomic and the characteristic radiation is emitted when it resumes its ordinary state.

E. P. Lewis.

Department of Physics,
University of California.

Active Hydrogen by the Action of an Acid on a Metal.

Evidence for the formation of active hydrogen from its positive ion in an acid has been negative. The reports of the latest workers in this field, Wendt and Landauer (Jour. Amer. Chem. Soc. 42, 930: 1920) show that there are certain difficulties to be met. The main one is to eliminate the moisture that accompanies a rapid evolution of hydrogen and at the same time not to destroy the active hydrogen if any were formed. If the velocity of the gas stream were too low, the active component would decay before reaching the sulphur. Then if the velocity were too high the moisture carried over would form a protecting film on the powdered sulphur and prevent the reaction between the two to form hydrogen sulphide.

During the work on the activation of hydrogen by corona discharge it was found by Wendt and Grubb (Jour. Amer. Chem. Soc. 42, 937: 1920) that active hydrogen combines with pure nitrogen to give ammonia. This method of testing for active hydrogen can be used to good advantage where moisture is carried along with the evolved hydrogen, since the spray does not prevent the contact of active hydrogen and the nitrogen.

If hydrochloric acid or sulphuric acid is dropped upon metallic magnesium suspended in such a way that the metal is at no time immersed or partly covered with any large portion of liquid, the drop of acid can react with the metal in the shortest possible time. This gives off hydrogen very rapidly, in fact almost explosively, and with a minimum quantity of spray. If this evolved hydrogen is brought in contact with pure nitrogen it is found that ammonia is formed very readily. The active hydrogen was then passed through a plug of glass wool before coming in contact with the pure nitrogen. The activity of the hydrogen still persisted as shown by the formation of ammonia. Therefore, the activity of the hydrogen cannot be due to ions or atomic gas. But Langmuir (Jour. Amer. Chem. Soc. 34, 1324 (1912)) has shown that monatomic hydrogen does not react with nitrogen to form ammonia. In view of this fact, if we allow pure nitrogen to escape at the surface of the magnesium where the hydrogen is evolved we find a maximum quantity of ammonia formed. The amount of ammonia formed increases with an increase in the rate at which the acid is dropped upon the metal. This, of course, means that the amount of the active component varies with the velocity of the gas stream.

If the acid is dropped on the metal very slowly and the evolved hydrogen passed through glass wool before coming in contact with nitrogen, no ammonia is formed. This indicates that the active hydrogen has reverted to the ordinary form before meeting the stream of nitrogen. The life of the active gas seems to be not longer than two minutes. This checks very closely with the life of triatomic hydrogen formed by other methods.

These results seem to substantiate the theory of Wendt and Landauer (Jour. Amer. Chem. Soc. 44, 510: 1922), namely, that triatomic hydrogen ought to be produced wherever atomic hydrogen is evolved. It is reasonable then to expect that a higher percentage of active hydrogen would be found in the gas evolved from the surface of the metal, than in the molecular hydrogen subject to electronic bombardment in a discharge tube. In the former all the hydrogen evolved goes through the atomic state, while in the latter case only a very small amount of atomic gas may exist at one time. The discharge would also destroy some of the active variety.

The preliminary results to determine the percentage of activation are in harmony with this theory. Further work is in progress to determine the quantitative relations of some of the factors involved.

A. C. Grubb.

Department of Chemistry,
University of Saskatchewan,
Saskatoon, Sask., Canada, April 2.

The Viscosity of Liquids.

I wish very briefly to supplement the remarks made in a previous communication on this subject in which I have suggested that the viscosity of liquids and its variation with temperature may be explained on the hypothesis that the liquid state of aggregation is composite in character; that is, is composed in part of molecules "rigidly" attached to each other as in a solid, and in part of molecules which are relatively mobile as in the gaseous state (NATURE, April 21, p. 532).

That the supposition made regarding the constitution of liquids is *prima facie* a reasonable one is, I think, clear from thermodynamical considerations. The liquid stands midway between the solid and the gas and has affinities to both. The volume of a liquid at temperatures slightly higher than the melting point is only moderately different from that of the solid, and hence the probability that many of the molecules are at any instant at the same distance from each other as in a solid is considerable. This probability may indeed be found from the latent heat of fusion of the substance. If W be the heat of fusion in ergs per mol, the number of molecules in the "rigid" and "mobile" states should be approximately in the ratio $e^{W/RT}$.

The mechanism of viscous flow of a liquid is perhaps clearest if we consider the case of a thin layer enclosed between two parallel plates, one of which slides over the other. When a steady state is reached, the "rigid" parts of the liquid move practically as complete wholes, and hence the effect of their existence is to diminish the thickness of the layer through which momentum has to be transported by the "mobile" molecules, and thus to increase the viscosity. As a rough approximation, this increase is in the proportion of the numbers of the two types of molecules. A more exact theory should take into account also the volumes occupied by the two types of aggregation and their changes with temperature.

The effect of pressure on viscosity of liquids would arise in two distinct ways. In the first place, we have a change of volume on fusion, and hence, by the Le Chatelier-Braun principle, the assumed dissociation from the "solid" to the "mobile" aggregation would be retarded by pressure, so that the viscosity should be increased. With substances such as ice which contract on melting, we have the opposite effect. In the second place, pressure diminishes the volume occupied by the "mobile" molecules, and therefore also the distance through which they have to transport momentum. This would increase the viscosity. At temperatures not much higher than the melting point, the first effect would preponderate. This is strikingly illustrated in the case of water, the pressure-coefficient of viscosity of which is negative up to 32° C., that is, even at temperatures much higher than that of maximum density.

C. V. RAMAN.

210 Bowbazaar Street,
Calcutta, March 15.

Green and Colourless Hydra.

IN NATURE of April 7 a short account is given of the interesting experiments made by Goetsch on the conversion of the green Hydra into a pale Hydra. Some years ago I observed what may be called a natural experiment of the same kind. At the south end of the tunnel that conducts the water supply of Manchester from Lake Thirlmere under Dunmail Raise to the Grasmere valley there is a small settling tank, and on the walls of this tank I found a very large assembly of milk-white Hydras. An examination with a pocket lens led me to the conclusion that they were only a white variety of the common *Hydra viridis*, and were probably the offspring of parents living in the tunnel. These white Hydras were evidently enjoying the full vigour of life.

SYDNEY J. HICKSON.

The University, Manchester, April 11.

Single Crystals of Aluminium and other Metals.

WITH reference to Prof. Porter's letter in NATURE of March 17, p. 362, the accompanying photographs (Figs. 1 and 2) may be of interest. They illustrate at a magnification of 100 diameters the type of fracture obtained when a drawn tungsten wire consisting of a single crystal is broken in tension. The fracture is always of the wedge type, the wire being very greatly reduced in diameter in one plane while it suffers no appreciable reduction in the plane at right angles. The photographs show the same specimen after fracture taken from two planes at right angles. The diameter of the wire was 0·05 mm.

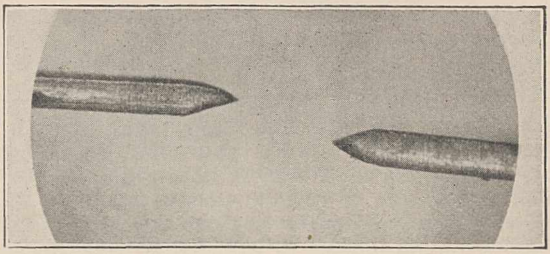

FIG. 1.—0·05 mm. single crystal tungsten wire broken in tension, showing reduction in diameter. (×100.)

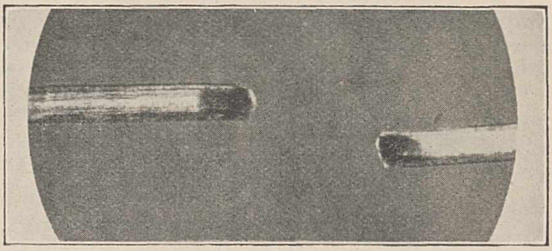

FIG. 2.—Same specimen photographed in a plane at right angles to that of Fig. 1, showing no reduction in diameter in this plane.

C. J. SMITHELLS.

Research Laboratories,
General Electric Co., Ltd.,
Wembley, March 20.

Stirling's Theorem.

A SMALL modification of the proof given by Mr. Strachan in NATURE of March 24, p. 397, leads to an asymptotic series for $n\,!$ rather more convergent than Stirling's. The symbol $n\,!$ standing, generally, for $\Gamma(n+1)$, we have

$$\log (n+\tfrac{1}{2})\,! - \log (n-\tfrac{1}{2})\,! = \log (n+\tfrac{1}{2}).$$

Hence, by Taylor's theorem,

$$\left(D - \frac{D^3}{2^2\,3\,!} + \frac{D^5}{2^4\,5\,!} - \ldots\right) \log n\,! = \log (n+\tfrac{1}{2}).$$

$$\therefore \log n\,! = \left(\frac{1}{D} - \frac{D}{24} + \frac{7D^3}{5760} - \ldots\right) \log (n+\tfrac{1}{2}).$$

$$\therefore n\,! = \sqrt{2\pi}\left(\frac{n+\frac{1}{2}}{e}\right)^{n+\frac{1}{2}} \times \exp.\left(-\frac{1}{24(n+\frac{1}{2})} + \frac{7}{2880(n+\frac{1}{2})^3} - \ldots\right),$$

the constant in the integration being determined as before.

Stirling's first approximation, $\sqrt{2\pi n}\; n^n e^{-n}$, makes $1\,! = 0{\cdot}922$, whilst $\sqrt{2\pi}\{(n+\frac{1}{2})/e\}^{n+\frac{1}{2}}$ makes $1\,! = 1{\cdot}028$ and so is a little closer.

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Selection and Segregation.

IN view of recent discussions in the columns of NATURE, the following remarks may be of interest.

Charles Darwin did not explore for himself the vast resources of the new territory which he discovered, nor did he traverse all the passages leading to it. He "allured to brighter worlds and led the way." In doing so it is possible that he did not arrive at the point of disentangling the qualitative from the quantitative implications of selection. It will be remembered that his theory was followed by long discussions on "What is a species?"

Natural selection is mainly qualitative, while specific differences are essentially quantitative. If Darwin can be said to have missed this distinction it was because he could not anticipate all the objections that might be brought to bear upon his marvellously fruitful concept. Moreover, quality and character often appear without any obvious separation, and in all cases the mind has to be addressed to the task of discrimination.

It is the province of Mendelism or genetics to deal with the analysis of unit characters and to exploit favoured individuals. Natural selection is concerned with the combination of characters, internal as well as external, and with the preservation of favoured races. Combination of characters gives quality to a genus; segregation of characters imparts novelty to a species. Mendelism and Darwinism clearly belong to different categories; though of course they meet on the common stamping-ground of heredity.

Natural selection is the directive force which controls the motive impulse of evolution and holds it within bounds. It thus becomes to our view the guardian of mutations, the custodian of change; that is to say, it provides an automatic control over the fitful mutations of the organism. The four pillars of organic evolution—struggle, survival, mutation, and adaptation—are properly orientated by natural selection. This operates in certain directions under certain conditions of climate and contact; it is the chain of events which assigns an organism to its place in Nature. Nevertheless, the simple thesis had not been excogitated before it was expounded by Darwin. It was a permanent gain to knowledge which can never be repeated, like the discovery of the circulation of the blood by Harvey and the biogenesis of reproduction by Redi.

Darwin gave us a theory of qualitative evolution by the natural selection of spontaneous variations in the open. Survival for an hour or for an æon implies unconscious selection for the time being. On the other hand, Mendel gave us a quantitative law of alternate inheritance of contrasting characters under culture. A single example, expressive of many, may serve to bring the distinction between intrinsic qualities and gross realities into crude relief.

Leaf-mimicry is one manifestation of interrelation of plants and animals, of which floral imitation and stick and twig shapes are others. It is a quality so intangible that it may be called into question even when most obtrusive. Individual observations are therefore of little moment until confirmed. The leaf butterfly (Kallima) and the leaf insect (Phyllium) resemble a leaf in different senses—the former vertically, the latter horizontally—the recognition of the resemblance in these classic examples being old-established. Some years ago ("Spolia Zeylanica," II, 1904) it was my privilege to bring to scientific notice for the first time the behaviour of a leaf fish (Platax) in Ceylon. Similar observations on a species of Platax in the Philippines have since been recorded by Dr. Th. Mortensen of Copenhagen. (*Vidensk. Medd. fra Dansk naturhist. Foren.*, Bd. 69, 1917, p. 63.)

Admitting the existence of leaf-mimicry in diverse planes and orders, we can only begin to explain it on the basis of natural selection, the leaf shape being desirable and attainable when other contributory factors are equal. ARTHUR WILLEY.

Department of Zoology,
McGill University,
Montreal, April 1.

Distribution of Megalithic Monuments.

IN NATURE of March 31, p. 442, reference is made to Mr. W. J. Perry's speculations upon the builders of megalithic monuments. Perhaps you will be good enough to find room for some criticisms. There is a real danger that the scientific study of archæology may be overwhelmed by the tide of theorising which is now flowing so strongly in this country.

Mr. Perry believes that the builders of megalithic monuments chose to settle in those regions which furnished natural supplies of what the note in NATURE terms "precious metals and other valuables." If so, then why did so many of them settle in the Cotswolds, where natural flint is almost non-existent, and where no metals occur? In this region—in the counties of Gloucestershire and Oxfordshire—there are fifty-six Long Barrows, which Mr. Perry rightly includes within the class of megalithic monuments. Why are there more than twice as many Long Barrows in Gloucestershire alone as in all the other flint-producing counties of East and South-east England?—The East Riding of Yorks, Lincolnshire (none), Norfolk (none), Cambridgeshire (none), Essex (none), Herts. (one), Bucks. (none), Beds. (two), Oxfordshire (none in Chilterns), Surrey (none), Sussex and Kent (perhaps a dozen at most between the two). If it was flint that determined their settlement-areas, there is more to be found in any single *parish* of any one of these counties than occurs naturally in the whole of Gloucestershire! Why, further, is it that there is not a single Long Barrow within forty miles of Grimes Graves, the great Neolithic flint-mining district of East Anglia, and no megalithic monuments within a hundred miles?

But the greatest difficulty is in Mr. Perry's suggestion that the builders of megaliths travelled in search of metals. There is no evidence that the builders of British megaliths knew of or made any use of metals. Not a single fragment of metal has ever been found in a megalithic burial chamber in England, Wales, or Scotland. Accordingly, the opinion of archæologists for half a century has been that all megalithic burial-chambers (including those in Long Barrows) are neolithic; and there is no evidence of any sort to suggest that this opinion is erroneous, much less to prove it wrong.

Some controlling factors in the distribution of Long Barrows over a part of England and Wales were suggested in Ordnance Survey Professional Paper No. 6. The facts upon which my conclusions were based were presented fully, both in tabular form and upon a map (O.S. quarter-inch, Sheet 8). For this region the facts—about a quarter of them new to science—are not available elsewhere. When the survey of England and Wales is complete, it will be time to draw conclusions about the country as a whole. Until then, those interested would be serving science better by assisting in the collection of facts than by indulging in premature speculation.

O. G. S. CRAWFORD.

Ordnance Survey Office, Southampton,
April 14.

The Surface Movements of the Earth's Crust.[1]

By Prof. J. JOLY, F.R.S.

THE land surface of the globe has been, for the most part, many times covered by the sea in the course of geological time. The mountain ranges of the earth, as now known, have only recently attained their present elevation; other mountain ranges formerly existed which have now been all but obliterated by the remorseless effects of denudation.

It is important that we should study for a little what happens when a great mountain range is developed on the surface of the globe. There is a long period of preparation for the stately event; a period many millions of years in duration. First, there are signs of unrest in the solid land of the continents. The sea rises on the coasts and transgresses on the wide lands within, very gradually stealing over the lower levels. This process may not be steady and continuous. There may be periods of retreat followed by periods of advance, but always the land, as a whole, goes on sinking deeper and deeper into the sea. Many millions of square miles may be covered with the shallow seas—perhaps to a depth of two or more hundred fathoms—so that a considerable portion of the land area of the globe may become sea before the downward movement ceases. This transgression is a slow process; so slow and long-enduring that, while the submergence lasts, great depths of sediment accumulate in the transgressional seas.

Then at length there comes a resurrection. The land begins to emerge; but not the old land which went down. Where the great accumulations of sediment had been, mountain ranges arise. In short, what arises from the ocean grave is a crushed and wrinkled world, shattered by faults and over-thrusts and exhibiting every evidence of great horizontal compression. One attendant of these events is the outbreak of volcanoes and floods of lava welling out of fissures in the earth's crust. The latter generally appear along western coasts, or to the west of the new-born mountain ranges.

These events draw to a close when the land has attained its former elevation, more or less. There is then a new era of geological history—a long era of organic progress, lasting many millions of years, during which minor oscillations of the crust and local deformation may occur. This is a period of active denudation. The last-born mountains are degraded by denudation, and their sediments collected into the great troughs or geosynclines, and the sublime but unreasoning sequence of events is repeated all over again.

Such has been in leisurely repetition the history of the earth. Certain world-revolutions are generally accepted—although geologists are not all agreed as to their number—as comprised in the period of 150 or 170 million years which the statistics of denudation and the record of thorium lead ascribe to the age of our era. Four or five world-revolutions appear to enter into that time interval. Thus 30 or more millions of years may, tentatively, be ascribed to the genesis and consummation of a world-revolution.

From these broad features of geological history it is evident that some source of unrest, acting upon the surface of the earth, which periodically recuperates its strength, runs a course involving an enormous expenditure of energy, and then dies down into quietude, must exist. What can this source of unrest be?

In the science of isostasy we are confronted with the strange fact (for fact it undoubtedly is), that the lands of the earth—firm as they may appear—are yet floating like rafts or pontoons on a yielding substance far beneath. Now, the continents are built of rocks, such as granite, gneiss, sandstone, etc., and in the same way as the sea-water must be denser than the icebergs which float upon it, so the substance which buoys up the continents must be denser than granite and chemically similar materials.

We get a very sure guidance as to the nature of the sustaining substance in a direct and simple way by paying attention to the nature of the lava which is poured out in enormous volumes on the surface of the land during times of revolution. This substance comes up as a thin and very fluent liquid. It may flow for 50 or 60 miles over the ground before congealing. It solidifies to a black and heavy solid—basalt.

There appears to be no doubt—and in this many petrologists are agreed—that basalt is the primary rock-magma upon which the continents float and which buoys up the great oceans of the earth. Just beneath continents and oceans it forms a layer over the whole earth—a layer to which isostasy ascribes a depth of some 60 to 70 miles. This substance, basalt, therefore, plays a very important part in the surface history and physical phenomena of the globe. Primarily, and most important of all, we know that it contains a small quantity of radio-active substances. No basalt ever examined failed to reveal this fact. These radio-active substances continually evolve heat. We know of no conditions which can check, or in any way alter or modify, this ceaseless evolution of thermal energy. Hence we must recognise that in every cubic centimetre of this great magmatic ocean upon which the continents and seas float there is a source of slow thermal evolution.

Keeping in mind that the central problem to be solved with respect to the great land movements affecting the surface of the globe is to account for the great outbreak of igneous activity and crustal disturbance all over the surface of the earth every 25 or 30 million years, we naturally ask if the perennial supply of radio-active heat may not furnish the explanation.

The thermal properties of basalt under ordinary conditions have been fairly well examined. At a temperature of 1150° it softens, at 1225° it flows freely, forming a very mobile but heavy liquid. In passing from one state to the other there is a volume increase of about 10 per cent. of the initial volume. This may be a rather excessive value. It is not less than 6 per cent.

Now, the fact that the basalt in these great floods reached the surface in a fluid state is adequate proof

[1] From a public lecture delivered under the auspices of the Royal Dublin Society on March 7.

that it was at a high temperature in the regions deep down from which it came. This is its condition generally all the world over during times of revolution. There are many reasons for believing that at the present time it does not and cannot generally exist in the fluid state; although deep pockets of the fluid magma must probably exist at all times throughout the magma-ocean and beneath the continents, there extends for a very long period after a revolution a shallow layer of the melted rock. Generally throughout the deep isostatic layer it possesses the characters of a plastic solid and is yielding enough for the continents to float upon it. The addition of a certain known quantity of heat to each gram of the highly heated basalt will convert it to the liquid state.

We know, as the result of many experiments, the quantity of radio-active substances in basalt. Samples from various great lava flows and volcanoes have been examined. There are certain variations in the quantities observed from one great flow to another. Taking a mean we can calculate the quantity of heat which would be generated, say, in one million years in each gram of the basalt. Briefly stated, the results of our investigation show that the heat accumulated in about 25 million years would suffice to turn the solid basalt, nearly at its melting-point, into a liquid.

The first effect of this change will be a considerable expansion in volume and corresponding loss of density and buoyancy. For, as has been stated, the solid basalt near its melting-point expands some 6 to 10 per cent. of its volume in changing to the liquid state. The result upon the continents is easily inferred. When a ship sails from the salt water of the ocean into a river of fresh water it sinks a little; so also the continents will sink a little. The waters of the ocean will therefore transgress upon the lands, advancing century after century as the basalt changes its state, as we know happens in periods preceding a revolution. Hence the earliest phase of geological change finds an explanation in the melting of the basalt which floats the continents.

But other consecutive consequences follow. For when, all over the earth, beneath continents and oceans, there extends a deep sea of melted lava, it is evident that conditions arise favourable to greatly increased volcanism both on the land and over the floor of the oceans.

The melted basalt will again lose heat and revert to the solid state. It may take 3 to 4 million years for this to happen, but happen it must. For liquids part with heat much more quickly than solids, just because circulation can go on in them. Now the basalt, where it laps against the rocky floor underlying the oceans, loses its heat far more rapidly than radio-activity can supply it. It probably melts away a good deal of the ocean floor in the process of parting with its heat. The ocean floor is very probably, almost certainly, also basalt. Possibly this floor becomes very thin indeed in the course of the long period during which the great ocean of lava is returning to the solid or plastic state.

It will be understood that the change of state has completely altered the conditions of heat-loss, the gain of heat per gram remaining the same at all times. The solid basalt can only lose heat by conductivity—a very slow process. Beneath the continents even this means of escape is almost closed, because the base of the continents possesses a high temperature, arising from the radio-active content of the continental materials themselves. Beneath the ocean, a few miles down, the conditions become much the same. Thus the solidified magma must conserve practically all its heat-gains. When fusion becomes general convection begins, as well as other movements later to be referred to. The escape of heat beneath the oceans becomes then relatively rapid.

But now notice the effect upon the continents of this reversion to the solid condition. When the basalt regains the solid state it also regains its original density; and the land regains its original buoyancy. The continents must now rise again to their former altitude above the sea. They are as ships passing from the river to the ocean. The waters which flowed in upon the continents during the slow process of the melting of the basalt must recede again as the basalt resolidifies. Hence a final great phase of geologic change finds explanation in the physical properties of the basaltic ocean and its inevitable thermal changes.

We can only discuss with any degree of definiteness the events progressing in the upper region of the great basaltic ocean. For the depth of this ocean is probably not less than 60 miles, and the pressures prevailing in such depths greatly modify the behaviour of substances experiencing accession or loss of heat, but there is no reason to believe that any effects to which reference has been made will be seriously modified. On the contrary, the effects, so far as we can infer them, of great pressure in the depths appear to bring events still more into harmony with geological observations and inferences.

From what has been stated we see that the reason for the long time intervals between the epochs of world-wide revolution is to be found in the smallness of the quantity of radio-active substances existing in the great sustaining magma supporting the continents and the oceans. On an average, it takes some 25 millions of years for the change of state to be brought about attending which the continents must sink and the waters transgress upon their surface. Then some 3 to 5 millions of years may be required for the stored radio-active heat to be again dissipated. The cycle is therefore accomplished in, say, 30 millions of years. These figures are given merely as suggestive of what might prevail. Various causes, which cannot be discussed, may modify them.

We live at a period immediately succeeding a very great world-revolution. The lava ocean has lost its heat of fluidity for the most part, and the continents float upon the basalt sea as upon a plastic or viscous body nearly at its melting temperature. These conditions are really very wonderful; but the explanation of our immunity is simple. The melting-point of the continental rocks is from 200° to 500° higher than that of basalt. Again, solid rock conducts heat badly. Hence little or no heat reaches us from the fiery ocean beneath.

We have next to consider if we cannot find an explanation of mountain-building and volcanic phenomena as involved in the changes we have been discussing. We know that the ocean tides are due to lunar and solar gravitational attraction. Oceanic tides are comparatively feeble phenomena; for not only is the ocean shallow and obstructed by land, but also water is a fluid of low density. But during times of revolution, just beneath the continents and oceans, there comes into existence a vast and far deeper ocean, composed for a great part of a highly fluid substance having a density three times that of water. We seem to have, therefore, good and sufficient reason for expecting greatly intensified tidal phenomena to arise during these times. So also a precessional force must act with intensified effect in periods of revolution. Both these forces tend to retard the surface crust of the earth in its diurnal rotation from west to east; that is, they tend to hold it back a little from partaking of the general easterly rotation of the globe. The effect is greatest in equatorial regions.

Fig. 1 shows, to an exaggerated vertical scale, a portion of a continent seen in section, along with a part of a neighbouring ocean, both floating upon the basaltic magma. West is to left and east is to right. We must imagine that the lower, more viscous part of the magma possesses the full west-to-east angular velocity of the earth; but the continents and oceans and upper layers of the magma are, in virtue of the westerly forces just referred to, not moving quite so fast in that direction. They respond, in fact, to the forces urging them westward. We perceive that this involves, of necessity, an east-going force or pressure acting upon the submerged parts of the continents, and more especially upon the more deeply submerged parts; that is, upon the displacements required by isostasy to float the greater raised features of the continents.

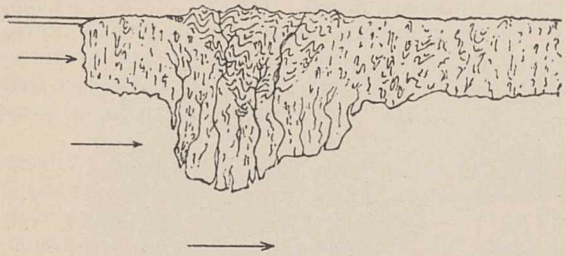

FIG. 1.—Diagram of continental border-section W. to E.

The diagram is intended to illustrate the effect of the magmatic pressure with reference to mountain-building. We have already seen that mountain ranges arise where great depths of sediment collect for long ages. These accumulations may amount to several miles in depth; the sediments pressing down the crust as they collect.

It is well known that this process creates a linear area of weakness in the floating continent. We can picture what happens. The great load bends down the crust, forcing it deep into the hot magma. It becomes seamed with gaping vents and cracks, extending parallel with the axis of the trough into which the magma forces itself.

Now, if a horizontal force acts upon a continent affected with such an area of weakness, this part yields first and the sediments are crushed and forced both upwards and downwards. The part that rises up forms the mountain range; the part that is thrust downwards acts as compensation or buoyancy, which serves to float the mountain. The one adjusts itself to the other. The mountains slowly sink or rise till there is equilibrium. Thus, in course of ages, we get the floating mountain range. It will be perceived that the volume of the downward displacement is much greater than the mountain range. This is because the density of the crust does not differ greatly from that of the sustaining magma.

Such great ranges as the Cordilleras of North and South America rose up out of troughs of sediments in this manner. They were specially favourably oriented to receive the easterly pressure of the underlying magma, and, correspondingly, they are in many respects the greatest mountain developments of the globe.

However, while it seems easy to understand that the formation of mountain ranges directed more or less north and south might arise in this manner, it is more difficult to imagine chains of mountains like the Himalayas or like the Pyrenees originating in the west-to-east force arising from tidal or precessional effects. This brings us to the consideration of the possibility of the continents having shifted their relative positions during geological time.

Many are now weighing evidence for and against such extraordinary possibilities as to whether the Atlantic Ocean is not a comparatively recent innovation; whether New Zealand was not recently detached from Australia, and India from the eastern shores of Africa, and so on. Before this interesting question arose biologists and geologists generally got out of their difficulties by assuming the former existence of land connexions or "bridges" which subsequently "foundered" and disappeared.

Now, according to the present explanation of the surface movements of the earth, the foundering of such "bridges" would be difficult to realise; for they are of lower density than the basaltic magma upon which they at one time floated. So that it becomes very difficult to imagine the former existence of these bridges. Not only is this the case, but also the present theory certainly suggests that differential movements of the continents might quite possibly have taken place. I do not mean to convey that these supposed great movements *necessarily* arise out of our theory, but it is at least remarkable that a theory which appears to explain much—and on a basis which can claim to be more than merely hypothetical—should offer what may be regarded as a *vera causa* for continental drifting if other considerations require it. The continents during times of revolution become acted upon by forces tending to move them towards the east; and, what is even more relevant, these forces must of necessity be different in intensity from one continent to another. In fact, the magmatic drive applied to a continental mass depends upon the depth of its immersion and also on the existence of great displacements extending downwards into the deeper parts of the magma.

Another consideration in favour of continental drifting must be taken into account. The continents become acted upon by these forces only during the period of magmatic fluidity. We saw that this fluidity is ultimately lost, mainly in consequence of heat escaping through the ocean floor; this floor being probably more or less melted away during the process. It may be that the reduction in thickness of the ocean floor is carried so far as to remove what is really the main obstacle to differential continental movement—the existence of a strong and rigid ocean floor, holding the continents immovably fixed to one another.

We return for a moment to the problem of the elevation of such ranges as the Himalayas, which trend more or less east and west. We are now prepared for the possibility that the explanation of these events was due to a certain small amount of continental movement. It is a fact that tidal and precessional forces are greatest in equatorial regions. May it not have been that the great continent of Africa, experiencing the effects of this, rotated just a little, its southern extremity moving eastward; and so also for Peninsular India; so also for the Spanish Peninsula? A small turning movement, crushing the ancient geosynclines, would suffice. For, after all, the greatest mountains are but very tiny wrinkles upon the surface of this huge world.

The outflows of lava on the western coasts of the continents, or to the west of great mountain masses, or brought up by the downward faulting of rift valleys, to which I have already referred, seem to give us direct evidence of the magmatic pressures of which we have been speaking. The injection of lava into the great mountains, or its ejection from lofty volcanoes, finds explanation in the great volumes of included basaltic magma which are taken up in the crushed and shattered sediments of the geosynclines when these are floated up from the depths of the earth's crust.

In the foregoing remarks I have endeavoured to trace, on the basis of isostasy and radio-activity, the existence of cyclical changes, prevailing in the isostatic layer, which are in harmony with the observed recurrent world-revolutions. While a certain grand simplicity in the nature of these events, and the existence of a general resemblance between the character of one revolution and that of the next, permit of this treatment, it would be an erroneous inference that the physical events of historical geology are concentrated in the relatively brief periods of world-wide mountain-building. For in truth an endless succession of minor changes have affected the crust of the earth. Between the great revolutions transgressions of the ocean have occurred over considerable areas. Crustal warping, and even mountain elevation of lesser ranges and batholithic invasion of the crust, as well as renewed volcanism, have not been uncommon. All the events of the greater revolutions may appear locally, and always on a lesser scale.

In point of fact, these lesser, inter-revolutionary events are, probably, part of the primary phenomenon and owe their existence to energy concerned with the genesis of the former. For consider that during millions of years the continental crust, throughout every part of it, has been subjected to those same enormous stresses, vertical and horizontal, that served to uplift the Cordilleras to heights of more than 20,000 feet; and that, at the time when the floor of the ocean congealed around the continents and tidal effects died out, the vast volume of the land was left deformed by these great stresses, strained, often to fracture wherever rigidity prevailed, and with isostatic adjustments profoundly disturbed.

The inter-revolutionary periods of geological history must witness the readjustments necessitated by this accumulation of potential energy. Areas of low resistance—*i.e.* the geosynclines, the volcanic areas, or recently deformed regions—must experience the concentrated results. Moreover, all the conditions for very prolonged continuance of these minor activities exist. For there is no other way in which the accumulated energy may find relief save in crustal disturbance or readjustment. It will be slowly doled out for ages as the effects of denudation call upon it, or as thermal events give it occasion to intervene, for the cooling of the magma beneath the continents must be extremely slow. Sheets of melted lava must underlie them, throughout almost the whole of geological time, although deeper down there may be comparative rigidity.

It will be apparent from all this that there is nothing unaccountable either in the existence or nature of inter-revolutionary events. On the contrary, we may say that their absence would be highly unaccountable. Even more, I think that as we study these events we must conclude that they cannot represent more than a fraction of the stored energy attending a great revolution.

This leads to the energy question at large. Whence does it all come? To answer fully that question would lead us back over much of the ground we have already pursued. But as regards energy other than radioactive we may briefly answer: "From the rotation of the earth." And is it not adequate? Look at the diagram of an earth-sector (Fig. 2); with a floating

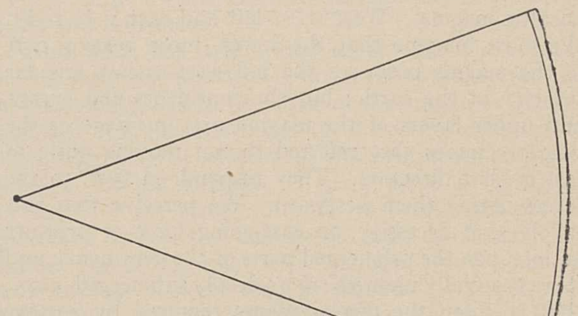

FIG. 2.—Earth-sector showing basaltic layer and continents to scale of radius.

crust 20 miles thick and an isostatic layer 70 miles deep. Consider how petty are the crustal energies contrasted with the stored energy of the globe, built as it is out of materials twice as dense as the continental rocks, and possessed, even to-day, of a surface velocity of 1000 miles an hour.

In its biological aspect how great and wonderful it all is! The living being working out his destiny on this poor raft, unknowing of the fiery ocean upon which his world is floating: unknowing of the inevitable sinking and uplifting which in truth largely control the destinies of his race. Death-dealing forces all around, and yet the light of life shining age after age upon the earth.

Water-Power in the British Empire.[1]

By THEODORE STEVENS.

THE Water-Power Committee of the Conjoint Board of Scientific Societies in its various reports has ably summarised the information on water-power available throughout the British Empire, and the Board of Trade Water-Power Resource Committee and Sub-Committee have dealt with the British Isles in a similar way. Canada has done more measuring of those resources than any other part of the Empire. Canadian water-powers in service, catalogued in Water Resources Paper Number 27, numbered, in 1920, 336 developed water-powers. Of these the summary, arranged by me under the different heights of falls, shows

43 were working with heads of water between 5 and 10 feet;
47 at heads between 11 and 15 feet;
84 „ „ „ 16 „ 30 „
84 „ „ „ 31 „ 70 „

With these figures before us, development of any head of water that may be available can be justified from past experience; but it is a great mistake to conclude that sufficient power can be developed from a stream until all the details of the problem have been fully studied.

There have been, within the last twenty years, water-plants installed in twenty different places, in every one of which after the capital was spent there was a rude awakening to the fact that the quantity of water necessary for the work undertaken was not available. A total of 25,000,000*l*. has been spent in those twenty places, and has proved financially unprofitable. Much more capital has elsewhere been profitably invested. Many other water-powers have proved successful. Enough has been said to show that reasonable caution necessitates efficient preliminary study before capital is invested.

Another note of caution refers to the distance that it is economical to transmit power. For example, it would not pay to generate hydro-electric power to supply a lighting load 75 to 100 miles away, if there is a coal-mine near the consumers' end of the transmission line; nor is it practicable to undertake to supply separate villages and farms on the line of a high-voltage transmission, because it costs many thousands of pounds to tap power from a high-voltage line, and the small consumption in village and farm cannot possibly pay the interest on this expenditure. It would be unnecessary to make such comments if this uneconomical arrangement had not been seriously advised by

[*Photo by Col. Sir H. A. Van Ryneveld, K.B.E.*

FIG. 1.—Victoria Falls, Rhodesia; view from the air.

The river at the fall is 1 mile wide and drops into a narrow gorge 400 feet deep.
The large model of Victoria Falls in the Imperial Institute, South Kensington, London, aids one to visualise this configuration.

[1] Substance of two lectures delivered at the Royal Institution on March 1 and 8, when illustrations of the important waterfalls in each part of the Empire were shown.

engineers whose experience evidently did not include such electrical details.

Seventeen years ago it was suggested that Victoria Falls (Figs. 1 and 2) would supply Johannesburg, and I have preserved a copy of the original prospectus of the company, including a map of the proposed transmission over a distance of 600 miles from the water-power across and into coal-mining districts. The company which was then floated has paid handsomely; but it wisely burns coal and says nothing about water-power. Even the hotel at Victoria Falls is lit by an oil engine. Similarly, if an examination is made of the super power zone in the United States, which embraces the great industrial area in the Eastern States, it will be found that it approaches within 200 miles of Niagara Falls, where many millions of horse-power run to waste, but it is not suggested that power should be derived from Niagara for that super power zone.

FIG. 2.—Victoria Falls; part of main falls. By courtesy of the British South Africa Company.

It is also true that Niagara power is delivered 270 miles from the Falls. The selling price (by Government, without profit) in bulk to the towns at that distance is three times the selling price for similar power near the Falls. There is always an excess of water at Niagara Falls. Under other conditions, for example, where summer flow is limited and cheap coal is available, it might be easy to prove that it is cheaper to generate electricity locally from coal than to transmit water-power so far.

Tidal-power fascinates every one who studies it; and when our coal supplies are much nearer depletion than at present, it may be utilised on a large scale. The Ministry of Transport published a scheme (since withdrawn) for developing tidal power on the river Severn, and said that the power was so vast that it exceeded "all the potential sources of inland water-power in the United Kingdom put together." But two and a half times the power proposed for development in the Severn exists in other parts of the British Isles, where it is free from the irregularity due to the variation in the times of the tides, and it can be developed for 5,000,000*l.* less in first cost than the estimate for that tidal power; the estimate, in my opinion, was not half enough to do the work specified.

We might allow this scheme to rest in peace, since the Geddes axe was first sharpened for use on the promoters of it; but, from time to time, it is brought forward as practicable. If one reads the Interim Report on Tidal Power by the Board of Trade Water-Power Resource Committee, it will be seen that nothing more costly than further investigation and study of the complications involved was recommended by that Committee; and the Electricity Commissioners dissociated themselves from any knowledge of the power-house, two miles long, with railway trains using the power-house as an economical bridge across the river.

We have an example of a corporation electricity supply being changed from a financial burden on the rates to a satisfactorily profitable undertaking in the report of the Chester electrical engineer, Mr. S. E. Britton, by utilising a small head of water (which varies from nothing up to 8·5 feet, because the tide comes up to the water-power plant's discharge). In seven years, on a capital of 56,000*l.* in steam-plant, there has been a relative loss of 15,000*l.*; while 18,000*l.* capital invested in the water-plant has shown 82,000*l.* profit, leaving a net profit of about 67,000*l.*; but it is essential to realise that this water-power cannot be utilised for a satisfactory statutory supply of electricity in Chester without the steam-plant to produce current from coal when the water-power is not available (due to high tide or to insufficient flow in the river).

Shawinigan in Canada is an example of a beautiful waterfall concerning which, I believe, it was an American who wrote:

At every waterfall two Angels stay,
One clothed in rainbows, the other veiled in spray.
The first, the beauty of the scene reveals;
The last revolves the mighty water-wheels.
And there those two fair sisters ever stand,
Utility and Beauty, hand in hand.

To-day, instead of standing to be admired, "Beauty" is to be found voluntarily undertaking some useful work.

The water at Shawinigan Falls now flows down inside pipes. Where, in the days of Beauty, only an occasional sportsman visited the falls, is to be found to-day a town of 12,000 inhabitants, amply provided with work and wages by the water-power which is utilised for various electro-chemical manufactures, as well as for supplying the cities of Montreal and Quebec with electricity.

In Ireland the writer carried out surveys of the power available in the largest rivers, for the Irish Hydro-Electric Syndicate and for the Water-Power Resources of Ireland Sub-Committee under the chairmanship of Sir John Purser Griffith, and has shown that it would be practicable in an average year thus to supply a demand three times as great as the present demand in the whole of Ireland for electricity, and has recommended and shown the economy of linking up this supply to all important towns and cities; utilising existing steam-electric stations to supply current when, owing to drought, one summer's flow of the rivers is too far below the average summer flow. The combination is like that at Chester, but on a much larger scale.

Suppose we allocate part of each of the rivers Shannon and Erne to the manufacture of carbide and of nitrogen fertilisers and operate this plant as fully as the flow of water permits; with an average output we could make in a year fertilisers containing 20,000 tons of nitrogen. Each of these works would be of the size recommended as economical by the Nitrogen Products Committee of the Ministry of Munitions.

It is not definitely known how much nitrogen fertiliser can be utilised within Ireland; but there are markets for carbide and for nitrogen fertilisers outside Ireland, so any excess over home requirements could be exported at a profit.

The nitrogen in various compounds used in a year in the world amounted to 694,600 tons[2] pre-War and 1,219,000 tons post-War (1919). There is nothing excessive in recommending fixation in Ireland of 3 per cent. of the world's annual pre-War consumption of nitrogen.

There would be work throughout the year, but more people employed at the chemical works in winter-time than in summer. It is well known that about 10,000 workers leave Ireland every summer to do farming in Scotland and England and return to their more economical life in Ireland during the winter-time. For some of those there would be thus provided winter work in their own country; while, of course, there would be employment throughout the year for an appreciable number.

There are nitrogen fixation plants near Niagara and at various other places in the world. About half of the pre-War consumption of nitrogen was in the form of native nitrate of soda. Among the many important applications of water-power, the one in Tasmania, where the Electrolytic Zinc Co. of Australasia, Ltd., utilises 30,000 horse-power from the Tasmanian Government Plant for the preparation of high-grade zinc, is worthy of especial mention.

More attention should be paid to the selection of industries that require large amounts of power, and to their establishment at sites where suitable water-power is available. We cannot recall too often the history of Niagara's development. Before electricity was a commercial form of energy, capital was invested (during the years 1853 to 1861) in making provision for direct water-power; in 1861 it was ready, but it ran to waste for ten years before the first consumer arrived in 1871. It was not until 1894 (forty-one years after the commencement referred to) that a profitable amount of power was utilised. Water-power is the cheapest form of energy when fully utilised twenty-four hours in the day.

[2] American Electro-Chemical Society's Proceedings, Volume 34.

Obituary.

PROF. J. D. VAN DER WAALS.

WITH Johannes Diderik van der Waals, who died on March 8 at Amsterdam, at eighty-five years of age, one of the great figures in the history of modern physics and physical chemistry has passed away. His thesis on the continuity of the liquid and gaseous state was a revelation in the study of fluids, the remembrance of which was to glorify the golden jubilee of his doctorate next June, and after establishing it he continued for some forty years to apply his efforts to the same subject, marking the steps of his success by further brilliant discoveries. When the Nobel Institute honoured this lifework, van der Waals was still occupied rounding off the comprehensive views science owed to him. For about half a century he was in the front of the workers in the domain he had opened. In the ten years which separate us now from then his forces began to give way, and later bodily and mental sufferings, borne with modest resignation, set in. At last, only short visits allowed us to show to the venerated and beloved friend, whose heart we felt remained unchanged, what he had done for us.

Van der Waals was born on November 23, 1837, at Leyden. He was a self-made man who took advantage of the opportunities offered by the University which he later honoured by his curatorship. It was not until he was thirty-six years of age that he wrote his thesis. With it he himself opened the period of Dutch science, which his elder friend Bosscha and he hoped to be one of the results of secondary education. In 1877, van der Waals became a professor at Amsterdam, and began to exert his great influence on the development of Dutch physics. One of the characteristics of his highly admired teaching was the introduction of Gibbs's great work to the chemists. I vividly remember as an example of it how Bakhuis Roozeboom, to whose first experiments the Leyden physical laboratory had been in the position to give some help, obtained results, which were inexplicable until van der Waals came to give him the key to it in Gibbs's doctrine of phases, his deep insight clearing the way for Roozeboom's brilliant work on the phase rule.

Very much was done by van der Waals for the Royal Academy of Sciences at Amsterdam. For twenty-four years he was the soul of the Board, and in 1896 he even accepted the secretaryship of the Academy, a post which he filled until 1912. Here as everywhere else he showed a never-failing unselfishness and high conception of duty. We owe to him the modern form of the Proceedings and their English translation, which he directed, both with an incomparable energy. The great efforts he bestowed on these periodicals have been well rewarded by the effect their stimulating influence had on Dutch science.

The scientific work of van der Waals forms a monumental whole of a special style. Characteristic of it is the intuition by which he introduced happy simplifications and approximations leading to a high degree of qualitative agreement of his theories with Nature, which in the case of the law of corresponding states rose even to a surprising quantitative approximation.

The first idea of the image of the fluid state which was gradually developed by van der Waals came to him when he combined the kinetic theory of gases with the determination of the cohesion in Laplace's theory of capillarity. With the aid of very happy approximations he built up the kinetic theory of the fluid state. Such a simplification gave in the first place the calculation of a molecular pressure which represents the cohesion, and the result of the calculation led him to the profound conception that the molecules of the gaseous and the liquid state are identical and exert identical forces. Secondly, he accepted as by inspiration an exceedingly appropriate form for what would be the outcome of the calculation of the kinetic pressure at higher densities. The simple equation of state which he obtained in this way reproduced the well-known diagram of Andrews-Thomson, as the representation of a series of stable and unstable states of mechanical equilibrium. It gave a deeper insight into the continuity of the liquid and gaseous state as well as a luminous explanation of the critical phenomena. It stood even the crucial test which van der Waals only with apprehension undertook to apply to it; that is, the calculation of the critical data of carbon dioxide of Andrews from the deviations from Boyle's law according to Regnault. Finding correct values for these meant a great discovery. The various thermal properties of fluids treated until then in different chapters of physics proved now to be at least approximatively contained in a single equation with only two specific constants, the volume and the attraction of the molecules, their molecular weights being given by their composition. Later researches have proved, more and more, the greatness of the genius which led van der Waals to his equation of state. Even now it is the most appropriate one to discuss qualitatively the properties of fluids.

Directly from this can be derived the second great discovery of van der Waals, namely, that it is only necessary to introduce the reduced values of volume, temperature, and pressure obtained by dividing the values of these variables by their critical values into the equation of state, to reduce this equation to the same equation for all substances. Simple as this substitution is, it took seven years before it was arrived at, and then only by van der Waals himself, who had been wrestling for a long time with the explanation of the deviations between his equation of state and reality. He had followed many false tracks in order to find some regularity in the deviations of the different substances, and had reached the conviction that to compare substances they have to be considered in corresponding states; that is, at the same values of the reduced variables. At that moment he found the law of corresponding states. Its scope is far wider than that of the equation of state. It involves the bold idea that the thermal properties of all substances can be derived from those of a single one simply by numbers of proportionality; and, what is marvellous, the law approximates more closely to Nature than the equation from which it is derived. How much I was under the influence of its great importance as much as forty years ago may be best judged by my taking it then as a guide for my own researches. It has had a great effect on the work of liquefying the permanent gases (in his thesis van der Waals predicted that air had to be cooled below $-158°$ C. to be liquefied, which has proved nearly correct) and of attaining the *nadir* of temperature.

This cannot be better illustrated than with the words of our deeply mourned Sir James Dewar in a letter to me, expressing that van der Waals was "the master of us all," "whom we cannot honour too much." All substances, except for small differences, appear in the light of the law of corresponding states, as van der Waals expresses it, as individuals of the same kind. He liked to direct attention to the fact that his friend Dewar had proved that, taking temperature as a measure, hydrogen was, according to his prophecy, a dwarf. To read to van der Waals a report of the experiments which proved that helium, though a very small dwarf, was yet well shaped, was a happy moment in my life, especially as the report showed the profit derived from van der Waals' law of corresponding states and at the end referred to his words that "matter would always show attraction."

As all normal substances are almost copies of the same model, van der Waals was anxious to bring his equation of state in closer approximation to this general model and to understand the differences between the various substances. To his pondering on the influence of association into double molecules on the deviations, we owe his theory of binary mixtures, which covers a yet vaster and more varied field than his previous discoveries. It is especially this theory to which, in connexion with the beautiful work of our deeply mourned Kuenen, I owe the strong ties which united me to van der Waals. For many years I went to his study at Amsterdam for a "monthly private course," that is, a consultation on the Leyden work, and I found van der Waals always at his table filled with papers, with the portrait of his wife, who died at an early age, on the chair in front of him. In these hours it often occurred that from an unpublished calculation he could rightly predict some error to be found in the diagrams of the experiments; and it is from them that I have got an idea of the amount of work from which his genius came to his intuitions.

It would occupy too much space here to refer in detail to the work of van der Waals, which groups itself around these three great discoveries. I can only point out that he tried to combine the theory of specific heats with that of the equation of state, and that in the end he was occupied with the very interesting problem of the influence of the conglomeration of greater number of molecules; that of quasi-association. Rounding off in this way the chapter he wrote in the history of science, he gave us, at the same time, a glimpse of that chapter which the next generation has to write, containing a rational application of quantum considerations in van der Waals' theory of the fluid state.

Not less than the extraordinary intellectual gifts which made possible his great life work, his friends admired his severe culture of the ideal and his noble character. We remember the pious heart, in whose friendship we rejoiced, and with a feeling of deep sorrow at the loss of his presence, we give him here the tribute of our profound gratitude.

H. KAMERLINGH ONNES.

DR. ARTHUR LATHAM.

THE medical profession has lost a somewhat striking personality by the death of Dr. Arthur Latham at the relatively early age of fifty-six. The son of a former Regius professor of medicine at Cambridge, who still survives, Dr. Latham was brought up in a cultured and scientific atmosphere, while his Oxford degree implied the double advantages of the two older English Universities. He was elected assistant physician to St. George's Hospital in 1898, and there soon showed his ability in teaching and his always masterful and dominating personality. A man of precise logical thought and of great determination, he could ill tolerate indefiniteness of view and indecision, and it is not surprising therefore that he had enemies as well as cordial friends.

Whatever Dr. Latham undertook, he made himself thoroughly acquainted with, and it was fortunate that the award to him of a prize for an essay on a tuberculosis sanatorium early determined the chief trend of his work. Although sanatoria for consumptives have not achieved all that was expected of them, this has been largely owing to their misuse under the pressure of the administration of the National (Health) Insurance Act, patients being sent in large numbers to sanatoria, for whom treatment in hospitals was indicated. Dr. Latham contributed other papers and small books on tuberculosis; he was a member of the Departmental Committee on Tuberculosis, which laid down the lines on which the state anti-tuberculosis measures were to be carried out; and in many other ways helped to bring the anti-tuberculosis crusade to its present advanced condition.

Of Dr. Latham's value as a medical politician, of the important work which he did to secure the firm beginning of the Royal Society of Medicine, this is not the place to write; but the memory of his clear and incisive speaking, arising out of logical thinking, of his pertinacious advocacy of great causes, and of his success in advancing the interests of preventive medicine, will not soon die.

WE regret to announce the following deaths:

Prof. Gustav Köhler, director of the Mining Academy, Clausthal, for the years 1887–1914, and who had taught there since 1880, at the age of eighty-four.

Sir Shirley Murphy, vice-president of the Royal Sanitary Institute and other scientific societies, and for twenty-two years Medical Officer of Health for London, on April 27, aged seventy-four.

Dr. Alfred Scholl, a director of the Agricultural Experimental Station, Münster, and deputy-editor of the *Zeitschrift für Untersuchung der Nahrungs- und Genussmittel*, on February 12, at the age of forty-six.

Mr. H. J. Seaman, for many years general director of the Atlas Portland Cement Co., New York, who was responsible, with Hurry, for introducing the use of coal dust in rotary tube furnaces for the burning of clinker, on February 9.

Current Topics and Events.

PROF. DE SITTER, who is to give a lecture at the Imperial College of Science and Technology on May 7, on "Problems of Fundamental Astronomy," and will lecture also at Manchester on May 9, and at Edinburgh on May 18, was a pupil of Kapteyn's, who was invited by Gill in 1896 to work for a time at the Cape. He made determinations of the parallaxes of several southern stars with the heliometer. For his thesis for doctor of science at Groningen he presented a "Discussion of the Heliometer Observations of Jupiter's Satellites." He has continued these researches and developed a new method for treating the mutual perturbations of the satellites, and is still engaged discussing photographs taken at the Cape and Greenwich for the determination of the necessary constants. After his return to Groningen Prof. de Sitter participated in a number of Kapteyn's investigations dealing with the dimensions and structure of the stellar universe. British men of science owe a debt to Prof. de Sitter for giving during the War, before Einstein's work reached England, three papers in the Monthly Notices of the Royal Astronomical Society which presented to English readers an account of the generalised theory of relativity. Prof. de Sitter has made important contributions to this subject and has examined the various cases where any astronomical verifications may be obtained.

IN an article in the April *Quarterly Review*, Lord Ernle writes on "Victorian Memoirs and Memories." His account of Huxley runs as follows: "Mrs. Asquith, who describes a meeting with Huxley at Jowett's, and remarks that he had about him little of the *juste milieu*, does not appear to have been favourably impressed. But Huxley was not always the gladiator. To me he was irresistibly attractive, because I fancied that I had caught a glimpse of his true outlook on life. When I think of his destructive criticism, I see again the arabesque with which he had adorned the side of the first page of his article on 'Lux Mundi.' Up the margin ran a vine-clad trellis: on the top crowed the cock of theology, and towards him crept the fox of science. I remember also discussing with him one of his numerous controversies—I think the Gadarene swine. With the impertinence of comparative youth, I expressed surprise at the quantity of vinegar and mustard which he mixed with the discussion of questions that to many people were matters of life or death. 'My dear young man,' he answered, 'you are not old enough to remember when men like Lyell and Murchison were not considered fit to lick the dust off the boots of a curate. I should like to get my heel into their mouths and scr-r-unch it round.' A wistful smile lit up his plain rugged face, as he added: 'And they never seem to reflect what a miserable position mine is standing on a point of Nothing in an abyss of Nothing.' The world saw much of the first mood, little of the latter."

THE council of the Zoological Society of London presented an eminently satisfactory report for the last year at the annual general meeting on April 30. There has been an increase of nearly two hundred in the number of fellows; the additions to the collections are more numerous than in the preceding year, the result chiefly of the receipt of H.R.H. The Prince of Wales's Nepal and Malayan collections; the attendance at the gardens maintains a very high level; and the financial position of the Society is thoroughly sound. The Proceedings have reached their pre-War standard as to bulk, the number of illustrations, and the promptness of publication; but the issue of Transactions has not yet been resumed. An appreciative reference is made to the work of Mr. Pocock, whose resignation of the post of superintendent has lately taken effect. Zoologists will learn with regret, akin to dismay, of the decision of the Society to cease publication of the "Zoological Record," owing to the inadequate support received. The Society has rendered an invaluable service to zoological science throughout the world in having undertaken the responsibility of the Record for so long a period, and it is a matter of grave concern that its efforts have met with so poor a measure of support. The council reports that excellent progress has been made in the construction of the new aquarium, and it is hoped that this will be ready for opening in the autumn of the present year. A favourable report is given of the durability of the coloured labels, painted in fusible enamel on tiles, which were introduced last year on the results of special experiments, and their use is to be extended as rapidly as possible. The scheme for the instruction of school teachers, which has been in operation since 1910, has been suspended for the present, as a large proportion of the London school teachers have now taken advantage of it.

THE results of a conference of veterinary authorities convened by the Government of India at Calcutta in February last were summarised in the *Times* of April 17. Anthrax infection in the case of East Indian wool, hair, and hides is so serious that special attention has been directed to the subject. Yet, according to the official returns, anthrax is a rare disease in India. The cost of disinfecting wool is greater than its present value, and the conference came to the decision that the agencies for notification of the disease in India must be improved, and that much skilled research and inspection are needed among the living animals in the country, if the disease is to be attacked at its seat. Surra, a disease of horses and camels, is now known to be due to a parasite of the group that gives rise to sleeping sickness in Africa. Tuberculosis is proved to be a frequent cause of loss of cattle, but little is known as to its prevalence. In short, "veterinary education, veterinary research, and veterinary legislation and administration in India are wholly unsatisfactory, and it is urgently to be hoped that the Government of India will give immediate and serious attention to the conclusions reached by the Conference."

THE meeting of the Illuminating Engineering Society on April 24 was notable for the large number of representatives of associations concerned with the printing industry which attended to join in the discussion of Mr. L. Gaster's paper on the lighting of printing works. Employers and employees joined in expressing appreciation of the importance of adequate illumination, and the Rt. Hon. C. W. Bowerman, who opened the discussion, contrasted the attention that is now being paid to the subject with the neglect of past years. Mr. Gaster dealt very fully with the lighting of compositors' benches, machine-rooms, etc., showing a number of attractive photographs taken by artificial light, and mentioning the values of illumination recorded in each case. It would appear that recent experience favours the use of general lighting as compared with the "patchy" local lights formerly customary, and pictures were shown of rooms flooded with light up to 10-12-foot candles. It was interesting to learn that the cost of lighting in general forms only about 1 per cent of the wages bill in this industry, which employs highly skilled labour. Mr. Gaster also put in a word for the requirements of the journalist, who is called upon to read manuscripts at high speed, and whose work often demands scrupulous accuracy. Proper lighting, both for proof-readers and in the editorial rooms, is most important, and it is singular that in some large newspaper works this matter is neglected, although the section of the building devoted to the actual printing processes may be relatively well lighted.

PROF. J. A. FLEMING, University College, London, has been asked by the British Broadcasting Company to broadcast an appreciation of the scientific work of Sir James Dewar on Friday evening, May 4, at 9 P.M. The message may be heard by all having a wireless telephone set which can pick up from 2 LO in London.

THE eighth Guthrie lecture of the Physical Society of London will be delivered on Friday, May 11, at 5 o'clock, at the Imperial College of Science and Technology, by Dr. J. H. Jeans, who will take as his subject "The Present Position of the Radiation Problem."

PROF. J. B. LEATHES, professor of physiology in the University of Sheffield, will give the Croonian lectures of the Royal College of Physicians in June; Prof. E. H. Starling, the Harveian oration on St. Luke's Day, October 18; and Dr. John Hay, of the University of Liverpool, the Bradshaw lecture in November.

IT is stated by Dr. Theiler in the *Chemiker-Zeitung* for March 20 that pure methyl alcohol is quite non-poisonous. The poisonous nature of impure wood spirit is due, not to the methyl alcohol it contains, but to the impurities which are present, such as allyl alcohol, allyl acetate, acetone, and their very poisonous homologues.

ACCORDING to the *Chemiker-Zeitung* for March 22, Prof. G. Tammann, of Göttingen, has received the Bakhuis-Roozeboom medal of the Royal Academy of Sciences, Amsterdam. This medal is conferred for researches connected with the phase rule, and was presented, for the first time, to Prof. F. A. H. Schreinemakers of Leyden in 1916. Prof. Tammann will receive the medal personally at the May sitting of the Academy.

THE fourth of the series of lectures on physics in industry, being delivered under the auspices of the Institute of Physics, will be given in the hall of the Institution of Electrical Engineers, Victoria Embankment, W.C.2, on Wednesday, May 9, at 5.30 P.M., by Dr. J. W. Mellor, of Stoke-on-Trent, who will deal with "The Application of Physics to the Ceramic Industries." Sir J. J. Thomson will preside. No ticket of admission is required.

AT the anniversary meeting of the Royal Society of South Africa, held in Cape Town on March 21, the following officers were elected: *President*: Dr. A. Ogg; *Hon. Treasurer*: Dr. L. Crawford; *Hon. General Secretary*: Dr. W. A. Jolly; *Members of Council*: Mr. K. H. Barnard, Dr. J. W. Bews, Dr. J. P. Dalton, Dr. J. D. F. Gilchrist, Dr. S. H. Haughton, Dr. J. S. v. d. Lingen, Dr. T. J. Mackie, Dr. A. W. Rogers, and Dr. S. Shönland.

AN address on "The Worth of Science" will be given at a meeting of the London Branch of the National Union of Scientific Workers on Tuesday, May 8, at 6 P.M., at the Birkbeck College, Bream's Building, E.C., by Sir Richard Gregory. The chair will be taken by Mr. C. S. Garland, M.P. The meeting is intended primarily for members of the Union who are scientific workers in Government departments, but a cordial invitation is extended to non-members interested in the work of the Union, especially those in public employment.

APPLICATIONS are invited by the Secretaries of the Royal Society for a Moseley research studentship, value 300*l*. per annum, "for the furtherance of experimental research in pathology, physics, and chemistry, or other branches of science, but not in pure mathematics, astronomy, or any branch of science which aims merely at describing, cataloguing, or systematising." The appointment will, in the first instance, be for two years, but it may, in exceptional circumstances, be extended. Further particulars and forms of application are obtainable from the Assistant Secretary of the Royal Society, Burlington House, W.1. The latest date for the receipt of applications is Friday, June 1.

THE eleventh International Physiological Congress will be held in Edinburgh, on July 23-27, and the following officers have been appointed: *President*, Sir Edward Sharpey Schafer; *Treasurer*, Prof. A. R. Cushny; *Secretaries*, Prof. G. Barger and Prof. J. C. Meakins; *Assistant Secretary*, Miss Dorothy Charlton. Those who desire to be enrolled as members are requested to forward their names and addresses, together with the amount of their subscription (25*s*.), to Miss Charlton, Department of Physiology, University, Edinburgh, who will send on request particulars of hotels and lodgings, and all other necessary information. Opportunities will be afforded for the exhibition of physiological apparatus.

THE Minister of Health has appointed the following committee "To investigate the comparative value, for the therapeutic purposes for which cocaine is at present used, of various possible substitutes, and the evidence as to risk, if any, of such substitutes becoming drugs of addiction": Dr. J. Smith Whitaker, Dr. N. G. Bennett, Dr. R. W. Branthwaite, Dr. T. Carnwath, Dr. J. H. Chaldecott, Dr. H. H. Dale, Mr. T. B. Layton, Dr. G. F. McCleary, Mr. R. Foster Moore, and Sir William Henry Willcox. The secretary is Dr. E. W. Adams, Ministry of Health, to whom all communications relating to the work of the committee should be addressed.

THE Postmaster-General has appointed the following committee to consider broadcasting: Major-General Sir F. Sykes (chairman); the Hon. J. J. Astor; Mr. F. J. Brown, Assistant Secretary of the Post Office; Sir Henry Bunbury, Controller and Auditor-General of the Post Office; Viscount Burnham, chairman of the Newspaper Proprietors' Association; Dr. W. H. Eccles, president of the Radio Society of Great Britain; Sir Henry Norman; Mr. J. C. W. Reith, general manager of the British Broadcasting Company; Sir William Robertson; and Mr. C. Trevelyan. The terms of reference of the committee are: "To consider (*a*) broadcasting in all its aspects; (*b*) the contract and licences which have been or may be granted; (*c*) the action which should be taken on the determination of the existing licence of the British Broadcasting Company; (*d*) the uses to which broadcasting may be put; (*e*) the restrictions which should be placed on its user or development."

AN article on "Botulism in Scotland" which appeared in NATURE of March 24, p. 415, referred to the difficulty, due to breakages, in heating glass containers for potted meats, so as to secure preventive sterilisation. Dr. G. R. Leighton, the author of the report described in our article, says on this subject: "I find it is a common experience in the trade that glass containers cannot be heated above boiling-point without the risk of a good many being broken." Mr. R. L. Frink, director of research of the Glass Research Association, in a letter to us, urges that such statements are scarcely justified, and do not take into account "the strenuous efforts that are being made to establish glass in its proper place as the most suitable container for foodstuffs." He adds: "Within the last month I have received information dealing with those properties and the use of glass as a food-container requiring pasteurisation and sterilisation (the latter being at temperatures of 230°-250° F.). It is shown that of more than 400,000 gross of containers used, there was less than 0·25 per cent. breakage, causing a loss not exceeding two-thirds of that suffered by the use of tins." Also as "the contents of tins are susceptible to fermentation or decomposition there is great danger that ptomaine may be propagated or that soluble salts of lead may exist in the contents."

THE Geological Survey of New South Wales is fortunately able to continue the publication of its valuable Records. The last two numbers, vol. x.

pts. 1 and 2, have been received, and contain some important communications, such as :—" Palæontologia Novæ Cambriæ meridionalis ; Occasional Descriptions of New South Wales Fossils," No. 8, and presumably the last, from the pen of the late R. Etheridge, junr. ; " A Census and Index of the Lower Carboniferous Burindi Fauna," by Dr. W. N. Benson ; " Note on the Occurrence of Graptolite-bearing Beds of Ordovician Age at Yalgogrin and Ariah Park," by L. F. Harper ; " Materials for the Study of the Devonian Palæontology of Australia," by Dr. W. N. Benson, in which is included a useful bibliography, and a " Census and Index " which will prove invaluable to students.

An article on " The Present Situation in the Radium Industry," by H. E. Bishop, in *Science* of March 23, gives an interesting account of the influence which the discovery of a rich deposit of radium will have on supplies in the future. Rich ore was discovered near Elizabethville in the province of Katanga in 1913, during prospecting work by the Union Minière de Haut Katanga, a Belgian corporation. Before any developments of the find could occur the War broke out. The secret was so well kept that no word reached the outside world until a very large plant for radium extraction had been erected at Oolen in Belgium. In spite of the fact that the ore is transported 2000 miles down the Congo, across the ocean to Antwerp, and then by rail to Oolen, its richness allowed of radium preparations being put on the market in the early part of last year at a considerably lower figure than that at which it has been maintained for some years by the American companies. As a result of conferences between the representatives of the American companies and the Belgian, a joint selling organisation has been formed. We learn from the article that the question of a tariff to protect the radium industry of America has been discussed, and apparently the decision taken that the preferable policy is one by which a lower price of the commodity will lead to its more widespread use.

Circulars Nos. 120 and 121 of the U.S. Bureau of Standards, Washington, are of interest as showing the wide scope of the work of the Bureau and how the interests of various sections of the community are looked after in America. No. 120 describes the " Construction and Operation of a Simple Home-made Radio Receiving Outfit," and No. 121 describes the " Construction and Operation of a Two-circuit Radio Receiving Equipment with Crystal Detector." They are both clearly written, and can be obtained from the Government Printing House at Washington for a few cents. The apparatus described can all be made at home. The movable coil tube, for example, can be made from a round cardboard box which contained table salt, and the outer cardboard cylinder can be an old oatmeal box. For a set which will receive messages from a high-power radio telephonic station up to 75 miles, or from a medium station up to 10 miles distant, the cost varies from 10 to 15 dollars. The simple apparatus described is suitable for every-day work, but mention is made that parts of the apparatus may possibly be covered by existing patents. A test buzzer for finding the most sensitive spots on a galena crystal is regarded as a necessity, and is included in every estimate. As crystals are quite cheap, insensitive crystals should never be used.

We have received the first five parts of the *Japanese Journal of Chemistry*, issued by the National Research Council of Japan, Tokyo, 1922. The president of the Council is Baron K. Furuichi, and the vice-president Prof. J. Sakurai, and there is a committee of publication. As we have already stated in these columns (April 7, p. 478), the Council issues a journal devoted to chemistry and another to physics, each in ten numbers annually, a journal dealing with geology and geography quarterly, and a proceedings and journals covering botany, zoology, medical sciences, astronomy and geophysics, and engineering, occasionally. Communications relating to these publications should be addressed to the Secretary, National Research Council, Department of Education, Japan. The editorial matter, and most of the papers, in the numbers of the *Journal of Chemistry* which have been received are in English. Besides original papers, there are abstracts of papers which have been published in Japanese journals. The standard of the publications is high, and the journals will be useful to European readers in keeping in touch with much first-class work now appearing in Japanese journals.

The Ministry of Public Works, Egypt, has published the report on the work of the physical department for the year ending in March 1922. Dr. H. E. Hurst, controller of the department, records that in spite of an inadequate staff the scope of work has widened in several directions. Rainfall returns were received from thirty stations in Egypt, eighty-nine in the Sudan, forty-five in Uganda, fifty-five in Kenya, five in Abyssinia, and one each in Aden, Somaliland, Zomba, Seychelles, Mauritius, and Cyprus. Arrangements have been made to start a new station at Dangela in north-west Abyssinia. Regular readings of river discharges were made at sixteen stations on the Nile, Atbara, Rahad, and Dinder. The discharges of the White Nile and Main Nile in February 1922 proved to be the lowest on record. The level of the Bahr-el-Gebel and the White Nile fell below the bottom of many of the gauges, and new methods had to be devised quickly to mean the levels. The meteorological service has been active. During the year Egypt had twenty-six and the Sudan twenty-nine meteorological stations. This was an increase of four; new stations have been opened at Suez, Delta barrage, Giza, Makwar, and Bir Abu Tif in the Sinai peninsula. The station at Mansura was closed. Of the Egyptian stations, that at Helwan is of the first order and fourteen are of second order. Investigation of the upper air continues at Helwan and elsewhere in co-operation with the Royal Air Force. The report contains records of other valuable work.

Messrs. W. Heffer and Sons, Ltd., Cambridge, have sent us a copy of their catalogue (No. 223) of 381 publishers' remainders. The copies are as published, *i.e.* not second-hand, and the reductions in many cases are considerable. Several books of scientific interest are included. The list should be seen by all who are in search of book bargains.

THE Oxford University Press announces "Race Problems in the New Africa," by the Rev. W. C. Willoughby, in which will be discussed the relation of Bantu and British in the parts of Bantu Africa which are under British control. The same house will also publish "A Practical Hausa Grammar, with exercises, vocabularies, and specimen examination papers," by Capt. F. W. Taylor.

MESSRS. A. AND C. BLACK, LTD., have in preparation new editions of vol. 2 of Dr. D. H. Scott's "Studies in Fossil Botany" (Spermophyta) and vol. 1 (Radiography) of Dr. R. Knox's "Radiography and Radio-therapeutics." In the first-named work the account of the so-called "Seed Ferns" (Pteridosperms) has been completed, rearranged, and for the most part rewritten. A number of families are described more fully than in the previous edition. The systematic position of the Pteridosperms is discussed, and a new view is taken of this question differing widely from that formerly maintained. In the second work the opportunity has been taken to bring the text up-to-date in regard to the progress of radiography, and to include a chapter on the author's recent work on gallstones. The volume also includes some appendices, one consisting of a report of the committee which was appointed to consider the protection of the operator from the effects of over-exposure to X-rays or radium.

Our Astronomical Column.

THE PRESENT CONDITION OF THE GIANT PLANETS.—Some surprise was created at the meeting of the Royal Astronomical Society on April 13 by a paper from Dr. Harold Jeffreys in which he raised doubts about the generally accepted view that these planets are still at a very high temperature. He made an estimate of the amount of heat that would have been radiated by Jupiter in the course of a period of three hundred million years, on the assumption of a high temperature throughout this period, finding that it exceeded the probable initial supply; he drew a further argument from the low densities both of primaries and satellites, in the case of these four planets, concluding that they are built of less dense materials than the inner planets. While there was some agreement with these views at the meeting, there were several expressions of dissent. The very energetic processes that are obviously going on upon Jupiter can scarcely be ascribed to the very feeble solar radiation, which is only one-twenty-seventh of that received by the earth. Moreover, if Jupiter were formed of material of the same density as that forming its satellites, the much greater force of gravitation upon it would produce a higher density through compression, unless counteracted by heat or some similar agency. A further argument was drawn from the spectra of these planets photographed at Flagstaff; these all showed broad absorption bands, implying dense atmospheres.

It will be remembered that recent studies of Jupiter by the bolometer indicated no sensible heating effect; but this was ascribed at the time to a dense absorbing atmosphere rather than to an actually cool interior. In any case, it is always in the interests of truth for any weighty evidence that can be put forward against accepted results to be considered seriously in an impartial frame of mind.

NATURE OF THE SPIRAL NEBULÆ.—Recent discoveries on the rapid rotational motion of the spiral nebulæ, which has been revealed both by spectroscopic determinations of velocity in the line of sight, and by Dr. Van Maanen's discussion of photographs taken at an interval of some years, has shown that these objects are not directly comparable with the Galactic system. Their distance can be roughly estimated by comparing the angular and linear rotational velocities; it is of the order of a few thousands of light-years, which is far too small to permit us to regard the regions of uniform luminosity as being due to the combined light of millions of stars. Prof. Lindemann read a paper before the Royal Astronomical Society on April 13 in which he put forward the view that they are simply vast collections of cosmical dust, the diameters of the particles being of the order of 10^{-4} cm., that being the size for which light-pressure is most efficient.

In other words, as Prof. Turner expressed it in the discussion which followed, the spirals are regarded as the dustbins of the stellar system, into which all interstellar dust is swept by the light-pressure exerted by the stars. An explanation would thus be afforded of the remarkable freedom from dust of the interstellar spaces, which was brought out by Prof. Harlow Shapley's work on the globular clusters, and by other researches. Prof. Lindemann suggested that the light of the spirals was simply reflected light from the whole stellar system; their spectrum, which seems to be a blend of all the stellar types, is in accord with this view. The case would be analogous to that of the Pleiades nebulæ, which give the same spectra as those of the stars which they surround. Prof. Lindemann showed that on certain assumptions as to the thickness of the spirals, reflected starlight would account for the observed luminosity. The mass of the spirals would still be of the order of thousands of suns, and they might still be regarded as providing the material of future clusters.

VARIABLE WITH A REMARKABLE SPECTRUM.—Dr. Harlow Shapley, in Harvard College Observatory Bulletin No. 783, describes the spectrum and the light variation of the tenth magnitude star H.D. 81137 (R.A. 9^h $18{\cdot}7^m$, Dec. $-52°$ $8'$) as "both of unprecendented types." The spectrum belongs to the type Ma of the Harvard Classification, and contains five well-marked bright lines or bands coinciding with some of the strongest bright lines in the spectrum of η Carinæ, the origins of which are unknown.

The spectrum of η Carinæ is not classified by the Harvard observers but described simply as "peculiar," but it is probably a hot star. H.D. 81137, as it is classed Ma, is comparatively a cool star, so this is an example of a cool star exhibiting bright lines of a hot star nature. Approximate positions of these lines are $\lambda\lambda$ 4244, 4287, 4352 to 4358, 4414 to 4416, and 4452 to 4457.

The light curve showed a steady rise from 9·8 in 1890 to 9·2 in 1901, and has since steadily dropped, reaching 10·1 in May 1922, so the period of variability is long.

Research Items.

THE COIN COLLECTION AT HULL.—The Wilberforce House Museum at Hull contains an interesting collection of local coins and tokens, a catalogue of which by Mr. W. Sykes has now been published. A mint was established in the city by Edward I. in the year 1300, and two silver pennies, the only variety of coin, so far as is known, struck in this mint, are included in the collection. The inscription on the obverse is "Edwardus Rex Angliæ Dominus Hyberniæ," "Edward, King of England, Lord of Ireland," and on the reverse "Vill. Kyngeston," "Town of Kingston-upon-Hull." The collection of seventeenth century tradesmen's tokens is fairly complete, containing 30 out of 34 examples.

THE ROMAN WALLS IN NORTHERN BRITAIN.—The study of the Roman Walls has been considerably advanced by two papers published in the Journal of Roman Studies (vol. xi. part 1, 1921). In the first paper Mr. G. Macdonald discusses the building of the Antonine Wall, with a fresh study of the inscriptions; in the second Mr. R. G. Collingwood enters upon the history of Hadrian's Wall. These two exhaustive papers must form the basis of all later attempts to discuss the problems involved in their construction. Mr. Collingwood suggests that Hadrian's Wall was not, as one is apt at first sight to suppose, a military work intended to give tactical advantage to troops on the defensive, but a police work, intended to facilitate the patrolling of the frontier-line against unauthorised crossing.

THE NORTHMEN IN ENGLAND.—An admirable article in the April issue of the *Quarterly Review*, by Mr. Reginald Lennard, shows that so far from the warrior West Saxon kings like Alfred the Great being the protagonists in this period, it was the intrusion of the Northmen which changed the fabric of Anglo-Saxon society. This view is based partly on the work of sociologist-historians like Maitland and Vinogradoff, but mainly on that of philologists like Mr. Allen Mawer, who have been working at the place-names of northern England. The extent of the Norse vocabulary on place-names is a new and important discovery, and the writer points out that in the early English kingship, taxation, and the judiciary, the Norse influence was great. The explanation suggested is that the Norsemen gained by travel and commerce an experience denied to the home-loving Saxon. They were champions of freedom: the growth of the English manor was largely influenced by them: and in art the Norse spirit is now widely recognised.

OUR TEUTONIC FORBEARS.—Under this title Prof. F. G. Parsons contributes a valuable article, in which, from the point of view of an anatomist, he describes in the *Times* of April 14 the results of the exploration of Saxon burial-grounds at Margate, Mitcham, and Bedford-on-Avon. At Margate the dead are found buried in regular rows, as in a modern cemetery, a habit the Jutes brought with them from the continent, where the so-called "row-graves" or *Reihengraben* have been long recognised in North-West Germany. The Jutes' burials may be always recognised from their habit of burying an earthenware bottle, usually near the face of the dead: it possibly contained ale or mead for the refreshment of the ghost. From the arms and other adornments it is certain that at Mitcham and Bedford-on-Avon the sites were occupied by pagan Saxons, long-headed, long-faced members of the Nordic race, though every now and then a broad head of Mid-European origin turns up, warning us that the Angles, Saxons, and Jutes were not an altogether pure race. The average height 5 ft. 6 in. contrasts with 5 ft. 9 in. of the average Englishman of our day. The well-worn teeth show that much of his food consisted of grain, roughly ground by soft stones; he suffered terribly from chronic rheumatism or osteo-arthritis, and among the men fractures, often wonderfully well set, appear; old head injuries are common, showing the rough, adventurous life they led. Most of them died before 40, and the proportion of adolescents between 15 and 20 was very great.

SOCIOLOGICAL ASPECT OF FATIGUE PROBLEMS.—In *Psyche* (vol. iii. No. 3) Miss Mona Wilson discusses the "Problem of Industrial Fatigue" in Great Britain. She states that she wishes to treat the subject from a sociological, rather than from a technical point of view, because, however valuable the results of scientific research into fatigue may be, they cannot be adequately utilised without a fundamental change in the relations between employer and employed. Until recently no systematic study of industrial fatigue had been undertaken in Great Britain. The War, however, with its urgent demands for maximum output, compelled the Government to consider the problem of fatigue in relation to output, and ultimately the Industrial Fatigue Research Board was established to study the human side of industry. Fatigue showed itself to be a very complicated problem, and already it has had to be considered in relation to problems of vocational selection, training, and motion-study, as well as to the more obvious problems of hours of labour, speed of production, division of the working day. As the problems are too detailed for a single body to undertake them all, the writer suggests that while the Industrial Fatigue Research Board might initiate lines of inquiry, some of the better organised trades might form Joint Research Associations responsible for their own investigations, and that for this purpose they might co-operate with the Institute of Industrial Psychology as well as with the Board. General conditions for working such Associations are given, and in particular there is emphasised the need for giving guarantees to the employees that, should the result of the research work be to employ fewer people, those displaced will be absorbed elsewhere. The article is worthy of careful consideration both by technical researchers, who sometimes tend to become absorbed in a too narrow aspect of their investigations, and also by the student of social problems, who not infrequently tends to neglect the scientific problems inherent in them.

NEW EOCENE MOLLUSCA FROM TEXAS.—Appended to "A geological reconnaissance in the Gulf coastal plain of Texas near the Rio Grande," by A. C. Trowbridge, is an account of the "New species of Mollusca from the Eocene deposits of south-western Texas," by Julia Gardner (U.S. Geol. Surv. Professional Paper 131-D). They are few in number but decidedly interesting. A subspecies of *Ostrea alabamiensis* seems the most abundant form, and Cucullæa one of the more conspicuous. There is a doubtful example of Cerithium, which on the plate has been styled "Melania ?" and a handsome nautiloid referred to the genus Enclimatoceras, although as pointed out by Foord in 1891 (Cat. Fossil Cephalop. Brit. Mus., Pt. ii.), this should have borne the prior name of Hercoglossa.

GEOLOGICAL RESEARCH IN SWEDEN.—Volume 18 of the Bulletin of the Geological Institution of the University of Uppsala (1922) bears the name of

Hjalmar Sjögren as its editor; but it also records his death from apoplexy, early in the year. The long list of his papers, from 1877 onwards, and the appreciation so aptly written in English by Prof. A. G. Högbom, show how greatly geological science has lost by the passing of one who did not cease to be an investigator when he could also afford to be a patron. The Bulletin is prefaced by a portrait that will record Sjögren's truly noble personality for friends in every quarter of the globe; it is difficult to realise that he was already well on his way towards his seventieth year. The volume covers even a wider range than usual, from the crystallography of amphibole to Cretaceous mosasaurs from Texas. We may specially note G. Frödin's elaborate study of the highlands of central Sweden, including the Åre district, written in German, and his paper in English "On the analogies between the Scottish and Scandinavian portions of the Caledonian mountain-range." In the latter, as the result of his studies of deep continuous sections in Sweden, the author urges that the Moinian and Dabradian complexes in Scotland received their metamorphic characters during the Caledonian movements, and that they are formed of Torridonian (Sparagmite) and early Palæozoic formations, rather than of a pre-Cambrian series metamorphosed before Palæozoic times. However much this conclusion might simplify the stratigraphy of certain areas, it seems incompatible with the known unconformity of unmetamorphosed Ordovician beds on Dabradian schists and quartzites in western Ireland.

OIL FIELDS AND THE GRAVITY BALANCE.—The recent use of the Eötvös gravity balance by the oil companies in prospecting for new and exploring old oil fields has brought into prominence an extremely sensitive instrument devised nearly thirty years ago by Baron Eötvös, professor of physics at Budapest, and constructed in 1888 by Süss, then director of the mechanical training workshops of Budapest. The instrument and the measurements made by means of it were described in Hungarian periodicals in 1890 but were not generally known till 1896, when a short account appeared in the *Annalen der Physik*, vol. 59, p. 354. An instrument has now been acquired for the Science Museum at South Kensington, and a paper by Messrs. H. Shaw and E. Lancaster-Jones describing it and giving its theory and some account of tests made by means of it, appears in the April issue of the Proceedings of the Physical Society of London. The instrument consists of a fine fibre which supports a horizontal rod, to one end of which a small mass is directly attached, while from the other an equal mass is suspended by a second fine fibre. The instrument determines the difference of the values of gravity at the two masses, and according to Eötvös will detect a difference of 1×10^{-9} C.G.S. unit.

MAGNETIC RECORDING DRUM FOR ELECTRIC RELAYS.—It is now becoming increasingly difficult to differentiate between telegraph, telephone, and radio engineers. The paper read by Dr. N. W. McLachlan to the Radio Section of the Institution of Electrical Engineers on April 11 illustrates this. It is entitled "The Application of a Revolving Magnetic Drum to Electric Relays, Siphon Recorders, and Radio Transmitting Keys," and it is of equal interest to every kind of communication engineer. When the drum is magnetised, part of it is pressed on fixed iron rings with considerable force, and this alters the speed. The author finds that the tangential pull thus obtained is many times greater than the product of pressure due to the product of the magnetic attraction and the coefficient of friction. The ratio of the experimental pull to the calculated pull may exceed 50. It is suggested that the operation of the device depends on some form of cohesive action brought into play by magnetism.

UPPER AIR DATA IN AMERICA.—Free-air winds at Lansing, Michigan, are dealt with by Mr. C. L. Ray, of the U.S. Weather Bureau, in the U.S. *Monthly Weather Review* for December 1922. Pilot-balloon observations have been carried out at this station daily since June 1919, flights having been made for more than two years at 7 A.M. and 3 P.M., except when impossible through bad weather. Latterly, observations have only been made at 3 P.M. For the three-year period, the results are given for the four seasons of the year for various altitudes from the surface to 6000 metres, and the percentage of the winds from various directions is shown. More than 50 per cent. of the surface winds have a south component and more than 56 per cent. have a west component. At 4000 and 6000 metres the preponderant direction lies between west and north-west. The variation of the winds with altitude for each season is given by tables and graphs. Surface velocities average about three metres per second. At 250 metres the velocities average two and a half times greater than at the surface. Above 1500 metres, winds are consistently west to north-west. Velocities are greater in the winter months, and at the 6000 metre elevation the average reaches 27·7 metres per second as compared with the summer mean of 12 metres per second at that level. In the upper levels the easterly winds do not reach the velocities attained by the westerly winds. Winds with a surface south component all show a clockwise movement with altitude and generally have a west-south-west direction at about 2000 metres. There is a more or less persistent north component to the highest levels. The highest velocity reached at Lansing was 83 metres per second from the north-west at an altitude of about 7000 metres on December 17, 1919.

ICE PATROL SERVICE IN NORTH ATLANTIC.—The U.S. *Monthly Weather Review* for December 1922 contains an article by Lieut. E. H. Smith on "Some Meteorological Aspects of the Ice Patrol Work in the North Atlantic." The disaster to the s.s. *Titanic* on April 14, 1912, when what was then the largest ship afloat was sunk by striking an iceberg off the tail of the Great Bank of Newfoundland, resulted in an ice patrol being established with the object of preventing the recurrence of a similar loss. The patrol was of International origin, the management of the service being undertaken by the U.S. Government. It is now about ten years since the service has been in operation, and much information has been gathered as to the determination of the variable limiting lines of menacing ice, and efforts have been made to determine the causes of the variations as to seasonal and other differences. Glaciers on the west coast of Greenland are said to be the great source of icebergs which appear during March drifting south along the east side of the Great Bank, and during April, May, and June they constitute a menace to steamships. The summer winds in West Greenland, the birthplace of the bergs, have an immense influence on the number of bergs over the North Atlantic in the following season. Off-shore winds drive a great number of bergs westward into the southerly current, while on the other hand, on-shore winds tend to cause a poor ice year. It is said to take approximately five months for a berg passing Cape Dyer to appear south of the 45th parallel. If the dates of the bergs passing Cape Dyer were known, long-range forecasting of ice conditions in the North Atlantic would probably be possible.

The Total Eclipse of the Sun, September 21, 1922.

By Dr. WILLIAM J. S. LOCKYER.

SOME time ago an account was given in these columns (December 29, 1921, vol. 108, p. 570) of the probable expeditions which would go out, and the stations that would be occupied, for the observation of the total eclipse of the sun in September of last year. This programme was very nearly followed, excepting that Mr. Evershed's party from South India, instead of occupying one of the islands of the Maldive group, went to a station, Wallal, on the north-west coast of Australia, thus joining up with other expeditions located there.

The eclipse track, it may be remembered, passed over the Maldive Islands, Christmas Island, and Australia, leaving that continent on its eastern coast. The Maldive Islands seem to have been unoccupied on this occasion, and the British and German expeditions to Christmas Island were so clouded out that no observations could be made. All the stations in Australia were favoured with fine weather, so a valuable series of records may be expected in due course.

The success of the Crocker Eclipse Expedition, which occupied Wallal, is shown by Dr. W. W. Campbell's account of the expedition which appears in the Publications of the Astronomical Society of the Pacific (vol. 35, p. 11). In the first instance, this expedition was organised on a modest scale, owing to the probable great difficulties of transport, etc., at this remote and somewhat inaccessible station in Australia. The generosity of the Australian Government in providing transport from Fremantle, and assistance both in personnel and material, altered the whole aspect of affairs. A much enlarged programme was, therefore, decided upon and was eventually carried out successfully.

The main programme was as follows:

A pair of cameras of 5 inches aperture and 15 feet focal length for application to the Einstein eclipse problem: the Shaeberle camera, aperture 5 inches and focal length 40 feet, for the photography of the solar corona: two cameras of 4-inch quadruplet lenses and 5 feet focus for the Einstein effect and other possible results of the sun's surroundings: several spectrographs for the photography of the coronal spectrum: and a camera of 5-inches aperture and 66 inches focal length for the photography of the form of the corona.

Dr. Campbell's account describes very fully the many and varied experiences of the trip to the station, the landing, the erection of the instruments, and the procedure to prevent the great amount of dust from affecting the mechanisms of the instruments. He pays great tribute to the valuable assistance rendered by Mr. H. A. Hunt, the Government meteorologist, charged with the general organisation of all the expeditions, and to the officers and men of the Royal Australian Navy detailed to accompany the expeditions to Wallal and provide for their needs at transfer points and at Wallal itself. The camp was quite up-to-date, receiving wireless time signals and a weekly aeroplane mail service.

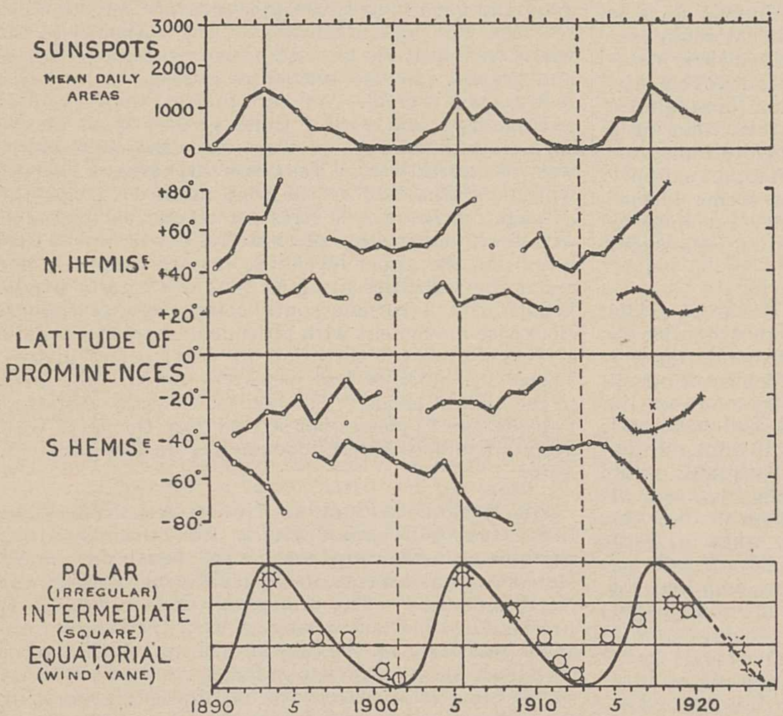

FIG. 1.—Comparison between prominence zones and forms of the corona. From Monthly Notices R.A.S., April 1922, vol. 82, No. 6, p. 324. By permission of the Royal Astronomical Society.

Eclipse day proved ideal and the whole programme was followed successfully.

Owing to the irregularity of the moon's motion, the times of the eclipse were not exactly as forecasted. On this occasion the duration of the total phase for Wallal, assigned by the "Nautical Almanac," was five minutes nineteen seconds. At Wallal the beginning of totality came about sixteen seconds earlier than the predicted time, and the end occurred about twenty seconds earlier. Thus, mid-totality was eighteen seconds early and the whole total duration lasted five minutes fifteen and a half seconds.

The corona appeared visually small and relatively faint, and no large prominences were visible. It is stated that the form of the corona corresponded to that generally associated with sunspot minimum. This verifies the forecast I made in the article in this journal mentioned above, where it was stated that "the corona will most probably be of the 'wind-vane' type, in which the coronal streamers are restricted to the lower solar latitudes, while the regions of both poles will be conspicuous by the presence of the well-known polar rifts." The illustration which accompanies Dr. Campbell's paper indicates a typical form of "wind-vane" corona. (See Fig. 1.)

Dr. Campbell seems to have made supreme efforts to measure, on the spot, some of his plates for the Einstein effect, having previously succeeded in his arrangements for securing night comparison plates in the island of Tahiti. He wished at least to make a preliminary statement concerning the contribution of the expedition to the solution of the Einstein eclipse problem before he left Perth on his homeward journey. In his own words, " it was a severe disappointment to me, that the many delays, wholly beyond our control . . . prevented me from carrying out this plan." (The plates have since been measured, and, as was announced in *Nature* of April 21, p. 541, the results confirm Einstein's prediction.)

It was intended that the large-scale photographs of the corona obtained at Wallal, and by the Adelaide expedition at Cordillo Hills, should be compared for evidence of motion within the coronal streamers, during the interval of 35 minutes between the times of totality at the two stations. The very quiescent solar conditions at the time did not hold out very good prospects, as Dr. Campbell states, but probably the high quality of the negatives will on closer examination lead to positive results.

All the spectroscopic results of the corona indicated also a low activity of the sun, the coronal lines being very much fainter than those recorded in the eclipse of 1918.

The absence of prominences, the smallness of the corona and its faintness, all tended to make the eclipse a dark one, thus favouring ideal conditions for the Einstein plates to secure as many star images as possible.

There is little doubt that when the complete results of the Crocker Eclipse Expedition come to be published they will contain a valuable record of the work accomplished during the brief interval of five minutes fifteen and a half seconds.

Perhaps one may be permitted to take this opportunity of congratulating Dr. Campbell not only on the success of this expedition which he so ably led, but also on his election in January last to the presidency of the University of California. While this position will involve great responsibilities and absorb much of his time, he will still, fortunately, retain his directorship of the Lick Observatory and his residence on Mount Hamilton, and he will return there on all available occasions.

Alloys Resistant to Corrosion.

A GENERAL discussion on the subject of alloys presenting a high resistance to corrosion was held on April 13 at the University of Sheffield, the meeting being arranged jointly by the Faraday Society, the Sheffield Section of the Institute of Metals, and the Manchester Metallurgical Society. Sir Robert Robertson, president of the Faraday Society, occupied the chair. In his opening remarks the chairman referred to the economic loss involved in the corrosion of steel, and to the great step in advance represented by the introduction of stainless steel. In the chemical industry, the use of high-silicon irons had proved to be of great value. It was important to remember that the order of resistance of materials might be quite different towards different reagents, so that in nitration, for example, while iron and steel would resist the action of the concentrated acids, the same solutions after being deprived of their nitric acid would cause attack. The time was ripe for a general survey of the subject.

Prof. C. H. Desch, while noting that no theoretical paper was to be presented at the meeting, remarked that the study of corrosion had undergone a profound change in recent years. Formerly, the usual method of experiment was the determination of loss of weight of specimens under more or less arbitrary conditions, coupled sometimes with measurements of electrolytic potential. The first method gave purely empirical results, whilst the second was difficult to interpret, and the resistance of different metals and alloys often appeared to be quite incompatible with their positions in the electrochemical series. Gradually, investigators had become convinced that the physical character of the products of corrosion was a most important factor in the process. A metal which from its electrochemical position might be expected to corrode rapidly might in the early stages become coated with a protective film, after which the action was negligible. It was not only films of perceptible thickness that exerted such an influence. Recent work had shown the importance of films of oxygen and other substances, one atom or one molecule thick, to which no definite formula could be assigned, but they altered entirely the chemical character of the surface. It is still impossible to predict the composition of highly resistant alloys, and we have to be content with empirical trials, such as have led to the discovery of the alloys to be described. The theory of the subject is still imperfect, and he urged that more attention should be given to the fundamental work of Faraday, the neglect of whose teaching was responsible for much confusion of thought on the subject of corrosion.

Three main classes of alloys were dealt with by the readers of papers, namely, the stainless steels, the alloys of nickel with chromium, and the alloy known as Monel metal. Dr. W. H. Hatfield gave an account of the extensive series of laboratory tests made in the Brown-Firth Laboratory, in which many specimens were exposed to the action of simple and mixed electrolytes, the results being recorded numerically and by means of colour photography. The high resistance of the alloys of iron with chromium and varying amounts of carbon, known as stainless steels, was very evident from these experiments. This class of steels was described in detail by Mr. J. H. G. Monypenny. The greatest resistance to corrosion in these steels is obtained by quenching in such a way as to obtain a homogeneous martensite, while the attack by reagents is greatest when the steels are annealed so as to bring about the greatest separation of the carbide and the ferrite. This is in accordance with the known effects of galvanic action. Tempering at such a temperature that the internal stresses are relieved, but coalescence of the carbide is avoided, does not lessen the resistance. With a very low carbon content, nearly all the chromium is in solid solution, so that the steels are resistant even in the unhardened state, and this property has led to many new uses for the metal. The retarding effect of colloidal substances on corrosion is shown by the fact that while a properly hardened stainless steel is not attacked by vinegar or lemon juice, pure acetic or citric acid of the same concentration produces a marked attack. The same alloys are highly resistant to the action of air at high temperatures or of superheated steam.

It is for their resistance to these agents that the next series of alloys, those containing nickel and chromium as their principal constituents, are specially valued, and these alloys were described by Mr. J. F. Kayser. The technical alloys contain iron, and the useful compositions are limited to a comparatively small area on the ternary equilibrium diagram, although some experiments have been made with alloys outside that range. Copper is occasionally added when resistance to acids is required, but is detrimental when high temperatures are involved. Aluminium has a remarkable hardening effect, owing to the formation of the very hard and infusible compound NiAl. Wires for electric furnaces, case-hardening boxes, and reaction vessels for ammonia synthesis, are among the uses to which this group of alloys has been put. The corroding action of furnace gases containing sulphur compounds is due to the formation of nickel sulphide, which forms a fusible scale.

Mr. J. Arnott gave a short account of the behaviour of Monel metal, which is composed chiefly of nickel and copper, towards various reagents. This alloy is particularly resistant to sea water, to impure waters such as those of many mines, and to steam.

An important point was brought out by Mr. J. H. S. Dickenson, who remarked that for many technical purposes stainlessness as usually understood was not required, freedom from pitting and gross rusting being more important. For example, in submarine work it is not essential that parts should remain quite bright, but it is necessary that they should not become jammed by accumulations of rust. A piece of soft stainless steel, merely sand-blasted, had been exposed in the garden for eighteen months, and, although it had rapidly assumed a yellowish tarnish after the first rain, it had not lost weight, while a mild-steel sample had rusted badly. Mr. Macnaughten remarked that for some purposes a good electrical conductivity was required as well as resistance to corrosion, and that in such cases pure nickel had advantages even over Monel metal.

Some differences of opinion were manifested in regard to the chromium steels. The comparatively recent introduction of alloys so low in carbon as to be available for use without hardening, and in the cold-worked condition, has led to the use of the term "stainless iron" for such alloys, while other authorities prefer to regard the stainless steels as forming a continuous series of varying carbon content. Commercial considerations are involved, but it appears that for practical purposes there is a division, which occurs at the point where the carbon falls so low that the use of an expensive ferro-chrome becomes necessary in the manufacture. Scientifically, there is no break in the series.

Turning to another class of alloys, an interesting announcement was made by Mr. Harold Turner, who exhibited articles made of a new standard silver, free from copper, but containing the 92·5 per cent. of silver required in order to obtain the hall-mark. Although it is not claimed that such an alloy is resistant to acids, experiments had shown that the tarnishing caused by the atmosphere of a town was very greatly less than that of standard silver. Fuller particulars of this interesting alloy will be given at a later date. The working qualities prove to be excellent. No account was given of the alloys of the nickel silver group, some of which have been improved in respect of their resistance to corrosion, particularly by the introduction of tin in place of zinc; but Mr. F. Orme described some acid tests with several alloys of this class, showing little difference between them and the older alloys. It was, however, argued that these alloys are not intended for exposure to acids, and that only a higher resistance to atmospheric action is to be expected from them.

A valuable paper on the mechanism of so-called "dry corrosion" was read by Mr. U. R. Evans, of Cambridge, whose experiments included the examination of a number of metals and alloys when exposed to various gases, either saturated with moisture or in a relatively dry state, excluding the case of the complete absence of moisture. The action was regarded as electrolytic, the formation of a thin liquid film being an essential part of the process. The conductivity of such a film is an important factor. When the product formed is hygroscopic, so that the surface of the metal becomes visibly wet and the liquid may fall off in drops, as in the attack of zinc by hydrogen chloride, nickel by sulphur dioxide, and copper by ammonia, the corrosion is very rapid. Observation of the tarnish colours formed in the early stages of the corrosion seems to indicate that local anodic and cathodic areas are present at the beginning. The formation of temper colours by oxidation at higher temperatures, as in the case of iron above 220°, appears to be a different phenomenon. Dr. R. S. Hutton mentioned that this side of the subject was engaging the attention of the Non-Ferrous Metals Research Association, and that Mr. Vernon was conducting experiments for the Atmospheric Corrosion Committee in this direction. Mr. Vernon, in a written communication, questioned the necessity for the presence of water in such attack by gases, and offered an alternative explanation of the facts.

The discussion undoubtedly served a useful purpose in bringing together data as to the classes of alloys now available when a greater resistance than usual to corroding agents is required. Great progress has been made in this direction, to which the stainless steels and the alloys of the nichrome class, as well as the older silicon irons, bear witness. The new silver alloy is a further indication of the attention being given to the production of alloys which will suffer less by exposure to the atmosphere of towns. Unfortunately, a scientific theory of the phenomena is still lacking, the theory of corrosion, in spite of its very extensive literature, being lamentably imperfect. The process of trial and error, which is at present almost the only method for the discovery of resistant alloys, needs to be replaced by a systematic conception of the process, which will make it possible to predict, with some approach to accuracy, the behaviour of a new combination of metals towards a given environment. The Faraday Society has already performed useful services in regard to this matter, and it is to be hoped that when the next symposium is held it may be possible to review the subject in a less empirical manner.

University and Educational Intelligence.

ABERDEEN.—Sir Robert Horne, who delivered his address as Rector of the University on Thursday, April 26, dealt with the relation of the Universities to post-War problems, and with their increasing responsibility for "cultural" education in an age in which the pressure of business leaves less and less time for the cultivation of the arts. After the address, he announced that he intended to offer a prize of 25*l*. for an essay on "The Function of Universities in the Modern State."

CAMBRIDGE.—Prof. Nuttall and Sir William Pope have been appointed to represent the University at the ceremonies connected with the centenary of the birth of Pasteur to be held in Paris and Strasbourg during the present month.

In connexion with the jubilee celebration of the Local Lectures to be held in Cambridge in July, it is proposed to confer honorary degrees on Sir Michael Sadler, Prof. R. G. Moulton, and Messrs. Albert Mansbridge, G. P. Bailey, J. H. Fisher, and A. Cobham.

Sir Archibald Garrod, Regius professor of medicine, Oxford, will deliver the Linacre Lecture on May 5, the subject being "Glimpses of the Higher Medicine."

LONDON.—A research studentship for post-graduate work at the London School of Economics and Political Science will be awarded in July next. Its value will be 175*l*., in addition to fees, and it will be tenable for two years. Application forms (which must be returned not later than May 31) can be obtained from the director of the School, Houghton Street, Aldwych, W.C.2.

MANCHESTER.—Prof. de Sitter, of the University of Leyden, will deliver a lecture on "The Theory of Jupiter's Satellites" at the University on May 9, at 5.30 P.M. Visitors will be welcomed.

OXFORD.—Sir Michael Sadler has been elected Master of University College, in succession to Dr. R. W. Macan, who retired from the office on April 1. Sir Michael Sadler was well known in Oxford from 1880 to 1895 as scholar of Trinity and steward and senior student of Christ Church. He was president of the Union in 1882, and from 1885 to 1895 he did valuable work as secretary to the then lately-established Oxford University Extension Scheme. He was appointed professor of the history and administration of education at the Victoria University of Manchester in 1903, and became Vice-Chancellor of the University of Leeds in 1911. Sir Michael Sadler is the leading authority upon education in Great Britain, and his return to Oxford is confidently expected to prove a source of increased strength to the educational efficiency of the University.

BY the will of Dame Ella Mabel Farrar, the sum of 4000*l*. is bequeathed to such university or university college in the Transvaal as her executors shall select, to found a George Farrar agricultural scholarship for students of European birth.

H.R.H. PRINCESS MARY, Viscountess Lascelles, has consented to present the prizes and certificates to the students of the London (Royal Free Hospital) School of Medicine for Women (University of London), Hunter Street, Brunswick Square, W.C.1, on Saturday, June 2. Scholarships to the total value of 1010*l*. will be awarded for the session beginning in October 1923. Full particulars and forms of entry can be obtained from the warden and secretary of the hospital.

ON April 4, the Sterling Chemistry Laboratory of Yale University, the first building to be erected out of the funds provided by the bequest of John W. Sterling to the University, was formally opened, and Sir Joseph Thomson delivered an address on "The Unity of Physics and Chemistry." The date is interesting as being the centenary of the first lecture in chemistry delivered at Yale by the first professor of chemistry, Benjamin Silliman. The building has cost about 400,000*l*., and according to *Science* of March 23, in which some details of its equipment are given, it is the finest material plant in the world for the teaching of chemistry and for research. There is a laboratory for industrial chemistry, which contains apparatus of factory size, and extends from the foundations of the building to the roof. The centre of the building is devoted to teaching laboratories, all on the same level, and separated from each other by light walls, which can readily be removed should it be necessary to enlarge any laboratory. The building also contains a large number of small private laboratories, two large lecture-halls, classrooms, and a well-furnished library.

THE foundation, recently announced, of six Henry P. Davison scholarships tenable by Oxford and Cambridge men for one year in Harvard, Yale, and Princeton Universities, may perhaps be regarded as significant of a movement in the United States in favour of endowments reciprocal to the Rhodes Scholarship Trust. Each of the Davison scholarships is worth 1500 dollars plus tuition fees, or about 375*l*. in all. According to an announcement by the Oxford selection committee, preference will be given, other things being equal, to undergraduates in their second year proposing to return, on the expiry of the term of tenure of the scholarship, to their own University for a further year of study. Selection will not be by examination. The selection committee will base their choice on a consideration of character, scholarship, and of general fitness to represent the University. It is understood that the scheme is, in its present form, experimental. Compared with the 96 Rhodes scholarships tenable in Oxford by Americans, the number of American university and college scholarships for British students is rather small. A list published in the "Universities Yearbook" gives: the Rose Sidgwick Memorial, 1000 dollars; Choate Memorial (Harvard), 1850 dollars; Bryn Mawr, three of 720 dollars each; Union Theological Seminary, New York, 1200 dollars; Jane Eliza Procter (Princeton), two of 2000 dollars each; and Auchinloss and Dawson (Yale), 2000 dollars. The very magnitude of the Rhodes Scholarship Trust has perhaps hitherto tended to discourage reciprocity.

EDUCATION WEEK in America, December 3-9, was marked by proclamations by the president of the United States and by governors of 42 States, by hundreds of thousands of addresses, sermons, and speeches, by special editions of or editorial support in half of the newspapers of the country and by articles in practically all the others, by special exhibitions in practically all the motion-picture theatres, and by messages from numerous broadcasting stations. What is the justification for such a raging and tearing campaign? The United States Government Commissioner of Education answers this question by saying that no step forward in education can be made except as the result and with the approval of public sentiment, and it is therefore of fundamental importance to arouse the interest of the public generally, and not merely of the educator and educated man, in the needs of education. The Bureau of Education itself made use in Education Week of the Government naval aircraft broadcasting station, and followed this up by establishing a regular service of broadcast messages. The "radio talks" are given on Monday and Thursday evenings, and deal with such subjects as consolidation of rural schools, health work in schools, etc.

THE report for 1922 of the Carnegie United Kingdom Trust gives particulars of grants amounting to 106,669*l*., distributed as follows: Libraries 68,303*l*., music and the drama 17,320*l*., physical welfare 10,300*l*., hostels 6452*l*., miscellaneous 4294*l*. Of the grants for libraries 36,000*l*. went to rural circulating, 24,000*l*. to urban, and 5000*l*. to special libraries (central libraries for students, Co-operative Library of Dublin, Royal Aeronautical Society, College of Nursing, and Merchant Seamen's), while 1500*l*. was given to the School of Librarianship and 1600*l*. to the "Subject Index to Periodicals." The trustees aim at "providing the initial expenditure necessary for the efficient inauguration" of projects likely to have permanent national value, and especially new projects of a pioneer character, rather than at maintaining indefinitely enterprises which give no promise of becoming self-supporting. Their operations derive from this principle a certain liveliness not commonly associated with the administration of property in mortmain. In connexion with the rural libraries scheme the report comments on the disadvantages of the system under which in England and Wales the Education Committee is only a department of the County Council instead of being an autonomous authority as in Scotland. Among other important benefactions are: a guarantee of 1000*l*. in connexion with the publication of a "World List of Scientific Periodicals," showing libraries in Great Britain where they are on file, and a grant for the National Institute of Industrial Psychology.

Societies and Academies.

LONDON.

Royal Society, April 26.—W. A. **Bone**, D. M. **Newitt**, and D. T. A. **Townend**: Gaseous combustion at high pressures. Pt. III.—The energy-absorbing function and activation of nitrogen in the combustion of carbon monoxide. Nitrogen can no longer be regarded as an inert gas in the combustion of carbon monoxide, because when present as a diluent in a mixture of two volumes of carbon monoxide and one volume of oxygen undergoing combustion in a closed vessel under high pressure, it exerts an energy-absorbing influence which (*a*) retards attainment of maximum pressure, and (*b*) diminishes maximum temperature attained in explosion. The effects are much greater than those due to any other diatomic diluent. The energy so absorbed by nitrogen during the combustion period is slowly liberated as the system cools down after attainment of maximum temperature, and consequently the rate of cooling is greatly retarded. These effects are very marked in the case of a carbon monoxide-air mixture ($2CO + O_2 + 4N_2$). In consequence of such energy-absorption, nitrogen becomes chemically "activated" in such explosions, and while in this condition will combine with oxygen, forming oxides of nitrogen. If no nitrogen be present in a carbon monoxide-oxygen (2 : 1) mixture, carbon monoxide burns in oxygen at high pressures almost as rapidly as does hydrogen. There is no correspondingly large (if any) energy-absorbing effect (other than purely "diluent") when nitrogen is present in hydrogen and oxygen mixtures similarly undergoing combustion, and there is no evidence of nitrogen being then activated. Two or three per cent. of hydrogen in a carbon monoxide-air mixture undergoing combustion prevents any material activation of the nitrogen. It appears that the influence of nitrogen in the carbon monoxide-oxygen explosions is due to its ability to absorb the particular quality of radiation emitted; such radiation is known to be of a different wave-length from that emitted during the flame-combustion of hydrogen. In other words, there seems to be some constitutional correspondence between carbon monoxide and nitrogen molecules, whereby the vibrational energy (radiation) emitted when one reacts with oxygen is of a quality readily absorbed by the other, the two acting in resonance.—R. A. **Watson Watt** and E. V. **Appleton**: On the nature of atmospherics. Observations with a cathode ray oscillograph, on the temporal variations of the electric force occurring in radio telegraphic atmospherics are described. The principal constants of six hundred typical atmospherics are examined. A bare majority are quasi-periodic, consisting normally of one complete oscillation, of duration 2000 micro seconds, the mean change of field being 0·128 volts per metre, with no marked unbalanced transport of electricity on the whole group. The second group consists of aperiodic impulses, of duration generally about 1250 micro seconds, but frequently reaching 0·025 of a second, the mean change of field being 0·125 volts per metre, with a seven to one numerical predominance of discharges tending to carry negative electricity to earth in the receiving antenna.—I. **Masson** and L. G. F. **Dolley**: The pressures of gaseous mixtures. Measurements have been made at 25° of the compressibilities up to 125 atm. of ethylene, argon, oxygen, and a series of binary mixtures of these. The volume of a compressed mixture usually exceeds the sum of the separate volumes of its two components, the excess depending on the molecular ratio of the two gases chosen and upon the pressure. Thus with an equimolecular mixture of argon and ethylene at 80 atm. the volume is greater than the additive value by 24 per cent. At a given pressure there is an "optimum" composition, and with a given composition there is an optimum pressure. Oxygen-ethylene mixtures behave quantitatively in the same way as argon-ethylene; oxygen and argon when mixed show a negligible volume increase, and are individually equally compressible. The pressure of a mixture at high densities exceeds the sum of those measured for the separate constituents; at moderate densities it is definitely less. The former occurrence is due to the actual space filled by the molecules; the latter is due to a mutual cohesion between each.—T. R. **Merton** and R. C. **Johnson**: On spectra associated with carbon. The spectral changes due to the admixture of helium to vacuum tubes containing carbon compounds, and the conditions for isolating the band spectra associated with carbon, have been investigated. The "high pressure CO" bands can be isolated almost completely; the "comet-tail" bands are found in vacuum tubes containing helium and carbon monoxide. In the presence of helium the distribution of intensity in the comet-tail bands differs markedly from that observed by Fowler in tubes containing carbon monoxide at very low pressures. By the admixture of hydrogen the comet-tail bands are replaced by a system of triplet bands, and the wave-lengths of the heads of these bands fall into two distinct band series. In helium containing a small quantity of carbon monoxide a new line-spectrum has been observed under suitable conditions of excitation, which is attributed to carbon.—W. R. **Bousfield** and C. Elspeth **Bousfield**: Vapour pressure and density of sodium chloride solutions. A standard set of vapour pressure determinations at 18° C. for aqueous solutions of common salt at all concentrations was required. Water and the solution were introduced into the legs of a V tube surmounting a barometric column of mercury, excluding all air. This necessitated the boiling of the solutions so that they became of unknown concentration. The vapour pressure observations were therefore correlated to the densities of the solutions and the latter with a complete set of density observations at 18° C. made on solutions of known concentration accurate to ± 2 in the fifth place of decimals.—F. A. **Lindemann** and G. M. B. **Dobson**: A note on the temperature of the air at great heights. The relatively high temperature of the atmosphere above 60 km. appears to be due to absorption of an appreciable amount of direct solar radiation. Thus there should be a large variation in temperature at these great heights. Some evidence of such variation has been found.—G. H. **Hardy** and J. E. **Littlewood**: On Lindelöf's hypothesis concerning the Riemann zeta-function.

Physical Society, March 23.—Dr. A. Russell in the chair.—W. J. H. **Moll**: (1) A new moving-coil galvanometer of rapid indication. The galvanometer is designed to secure rapid indication and steadiness of reading without unduly sacrificing the sensibility. The coil is long and narrow, and therefore of small moment of inertia; the mirror is supported by the wires forming the coil, between which it is slipped, and the coil is supported between an upper and a lower vertical wire, as distinct from strips, made of silicium bronze and put in tension. (2) A thermopile for measuring radiation. The thermopile is designed to be quick-reading and free from zero-errors, as well as sensitive. The cold junctions are in contact with metal masses, and in order that the hot junctions may have small heat capacity, the bi-metallic strips composing the thermopile are made of plates of constantan and manganin silver-soldered along an edge, rolled in a direction parallel to the edge into thin foil, and then cut into strips perpendicular to the edge.—C. W. **Hume**: A note on aberration and the Döppler effect as treated in the theory of relativity. Aberration has been explained as due to the compounding of the velocity of light with the velocity of the earth relative to the ether; hence it appears to conflict with the principle of relativity. Simple methods are given of treating this problem consistently with the restricted principle, and of finding the Döppler effect. The result differs from the non-relativity result by terms of the second and higher orders in v/c.—C. R. **Darling** and C. W. **Stopford**: Experiments on the production of electromotive forces by heating junctions of single metals. When a circuit is closed through a junction of a cold metal with a hot piece of the same metal, large electromotive forces are often noticed; *e.g.* a bare copper wire connected to the terminals of a galvanometer was cut at the middle, one of the cut ends heated and brought into contact with the cold end, and a large deflexion was obtained. Electromotive forces up to 0·25 volt may thus be produced.—R. H. **Humphry**: The double refraction due to motion of a vanadium pentoxide sol, and some applications. In linear flow the liquid behaves in the same way as a plate of uniaxial crystal cut parallel to the axis and placed with axis parallel to the direction of flow. The field between crossed nicols lights up near an obstacle interposed in a stream of the liquid. Similar effects due to efflux of the sol from a jet, to the convective stream from an electrically-heated wire, etc., were also described.

Optical Society, April 12.—Prof. A. Barr, president, in the chair.—F. **Twyman**: The Hilger microscope interferometer. The instrument is used for measuring the aberrations of microscope objectives. A collimated beam of monochromatic light is separated into two beams at the transmissively silvered surface of a plate of plane parallel glass. The transmitted beam passes through the lens under test, and is reflected back from the surface of a convex mirror, which coincides nearly with the approximately spherical wave front of the light as it converges after passage through the lens. The second beam is reflected back along its own path by a mirror so that the two beams recombine at the silvered surface of the plane parallel plate. Portions of each beam then pass on together through a lens to the observer, who sees an interference pattern apparently located on the surface of the lens under test, which is a contour map, to a scale of half wave-lengths of the light used, of the aberrations of wave-surface caused in a plane wave.—A. **Whitwell**: On the form of the wave-surface of refraction. A series of wave-surfaces is drawn for each of a number of refracting surfaces or lenses. Each series consists of the following forms, which always follow each other in the same order. (1) Saucer type; convex to the incident light when the refracted pencil is converging, and concave when the pencil is diverging. (2) Saucer with inturned edges; like (1), but the edges of the wave-surface which have passed through the primary focus are concave towards the incident light when the refracted pencil is converging. (3) Closed surface type; the wave-surface is completely closed like a cone with a dished bottom, the axis of the cone being coincident with the optic axis. (4) Goblet type; somewhat like a champagne glass set sideways, the bowl being towards the incident light and the base towards the secondary focus. (5) Basin type; the base of the goblet has disappeared and just beyond the focus the surface is like a basin concave towards the incident light. The diffraction spectra are found in the neighbourhood of the edges of the saucers, of the apex of the closed surface type, and of the rims of the goblet and basin type. Interference patterns occur in the region bounded by the caustic and by the extreme marginal rays. By drawing wave-surfaces half a wave-length apart lines of maximum and minimum intensity are found which are the sections of surfaces of revolution on which the intensity is a maximum or minimum. Sections of these surfaces by a plane at right angles to the axis show interference rings. The goblet type of wave-surface always occurs between the focus for marginal rays and that for paraxial rays, and may be called the characteristic of the focus.

Linnean Society, April 19.—Dr. A. Smith Woodward, president, in the chair.—A. B. **Rendle**: The structure of the fruit of the mare's-tail (*Hippuris vulgaris* Linn.). The fruit is a drupe, the upper portion of which around the persistent base of the style, with the seedcoat, is developed in the form of a stopper which is easily withdrawn on soaking the ripe fruit. The embryo ultimately fills the seed, and has the large radicle and hypocotyl so often found in water plants. The radicle is placed directly beneath the stopper which provides a place of exit on germination.—B. Daydon **Jackson**: History of botanic illustration during four centuries (Colour). In the early years of printing, copper-plate engraving was employed in providing outlines for hand-colouring and was in use until the last century, when it was ousted by lithography. In Redouté's method of semi-stipple for coloured prints each colour was separately applied to the plate and cleaned off, before finally heating the plate and pulling the print. Chromo-lithography has greater permanence, if lasting colours are employed, than hand-coloured plates. In the three-colour process three (or four) half-tone blocks are prepared, each to print its own colour, to give a complete colour scheme. The weakness of the process lay in this, that it almost demanded a paper coated with baryta or china-clay, which could not be guaranteed as permanent: in addition was the temptation to use inks, made from aniline dyes, which were fugitive.

CAPE TOWN.

Royal Society of South Africa, March 21.—Dr. A. Ogg, president, in the chair.—B. T. **Schönland**: On the passage of cathode rays through matter. The absorption, reflexion, and secondary emission involved in the passage of fast cathode rays through thin foils of various metals, and their variation with the velocity of the rays, were examined. Accurate measurements were possible up to 0·4 of the velocity of light. The results show that Lenard's Law is only an approximation. The existence of a "range" for these particles appears to be established, two independent methods of measuring it agreeing very satisfactorily. The values obtained are in agreement with the theory of absorption due to Bohr.—T. **Stewart**: Holtzhuisbaaken Spring, Cradock. The spring is a typical Karroo spring. Measurements of the flow have been taken over a period of 38 years. The rainfall of a particular season is found to be reflected in the flow, but is not necessarily proportional to it; regard must be had as well to the rainfalls of previous seasons and the "tail" of the flow produced by them.—Gertrud **Theiler**: Two new species of nematodes from the zebra. *Cylindro-*

pharynx intermedia inhabits the pelvic flexure and dorsal colon of the host, of which it is one of the commonest parasites, and *Habronema zebræ* occurs in fairly large numbers in the stomach.—Sir Thomas Muir: Note on Zeipel's condensation-theorem and related results. Both Zeipel's papers on determinants are now over fifty years old and have been somewhat neglected. One or two of the basic results of Zeipel's first paper are discussed and a number of deductions that cluster somewhat picturesquely round them.

Official Publications Received.

Mysore Agricultural Calendar, 1923. Pp. iii+54. (Bangalore: Government Press.) 1 anna.

The Journal of the Royal Agricultural Society of England. Vol. 83. Pp. 8+260+cxlviii+24. (London: J. Murray.) 15s.

Thirty-fourth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1912-13. (With accompanying paper, "A Prehistoric Island Culture Area of America," by J. Walter Fewkes.) Pp. 281+120 plates. (Washington: Government Printing Office.)

Report of the Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii for the Biennial Period ended December 31, 1922. Pp. vi+102+16 plates. (Honolulu, Hawaii.)

Diary of Societies.

SATURDAY, MAY 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. L. L. B. Williams: The Physical and Physiological Foundations of Character (2).

MONDAY, MAY 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—P. Mauclère: Pneumatic Handling of Petrol and other Inflammable Liquids.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—L. J. Russell: Some Points in the Philosophy of Leibniz.

ROYAL SOCIETY OF ARTS, at 8.—S. S. Cook: The Development of the Steam Turbine (2). (Howard Lecture.)

SURVEYORS' INSTITUTION, at 8.—C. H. Bedells: Some Functions of a Surveyor under the Settled Land Acts 1882-1890, and Part II. of the Law of Property Act, 1922.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—F. Kingdon Ward: The Tibetan Border; Yangtse to Irrawaddy.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section) (Annual General Meeting), at 8.30.—Lt.-Col. A. E. Hamerton: The Establishment of an Anti-rabic Institute in the Tropics.

TUESDAY, MAY 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. C. Seward: The Ice and Flowers of Greenland.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—W. A. Guthrie: Heavy Grade Egyptian Crude Petroleum.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Exhibition of Photographs of Big Game from Choma, Northern Rhodesia.—Miss L. E. Cheesman: (1) Exhibition of Living Specimens of *Peripatus* from Trinidad. (2) Exhibition of Section of a Nest of the Stingless Bee from Australia.—H. Burrell: Note on a Hibernating Female Specimen of the Marsupial *Acrobates pygmæus*.—F. Martin Duncan: The Microscopic Structure of Mammalian Hairs.—I. The Hairs of the Primates.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 5.30.—Annual General Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—R. R. Dobson: Mental Tests.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—E. Kilburn Scott: The Pioneer Work of Le Prince in Moving Pictures.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—R. Paulson: Fungi and Birch Trees.

WEDNESDAY, MAY 9.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. G. Keynes: Chronic Mastitis.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-section of Proctology) (Annual General Meeting), at 5.30.—Sir Humphry Rolleston, Sir Thomas Horder, W. E. Miles, P. Lockhart-Mummery, Prof. L. S. Dudgeon, Dr. W. E. Carnegie Dickson, and Dr. A. F. Hurst: Discussion on Ulcerative Colitis.

INSTITUTE OF PHYSICS (at Institution of Electrical Engineers), at 5.30.—Dr. J. W. Mellor: The Application of Physics to the Ceramic Industry.

INSTITUTION OF AUTOMOBILE ENGINEERS, at 7.30.—Col. R. E. Crompton: The Effect of Motors on Roads.

ROYAL SOCIETY OF ARTS, at 8.—Prof. W. A. Bone: Recent Developments in Surface Combustion, with Special Reference to Recent Developments in Radiophragm Heating.

THURSDAY, MAY 10.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10 a.m.—Report.—Presentation of Bessemer Medal to Dr. W. H. Maw.—E. R. Sutcliffe and E. C. Evans: The Reactivity of Coke as a Factor in the Fuel Economy of the Blast Furnace.—F. Clements: British Steel Works Gas Producer Practice.—J. E. Fletcher: Some Characteristics of Moulding Sands and their Graphical Representation.—J. H. Whiteley and A. Braithwaite: Some Observations on the Effect of Small Quantities of Tin in Steel.—L. Northcott: Note on Temper Carbon.—J. W. Landon: Change of Density of Iron due to Overstrain.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 2.30.—Prof. H. C. H. Carpenter: The Production of Single Metallic Crystals and some of their Properties.—Prof. J. O. Arnold: The Co-relation of the Chemical Constitutions of "True Steels" to their Micrographic Structures.—D. Hanson and J. R. Freeman: The Constitution of the Alloys of Iron and Steel.—T. F. Russell: The Potential Energy of Cold Worked Steel.—F. C. Thompson and A. Goffey: The Changes in Iron and Steel below 400° C.—L. E Benson and F. C. Thompson: Some Experiments on Grain-growth in Iron and Steel.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. J. T. MacGregor-Morris: Modern Electric Lamps (3); Glowing Gases (Neon Lamps).

ROYAL SOCIETY, at 4.30.—Prof. A. Fowler: The Series Spectrum of Trebly-ionised Silicon (Si IV).—Sir Robert Robertson and W. E. Garner: Calorimetry of High Explosives.—Dr. H. S. Hele-Shaw: Stream Line Filter.—Dr. F. W. Aston: A Critical Search for a Heavier Constituent of the Atmosphere by means of the Mass-Spectrograph.—Prof. H. E. Armstrong: Electrolytic Conduction; sequel to an attempt (1886) to apply a Theory of Residual Affinity.—Prof. H. E. Armstrong: The Origin of Osmotic Effects. IV. Hydrono-dynamic Change in Aqueous Solutions.—Prof. R. W. Wood and A. Ellett: The Influence of Magnetic Fields on the Polarisation of Resonance Radiation.—W. G. Palmer: A Study of the Oxidation of Copper and the Reduction of Copper Oxide by a new Method.—E. A. Fisher: Some Moisture Relations of Colloids. II. Further Observations on the Evaporation of Water from Clay and Wool.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 5.—Annual General Meeting, to be followed by a Clinical Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. J. A. Fleming: Problems in Telephony, Solved and Unsolved (Fourteenth Kelvin Lecture).

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. J. W. French: Stereoscopy restated.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. W. H. Perkin: Adolph von Baeyer Memorial Lecture.

FRIDAY, MAY 11.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10.—Announcement of award of the Andrew Carnegie Research Scholarship.—C. A. Ablett: Economic Principles governing the Use of Electrical Power in Iron and Steel Works.—T. P. Colclough: The Constitution of Basic Slags—its Relation to Furnace Reactions.—Prof. C. H. Desch and A. T. Roberts: Some Properties of Steels containing Globular Cementite.—K. Honda and T. Murakami: The Structural Constitution of Iron-Carbon-Silicon Alloys.—T. Matsushita: Some Investigations on the Quenching of Carbon Steels.—E. J. L. Holman: Note on a Value for the Surface Tension of Iron Sulphide.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 2.30.—C. A. Edwards and C. R. Austin: A Contribution to the Study of Hardness.—F. C. Langenberg: An Investigation of the Behaviour of Certain Steels under Impact at Different Temperatures.—J. Stead: The Cold Working of Steel with Reference to the Tensile Test.—J. J. A. Jones: The Acl Range in Alloy Steels.—C. R. Austin: Some Mechanical Properties of a Series of Chromium Steels.—H. O'Neill: Variation of Brinell Hardness Number with Testing Load.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—J. H. Jeans: The Present Position of the Radiation Problem (Eighth Guthrie Lecture).

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5.30.—Prof. C. W. Valentine: The Place of Imagery in the Appreciation of Poetry.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. F. C. Cooper: The Theory of Resistance to the Flow of Gases and Fluids in Pipes (Durham Bursar's Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. A. Bone: Gaseous Combustion at High Pressures.

PUBLIC LECTURES.

MONDAY, MAY 7.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.15.—Prof. W. de Sitter: Problems of Fundamental Astronomy.

TUESDAY, MAY 8.

UNIVERSITY COLLEGE, at 5.—Prof. H. R. Kruyt: The Electric Charge of Colloids.—At 5.30.—J. H. Helweg: Danish Scenery.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: Blaise Pascal: Tercentenary of his Birth, June 19, 1923 (1) (succeeding Lectures on May 15, 22, and 29).

BIRKBECK COLLEGE, at 6.—Sir Richard Gregory: The Worth of Science.

WEDNESDAY, MAY 9.

UNIVERSITY COLLEGE, at 5.15.—Sir Thomas H. Holland: Phases of Indian Geology (succeeding Lectures on May 23 and 30).

THURSDAY, MAY 10.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 4.30.—Dr. H. H. Dale: The Physiology of Insulin.

KING'S COLLEGE, at 5.30.—Principal L. P. Jacks: Reality in Religion and Education (Hibbert Lecture).

FRIDAY, MAY 11.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. P. Giles: The Aryans (succeeding Lectures on May 25 and June 8.