Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME LXXXIV

JULY to OCTOBER, 1910

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

London
MACMILLAN AND CO., LIMITED
NEW YORK: THE MACMILLAN COMPANY

RICHARD CLAY AND SONS, LIMITED,
BREAD STREET HILL, E.C., AND
BUNGAY, SUFFOLK.

INDEX.

REVIEWS AND OUR BOOKSHELF.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, JULY 7, 1910.

THE LAWS OF HEREDITY.

The Laws of Heredity. By G. Archdall Reid. With a diagrammatic representation by Prof. H. H. Turner. Pp. xi+548. (London: Methuen and Co., Ltd., 1910.) Price 21s. net.

DR. ARCHDALL REID confesses that he is an "extreme Darwinian." It is interesting that he has reached this position from the study of the human species. He finds that this "vast field of research has been left practically untilled by students of heredity." He is not, properly speaking, a naturalist; in fact, he has rather a poor opinion of naturalistic work, and especially, I am sorry to say, of botanical. This is the more remarkable as Darwin himself loved "to exalt plants," and largely drew upon their study for his theory. The author is, however, a physician who, unlike most of his calling, is not satisfied with being empirical. He finds himself "able to watch, under conditions ensuring great accuracy, the tremendous and crucial experiments made by nature." With many of his results we are already familiar from his previous writings. They are beginning to obtain general acceptance; in proportion as they do so, they must profoundly change our mode of dealing with social problems of the utmost importance.

The object of the present work is apparently to set out the results of his investigations in a systematic form, and to show that they can be exhibited as deductions from widely accepted principles. The method has undoubtedly the advantage that it has enabled him to look at the whole subject from a new point of view, and to bring a very acute criticism to bear upon a good many questions on which opinion at the moment is much divided.

As Mill long ago pointed out, all science tends to become deductive, and biology cannot be excluded. But the progress which any particular science can make in this direction altogether depends on the certainty which attaches to the assumptions or propositions with which we start. And where the phenomena, as in the case of biology, are complicated and obscure, the difficulty must always arise as to whether the proposition we start from is really exhaustive of the fact. The validity of the conclusion cannot exceed that of the premises. Lord Kelvin's attempt to determine the age of the earth is an example. The conditions of the problem have proved to be insufficient, and I suppose no physicist would now refuse an evolutionist a blank cheque as to time.

Darwin himself linked together a number of separate inductions into a more comprehensive one from which he then argued deductively. Dr. Archdall Reid has continued the process, and in the first ten chapters of his book has attempted a synthesis of existing evolutionary theory. It is to be noted that when this is done the order of exposition is rarely that in which discovery was made. This is well known, for example, to be the case with the text-book treatment of the Newtonian theory. The process is, however, valuable, as it not merely brings to light a clear chain of causation, but by vigorously testing the strength of each link, often reveals unsuspected weakness, and may even suggest new discovery.

The author accepts and starts from Weismann's theory of the continuity of the germ-plasm. From this he makes the fundamental deduction that "individuals, for example, men, are nothing more than dwellings which the germ-plasm builds about its germinal descendants." Thence it follows "that the child inherits nothing from his parent." What it does inherit is nothing more than what was "inborn" in the germ-plasm from which it started. The germ-plasm, under the stimulus of nutrition, reproduces itself, and also produces the enveloping soma. But the latter also requires the stimulus of use ("injury" may be regarded as use with a minus sign), as well as that of nutrition: a limb will not reach full development unless used, and mental powers will remain dormant unless exercised. But the characters so developed are "rooted, as it were, in the germ-plasm." They flow from it: the question which has long divided biologists is whether modification of those characters produced by the stimulus of use can flow back and be transmitted to a succeeding generation. Darwin latterly apparently thought they could.

Herbert Spencer built upon their doing so his ethical system. "Most biologists reject the Lamarckian doctrine," on the ground that it is against the weight of evidence. That is my own position. But the author himself admits that there is some evidence in its favour, yet unhesitatingly also rejects it on deductive grounds. The argument is rather subtle; but it amounts to this: a character which develops under the stimulus of use cannot develop under the stimulus of nutriment alone. If it did so it would be "a miracle." But I am not sure that this is not an assumption. In a unicellular organism the soma and germ-plasm are identical, and as we rise in the scale of plants the separation of the germ-plasm is far from being as complete as it is in animals. In many plants, as in the well-known case of Begonia, a somatic cell will reproduce the whole individual, germ-plasm and all. I am not prepared to assert that the new germ-plasm is free from derived somatic influence. On the other hand, I know of no reason to think that it is not.

The Lamarckian doctrine being dismissed, natural selection is examined. Like Prof. Karl Pearson, Dr. Archdall Reid infers this immediately from "selective mortality" in mankind. He points out that this cannot be proved in the case of "wild plants and animals," but "presumably" it occurs. I doubt if disease is a dominant selective factor in nature, though no doubt it has been occasionally operative, and on a large scale. He puts the theory on too narrow a basis, and ignores the struggle for existence. What plants have to fight for is room to perfect their seeds and space for them to germinate.

This is not the only short cut to the root of the matter. "The plain fact that living beings are able to exist is a proof of adaptation." It does not appear to me to be self-evident, though Paley would probably have agreed. Anyhow, it is rather like trying to enter Darwinism by the back-door instead of toiling up the steps. I collect a somewhat better argument. Man is "manifestly a bundle of adaptations." "The growth of modern physiology implies merely an increased power of interpreting human traits in terms of their utilities." "Presumably adaptation is not less perfect in plants and lower animals than in man." Yet, as Rolleston used to tell us at Oxford, that sort of statement would not convict a poacher. Fortunately, evolutionists have a better case for the court.

Next we come to variation, which affords the material for natural selection to work upon, and some important conclusions are arrived at. Excluding any possible influence of the soma, and I agree, variation must be resident in the germ-plasm. "Reasoning by analogy," it is inferred that this is itself "established and maintained by natural selection." This involves the paradox that it preceded that which produced it. "Its origins are lost in obscurity." No doubt; but if I may try my own hand at deduction, I would suggest that primitive variation was a necessary consequence of molecular instability, and as I regard natural selection as a sort of physical principle like "least action" or gravitation, it would begin to operate at once.

The most fundamental point in the whole argument is the relation of the germ-plasm to the environment. Here two classes of facts have to be faced; first, the undoubted one, on which I have often insisted, that a few years' cultivation of a wild species breaks down its stability; and, secondly, such cases as the supposed degeneration of European dogs in India. I can only accept variation at present as an unresolved phenomenon. I have never contended that the environment could act as more than a stimulus to it, and I have no doubt that it does. Someone has used a better expression in saying that it pulls the trigger. To suppose that it has any directive action lands one at once in Lamarckism. The degeneration question is much more serious. To attempt to get over it by saying that "evolution is never perfect" and that "exceptions occur" is not "facing the music." Now this story of the degeneration of domestic animals and plants is an obsession in India. I have had occasion to test it in the case of the latter, and satisfied myself that it was due to mongrelising; and, as to Clayton's beans, I completely exploded a similar case in Arabis some years ago in these pages. My own conclusion is that variation is inherent and spontaneous in the germ-plasm; and the "germinal power of resisting enforced change" is an undoubted fact which manifests itself in "specific stability."

The varying germ-plasm inherits and transmits variations. Thus we are led to the thorny question of recapitulation. Sedgwick agrees that it is "a deduction from the theory of evolution," but that it "is still without satisfactory proof." On the other hand, in the same volume, W. B. Scott finds that in brachiopods, "in the more advanced genera, the developmental stages clearly indicate the ancestral genera of the series." The botanist is constantly running up against recapitulative structures. When he finds a trace of a prothallus in a flowering plant and a spermatozoid in the pollen-tube of Salisburia, it is difficult to avoid the conclusion of Bower that land-plants had aquatic ancestors. We must, however, agree with Prof. Sollas that "nature no doubt is a strict adherent to logic, but she betrays a singular want of method in recording the steps of her argument."

Dr. Archdall Reid thinks, and no doubt rightly, that "the main reason against a full acceptance of the Darwinian doctrine" is "the retrogression of useless parts and organs." His solution of this difficult problem is one of the most novel and interesting things in his book, and will probably be subjected to most criticism. Thirty-two yearlings, costing 51,520 guineas, only produced two winners. From this and similar cases he draws the inference that retrogression preponderates over progression. He accounts for it by supposing that there has been a selection of germ-plasms which "tended on the whole to vary retrogressively." But retrogression in turn "is checked only by selection." The difficulty at once arises to reconcile this view with the biometric result which he admits, that "variation tends to occur about equally about the specific mean." Incidentally it may be noted that he identifies retrogression with reversion.

The various solutions of the problem which have been attempted are discussed. There is a risk that the terminology used may cover a *petitio principii*. Given

an organism, how is it to be adapted to a different environment? The adjustment may be effected by further complication or by simplification. It may be noted that in regard to the latter there is a close parallel in the evolution of machinery. Whole trains of mechanism are continually being swept away with an increase of efficiency. Compare, for example, a turbine with a marine engine. Here structural retrogression has made for functional progression. We owe it to Lankester for pointing out that "degeneration" is really simplification leading to closer adaptation. Progress in biology is not ethical, but position in the phyletic scale. The last of the Plantagenets is said to have kept a turnpike; but he may have been not the less authentic.

The instability of prize-bred domesticated races requires careful scrutiny. The late Duke of Devonshire pointed out to Lankester that racehorses are bred for speed and not for "points." The conclusion that I draw from Sir Walter Gilbey's facts is that breeders have not yet succeeded in fixing this particular quality. But short-horns, which are bred for points, have reached a high degree of stability; if they had not no one would give a thousand guineas for a bull. The purchase of a possible racehorse is confessedly a gamble. For my own part, I am content with Lankester's view that nature "with remorseless thoroughness" can throw overboard hereditary tendencies, if it is advantageous to do so; and this is really the same thing as Dr. Archdall Reid's selection of retrogressive germ-plasms, except that he throws on natural selection the burden of defeating its own aim.

Apart from speculation, we have in Galton's law of regression to mediocrity an empirical result which is perfectly general inasmuch as it deals impartially with excess and defect. It produces "a sensible stability of type and variation from generation to generation." It has always appeared to me the most important positive addition to the Darwinian theory, and it has seemed possible that it would open the door to a mechanical explanation of retrogression, or, as I prefer to say, of simplification; and this is apparently in Archdall Reid's mind, as he remarks that "regression is but the first phase of retrogression," though he has not followed it out further. Regression is independent, apparently, of natural selection, while retrogression is not.

This leads to another point which is often overlooked. The mere "maintenance of a structure" is dependent on the continued action of natural selection. As Poulton insists, it is by its operation that "all functional parts of an organism are kept up to a high standard." It may be a private heresy of my own, but I can attach no more meaning to the "cessation" and "reversal" of selection than if those terms were applied to gravitation.

The chapter on Mendel's laws is altogether admirable. It is probably the most luminous account of them which has been published. "There can be no doubt of the actual occurrence of the Mendelian phenomena. We must endeavour, therefore, to estimate the part played by them in nature." Now where species or stable varieties are crossed we get simple blending, as in the Mulatto. "Mendelian reproduction is one of the rarest things in nature." "Mendelian traits . . . are common only when artificial varieties . . . are crossed by man." It would be impossible with any justice to attempt to summarise the argument. The majority of Mendelian traits "are concerned with reproduction." The illuminating conclusion, in which, however, the author finds himself anticipated by T. H. Morgan, is reached that they are analogous to sexual characters which are alternative, *i.e.* are latent or patent in the opposite sex. If this explanation holds good, and it has the obvious merit of including phenomena not obviously connected at first sight, it effectually disposes of "segregation"; and "unit-characters" necessarily follow. But their existence had already become precarious, for Prof. Karl Pearson kindly informs me that he has entirely failed to discover any which, to put it briefly, can be described as having unitary properties. It is pointed out that the inheritance of mutations is alternative, and the inference is drawn that characters which blend in crossing cannot have arisen as mutations.

Lastly, we come to the "Function of Sex." This is found to be an adaptation "to blend parental characters." Further, it is concluded that "blending, with its swamping effects . . . eliminates useless characters and variations." This at once explains retrogression, and at bottom on this head there is probably not much difference between Lankester and the author. Mutations are alternative and Mendelian; fluctuations are blended; whence Galton's law of regression and stability at once follows. "The average experience of the whole race . . . becomes the determining factor in evolution."

Two incidental points deserve notice. Parthenogenesis "occurs as a rule amongst simple forms." But it is found to occur much more frequently than was supposed amongst flowering plants; the dandelion is an example. Still, it may be presumed that sexual reproduction and cross-fertilisation occasionally occur. Fertility, both on biometric and general grounds, is thought to be a transmissible adaptation. Karl Pearson has, however, arrived at the important conclusion that there is "little or no demonstrable inheritance of fertility." Further, he is "forced to the conclusion that the smallness of the hereditary factor in fertility is an essential feature of Darwinian evolution." It is interesting to note that in this case deductive reasoning has led to diametrically opposite conclusions.

This disposes of the first part of the book. I do not know that I have come across anything more suggestive on the subject since the "Origin" itself. It may be added that Prof. Turner has thrown the main argument into a quasi-mathematical shape in the appendix. The latter and larger portion of the book is difficult to review in any reasonable space. It is a striking commentary on the contention of de Vries that organic evolution has nothing to say on social problems. It ranges over a wide field, including even a short system of philosophy, and will probably be found the more interesting because the least technical, and might well have been published separately.

Disease and immunity are admirably discussed. Races become tolerant through selection working on germinal variation. Protoplasm learns to neutralise

toxins. Twenty years ago I ventured with bated breath to hint the possibility of its education. The result is that the microbe and not the sword is the ultimate "empire-builder"; and subject-races will either absorb or expel their conquerers. The argument is extended to alcohol and narcotics. All races who win their freedom from vicious indulgence must first be slaves to it. Insusceptibility to its charm, though not precisely parallel to disease-immunity, is, like it, a product of germinal variation. Meanwhile, selection slowly eliminates those who do not possess it. If it is true that the English are the most drunken of existing races, and that "about one death in seven" amongst them is due to alcohol, it has its work cut out for it. Still, it is at work; and any attempt to interfere with it by the total suppression of alcohol would simply result in the production of a more susceptible race.

Fortunately, though susceptibility is germinal, indulgence is an acquired habit. It follows that the children of drunkards will not necessarily follow in their parents' steps, and Karl Pearson confirms this from biometric data. The same reasoning applies to slum-dwellers. Here also the injury is somatic and not germinal, and would disappear if the conditions were improved; it is not transmitted, but reproduced in the offspring, which the experience of Dr. Barnardo's Homes shows is still capable of healthy development. Slums are continually recruited from outside; it is probable, therefore, that little, if any, germinal mischief has been produced. But it can be shown on Dr. Archdall Reid's own principles that, given time, an adapted and degenerate race would develop, which would be parasitic on the community, and probably prolific.

The chapters on mind I must leave to the psychologist. Lankester is followed in seeing in "the relatively enormous size of the brain in man and the corresponding increase in its activity and capacity," the fundamental distinction between man and other animals. "Educability is nothing more than a power of growing mentally under the stimulus of experience." This is inherited, while the resulting mental acquirements are not. The real test of education is the *quality* of thinking produced. I cannot, however, follow the author in his condemnation of Karl Pearson's Huxley lecture, the conclusions of which I believe to be, not merely perfectly sound, but of the deepest importance. Dr. Archdall Reid tells us that "ability is inborn"; Karl Pearson says it is "bred." I fail to see the distinction. Feeble-mindedness is found to consist in "incapacity to learn" and to be a "reversion to a pre-human mental state." Being germinal, it is inherited, and the community is justified in restraining its marked fertility.

Here I must conclude my review of a very remarkable book; the more remarkable as it is the work of a man somewhat aloof from the scientific world, and written as the recreation of a strenuous professional life. The author invites criticism, and I have not stinted it. He will doubtless get plenty more.

Perhaps Dr. Archdall Reid's more vulnerable point is the superior certitude which he (and Dr. Donkin) claim for deduction over observation and experiment (which is only observation of facts not immediately patent). It is true that when we come across an apparently irreconcilable fact, its improbability depends on the certitude of the law with which it conflicts. It may be due to experimental error in its widest sense; but it may be the germ of a new discovery. Newton laid aside his theory for a time because he could not reconcile it with the moon's motion. But Greenwich did not abandon it when it was found that the path of Halley's comet was not an ellipse. Certitude is built up by accumulated verification. Even mathematics, which are purely deductive, cannot wholly dispense with it. It was long thought that the conversion of linear into circular motion was impossible until Peaucellier effected it. And even so distinguished a mathematician as Sylvester once told me that he had published a number of theorems which, when tested arithmetically, proved to be untrue. Experiment cannot always wait on deduction. Röntgen's great discovery was an accident. A discrepancy in the weight of nitrogen revealed argon. It would possibly have been a long time before physicists found out for themselves Brownian motion and osmotic pressure unless botanists had done it for them. Darwin found by experiment that cross-fertilisation was advantageous to plants, and it is difficult to see how the fact could have been arrived at in any other way.

Huxley must have projected a prophetic eye into the future when he wrote:—

"The great danger which besets all men of large speculative faculty, is the temptation to deal with the accepted facts in natural science, as if they were not only correct but exhaustive; as if they might be dealt with deductively, in the same way as propositions in Euclid may be dealt with. In reality every such statement, however true it may be, is true only relatively to the means of observation and the point of view of those who have examined it. So far it may be depended upon. But whether it will bear every speculative conclusion that may be logically deduced from it, is quite another question."

The warning is not unneeded in many directions. It is, I think, particularly needed in regard to Dr. Archdall Reid's impatience with biometry and taxonomy, or rather, I should say, imperfect acquaintance with their aim and methods. He appears to think that biometric method begins and ends with mere enumeration. But such a research as that of Karl Pearson on the distribution of stars in space would show him that it goes a good deal farther. As Karl Pearson tells us, biology "has now developed theories of such complexity, that without the aid of the highest mathematical analysis it is wholly unable to state whether its theories are accurate or not." For my part, when a distinguished mathematician is willing to devote his splendid gifts to the task, my attitude is not querulous, but one of profound gratitude.

And taxonomy is even less a ground for impatience. For, as Linnæus saw, its real aim is to embrace all organisms in a natural classification. The principle of descent is implicit in this, and it was therefore towards it that all taxonomists were unconsciously working. Far from being hostile, it was amongst the systematists—Hooker, Asa Gray, Bentham, Bates, and Wallace—that Darwin found his most ardent champions.

W. T. THISELTON-DYER.

THE METABOLISM OF MARINE ANIMALS.

Die Ernährung der Wassertiere und der Stoffhaushalt der Gewasser. By Prof. August Pütter. Pp. iv+168. (Jena: Gustav Fischer, 1909.) Price 5 marks (unbound).

TWO years ago Prof. Pütter published three papers dealing with the metabolism of marine animals. The thesis advanced as the result of these investigations may be briefly summarised as follows:—the nutrition of a very great number of marine animals belonging to all phyla is not effected in the manner characteristic of the mammal, that is, by the ingestion of solid organised food, and by the subsequent digestion and absorption of this matter by special organs, but by the direct absorption of carbon and nitrogen compounds which are contained in solution in the sea. The notion that many animals were really saprozoic in their habits was not really a new one; most internal parasites, whether provided or not with an alimentary canal, obviously exhibit such a mode of nutrition; but the hypothesis that animals living in the open feed otherwise than by the ingestion of solid organised food, or by the utilisation of photosynthetic products elaborated by the activity of commensal algæ, was a new one, and has provoked much discussion. Pütter's methods have been criticised by Henze and Lohmann, and the paper now under review amplifies the author's former work, and to some extent meets the criticisms advanced.

The proof of the thesis is developed along three main lines. The author has studied the intensity of metabolism in a number of forms, and has found that this is proportional to the unit of surface, and not to the unit of mass. Therefore the relatively minute organisms which are found among the plankton, or even those larger animals which are provided with a large absorptive surface in the shape of gills, ctenidia, respiratory plumes, &c., and internal diverticula, are able to utilise the exceedingly dilute solution of organic carbon and nitrogen compounds contained in sea water. The intensity of metabolism is measured by the oxygen consumption and the carbonic acid output, and, generally speaking, the rate of exchange is, roughly, constant in animals of the same general type of organisation, when it is regarded as a function of the unit of surface. The divergencies from this approximately constant rate are to be regarded as dependent on the deviations from the usual mode of metabolism characteristic of the animal group considered.

The second line of proof depends on the existence of compounds of carbon other than carbonates, and compounds of nitrogen other than ammonia, nitrates, and nitrites, in solution in sea water. From the author's point of view the sea is an immense storehouse of dissolved food-stuff, which is utilised by most marine animals. In his first papers, Pütter estimated that the water of Naples Bay contained some 65 milligrams of organic carbon (volatile and higher fatty acids, and carbohydrates) per litre. Shortly afterwards Henze showed that the amount was greatly over-estimated, and that the proportion of such substances present was so small that it lay within the limits of error of the experimental methods employed by Pütter. Raben, however, showed that the water from the North Sea and Baltic did actually contain measurable quantities of organic carbon varying from about 3 to 37 milligrams per litre. If these results should be confirmed, they would back up Pütter's hypothesis, since the solution would then be sufficiently concentrated to act as a food medium.

The third line of proof is much stronger, but it depends on the author's estimates of the rate of exchange of oxygen and carbonic acid in the animals studied. Taking the case of plankton-feeding creatures, he shows that it is, in most cases, impossible that a sufficient amount of food can be obtained from the plankton to account for the rate of metabolic exchange. A sponge (Suberites), for instance, of some 60 grams weight required about 0·92 mgrm. of carbon per hour. Now taking a certain density of the plankton, this postulated that the sponge would have to pass some 242 litres of water through its canal system in order to get the necessary food-stuff from the plankton. It is quite impossible, of course, that the animal can filter this volume of fluid in the time. It has been shown by Lohmann that Pütter underestimated the density of the plankton, and by Henze that he over-estimated the concentration of the sea water in carbon compounds. But when the revised values are substituted, the argument is not materially affected. A further instance of the same nature is that of the copepod Calanus. If this animal feeds exclusively on plankton diatoms it must ingest some 16,000 medium-sized Coscinodisci, or about ten millions of Thalassiosiræ, in order to account for its metabolic exchange. Such figures appear to preclude the possibility of an exclusive feeding on diatoms.

It is, of course, quite probable that marine animals may feed in the same way as internal parasites, by absorption of dissolved food-stuff, and that this mode of nutrition may proceed simultaneously with that depending on the existence of an alimentary canal. If the metabolism of the lower invertebrates had been studied as carefully as that of the warm-blooded animal, this contention might have been accepted long ago. It is mainly by analogy with the latter that we ascribe respiratory functions to the structures called gills; they might just as reasonably be regarded as organs for absorption of food-stuff. However this may be, it appears from the work now noticed that the conclusions are only very probable ones until the data representing the rate of exchange of oxygen and carbonic acid have been critically revised. The proof or disproof of the author's thesis will be effected by such revision. J. J.

SMALLPOX AND VACCINATION IN BRITISH INDIA.

Smallpox and Vaccination in British India. By Major S. P. James. Pp. xi+106. (Calcutta: Thacker, Spink and Co., 1909.) Price 7*s.* 6*d.*

AT a time when the study of tropical diseases is setting its indelible mark on the history of the progress of medicine, it is well to be reminded that

in the tropics we have diseases that can by no means be considered exclusively tropical.

Major James's work deals with smallpox in India, that is, in a country, as the author bids us bear in mind, where the people

"live amid surroundings which could not be more favourable to the spread of epidemic disease if they had been especially devised to that end."

In a country "where sanitation is still in its infancy," where a continually growing proportion of the population lives in the towns and cities, where there is an enormous and continued extension of movement among the population and of communication within the country generally, where that typical "insanitary" disease, cholera, has on the whole increased, and where, in spite of all this, smallpox has decreased. Those who have studied the decline or disappearance of smallpox in other countries know that there is one, and only one, factor which could explain such a phenomenon, viz. vaccination; and that vaccination is the cause of the decline in India the author shows in plain and easily understood language, and with the aid of simple statistics that require no alleged "jugglery" for their setting forth.

Although there is a general belief that inoculation, the precursor of vaccination, was in use in India from time immemorial, yet the author adduces evidence that in modern times, where we have trustworthy information, it was entirely unknown in certain provinces, but he does not suggest any explanation of this curious discrepancy. Where inoculation was practised it was apparently done with marked success, but the regulations attending it were strict. At a later period, when irregularities in the practice arose, it became one of considerable danger, and was gradually superseded by the introduction of vaccination.

In chapter iii. is given a short account of the origin of vaccination from the first introduction of human vaccine threads into India in 1902 down to the use of calf lymph at the present day. It is interesting to note the opposition to vaccination in Bengal, as a few years ago the writer experienced there perfectly irrational opposition to the making of finger-pricks for simple blood examinations.

The following simple tables will suffice to give an idea of how smallpox had decreased from periods in which there was "less" vaccination to those in which there was "more," but to be fully appreciated the original data in Major James's book should be consulted.

	1868–1887 Smallpox death-rate per million of population	1888–1907 Smallpox death-rate per million of population
Bombay	537·2	240·5
Central Provinces ...	1020·1	502·7
Punjab	1099·3	520·7
Madras	1163·9	673·0
Berar	1083·1	183·0
British India as a whole	1032·3	466·0

If these latter figures are compared with the chart of the total number of vaccinations performed in British India, it will be seen at once that the fall in smallpox mortality coincides with the rise of vaccination.

Another method which is independent of statistics of population is to consider the proportion which smallpox deaths bear to the total deaths from all causes in two periods, one with "less" and the other with "more" vaccination. If an "epidemic" is now arbitrarily defined as one in which the deaths from smallpox form 5 or more per cent. of the deaths from all causes, we get the following data here put in tabular form:—

	1868–1887 No. of epidemics	1888–1907 No. of epidemics
Central Provinces...	5	0
Punjab	7	0
British India as a whole ...	9	0

Another interesting observation is that prior to 1886 the attack rate among natives was always greater than among the European troops, but that after this date the position was reversed. The explanation given by the author is that since 1885 vaccination and successful re-vaccination have been less carefully attended to among Europeans than among native troops, and figures are given showing that among Europeans in 1906 there were more than 20,000 individuals without any marks or record of vaccination—a sufficiently lax condition of affairs—but the proof to be complete should have given the corresponding figures for the native troops. Another very interesting table is that showing the constantly greater incidence of smallpox among the wives of European soldiers than among the men, while as regards cholera and enteric fever the reverse is the case. The difference is due, no doubt, as the author points out, to the almost total absence of successful re-vaccination among the women. To the table there should, we think, have been added the "strength" of the women.

Other equally convincing tables are given, invariably pointing to some factor (vaccination) influencing the figures in the same direction; the tables, moreover, have the merit of being simple, though, as the author points out, if subjected to analysis they would be even more convincing, if that were necessary.

The laborious task the author set himself has been well done. We are not aware what steps are taken in India to explain the merits of vaccination to the people, but nothing could do so better than this book, or a short digest of it if that be possible.

THE ALTERNATE-CURRENT THEORY.

The Foundations of Alternate Current Theory. By Dr. C. V. Drysdale. Pp. xi+300. (London: Edward Arnold, 1910.) Price 8*s.* 6*d.* net.

IN English text-books on electrical engineering one finds occasionally an attempt to elucidate some property of an electric circuit by a mechanical model. A favourite analogy is a water-tank with pipe and stop-cock. The head of water represents E.M.F., the pipe takes the place of the conductor, the stop-cock that of the switch, and the flow of water represents the current. Also, a railway waggon with buffer-springs is often used to explain inductance and capacity. These analogies are, however, only used as additional explanations of a theory built up independently of them. In the present book they are the theory itself, or rather the foundation on which the author builds up the theory of alternating-current

working. Hence it becomes a matter of the greatest importance that the mechanical properties of the particular model chosen should not merely approximately, but with mathematical precision, represent the corresponding electrical properties of the circuit it is intended to represent.

It becomes thus necessary to idealise the mechanical model by attributing to it properties which differ more or less from those it actually has in its natural condition. Take as an example the conceptions of electric current and ohmic resistance. According to the author's "foundations," these are respectively represented by speed (linear or angular) and friction. But what kind of friction? The coefficient of friction as applicable to solid bodies will not do, for this implies the existence of pressure between the surfaces in contact, and there is nothing analogous to pressure in the electrical case.

Thus one is driven to assume that ohmic resistance can only be represented by liquid friction of a particular kind, namely, of a kind which will cause the frictional resisting force to increase exactly in proportion to the speed with which a body is moved through the liquid. The author takes a boat which is towed through the water, and assumes that the pull in the tow-rope is exactly proportional to the speed. As an alternative to the tow-rope he assumes that the boat is fitted with a propeller which exerts the same thrust at all speeds, and he uses this model to illustrate the case of an inductive circuit. The mass of the boat corresponds to the inductance; the frictional coefficient, that is, the resisting force per unit speed, corresponds to the ohmic resistance, and the speed to the electric current. The E.M.F. is represented by the thrust of the propeller. Under these conditions the speed of the boat will increase by a logarithmic curve, and approach asymptotically the final value where the thrust of the propeller is exactly balanced by the frictional resistance. Thus, having discarded our conception of the real nature of ships' resistance and propeller thrust and substituted an idealised model, the performance of this model is an exact representation of what goes on in an electric circuit, and the equation of the speed of the boat is identical with the equation of the current in the electric circuit.

The author has not contented himself by merely imagining mechanical models, but has actually constructed one so as to be able to demonstrate the properties of an electric circuit. The model consists of a square frame, one side being provided with rails for a car to travel along. To represent ohmic resistance, the car can be fitted with a paddle moving in a liquid. The mass of the car represents inductance, the force with which it is pulled along stands for E.M.F., the speed for current, the displacement for quantity of electricity (coulombs), and if a capacity effect is to be shown an elastic string is attached to the car. In addition to this model, the author has others to show various electrical phenomena, all of them very ingenious and instructive, especially when he shows side by side curves of harmonic motions obtained by oscillograph attached to the electric circuit, on the one hand, and, on the other, curves obtained by mechanical means from the corresponding models.

The book is divided into four parts. In the first the fundamental principles are established by mechanical analogies; then comes an exposition of harmonic motions; whilst in the third part the properties of alternating-current circuits are studied in detail, including a chapter on the symbolic method. In the fourth part we find practical applications to transformers, motors, polyphase circuits, and high-frequency oscillations. At the end we find a number of problems given as exercises for students. These are well selected. GISBERT KAPP.

OUR BOOK SHELF.

The New School of Japan, Founded for the Purpose of Making the Use of the Newly Invented Letters. Pp. x+58. (Tokyo: Dokuritsu Bungakki.)

THIS singular production is an attempt, by means of a quaintly conceived dialogue between two Japanese script reformers, to enlist home and foreign support, especially financial support, towards the promulgation of yet another script for the purposes of the Japanese written language, by modifications of and additions to the roman alphabet of the West. But European scholars have already accomplished this, and the existing system of romanisation is sufficiently perfect for all practical purposes. That system uses the roman letters, as we use them, to transcribe the characters of the Japanese syllabary, each of which represents a vowel or an open syllable; thus *ka, ki, ku, ko, ke* represent simply and adequately corresponding simple *kana* (syllabic) characters. But the proposed system would use single alphabetic letters to represent the *kana*. Thus *ka, ki,* &c., are written *n, v, u, k*; for *ke* a sort of reversed *k* is used. The modifications of sound, voicing, doubling, and lengthening are denoted by ordinary devices and combinations of these, and a few new letters are invented. Thus *Kono hon wa, Okuma Shigeru to Yamada Eizo* . . . (this book contains a talk between Okuma Sh. and Yamada Ei.) is printed, according to the new system, *Pk cx g Ttuf-Cat m Ofr-Tict* (two or three new letters are represented here by their nearest usual ones). Eizo Yamada is the "originator" of the new system; the preface, dated November, 1909, is signed by him and Muneyasu Oki, who is "business associate," and photographs of inventor and associate follow the preface.

For our part we fail to see any advantage whatever in this proposal. Why the Japanese continue to put their thought on paper under a variety of forms that render mere decipherment an impossibility to all foreigners save a very few who have time and patience, or are under some necessity to undertake a most repulsive study of several years' duration at least, the people of Japan alone can tell. Written Japanese, mainly on this account, is more difficult to acquire, even to read merely, than Chinese, yet with a very few changes the difficulty might be very greatly lessened without change of character, and with romanisation would largely disappear. In no long course of time, probably, the unintelligent use of the Chinese ideograph would diminish, the assimilation of written to colloquial speech would develop, and Japanese would present only the ordinary difficulties incident to a strange vocabulary, a syntax based upon impersonality and lack of inflections, and a mass of idioms necessarily differing widely in allusion and reference from those of Aryan languages.

F. VICTOR DICKINS.

Catalogue of the Fossil Bryozoa in the Department of Geology, British Museum (Natural History). Vol. ii., the Cretaceous Bryozoa. By Prof. J. W. Gregory, F.R.S. Pp. xlviii+346; 9 plates. (London: Printed by order of the Trustees, 1909.)

OWING to the author's absence from England and his retirement from the staff of the Museum, a period of ten years has elapsed between the date of publication of the present volume and its predecessor. This unusual delay has, however, been by no means an unmixed disadvantage, since it has enabled Prof. Gregory to incorporate information and to take advantage of theories of classification which would not have been available had this volume appeared several years earlier. It was originally intended to complete the subject in two volumes, but the wealth of material has rendered it necessary to allot a third volume—now in preparation by Prof. Gregory's successor in the Museum, Mr. W. D. Lang—to the Chilostomata.

In concluding his share of the work, Prof. Gregory gives a valuable general account of the Cretaceous bryozoan fauna and its relationships. The Cretaceous is the era in which the modern types of Bryozoa first attained to importance and replaced the older forms. The most characteristic group of the epoch is the Cyclostomata, which is now a waning type, and dates from the Jurassic. A second ordinal group, the Trepostomata, represents a Palæozoic type, which became decadent in the Upper Cretaceous, and finally disappeared in the Cænozoic. On the other hand, the Chilostomata, of which but two Jurassic species are known, attained an enormous development in the Upper Cretaceous, and forms the dominant type in the seas of to-day.

After a long review of the classification of the Cyclostomata, Prof. Gregory points out the value of the Bryozoa for zonal classification of the Chalk, remarking that recent investigations have shown—in contradistinction to older views—many of the species to have a very restricted vertical distribution.

The work is a most valuable and trustworthy contribution to the natural history of the Cretaceous Bryozoa, which, in Great Britain, at any rate, have previously received comparatively little attention at the hands of palæontologists.

Problèmes et Exercices de Mathématiques générales. By Prof. E. Fabry. Pp. 420. (Paris: A. Hermann et Fils, 1910.) Price 10 francs.

THIS useful collection reminds us that mathematical examinations are not peculiar to Great Britain, and provides an interesting specimen of the kind of questions set in France to candidates of about the same standing as English candidates for an ordinary science degree. It contains the enunciations of 739 problems, ranging from elementary algebra and calculus to solid geometry and differential equations, and also including about a hundred questions in statics and dynamics. Pages 81–420 contain the solutions, which, as might be expected, are clear and elegant. No book of this kind can supply the place of a competent teacher, but a student who has to work by himself will find Prof. Fabry's work very helpful, and a good model in point of style. M.

LETTERS TO THE EDITOR.

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

Arthur's Round Table in Glamorgan.

THE history of the Gorsedd of the Bards is closely bound up with the history of Glamorgan. Early in the history of the winning of the district by the Anglo-Normans, one of the earls of Gloucester, as lord of Glamorgan, took the institution under his protection and patronage, and it became known as Gorsedd Tir Iarll, "Gorsedd of the Earl's Land," and the district, comprising the parishes of Llangynwyd, Bettws, and Margam, is still called after the title of the noble patron of the bards. From about the middle of the twelfth century, the history of the institution, as well as the succession of presiding bards, is as clear as one might expect to find the history of a largely secret society to be. What history is recorded in bardic writings of the institution before that date represents it as Arthur's Round Table, moved from place to place with the seat of government, from Caerleon-upon-Usk to Loughor, back to Cardiff, its wanderings having been confined within the boundaries of the diocese of Llandaff, until finally it found a resting-place in the Earl's Land. There is little reason to doubt the substantial truth of such records, and it is something to note that Arthur's Round Table, by name, has been all along regarded as the living institution known as Gorsedd of the Bards of the Isle of Britain.

The Maesteg Circle-avenue and its Builders.

There are bards still living who were received as members of the Gorsedd by bards who represented an unbroken tradition and succession in the Earl's Land at least from the twelfth century. One of these bards, "Morien," known also as "Gwyddon Tir Iarll," was present at the "re-awakening," in bardic parlance, of Arthur's Round Table on June 22, 1910, when a temple-observatory, which I had the honour of erecting at Maesteg, in the parish of Llangynwyd, the centre of the Earl's Land, was duly opened by the Archdruid of Wales, assisted by officers and members of the National Gorsedd, and other bards and friends of the bardic cause.

In designing the work, I endeavoured to combine the essential requirements of bardic tradition with all the ascertained principles of primitive architecture as shown in monuments of which the bardic Gorsedd is a representative. Every detail was based either on tradition or

actual practice as observed in monuments. As at Avebury and Stonehenge, the avenue was added to the circle. Each stone selected has a fairly straight side, which has been utilised as an independent alignment. The avenue, as well as the tallest stone, are approximately oriented to the sun's place on St. David's Day, March 1. Three divisions of the year, and alignments to sunrise or sunset for every three weeks, are provided by the stones. The use of each stone will be found by keeping its straight side to the right. The diameter of the circle is 27 feet; the length of the avenue 54 feet; the total length of the work is 81 feet. In all such measurements, the Gorsedd rule that all extensions should be in threes, or multiples of three, was observed. The width of the avenue represents the distance, as measured on the horizon and viewed from the centre stone, between Candlemas and the equinox. True to ancient practice, the westward view of the avenue is "blocked" by a stone, which otherwise represents the fashion in Aberdeenshire circles, noticed by Sir Norman Lockyer, of placing a stone at right angles to the direction required.

JOHN GRIFFITH.

Llangynwyd, Glam.

Halley's Comet.

I DO not know if the enclosed is of any general interest or not; it is an attempt to photograph Halley's comet (as seen here) without any special apparatus. The tail was about 90° long on May 17, and probably 115° on May 18,

Halley's Comet in Pisces as seen at 5.30 a.m. on May 17 with 15′ exposure.

taking the calculated position of the nucleus, which had not risen when dawn came. On May 20 (on the other side) the tail was only 15° or 20° long, but both twilight and moon interfered. It was 35° long on May 23.

JAMES MOIR.

Mines Department, Johannesburg, June 10.

Earth-current Observations in Stockholm during the Transit of Halley's Comet on May 19.

WHEN Halley's comet was passing across the sun on May 19 we took, at the central telegraph station at Stockholm, some observations of earth-currents, which were measured on two lines, Stockholm-Göteborg and Sundsvall-Stockholm. The measurements were performed from minute to minute from 0h. 40m. to 3h. 45m. a.m. (mid-European time). The geographical coordinates for the three places mentioned are the following:—

Sundsvall ...	$\phi = 62^\circ\ 23'$ N.	... $\lambda = 17^\circ\ 19'$ E. from Greenwich
Stockholm ..	59 21	... 18 3
Göteborg ...	57 42	... 11 58

The resistance of the line Stockholm-Göteborg was 2940 ohms, and that of the line Sundsvall-Stockholm 2336 ohms. From the current-strengths measured in milliamperes we obtain the potential differences expressed in millivolts per km. by multiplication with r/l, r indicating the ohm-resistance of the line and l the distance in km. from end to end. For calculating the components of the potential difference E.-W. (V) and N.-S. (V′) we have the formulæ

$$V = 7{\cdot}73i - 3{\cdot}32i'$$
$$V' = 0{\cdot}871i + 6{\cdot}60i',$$

i and i' indicating the observed current-strengths on the Stockholm-Göteborg and the Sundsvall-Stockholm lines. The measured current-strengths proved considerably above the normal at this time of day, though by no means reaching to that of a magnetic storm. The two components, expressed in millivolts per km. (every fifteenth minute), are as follows. The potential differences are considered positive in the directions E.-W. and N.-S.:—

h. m.	V	V′	h. m.	V	V′
0 45 ...	−55·6 ...	− 6·3 ...	2 15 ...	−16·5 ...	+24·6
1 0 ...	− 6 8 ...	+ 2·0 ...	0 30 ...	−23·5 ...	+12·7
0 15 ...	+ 3 9 ...	+ 0·4 ...	0 45 ...	−25·5 ...	+16·7
0 30 ...	− 3·4 ...	− 9·5 ...	3 0 ...	− 7·2 ...	+ 1·3
0 45 ...	− 6·2 ...	+ 4·2 ...	0 16 ...	− 0·4 ...	− 5·6
2 0 ...	− 8·0 ...	+15·8 ...	0 30 ...	− 8·8 ...	−10·2
			0 45 ...	−16·9 ...	+ 2·9

The greatest disturbances occurred shortly before and after 2h. a.m.: V max. = +68·1, V′ max. = +56·6 millivolts per km.

D. STENQUIST.
E. PETRI.

Leptocephalus hyoprororoides and L. thorianus.

IN my paper "On the Occurrence of Leptocephali (Larval Muræoids) in the Atlantic West of Europe" (*Meddelelser fra Kommissionen for Havundersøgelser*, Serie Fiskeri, Bind iii., No. 6, 1909, p. 12, Pl. i., Fig. 8, Pl. ii., Figs. 1–7), I have described and figured a hitherto unknown Leptocephalus species under the name of *Leptocephalus hyoprororoides*, n.sp. It had escaped my attention, however, that this name had already been employed by P. Strömman in "Leptocephalids in the University Zoological Museum at Upsala," Upsala, 1896, p. 39, Pl. iv., Figs. 5–6, for another form similar in habit, but differing quite definitely in several characters, *e.g.* the pigmentation and position of the anus, from the form described by me. I would therefore propose that the name of the latter should be changed to *Leptocephalus thorianus*, n.sp. (after the Danish research steamer *Thor*, on the cruises of which the species in question was discovered).

JOHS. SCHMIDT.

Static Charge in Bicycle Frame

WHILE riding a bicycle recently I was overtaken by a thunderstorm, and took shelter beneath a convenient tree after propping the machine against a wall. When the rain had ceased, in the course of about fifteen minutes, I re-mounted, with my hands upon the handles in the usual manner. The handles are of composition, resembling vulcanite or a similar non-conducting material, the pedals are shod with rubber, and the leather saddle completes the insulation of the rider from the frame. Upon exchanging my grip of one of the handles for the bar, I felt the effects of a static charge which was sufficiently startling to endanger equilibrium for the moment. I do not suggest that the pneumatic tyre, which successfully insulates a vehicle from the earth, adds a new terror to locomotion, for even a timid rider in traffic would hardly be endangered, but it would be interesting to know if this phenomenon has been observed before, either on cycles or motor-cars.

ROBERT S. BALL, JUN.

189 Gleneldon Road, Streatham, London, S.W.,
July 2.

MARINE BIOLOGICAL PHOTOGRAPHY.

THOUGH year by year photography plays a greater part in the illustration of works on natural history, marine biology does not appear to have received its full share of attention from the scientific photographer.

It can be claimed for photography that it is an accurate and rapid method of making marine biological records. The rapidity admits of the recording of delicate structures during life, thus avoiding the opacity and distortion that so soon follow death; but the main advantage lies in the fact that by means of photography the number of workers making records can be greatly increased. Expert biologists who have the time to make drawings of minute structures are distinctly limited in number, whereas the photographer with but a general biological knowledge is able to make accurate and useful records of structures, possibly quite new to him, and many points of which he might miss were he to draw them.

FIG 1.—Young Thornback Ray.

In order to derive the full advantages offered by photography, the worker must be prepared, in addition to illustrating minute structures, to deal with the habits, movements, characteristic postures, and general external appearance of any particular marine animal. Such records should preferably be made in natural environments, but, failing this, in special tanks.

Prof. Reighard, in his contribution "Photography of Aquatic Animals in their Natural Environments," describes very fully subaquatic photography and photography with the camera above water. Subaquatic photography, however, has a very limited application, mainly in consequence of the want of light, and for obtaining details of external structure is not nearly so satisfactory as photography in special tanks.

With the camera above water the main difficulty to be overcome is due to the photograph having to be taken through two media, air and water, for the light reflected from the surface of the water, being greater than that reflected from the object to be photographed, the desired image is obscured in the general fogging of the photographic plate. When photographing a submerged object with the camera directed at an angle to the surface of the water, this reflection from the water can be avoided by holding a screen at a suitable angle immediately above the object.

When taking a photograph directly above the object, the light must be cut off above the camera. The illustration of a young thornback ray was taken in 8 inches of water, with a golf umbrella held over the head of the operator.

For tank work the most useful arrangement is a tank about 3 feet long, 2 feet high, and 6 to 8 inches from front to back, the bottom and sides being of wood, the front and back of ¼-inch plate-glass. Inlet and outlet pipes pierce the sides, and there must be arrangements for a constant supply of salt or fresh water which can be sent through the tank at will. The specimen placed in the tank usually sulks at the bottom; if, after a time, the water is suddenly turned on, the fish or other creature heads up to the stream, and a snapshot can be taken in a natural position. For the above work it is desirable to use a reflex camera with a rapid lens of not less than 8-inch focal length.

For the photography of comparatively small and microscopic marine objects a special apparatus is necessary. I use a portable apparatus with which it is possible to take a photograph of a specimen in a horizontal or vertical position, by transmitted or reflected light, and by means of a mirror to see the object up to the last moment before exposure, so as to ensure a living specimen being photographed in a suitable position. There is also a fixed stage upon which a specimen can be placed in a tank or cell, and a photograph taken of any desired magnification without moving the specimen.

When photographing from life-size up to 25 magnifications I use lenses of 6-inch, 3½-inch, and 35-mm. focal lengths, on a camera having an extension of 36 inches without a microscope. For higher magnifications I drop a microscope into the apparatus, and get any desired magnification up to 2600 with a 1/12-inch oil immersion.

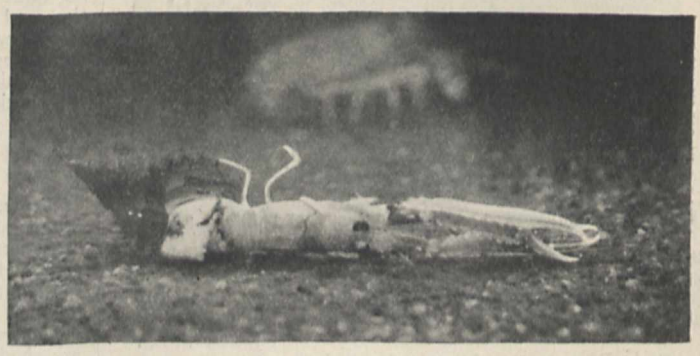


FIG. 2.—Whelk feeding on Crayfish.

The exceptional length of bellows extension is necessary in order to obtain a high degree of magnification from a lens of comparatively long focus, thus ensuring all parts of the specimen being in focus at the same time.

The advantages of such an apparatus at a biological station or on a research boat are obvious, for specimens taken from the trawl or tow-net can be placed in suitable tanks or cells by the biologist, and

FIG. 3.—Pecten turning over.

photographed, living, anæsthetised, or dead, by an assistant. Any number of useful records could thus be made from fresh specimens of any particular catch. For photographic purposes it is desirable to obtain perfect living specimens; but the photography of numerous imperfect specimens is also very valuable, for at any time a perfect drawing can be made from the material so collected.

As an additional use, this apparatus can with advantage be employed when counting specimens in the analysis of a plankton catch, for the area under the field of the microscope can be thrown on to a sheet of paper and the specimens ticked off.

When working with artificial light, the illuminant should be of sufficient power to ensure against the want of light being a hindering factor. I use a very useful little arc lamp made by Messrs. Leitz, when electric power is available; failing this, an oxyhydrogen light, though good results can be obtained with an acetylene lamp. When using arc or lime-light it is necessary to have a cooling tank between the light and the specimen.

With either arc or limelight, working with a Zeiss microplanar lens at F. 4·5 on a medium rapid plate, a full exposure can be obtained in one-tenth of a second up to twenty-five magnifications.

Reference has been made already to photographs taken in natural environments. As an illustration of the recording of the habits of marine animals is shown the photograph of the common dog-whelk (Buccinum) holding with its foot the abdomen of a dead crayfish. On removing the crayfish it was found that the whelk had partially sawn through the shell by means of its radula.

A characteristic movement is shown in the photograph of a pecten turning itself over.

Recently I had the opportunity of taking numerous pecten photographs under the direction of Mr. W. J. Dakin, and by his kind permission I am able to show an instantaneous photograph of this mollusc, in the act of turning itself over, after having been placed on the left valve. The other photographs taken showed the gradual opening of the pecten, until the valves were separated as much again as in the photo-

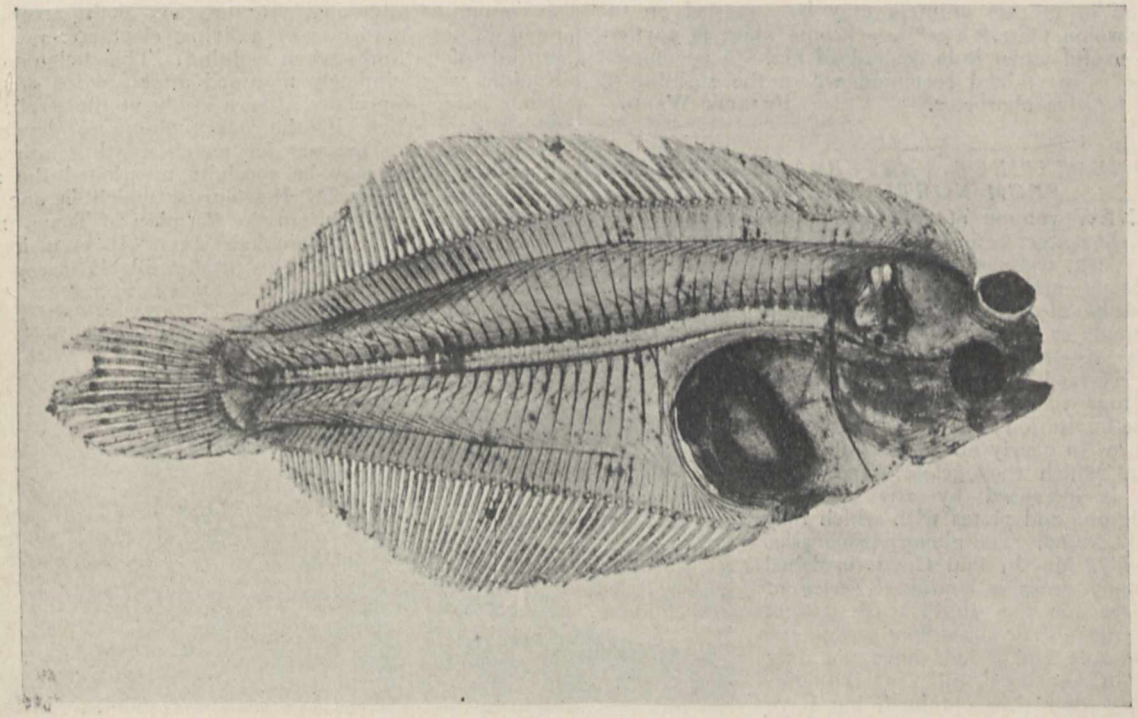


FIG. 4.—Plaice Larva.

graph shown. The present illustration shows the sudden act of closure, by which the turning movement is brought about, almost completed.

Of photographs taken with the special apparatus described, two illustrations are given; the first that of a plaice larva 13 mm. in length, and magnified

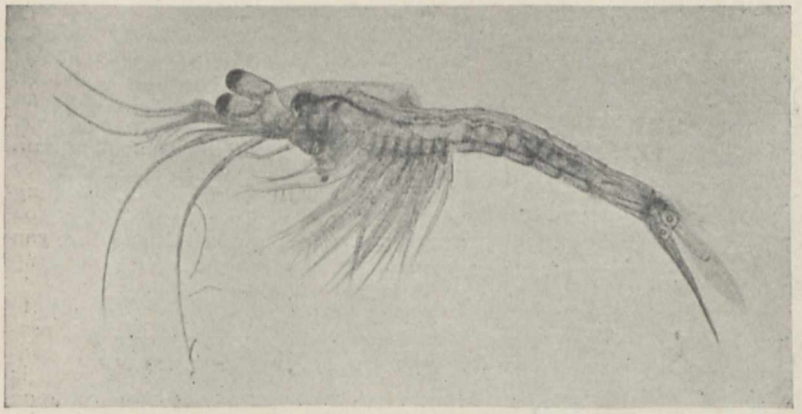


FIG. 5.—A Mysidacea.

five times; the second that of a crustacean, one of the Mysidacea, 2 mm. in length, magnified fifteen times. This photograph shows very distinctly the two statocysts on the uropods or appendages of the sixth abdominal segment, and gives a good general view of the animal.

Higher magnifications of any particular part are obtained as described by slipping the microscope into the apparatus.

In addition to the above methods, the natural colours of marine animals may be recorded on the autochrome plate. The autochrome plate is particularly useful when it is desired to make a permanent record of a stained specimen where the staining is of a fugitive character. FRANCIS WARD.

SOME EXTINCT VERTEBRATE ANIMALS FROM NORTH AMERICA.[1]

A NEW volume of collected papers, published by the American Museum of Natural History, New York, enables us to realise how important and numerous are the additions to our knowledge of extinct vertebrate animals still made by systematic explorations in North America. The contributions now received deal with the work of only four years, 1904–8, accomplished by one institution; but they make great advances in nearly all parts of the subject to which they relate, and their value is increased by the excellent text-figures and plates with which they are illustrated. The pioneer discoveries of Leidy, Marsh, and Cope furnished for many years a continual series of surprises for the student of extinct vertebrates; their successors during the past decade and a half have not only filled in many details in the preliminary view thus obtained, but have also been scarcely less successful in recovering unexpected groups and missing links. Present explorers have, indeed, the advantage of being able to pursue their work in the remote west in peaceful leisure, without any armed escort, and so have facilities for determining the relative positions of the strata from which they excavate the various fossils. In the early days, with hurried traverses, there was a tendency to decide the relative ages of the fossils solely by their own peculiar features, without any exact observations in the field. The result was sometimes an argument in a vicious circle. As shown by the volume now before us, that is all changed. We find detailed descriptions of specimens from the Permian of Texas, the Upper Cretaceous of Montana, the Eocene of Wyoming, and the Miocene of South Dakota. Accompanying them are well-illustrated exact accounts of all these formations and localities, determining the relative ages of the genera and species which were obtained from them.

The scientific work of the palæontologists in the American Museum is of two kinds. Part is devoted to the reconstruction and mounting of skeletons of general interest; part is concerned with the most detailed and special research, for which it often happens that not more than mere fragments are available. The publications record the results in both directions, and thus provide ample material, not only for the specialist, but for anyone interested in the broader features of natural history. It must also be added that the reconstructed skeletons are prepared with the greatest scientific care. The fine example of the Columbian mammoth now described, for example, was mounted after an elaborate study of the arrangement of the footprints of a living elephant and the attitude of its limbs when walking. The skeletons of Equidæ were similarly mounted after studies of the living horse—especially after a study of the Arab, to which one article in the new volume is devoted. Among startling mounts for which existing animals give little help may be specially mentioned the reconstructed skeleton of Naosaurus, which is one of the primitive reptiles from the Permian of Texas not hitherto found in a complete state. It is a long-bodied, squat reptile, with a formidable array of sabre-like teeth, and a high, thorny frill along the back, which is supported by the much-elongated neural spines of the vertebræ (Fig. 1). Prof. Osborn, who describes this specimen, is careful to explain exactly on what material the various parts of the recon-

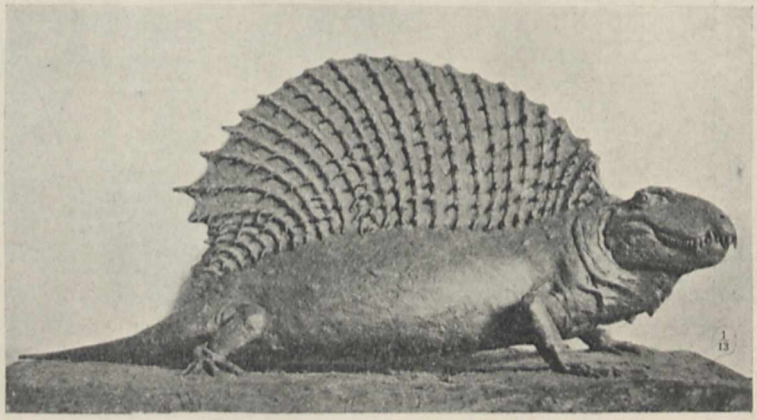


FIG. 1.—Model of *Naosaurus claviger*, by Mr. C. R. Knight.

[1] "Fossil Vertebrates in the American Museum of Natural History." Department of Vertebrate Palæontology. Vol. iii., Articles collected from the American Museum Bulletin for the years 1904–8, by H. Fairfield Osborn, &c. (New York, 1909.)

struction are based, so that each may judge of the extent to which it is trustworthy.

Perhaps the most interesting real novelty is a small skeleton from the Middle Eocene of Wyoming, determined by Prof. Osborn to belong to a primitive armadillo. Fragments of this animal were obtained some years ago by Dr. J. L. Wortman, and ascribed by him to a Lemuroid under the name of Metacheiromys. Four good specimens now seem to show that it is truly an armadillo, differing chiefly from the typical existing armadillos in "the probable presence of a leathery instead of a bony shield, of an enamel covering on the single large caniniform teeth in the upper and lower jaws and the degeneration of other teeth." This discovery confirms the suppositions of Marsh, Wortman, and Schlosser as to the existence of Edentata in North America in the Eocene period;

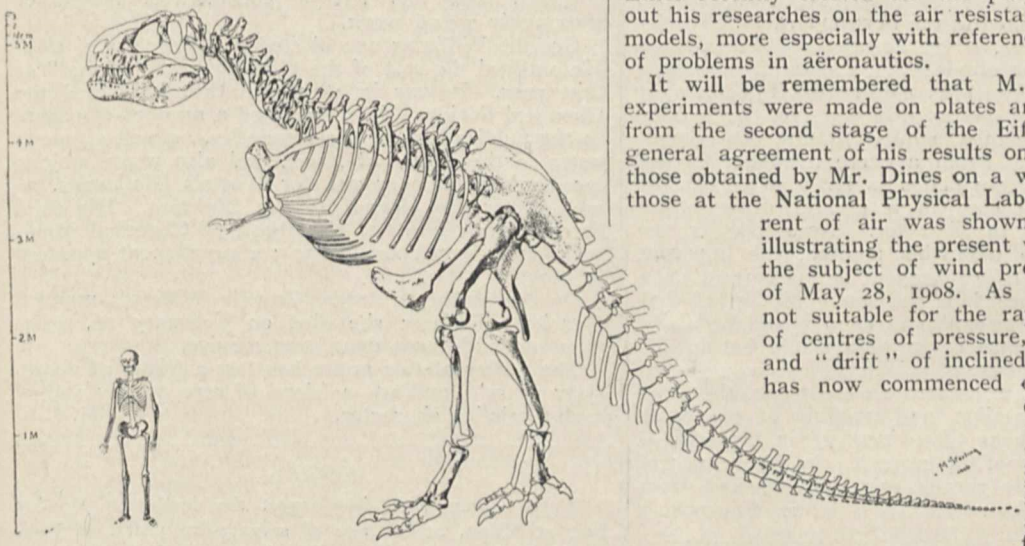


FIG. 2.—Restoration of *Tyrannosaurus rex*. From the type skeleton, American Museum of Natural History.

and it adds to the difficulties of understanding the early Tertiary mammal faunas of South America.

Another astonishing discovery is that of a colossal carnivorous Dinosaur, Tyrannosaurus (Fig. 2), from the Upper Cretaceous (Laramie formation) of Wyoming and Montana. It has hitherto been supposed that the flesh-eaters were all much smaller than the largest vegetable-feeders among Dinosaurs; but here is a reptile like Megalosaurus, with a skull from 4 to 5 feet in length, and when standing on its heavy hindquarters reaching a height of from 16 to 17 feet. Another new herbivorous Dinosaur, Ankylosaurus, from the same geological formation, measures 14 feet in length, and is armoured like the South American Glyptodons.

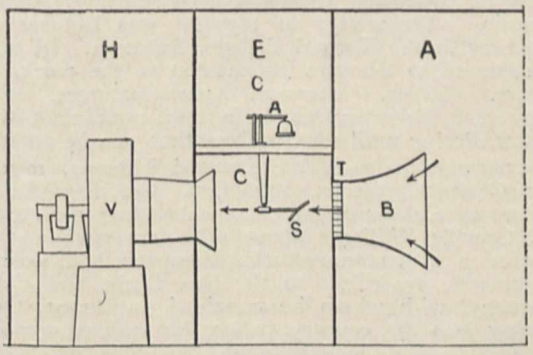
The technical papers on remains of horses and rhinoceroses, by Prof. Osborn and others, and on camels and deer, by Dr. Matthew, are of extreme scientific value. The discussion of the extinct horses is especially exhaustive, and the result is that it becomes impossible at present to recognise any exact genetic series. Mr. Gidley even remarks that "there is a considerable phyletic hiatus between the groups of the Equidæ, which are as yet not bridged over by intermediate forms"; and he adds that this hiatus is particularly marked between the Anchitherium-group and the Protohippus-group, which "greatly overlap each other in time." Dr. Matthew's explanation of most of our difficulties in understanding the evolution of the European and North American Tertiary mammalia is that northern Asia was their actual place of origin. He thinks that "in Europe, on one side of this centre, in America, on the other side, we have parallel series of approximate phylogenies; sometimes closer in the one country, sometimes in the other." Until the early Tertiary mammalia of northern Asia are discovered, we cannot advance much further towards real origins.

Prof. Osborn and his associates are indeed to be congratulated on the wide import of the work they have done, and the excellent manner in which it is published. We would commend it to the notice of all students of biology. A. S. W.

EXPERIMENTS ON AIR RESISTANCE.

IN *La Nature* (February 26) there is a description by M. Fournier of the new laboratory which M. Eiffel recently erected for the purpose of carrying out his researches on the air resistance of plates and models, more especially with reference to the solution of problems in aëronautics.

It will be remembered that M. Eiffel's earlier experiments were made on plates and models let fall from the second stage of the Eiffel Tower. The general agreement of his results on flat plates with those obtained by Mr. Dines on a whirling table and those at the National Physical Laboratory in a current of air was shown in the curves illustrating the present writer's article on the subject of wind pressure in NATURE of May 28, 1908. As this method was not suitable for the rapid determination of centres of pressure, and the "lift" and "drift" of inclined plates, M. Eiffel has now commenced experiments in a current of air, and the manner in which this current is maintained presents some novel and interesting features. Hitherto, experiments by this method have been carried out by suspending the models in a long channel with parallel sides through which air was drawn by means of a fan. This arrangement is open to two objections—(1) the difficulty of maintaining the velocity of the current uniform across the channel, and (2) the limited size of the models which could be used without an appreciable effect on the resistance due to the walls of the channel. The first difficulty is overcome by introducing resistances to the flow where necessary, which is a long and tedious process, and the second by limiting the size of the models to within two or three per cent. of the area of the channel. The novelty of M. Eiffel's method consists in his using a comparatively short channel, and in suspending his models in a closed



chamber which constitutes an enlargement of the channel.

The general arrangements will be clear from the diagrammatic sketch in the figure. C is the observation chamber, which is air-tight, and provided with a platform for carrying the observer and the necessary measuring appliances. B is the bell-mouthed air inlet, which is provided with a series of guide plates of honeycomb section on the delivery side to ensure that the air enters the chamber in parallel filaments. V is the outlet and suction fan. S is the model under test, connected to the weighing beam at A.

The advantages of this method as regards simplicity, comparative cheapness of construction, and convenience in making the observations are obvious, and in respect of its accuracy it is claimed that, using the results of M. Eiffel's earlier experiments on falling plates as data, a complete check has been afforded by the results obtained in the new apparatus. It may be doubted, however, if the accuracy of this method is so great as that obtained in a carefully designed parallel channel, for there can hardly fail to be a disturbance of the stream lines due to the sudden enlargement at the inlet similar to that observed in the flow of water. From a curve published in the article, it appears that plates as large as 90 cm. by 15 cm. have been used in a current drawn from an inlet 150 cm. in diameter. According to the writer's experience with this method, the apparent pressure for normal impingement of the current on a plate the area of which is the same fraction of that of the inlet as in the examples cited would be about 10 per cent. in excess of its true value, but in the case of small inclinations, which is, of course, relatively more important in aëronautical work, the error would be much smaller, and possibly of the same order of magnitude as those incurred in the estimations of the velocity of the current. In this branch of aëronautics valuable results may be expected from M. Eiffel's researches. T. E. STANTON.

C. H. GREVILLE WILLIAMS, F.R.S.

CHARLES HANSON GREVILLE WILLIAMS was born at Cheltenham, September 22, 1829, the son of S. Hanson Williams, a solicitor; his death occurred on June 15, 1910. He commenced his professional career as first assistant to Prof. Anderson, of Glasgow University; after some years spent in research work he moved to Edinburgh, where he conducted a tutorial class under Dr. Lyon Playfair. From 1857 to 1859 he was lecturer on chemistry in the Normal College, Swansea. In 1859 he returned to Glasgow as chemist to the works of Messrs. Miller, chemical manufacturers. He migrated to Greenford Green in 1863, remaining with Messrs. Perkin until 1868. About that year he entered into partnership with M. Édouard Thomas, at the Star Chemical Works, Brentford, the firm being makers of coal-tar colours, and subsisting until 1877. Mr. Greville Williams about this time gave up his connection with manufacturing chemistry and became photometric supervisor to the Gas Light and Coke Company, with whom he remained until 1901, then retiring into the country, where he seldom saw his old friends and acquaintances, but was much interested in the study of the ancient Egyptian language and the translation of inscriptions. Until rheumatism disabled him he was an expert draughtsman and calligraphist, a fair game shot, and an enthusiastic angler. Although in reality a charming companion, with unusual conversational powers, and a keen appreciation of literary and artistic culture, Greville Williams possessed a very modest and retiring disposition, and became, especially of late years, an almost complete recluse. He was more nervous about his state of health than he need have been, and, in consequence, cut himself off unnecessarily from scientific and social intercourse. This isolation was also due, no doubt, in part to his straitened circumstances, which necessitated strict economy and debarred him from the continuance of his scientific researches—hard lines for a thorough enthusiast; and such he was, possessed, moreover, with the true chemical instinct and a general scientific aptitude. It is a pity that the genius for investigation which was shown in his researches on isoprene, on beryl, and on the bases from bituminous shale, from the Boghead mineral, and from the destructive distillation of cinchonine, did not develop in accordance with more modern methods in his later years. But he made many interesting discoveries, and has left a considerable record of thoroughly sound work.

Greville Williams was elected F.R.S. in June, 1862. He outlived the rest of the distinguished "fifteen" of that year. It was in 1862 also that he joined the Chemical Society. He contributed a number of papers to the publications of these societies, as well as many notes to the *Chemical News*, and also wrote articles for Ure's Dictionary and for Watts's Dictionary, as well as for the *Journal of Gas Lighting*. His chief literary work was "A Handbook of Chemical Manipulation" (Van Voorst, 1857); a supplement appeared in 1879.

On November 25, 1852, Greville Williams married Henrietta Bosher; she died on February 16, 1904. One son and three daughters survive.

The writer of this notice has lost a friend of nearly sixty years' standing—a friend of rare quality and of high Christian character. A. H. C.

NOTES.

WE announce with deep regret the death, on Monday last at Milan, at the age of seventy-five years, of Prof. G. V. Schiaparelli, Foreign Member of the Royal Society.

THE death (on June 12) is announced of Dr. W. H. Seaman, professor of chemistry in Harvard University, at the age of seventy-three years.

WE regret to announce the death, on July 4, of Mr. R. Russell, I.S.O., who was for thirty-six years connected with the administration of education in Natal. In 1877 he became Superintendent of Education, and retired in 1903.

AT the general monthly meeting of the members of the Royal Institution, held on Monday last, it was announced that the King has consented to become Patron of the institution.

THE Janssen prize of the Paris Academy of Sciences has been awarded to Prof. W. W. Campbell, director of the Lick Observatory, University of California.

SIR J. J. THOMSON, F.R.S., has been elected president of the Junior Institution of Engineers, in succession to Sir H. J. Oram, K.C.B.

DR. F. A. BATHER, F.R.S., has been appointed by the trustees to represent the British Museum (Natural History) at the forthcoming International Geological Congress in Stockholm.

THE Cullen Victoria Jubilee prize has been awarded by the Royal College of Physicians of Edinburgh to Dr. R. W. Philip, for his work on tuberculosis. The prize is awarded once in every four years for the "most important contribution to practical medicine."

THE Journal of the American Medical Association states that a bronze relief portrait of Prof. W. Osler, F.R.S., has been placed in Osler Hall of the Medical and Chirurgical Faculty, Baltimore. It is an enlargement of the small one now in the Johns Hopkins Medical Library.

MR. C. O. WATERHOUSE, I.S.O., who for the period of forty-four years was in the service of the trustees of the British Museum, has just retired from the position of assistant-keeper in charge of the insect section of the Zoological Department of the Natural History Museum. To mark the occasion of his retirement, he was last week presented by many colleagues and friends with an illuminated address, a Sheraton bureau-bookcase, a gold watch, and an aneroid barometer.

PROF. ANGELO MOSSO asks us to announce that the Monte Rosa laboratories, which are equipped with all necessary scientific instruments, will re-open on July 15, and that the Royal Society has at its disposal nominations for two workers in botany, bacteriology, zoology, physiology, terrestrial physics or meteorology.

THE banquet to the five past-presidents of the Chemical Society (Prof. W. Odling, F.R.S., Sir Henry E. Roscoe, F.R.S., Sir William Crookes, F.R.S., Dr. Hugo Müller, F.R.S., and Dr. A. G. Vernon Harcourt, F.R.S.) who have attained their jubilee as fellows of the society is to take place at the Savoy Hotel on Friday, November 11 next. Applications for tickets must be made to the assistant secretary of the society by, at latest, November 4. It will be remembered that the banquet was postponed from May 26 in consequence of the death of the King.

A REUTER message from Catania states that a strong shock of earthquake was felt on Sunday morning in Sicily, at Giarre, Linguaglossa, and Zafferana. A slight shock was experienced at Mimeo.

THE twenty-first annual conference of the Museums Association was opened on Tuesday at York, when the president, Dr. Tempest Anderson, delivered an address on "Volcanoes and their Museum Treatment," and papers were read by Dr. F. A. Bather, F.R.S., Dr. Scharff, Dr. E. L. Gill, and Mr. L. E. Hope on, respectively, "Palæontology Exhibits at the Japan-British Exhibition," "Cleaning Bones by a Dry Sand Process," "A Method of Exhibiting Corals," "A Simple Way of Exhibiting the Reverse of Coins and Medals," and "The Natural History Records Bureau at the Carlisle Museum."

AN exhibition of Hygiene was opened at Buenos Aires on July 3. The British section is reported to be small. It is divided into twenty-nine sub-sections, and contains specimens of surgical instruments, orthopædic appliances, and drugs. The French section is incomplete. Italy exhibits numerous health foods. Chile furnishes exhaustive bacteriological laboratories, mainly for veterinary research. The Argentine Asistencia Publica displays first-aid and life-saving appliances, preventives, &c. The promised agricultural and railway exhibitions are expected to be opened this week.

THE fifth meeting of the International Congress of Mathematicians will take place at Cambridge in 1912. In connection with one of the sections of the congress, an International Commission on Mathematical Teaching has been constituted, which includes delegates appointed by the various Governments interested in the congress, and a series of national sub-commissions has been established to assist the International Commission. The President of the Board of Education has appointed Sir George Greenhill, F.R.S., Prof. W. W. Hobson, F.R.S., and Mr. C. Godfrey to be the British delegates, and he has further appointed an advisory committee to assist the commission in the collection of reports and papers on the teaching of mathematics, and this committee, which is to act also as the British sub-commission, has been constituted as follows:—Mr. C. E. Ashford, Sir G. H. Darwin, F.R.S., Mr. C. Godfrey, Sir George Greenhill, F.R.S., Mr. G. H. Hardy, F.R.S., Prof. W. W. Hobson, F.R.S., Mr. C. S. Jackson, Sir Joseph Larmor, F.R.S., Prof. A. E. H. Love, F.R.S., and Prof. G. A. Gibson. Mr. C. S. Jackson is honorary secretary to the sub-commission.

THE programme of the joint summer meeting of the Institution of Mechanical Engineers and the American Society of Mechanical Engineers is now available. As has already been announced, the meeting will take place in Birmingham and London on July 26 to 30. The following papers are to be read and discussed:—In Birmingham: English running-shed practice, by Mr. C. W. Paget; engine-house practice, or the handling of locomotives at terminals to secure continuous operation, by Mr. F. H. Clark; handling locomotives at terminals, by Mr. F. M. Whyte; handling locomotives, by Mr. H. H. Vaughan; American locomotive terminals, by Mr. W. Forsyth; high-speed tools, and machines to fit them, by Mr. H. I. Brackenbury; tooth-gearing, by Mr. J. D. Steven; interchangeable involute gearing, a joint paper by Members of the Committee of the A.S.M.E. on standards for involute gears. In London: electrification of suburban railways, by Mr. F. W. Carter; cost of electrically-propelled suburban trains, by Mr. H. M. Hobart; economics of railway electrification, by Mr. W. B. Potter; electrification of trunk lines, by Mr. L. R. Pomeroy; electrication of railways, by Mr. G. Westinghouse.

IN connection with the summer meeting of the Association of Technical Institutions, the Mayor and Mayoress of Salford are to give a garden-party in Peel Park, Salford, and hold a reception in the Royal Museum and Art Galleries on Thursday, July 14.

THE sixty-ninth annual meeting of the Medico-psychological Association of Great Britain and Ireland will be held at the Royal College of Physicians, Edinburgh, on July 21 and 22, under the presidency of Dr. John Macpherson. Dr. C. H. Bond, 11 Chandos Street, Cavendish Square, W., is the honorary general secretary.

AN International Congress of Forensic Medicine will be held at Brussels on August 4 to 10. The programme will include psychological medicine, bacteriology, toxicology, and legislation in relation to legal medicine. Governments, academies of medicine, universities, and associations of chemists and toxicologists have been invited to send delegates. There will be an exhibition of apparatus and medical instruments in connection with the congress. The general secretary is Dr. C. Moreau, rue de la Gendarmerie, 6, Charleroi.

ACCORDING to the Journal of the Royal Society of Arts, the second International Congress on Industrial Diseases is to be held in Brussels on September 10 to 14 next. Among the questions to be discussed are:—Can industrial diseases be distinguished from accidents? What should be their distinctive characteristics? What medical equipment is provided in mines, factories, workshops, &c.? the present state of the problem of ankylostomiasis; the eye and eyesight in connection with industrial diseases; work in compressed air.

THE tenth International Geographical Congress is to be held in Rome on October 15 to 22, 1911. The congress will be divided into eight sections, and communications may be made in Italian, French, German, or English. Abstracts of papers proposed for presentation to the meeting must be sent in not later than April 30, 1911, and reports on subjects brought before previous congresses or suggested by the executive subcommittee must be received not later than August 31, 1911. The president of the congress is the Marquis Raffaele Cappelli, president of the Italian Geographical Society.

ACCORDING to *Science*, plans for the extension of the American Museum of Natural History are being prepared by the trustees. The present building, erected between 1874 and 1908, includes eight units, and the plans now in preparation contemplate an additional six units, completing the central hall, the east and west transepts, the east entrance pavilion, and the south-east façade.

A SOCIETY called the Christopher S. Ledentzoff Society for the Development of Experimental Sciences and their Practical Applications has been formed in connection with the Moscow Imperial Technical School, the objects of which are to assist discoveries and experiments in connection with natural science; to develop technical inventions and improvements; to investigate and apply to practical use any scientific or technical discovery or improvement. The society expresses the hope that its aims will attract the notice of all similar institutions and persons working in scientific and technical spheres, and appeals for assistance to all such institutions and persons for any support which might be given by (*a*) interchange of correspondence; (*b*) a supply of lists of privileges and patents, and reports on scientific and technical subjects. Further particulars as to the aims of the society may be obtained from the secretary, care of the Imperial Technical School, Moscow.

A GEOGRAPHICAL society, called the Servian Geographical Society, has been established at Belgrade. Its first president is Prof. J. Cvijic. The society proposes to begin the publication of a quarterly journal in January next.

THE Institute of Chemistry of Great Britain and Ireland gives notice of the following examinations:—in biological chemistry, bacteriology, fermentation and enzyme action, with special reference to the chemistry and bacteriology of food-stuffs, water-supply and sewage disposal, and the application of biological chemistry to industries and manufactures, beginning on Monday, October 17 next; in chemical technology in October next, the exact date to be announced later.

SPEAKING in the House of Commons on Wednesday of last week on the Colonial Office Vote, Colonel Seely, the Under-Secretary for the Colonies, referred to the subject of sleeping sickness, and the work that has been done or is in progress in combating it. Coincident with the coming of the white man there had been, he said, a spread of various diseases. The spread of sleeping sickness alone had been most remarkable and disastrous. How many persons had died they did not know, but that hundreds of thousands had died they did know. Tremendous efforts had been made by many countries, and he thought we might claim especially by this country, to remove this great scourge. Sir David Bruce went, with his wife, into the heart of the plague-stricken country, and spent many months there investigating this great scourge of sleeping sickness. Almost every person in the place where he lived was suffering in some degree from this sickness, and when he told the House that, out of the hundreds of thousands of cases, they did not know of a single case of recovery, he thought they would realise to how great an extent those who tried to deal with the disease took their lives in their hands when they went out to these countries. He had mentioned Sir David Bruce, but there were many others. Some had already died in this great cause, and their names were, alas! already forgotten. But when the history of brave deeds came to be written, the deeds of those men who had gone into the heart of Africa to try to combat this insidious and most fatal of all diseases would not be forgotten, and would perhaps be considered as giving more striking proof of the ability of men to overcome natural fear than almost anything else in the annals of mankind. We now knew that these diseases were caused by flies, but the difficulty of finding a remedy was immense. It was thought that the removal of the natives from the infested areas might prove a remedy. Sleeping sickness was caused by the tsetse-fly, and it was thought that if the population could be removed from the shores of the lakes where alone that fly could live, they would be cured. Unfortunately, that had not proved to be entirely the case. But still we did know a great deal more than we did before about the origin and cause of sleeping sickness, and we had checked the mortality to a most remarkable degree.

DR. W. L. DUCKWORTH and Mr. W. J. Pocock contribute to vol. xiv. of the Cambridge Antiquarian Society's Proceedings for the current year a paper on a collection of human bones found in the course of excavations on the site of an Augustinian Friary near the Corn Market, Cambridge. Among these appear specimens of a tall, broad-headed race which may be assigned to the British Bronze-age type, to early Danish immigrants of the Borreby class, or to later arrivals from a southerly region, perhaps Normandy or Burgundy, these last being foreign ecclesiastics who founded the Cambridge Friary. After full discussion of the question, Dr. Duckworth favours the last explanation. An excavation at Durham supplies similar relics of foreign bishops, and the proportion of these broad-headed men is too great to be provided by the local mediæval population, which, though it doubtless contained individuals of the Bronze-age type, was yet, on the whole, characterised by a very large majority of individuals with distinctly narrow heads.

MR. W. MORFITT has been for some time engaged in the examination of a series of pit-dwellings accidentally discovered in the district of Holderness, in the East Riding of Yorkshire. Canon Greenwell and Mr. R. A. Gatty contribute an account of these discoveries to the June issue of *Man*. The people occupying this district, much of which, since their time, has been destroyed by encroachments of the sea, were evidently a very early Neolithic race, probably an early branch of that which introduced polished stone implements. Those which they possessed are almost Palæolithic in character. The fauna, however, which consisted of *Bos longifrons*, the horse, sheep or goat, hog, and red deer, is distinctly Neolithic. The only evidence of their acquaintance with the sea is the vertebra of a whale, which, on the analogy of the Guachos of the River Plate, Prof. Boyd Dawkins supposes to have been used as a seat.

THE Takelma language, one of the distinct linguistic stocks of America, is now nearly extinct, being spoken by only a few survivors of the tribe in the Siletz Reservation, western Oregon. It is therefore fortunate that Mr. E. Sapir, working under the direction of the American Bureau of Ethnology, has been able to secure the record of a con-

siderable body of their tribal mythology and folklore. This report, issued by the University of Pennsylvania, and forming part i., vol. ii., of their Anthropological Publications, is valuable from a linguistic point of view. The beliefs and mythology of the tribe exhibit curious resemblances and variances when compared with those of the neighbouring tribes, the explanation of which awaits further investigation.

To the June number of the *American Naturalist* Dr. R. L. Moodie contributes a note on the alimentary canal of a branchiosaurian salamander from the Carboniferous shales of Mazon Creek, Illinois, for which the new generic and specific name *Eumicrerpeton parvum* is proposed. The specimens, for there are two, are preserved in nodules, and were it not that soon after death the œsophagus became loosened and displaced, the viscera would recall those of a freshly dissected modern salamander. The author has compared the viscera with those of several genera of modern salamanders, and finds that they come nearest to those of an immature example of *Diemyctylus torosus* from Orcas Island, Puget Sound, the next nearest being Desmognathus, Spelerpes, and Hemidactylus. It is suggested that the adults of the three latter retain an ancestral condition of the intestine which is transient in Diemyctylus, and the author finds in the resemblance of the viscera of the fossil to the recent forms confirmation of his theory that modern salamanders are directly descended from the Branchiosauria.

In the same (June) issue of the *American Naturalist* Dr. J. Stafford gives a further account of his investigations on the early developmental history of the Canadian oyster, of which the first part was published in the journal cited for January, 1909. The author systematically employed plankton-nets in collecting the larvæ, which he claims to have been the first to recognise definitely in Canadian waters. He has also identified stages in development hitherto unobserved, including the young stages of the spat. He has defined the spatting period and the period during which the larva is free-swimming, while the developmental history has been followed up to adult stages. His results will, it is believed, be of importance in connection with commercial oyster-culture.

In a report on the giant moth-borer (*Castnia licus*), published at Georgetown, Demerara, Mr. J. J. Quelch directs attention in the strongest manner to the damage threatened to sugar-cane plantations, which form the staple industry of the colony, by the attacks of this insect. In spite of remedial measures, Enmore Plantation, where this insect inflicted so much damage in 1904 and 1905, is still suffering great loss, while Non Pareil Plantation is equally, if not more severely, affected. Some idea of the nature of the damage may be gleaned from the fact that the adult caterpillars are 3 inches in length and nearly ½ inch in thickness, and that their growth is abnormally rapid. Concerted action on the part of plantation-owners is essential if the plague is to be stayed.

A list of the grasses of Alaska, prepared by Prof. F. Lamson-Scribner and Mr. E. D. Merrill, occupies vol. xiii., part iii., of the Contributions from the United States National Herbarium. Most of the material examined comes from the coast region, as very few botanists have ventured into the practically unknown regions of the interior, so that the present list may be regarded as a working basis for future collections. It is very remarkable that not a single species of the series Panicaceæ has been collected, while all the tribes except Bambuseæ of the other series Poaceæ are represented. Poa furnishes a number of species, while Calamagrostis, Bromus, and Agropyron are well represented. The authors have provided analytical keys to the genera and species, as well as a short description for each item.

The authentic list of new garden plants of the year 1909 has been issued as Appendix iii. to the current volume of the *Kew Bulletin*. The Orchidaceæ provides, as usual, more species and varieties than any other family, amongst them being *Cirrhopetalum longissimum*, a fine plant introduced from Siam; *Dendrobium Sanderae*, *D. acuminatum*, both from the Philippines; and *Megaclinium purpureorachis*, from the Congo. China supplies a fair quota of plants, notably *Primula Forrestii*, *P. Littoniana*, *P. Bulleyana*, and *Rhododendron Souliei*, besides sharing with Japan in the supply of species of Juglans. The genus Salix receives additions from Asia, while Mexico furnishes several species of Mammillaria. The Kew introductions include an Encephalartos, *Baikiaea insignis*, a leguminous evergreen tree, and *Strophanthus Preussii*, a climbing shrub, all from tropical Africa; also *Euphorbia Ledienii*, from South Africa. Six new species of the fern genus Nephrolepis and *Adiantum grossum* are noteworthy.

The International Commission on Glaciers has just issued the fourteenth report upon "Les Variations périodiques des Glaciers," by Prof. E. Brückner and M. E. Muret (*Extrait des Annales de Glaciologie*, t. iv., March, 1910, pp. 161–76. Berlin: Borntraeger, 1910). This useful report, covering the year 1908, shows that the majority of glaciers under observation still continue to shrink, though the changes, as a rule, are not important. In the Swiss Alps fifty-three glaciers are probably or certainly decreasing, while fourteen are in the opposite condition. In the eastern Alps only one glacier shows some advance; in the others the general retreat continues. This it does, so far as observed, in the Italian and French Alps, but in the Pyrenees there is generally an increase, though not large. Of Norwegian glaciers thirty-five have been observed, and the table published ranges in most cases from 1904 to 1908 inclusive. In the latter year ten glaciers were growing and twenty-two shrinking. The author, Mr. P. A. ϕyen, directs attention to the fact that in the central highlands the oscillation of the glaciers nearly corresponds with that of the climate, but in the western coast range it is rather retarded. In Sweden some advance is perceptible. The North American glaciers are oscillating, more especially in Alaska, and from Asia little precise information has been received. Evidently the ground which glaciers began to lose nearly half a century ago has not yet been recovered.

The June number of the Journal of the Royal Geographical Society contains papers read before the society by Dr. T. G. Longstaff on glacier exploration in the eastern Karakorum, and by Prof. J. W. Gregory on the geographical factors that control the development of Australia. Dr. Longstaff achieved four important feats: the discovery of the Saltoro Pass; the fixing of the watershed in the eastern Karakorum; the discovery of the Siachen Glacier, the greatest glacier in Asia; the discovery of the peak "Teram Kangri," with an altitude of at least 27,500 feet, and possibly the highest mountain in the world. Prof. Gregory emphasises the isolation of Australia, the contrast between the marginal and the interior zones, and discusses the problem of the water-supply, the growth of population, and the question of the possibility of white colonisation in tropical countries such as North Australia.

In one of the useful scientific papers contained in the report of the Prussian Meteorological Institute for 1909 Prof. Hellmann compares the results of the exposure of

thermometers in windows and in screens, such as are now generally used in this country, with the view of a future critical discussion of temperature conditions in Germany. The first part of the inquiry, contained in the report for 1908, showed that the introduction of the window screen about the year 1880, instead of the unprotected window exposure adopted at all stations prior to that date, did not interrupt the homogeneity of the observations. In the second part of the inquiry, experiments carried out at Potsdam as regards window exposure and exposure in "Stevenson screens," now used at about two-thirds of the German stations, show that not only the readings obtained by these two methods, but those at some of the more recent stations, are not strictly comparable. The differences are relatively small in coastal cloudy and windy weather, but considerably greater in dry and sunny inland districts. For details of this interesting discussion reference must be made to the tables and curves of the mean daily range shown for each month in the original paper.

EVERY month sees a fresh issue of the bulletins from the Bureau of Entomology of the United States Department of Agriculture. In Circular 119 Mr. Webster describes the clover root-borer (*Hylastinus obscurus*, Marsham), which has been introduced from Europe and become established in fields of red clover in the eastern States and elsewhere, causing considerable damage. The life-history has been investigated, but no method of extermination could be discovered. Mr. Ainslie deals with the large corn-stalk-borer (*Diatraea saccharalis*, Fab.). This insect burrows in the stalks of maize close to the ground, and so weakens them that they often break off in a strong wind. It was originally a sugar-cane pest, and came from the West Indies and from Central and South America, but for some time now has devoted its attention to maize.

THE presidential address delivered by Prof. M. C. Potter before the British Mycological Society has now been issued, and deals with bacteria in their relation to plant pathology. The subject has been much neglected both by bacteriologists and mycologists, in spite of the fact that at least ten plant diseases are considered to be caused by bacteria. They are pear-blight (*Bac. amylovorus*), yellow disease of hyacinth (*Pseudomonas hyacinthi*), canker of the olive (*Bac. oleae*), corn-blight (*B. zeae*), potato wet-rot (*B. solaniperda*), soft rot of hyacinth (*B. hyacinthi-sepsticus*), bacteriosis of the vine (*B. uvae*), cucurbit wilt (*B. tracheiphilus*), brown rot of Cruciferæ (*Pseudomonas campestris*), and potato and tomato disease (*Bac. solanacearum*). A discussion of the problem is given and a bibliography is appended.

THE Chemical Society's Journal for May contains two papers by Mr. H. E. Watson on the molecular weights of helium, neon, krypton, and xenon. The neon was prepared in a state of exceptional purity by fractionating 40 litres of a mixture of helium and neon over charcoal at the temperature of liquid air, and full details are given of the methods used both in effecting the purification and in measuring the density of the gas; repeated determinations with various highly purified fractions gave values ranging from 0·8997 to 0·9006, the mean of eleven values being 0·9002. In the case of helium only two measurements were made, giving the values 0·17830 and 0·17814, mean 0·1782; as the gas which was weighed amounted only to 0·05 gram, the experimental error is placed at 1 part in 2000. Reduction of observed densities to zero pressure gave for the molecular weights of the gases of the series the values:—helium, 3·994; neon, 20·200; argon, 39·881; krypton, 82·92; xenon, 130·22.

ALTHOUGH the use of oil as a means of securing more rapid dissipation of the heat generated in transformers has become almost universal in the case of large transformers, very little information has been available as to the relative merits of the various oil- and air-cooling devices. This information is now supplied in a paper by Mr. R. D. Gifford, of the University of Birmingham, which will be found in the May number of the Journal of the Institution of Electrical Engineers. His measurements show that if the cooling effect of the air in the case of a transformer be taken as unity, that of the free air would be about 1·1 and that of a strong air blast about 2. With oil cooling the effect rises to about 3, and if the oil itself is cooled by the passage of cold water through a worm immersed in the oil, the cooling effect becomes 6 or 7.

BULLETIN No. 40 of the Engineering Experimental Station of the University of Illinois consists of an account of measurements made by Messrs. J. K. Clement and C. M. Garland of the heat transmitted through a steel tube of 1¼-inch external diameter, with walls ⅛-inch thick, from steam outside to water inside running through the tube. The temperature of the outside surface of the tube was measured at two points by means of thermojunctions of copper-constantan placed in small holes drilled in the tube. The temperatures of the incoming and outgoing water and of the steam were determined by mercury thermometers. Curves are given showing the variation of the heat transmitted with the velocity of the stream of water and with the temperature of the steam, and the resistance to the transmission of heat is shown to be almost entirely concentrated in the films of stagnant steam and water in contact with the surfaces of the steel tube. The authors regard the present communication, not as one devoted to new facts, but as a demonstration of the utility of their method of measurement, and propose to apply the method to the investigation of problems connected with steam boilers. We should like to point out that a good deal of work has already been done in this direction both in this country and in others, and it is to be hoped that the new experiments will be directed to the solutions of problems which have not been already dealt with by Mr. Jordan or by one or other of the experimenters mentioned in Prof. Dalby's bibliography of the subject contained in the Journal of the Institution of Mechanical Engineers for last year.

WE learn from *Engineering* of June 24 that Lloyd's Register of British and Foreign Shipping is about to issue rules for internal-combustion engines for marine purposes. The rules are divided into four headings. The section concerning construction strongly enforces the importance of accessibility for examination and repair, and requires that engines of more than 60 brake-horse-power, which are not reversible, and are manœuvred by clutch, must be fitted with a governor or other arrangement to prevent the racing of the engine when declutched. The cylinders are to be tested by hydraulic pressure to twice the working pressure to which they will be subjected; the water-jackets of the cylinders to 50 lb. per square inch, and the exhaust-pipes and silencers to 100 lb. per square inch. The tables are comprehensive, embracing smooth-water and open-sea service boats, and engines of 4-stroke cycle and 2-stroke cycle. Separate fuel-tanks are to be tested, with all fittings, to a head of at least 15 feet of water. Oil-fuel pipes are to be of annealed seamless copper, with flexible bends, conical joints metal to metal, with a cock or valve at each end of the pipe conveying the fuel from the tank to the carburettor or vaporiser. The machinery is to be submitted for survey annually, and practically all parts are to be examined, the fuel-

tanks and all connections being, if deemed necessary by the surveyor, tested to the same pressure as when new. The screw-shaft is to be drawn at intervals of not more than two years.

IN directing attention to the diversity of published results of compressive tests on cubes of concrete, the *Builder* for June 18 suggests that the explanation is to be found in the different methods and different pressures used in ramming the concrete into the test moulds. We may add to this explanation the fact that variation in the water used in mixing the concrete under test is a most important factor, influencing both the ramming pressure required and also the strength of the resulting specimen. Our contemporary suggests that an appliance such as is used in the Charlottenburg laboratory might be adopted in this country. In this appliance a ram is lifted by gearing and released by a cam, the arrangement being such that the ram always falls from the same height. After each blow the ram is automatically moved for a short distance in a direction parallel to the axis of the actuating wheel, while the mould is moved perpendicularly to the same axis. The effect is to ensure uniform ramming of the whole. It is stated that the experience at Charlottenburg shows the resistance of test blocks so prepared to be very uniform for concrete of given composition.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JULY:—

July 12. 14h. 11m. Jupiter in conjunction with the Moon (Jupiter 2° 58′ S.).
15. Mercury. Illuminated portion of disc=0·978, Venus =0·813.
16. 10h. 39m. Minimum of Algol (β Persei).
19. Saturn. Major axis of outer ring=39·96″, minor axis=12·35″.
21. 9h. 6m. Uranus in conjunction with Moon (Uranus 3° 44′ N.).
27. 6h. 29m. to 9h. 9m. Transit of Jupiter's Sat. III. (Ganymede).
27–31. Meteors abundant from Perseus and Aquarius.

HALLEY'S COMET.—A number of observations, generally confirmatory of those already noted in these columns, are recorded in No. 4421 of the *Astronomische Nachrichten*. Dr. Wolf gives a sketch of the tail showing its position, with regard to the surrounding stars, and its form as shown on a photograph taken on May 12 at 14h. 15m., Königstuhl M.T. This shows that a straight, narrow tail extended from the head to just south of 70 Pegasi, and from there to the end was bounded by two faint clouds of cometary matter, too faint to be seen visually. The outline of the northern cloud was very irregular, and departed considerably from that of the visual tail, and in any discussion as to whether the earth passed through any mass of cometary material these abnormal extensions must be taken into consideration.

Prof. Seeliger reports that, at Munich, careful observations failed to reveal any trace of the comet's head or nucleus during its passage across the solar disc, nor were any magnetic or electrical phenomena recorded which could be, with certainty, attributed to the comet. So many observers report the non-detection of the nucleus that it must now be taken as fairly certain that the material of which the head and nucleus are composed is too tenuous to interfere, effectively, with the passage of light.

M. Eginitis gives further details as to observations at Athens Observatory, and directs special attention to the peculiar shape presented by the comet on the evening of May 20. The appearance was very similar to that of a crescent moon, with a very bright condensation at the centre of the convex arc, and no extended tail was seen; such a form might be explained by assuming that the axis of the tail was nearly in the line of sight. This would also explain the apparent anomaly of the slight tail being turned towards the sun if one supposes that the curvature was sufficiently great; in this case, the passage of the earth through that part of the tail extending to its orbit would have been delayed some forty to sixty hours, and it appears to be probable, if these observations of May 20 are verified, that a passage did actually take place.

M. Comas Sola gives drawings showing the definite duplication of the nucleus on June 2, and the appearance of four or five separate condensations, *globes*, on June 4.

In an interesting communication to the *Comptes rendus* (No. 26, June 27, p. 1732), M. Nordmann discusses the amount and the nature of the light emitted by the comet, as observed with his colour-screen photometer. He finds that on three dates of observation, April 25, May 15 and 23, the nucleus contributed only about one thirty-seventh of the total light emitted by the head. By comparing his values with the observed diameters of the nucleus and coma, respectively, he deduces that towards May 15 the mean intrinsic light of the nucleus was about nineteen times that of the visible part of the coma. Taking the theoretical increase of light of a comet as varying in the ratio $1/r^2\Delta^2$, and comparing his observed with the calculated values, M. Nordmann finds that between April 25 and May 23 the augmentation of the brilliancy of the nucleus was much less than provided for by the theory. Finally, by the employment of his colour-screen method, M. Nordmann found that the distribution of energy in the spectrum of the nucleus was very similar to the distribution in the solar spectrum, and hence he concludes that the light of the nucleus is almost exclusively, if not entirely, reflected sunlight.

Mr. Leach, Malta, reports that, after finding the comet so faintly distinguishable on June 14, he gave up all hope of seeing it again. On June 25, however, he saw it quite clearly at 9 p.m., and was able to follow it each evening until the day of writing, June 30; with field-glasses, a tail 2° or 3° in length was clearly visible.

EPHEMERIS FOR COMET 1910*a*.—In No. 4422 of the *Astronomische Nachrichten* Prof. Kobold gives a continuation of his ephemeris for comet 1910*a*. The position is changing very slowly, and for July 7 is 21h. 40·5m., +33° 21·4′; an observation by Prof. Barnard on June 7 gave a correction of +7s., +1·6′, and showed the magnitude to be about 16·0.

PHOTOGRAPHS OF MOREHOUSE'S COMET.—From the Tokio Observatory we have received part vi., vol. iii., of the *Annales*, in which are reproduced nearly fifty excellent photographs of Morehouse's comet, 1908*c*. Messrs. Hirayama and Toda briefly describe the separate photographs, and discuss the remarkable changes which took place in the comet's tail. By comparing their results with those obtained at the Yerkes and Heidelberg Observatories, they find that between October 1 and 2 a recognised detached mass, at a mean distance of 2·4° from the head, was receding at an hourly rate of 8·5′; other values are:—October 15, 1° from head, northern mass 3·1′, southern mass 3·4′, per hour; October 15–16, 1·4° from head, 3·1′ per hour. As is pointed out, the accumulation of such data will serve to determine the nature of the repulsive force. A discussion of the photographs also discloses that on November 13, 14, 15, and 16, the outer streamers of the tail appeared to change in phase, predominating southwards on November 13 and 15, and northwards on November 14 and 16. This might be ascribed to a rotation of the head, with a period of forty-eight hours, but further discussion is necessary to establish this; in any case, the photographs show that if such a rotation existed it was not uniform throughout the tail, for the outer and inner streamers did not rotate with the same angular velocity.

THE DETERMINATION OF POSITION NEAR THE POLES.—As an excerpt from the *Geographical Journal* for March, we have received a copy of a paper by Mr. Hinks dealing with the methods of determining an observer's position when near the poles. Mr. Hinks suggests that a theodolite, say a 3-inch, read on both faces, would prove the most suitable instrument, and then proposes a modification of Sumner's method for the reduction of the observations. Two observations of the sun at two different known G.M.T.'s give two circles of equal altitude which intersect at the observer's position; a simple graphical method may be used for the reduction. A most interesting discussion, by well-known explorers, followed the reading of

the paper and dealt, with varying conclusions, with the several points raised by Mr. Hinks; the chronometer difficulty appears to be an important one, and some curious refraction anomalies have to be considered.

The same subject was discussed by Herr Charlier in a paper which appeared in No. 4393 of the *Astronomische Nachrichten*.

THE VARIATION OF LATITUDE.—The usual provisional results obtained by the International Latitude Bureau are published, for 1908·0–1910·0, by Prof. Albrecht in No. 4414 of the *Astronomische Nachrichten*. A marked increase in the amplitude of the departure of the momentary, from the mean, pole took place during 1909, the previous curve, 1907–9, having shown a regularly increasing spiral form. During the ten years that the International Service has been at work the curve has been fairly regular, with maxima in the years 1903 and 1909; the latter is clearly shown on the chart published with the results.

NEW CANALS AND LAKES ON MARS.—Seventeen "canals" and two "lakes" which were seen at the Hem Observatory, and which M. Jonckheere has been unable to identify from previous records, are enumerated in No. 4420 of the *Astronomische Nachrichten*. This brings M. Jonckheere's total of new "canals" up to forty, the previous lists having appeared in earlier numbers of the same journal. One of the "lakes," at the junction of Aethiops and Cambyse, is described as small and feeble, and the other, at the junction of Astaboras and Anubis, as large and diffuse.

THE INTERNATIONAL CONGRESS AT DÜSSELDORF.

THE fifth International Congress of Mining, Metallurgy, Mechanical Engineering, and Practical Geology met at Düsseldorf on Monday, June 20. Whilst, strictly speaking, this is the fifth congress, it is only the third that has assumed a really international character. The first congress was held in Paris in the year 1878, in connection with the Great Exhibition of that year, its initiation being due to the efforts of a number of prominent French mining and metallurgical engineers, and more especially to that well-known French association, the Société de l'Industrie minérale. The next great Paris Exhibition of 1889 again provided the occasion for a second congress, but both these first two congresses were attended mainly by French engineers, and could scarcely be called international. At the Paris Exhibition of 1900 a vigorous effort was made to interest foreign as well as French engineers, and was supported warmly by both their English and their German colleagues, our Iron and Steel Institute and Institution of Mining Engineers both taking an active part in forwarding the scheme. This congress was thoroughly international in all respects, and at its closing meeting it was decided to hold a quinquennial international congress, the next, that of 1905, to be held at Liége, in connection with the International Exhibition planned for that year. This congress, again, was completely successful, and its members gladly accepted the invitation of the Rheno-Westphalian Mining and Metallurgical Industry to hold the next meeting at Düsseldorf. This town is in many respects the centre of the above industries, and is remarkable not only for its great industrial development, but also for its highly advanced artistic culture; it is, furthermore, well situated on the main railway system of central Germany, affording ready communication with all neighbouring countries, and is thus admirably adapted for the purpose of such a congress. On the opening day the congress numbered 1762 members, of whom 1128 were Germans and 634 foreigners, the latter comprising 94 from France, 74 from Great Britain, 65 from Austro-Hungary, and 57 from Belgium. The number of entries in the different sections were:—Mining, 1141; metallurgy, 1140; engineering, 939; geology, 784. Of course, it will be understood that many members had entered their names in more than one section.

The great majority of the members of the congress had arrived in Düsseldorf on Saturday and Sunday, June 18 and 19, and on Sunday evening there was an informal open-air gathering at the Zoological Gardens, this being an excellent opportunity to make and renew many acquaintanceships. The actual work of the congress began next morning, the meeting-place being the *Tonhalle*, a concert-hall belonging to the town of Düsseldorf, the large main hall of which was admirably adapted for the general meeting of the congress. There are several smaller lecture-rooms available for the meetings of the sections, although it must be admitted that the accommodation thus provided was in some cases barely sufficient for the large audiences that assembled to hear some of the more important of the papers. The geological section met in a suitable room close to the *Tonhalle*.

The general meeting was opened on Monday morning by the president of the organising committee, Mr. Edward Kleine, who welcomed the congress in a short address, in which he referred more particularly to the increase in the production of coal and iron that had taken place since the last meeting of the congress. His speech was translated, first into French and then into English, by Mr. E. Schaltenbrand, chairman of the board of management of the Steelworks' Association. The Prussian Minister of Commerce, His Excellency Mr. Sydow, also welcomed the members of the congress in the name of the Prussian Government and of the Imperial Chancellor.

The honorary consultative committee of the congress was then formed, after which the meeting broke up into the various sections, of which there were five, namely, i., Mining; ii*a*., Practical Metallurgy; ii*b*., Theoretical Metallurgy; iii., Mechanical Engineering; iv., Applied Geology.

The official list of papers submitted to these sections is as follows:—

Section i., Mining.—W. Zäringer (Nordhausen), the freezing process and its latest developments; F. Bruchausen (Dortmund), shaft sinking by the process of petrifaction; H. Grahn (Bochum), the use of compressed-air locks in sinking; — Viebig (Kray), the use of reinforced concrete in mine workings; Prof. J. Stumpf (Berlin), the steam-engine with unidirectional flow of steam, with especial reference to its use as a winding engine; W. Schultze (Essen), recent improvements in pumping plant; O. Pütz (Tarnowitz), the present position of hydraulic stowage in Germany; Dr. W. Kohlmann (Diedenhofen), the mining development of the Minette iron-ore district; P. Nicou (Nancy), the present position of the Minette mining industry in French Lorraine; Prof. K. Haussmann (Aachen), modern improvements in mine surveying; Prof. G. Franke (Berlin), conveying of coals from the working face; J. Loiret (Clermont-Ferrand), value of a rescue-chamber in an outburst of carbonic acid gas at the Singles Colliery, July 26, 1909; sudden outbursts of carbonic acid gas in the collieries of the Central Plateau of France; S. v. Bolesta-Malewski (Nalenczow), critical observations on the existing methods of winding, and a proposal for their modification; F. Schember (Vienna), the development of machine kirving in coal mining; Dr. H. Bruns (Gelsenkirchen), to what extent does coal mining contribute to the dissemination of infectious diseases? F. Trippe (Dortmund), hydraulic impregnation of the coal-face in the solid, and hydraulic coal-getting by the Meissner method; J. Taffanel (Lens), the French experiments upon coal-dust; W. E. Garforth (Pontefract), the British coal-dust experiments.

The last two very important papers were admirably illustrated, that of Mr. Garforth by a very fine series of coloured lantern-slides, and that of Mr. Taffanel by lantern-slides and by the kinematograph.

There were further presented to this section two reports on the testing of colliery ropes, namely, Prof. H. Louis (Newcastle-on-Tyne), report on the testing of colliery ropes in England; L. Denoel (Liége), the testing of winding ropes in Belgium. These are to form part of a complete international report on the standardisation of rope-testing.

Section ii.a, Practical Metallurgy.—Dr. Blasberg (Dahlhausen), changes in the composition of fire-brick; G. Arnou (Paris), notes upon electro-steel; P. Breuil (Couillet), rail-steel; — Esser (Differdingen), the present position of the Thomas process in Germany; Prof. G. Franke (Berlin), the present position of the briquetting and nodulising of iron-ores in Germany; R. Genzmer (Julienhütte), the open-hearth ore process in Germany; J. Hofmann (Witkowitz), gas-producers; H. Terpitz (Hubertushütte), the employment of various kinds of gas in the open-hearth furnace, and their respective influence on the quality of the products; O. Friedrich (Julienhütte), recent improvements

in the construction of open-hearth furnaces; C. Grosze (Metz), the present position of the methods of purifying blast-furnace gases in Germany; Prof. F. Herbst (Aachen), on the development of coking as regards the construction of coke ovens and the improvement in mechanical appliances; Prof. E. Heyn (Gross-Lichterfelde), contribution to the subject of rusting; C. Irresberger (Mülheim), present-day iron-foundry practice in Germany; O. Mauritz (Nürnberg), the economics of the various forms of working blowing-engines in steel works; Dr. B. Neumann (Darmstadt), the existing processes for the production of electro-steel in Germany; H. Ortmann (Völklingen), improvements in the construction of rolling-mills during the last decade; Dr. R. Passow (Aachen), the value of the microscope in judging blast-furnace slags; Dr. J. Puppe (Dortmund), the results of recent investigations in rolling-mill practice in Germany; Dr. O. Rau (Aachen), the advances in the recovery of by-products in coke-oven plants; Dr. B. Schück (Berlin), a new process for the generation of hydrogen, and its application in metallurgy.

Section ii.b, Theoretical Metallurgy.—Dr. C. Benedicks (Upsala), the synthesis of meteoric iron; Prof. W. Borchers (Aachen), the reactions in the melting and refining of copper, their acceleration, and their simplification by electric smelting; Dr. K. Bornemann and P. Müller (Aachen), the electrical conductivity of alloys in the liquid state; Dr. H. Braune and E. Hubendick (Stockholm), the generation of producer-gas, free from tar, from uncoked fuel, from the point of view of organic chemistry; C. Brisker (Leoben), the theoretical and practical importance of the electric blast-furnace; G. Charpy (Montluçon), the part played by carbon and carbon monoxide in metallurgical reactions; Dr. W. Conrad (Vienna), the current and the voltage in the electric furnace; Dr. G. Gillhausen (Aachen), the balance of heat and of matter in the blast-furnace; Dr. P. Goerens (Aachen), the gases contained in the various kinds of iron; Dr. H. Grossmann (Berlin), the volumetric estimation of nickel and cobalt; Prof. Guillet (Paris), the thermic treatment of special steels; certain practical and theoretical observations upon cementation; — Joisten (Aachen), the influence of heat treatment upon the dimensions of the grain of iron; Prof. J. W. Richards (South Bethlehem), Gruner's ideal working of a blast-furnace; the *rationale* of dried blast; E. Richarme (Zarizinsky Savod), the dephosphorisation of iron in the presence of carbon; Prof. R. Ruer (Aachen), the iron-nickel system; O. Thallner (Remscheid), the relations between the thermic effect, the metallurgical phenomena, and crystallisation in basic and acid processes of electric fusion; F. Weyl (Aachen), cementation *in vacuo*; Dr. H. Winter (Bochum), the influence of galvanisation on the strength of wire; Prof. F. Wüst (Aachen), the causes of the economy of fuel and the increased production in the blast-furnace by the use of heated and dried blast; Prof. F. Wüst and — Felser (Aachen), the influence of segregation on the strength of ingot-iron.

It need only be said here that the division of the metallurgical section into two portions was rendered necessary by the large number of metallurgical papers presented, and even so the sections were somewhat overweighted with work.

Section iii., Mechanical Engineering.—M. Androuin and C. Stein (Paris), the influence of the improvements in heating on the development of machine forging; T. v. Bavier (Düsseldorf), the development of ventilators and compressors in German mining; P. Bernstein (Cologne), hydraulic compressors; P. Bodenstein (Kalk), modern ore-dressing; W. Ellingen (Cologne), aërial ropeways of great capacity; — Giller (Mülheim), haulage by compressed-air locomotives in mines; G. v. Hanffstengel (Leipzig), the cheapening of the cost of transport by means of wire-rope and electrical aërial railways;— Heym (Wetter), the influence of electricity on the development and efficiency of lifting appliances in mines and works; Dr. H. Hoffmann (Bochum), the working of motor engines, especially for winding engines, rolling-mill engines, and dynamos; Prof. P. Langer (Aachen), recent experience in large gas-engine plants; K. Maleyka (Berlin), electricity in metallurgy; W. Philippi (Berlin), electricity in mining; C. Matschoss (Berlin), the position of mining and metallurgy in the history of machine construction; Dr. Rateau (Paris), turbo-compressors; — Stach (Bochum), the development of independent and of central condensation; heat accumulators for the utilisation of waste steam; F. Tillmann (Saarbrücken), underground haulage.

It will be noticed that very few of these papers deal with purely engineering subjects; some of them are in the main metallurgical, and most of them are upon mining subjects. The only reason for their inclusion in this section lies in the fact that the other sections were overcrowded.

Section iv., Applied Geology.—Dr. C. Barrois (Lille), the origin of the clastic coal deposits and of the erratic pebbles found in the north of France; Dr. Beyschlag (Berlin), communication on the iron-ore supplies of the world; C. Capacci (Florence), the gold deposits of Abyssinia and Erythrea; Dr. G. Fliegel (Berlin), the tectonics of the Lower Rhine basin, and their importance in the development of the lignite formation; — Holz (Aachen), the utilisation of water-power, with special reference to Germany and Scandinavia; M. Krahmann (Berlin), the modern policy respecting mineral deposits, and its problems; P. Kukuk (Bochum), the tectonic conditions of the coal deposits of the Lower Rhine and Westphalia in the light of the most recent investigations; E. Link (Essen), the dams of the Ruhr district, and particularly the dam of the Möhne valley; A. Macco (Brühl), the science of mining economics, its objects and its limits; L. Mintrop (Bochum), on artificial earthquakes; H. Mortimer-Lamb (Montreal), the unique mineral resources of Canada; Dr. M. Mourlon (Brussels), a synthesis of Belgian geology as obtained from documents; Dr. H. Potonié (Berlin), the origin of coal; Prof. A. Renier (Liége), the state of our knowledge of the general stratigraphy of the Belgian coal-formation; B. Schulz-Briesen (Düsseldorf), the scientific and economic importance of practical geology; Dr. G. Steinmann (Bonn), the composite mineral veins in the South American Cordilleras; Dr. O. Stutzer (Freiberg), recent springs; H. Werner (St. Andreasberg), the silver-bearing veins of St. Andreasberg in the Harz; Dr. W. Wunstorf (Berlin), the coal-bearing formation in the region of the Rhine and the Maas; Dr. S. Papavasiliou (Naxos), on Grecian emery.

All this formidable list of papers was disposed of by the various sections in three sessions, on Monday morning and afternoon and on Tuesday morning. Whilst the standard of the various papers was, on the whole, a high one, some being, indeed, of especial interest, the discussions were disappointing, being, in general, brief, and of no great importance; the great majority of the papers were not discussed at all. This was probably due to the large number of papers set down for reading. It would have been far better to have limited their number, or to have read them only in the briefest abstract, so as to have left time for adequate discussion, this being usually the most interesting feature of such gatherings.

Tuesday afternoon, June 21, Wednesday, and Thursday were devoted to excursions, of which there was a list of more than forty, which gave an opportunity to see all the more important collieries and iron works of this flourishing industrial region. A special set of geological excursions was arranged for the members of section iv. An interesting series of trips had also been arranged for the ladies accompanying the members to a number of points of interest in and near Düsseldorf. The social functions included a reception on Monday evening, given by the town of Düsseldorf, a leading feature of which was an admirable speech by Mr. Marx, the Mayor of Düsseldorf. On Tuesday evening an official dinner was given in the large hall of the *Tonhalle*, after which a little allegorical play was performed. The conception of this was due to Dr. Schrödter, one of the general secretaries of the congress, and both the idea and its execution were in every respect beyond praise. On Wednesday evening a trip on the Rhine was made in one of the large steamers that ply on this river. This was rendered especially interesting by the presence of Count Zeppelin, who had come over in the forenoon from Friedrichshafen in his latest airship, the *Deutschland*.

The closing meeting of the congress took place at Essen under the presidency of Mr. Kleine. The secretaries of the various sections presented short reports on the work of each section. The only resolution submitted to the General

Meeting was one from the Mining Section, declaring that it was urgent that some international system for the unification of mining statistics should be adopted. This resolution was unanimously agreed to, and it was decided that steps should be taken to bring it to the notice of the various Powers that had sent representatives to the congress. An invitation to hold the next quinquennial congress, namely, that of 1915, in London was then submitted to the meeting by Prof. H. Louis (Newcastle-on-Tyne), and supported by Mr. G. C. Lloyd, secretary of the Iron and Steel Institute, and Dr. J. B. Simpson, president of the Institution of Mining Engineers. The invitation was tendered on behalf of the University of London, the Imperial College of Science and Technology, the Geological Society of London, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Society of Chemical Industry, the Institution of Mining Engineers, the Institution of Mining and Metallurgy, and the Institute of Metals, and it was unanimously and enthusiastically accepted.

This ended the business of the congress proper, but a reception was given in the evening by the town of Essen, and on the following day a numerous contingent of members left in two special trains for Brussels, where arrangements had been made to receive them at the exhibition now in progress there.

From every point of view the Düsseldorf Congress may be pronounced a brilliant success. The local members exerted themselves to the utmost to entertain their visitors, and, thanks in no small degree to the excellent system of organisation that pervaded the whole affair, everything went without a hitch. It is a matter of sincere satisfaction that English technologists will now have an opportunity afforded them of returning the splendid hospitality of their foreign colleagues, but they will have to exert their utmost endeavours if they propose to maintain the high standard of excellence that has been set by the congress of 1910.

THE TUBERCULOSIS CONFERENCE AND EXHIBITION.

THE annual meeting of the National Association for the Prevention of Tuberculosis and the conference is still in full swing, though by the time that this goes to press most of the work, except the exhibition and the public lectures, will have been completed. A local committee, consisting of the Right Hon. Lord Balfour of Burleigh, K.T., Sir Alexander Christison, Bart., as chairman, Dr. R. W. Philip, treasurer, and Drs. W. Leslie Lyall, Geo. A. Mackey, and James Miller, secretaries, and a number of public and medical men, prepared an admirable programme for the large number of members, old and new, which has been carried out both fully and successfully.

The exhibition, which is probably the best of the kind that has yet been seen in this country, containing not only the ordinary travelling specimens, but a number of very fine preparations from Edinburgh and Cambridge illustrating the various phases of the tuberculous process in man and in animals, was opened on Friday, July 1, by the Countess of Aberdeen, whose interest in this work induced her to send over the Irish exhibit that has done such excellent service in Ireland. On the evening of the same day Prof. McWeeney, of Dublin, gave an interesting lecture on "Consumption: what it is and how it can be prevented."

On Saturday morning the teachers and scholars in the various school centres were addressed by the Countess of Aberdeen at one, by Dr. Jane Walther at another, and by Drs. Gray, McWeeney, Squire, and Woodhead at others. These addresses, according to the newspaper reports, appear to have been followed with keen interest by both teachers and scholars.

In the afternoon, the Royal Victoria Hospital Farm Colony at Springfield, Lasswade, a beautiful and healthful spot, was opened by Lady Dunedin. This farm is for convalescents from phthisis, and is to be a kind of training ground for those who have to earn their living after their recovery. As it is only at the stage of opening, little of the plan of operations could be seen, but it appears that Frimley is the model on which it is to be carried out.

On Sunday there was a special service for university students in the McEwan Hall (the "Aula" of the University). Dr. Norman McLeod presided, and Dr. Kelman and Dean Wilson both took part in the service. Prof. Osler, of Oxford, spoke of man's redemption of man, referring to the great work done during the last fifty years by those who had set themselves to the amelioration of the sufferings and disease of their fellows. Then followed a short service in memoriam of Robert Koch, in which Dr. Hermann Biggs, of New York, and Drs. Woodhead and Philip took part. The whole service was most impressive, and was attended by a very large congregation.

On Monday evening the annual meeting of the National Association for the Prevention of Consumption, presided over by Lord Balfour of Burleigh, was a most successful gathering, and, like all the other meetings, was very largely attended.

This was followed by a reception given by the Right Hon. the Lord Provost, Magistrates, and Council of the City of Edinburgh, in the splendid Museum of Science and Art, at which the members of the association and their friends were most hospitably entertained.

The four conference meetings, at which such subjects as "The Avenues of Infection in Tuberculosis," "The Prevention and the Administrative Control of Tuberculosis," "The Incidence of Tuberculosis in Childhood," and "The Working Man in Relation to Tuberculosis," were well attended, and the subjects were well discussed. These discussions should be productive of much good in the way of disseminating information on the various points raised. Popular lectures were given on Friday, Saturday, and Tuesday, and others will be given up to the end of the week, each lecture being in charge of an authority on his subject.

This conference and exhibition is an advance on anything of the kind that has yet been attempted, and its usefulness and popularity should encourage the executive of the association to repeat the experiment of a provincial meeting.

INTERNATIONAL UNION FOR COOPERATION IN SOLAR RESEARCH.

THE fourth conference of the International Union for Cooperation in Solar Research will take place on Mount Wilson, California, between August 29 and September 6. The meeting promises to be a very successful one, about forty astronomers and physicists from Europe having signified their intention of being present, as well as a large number of Americans.

The members of the union and others who have accepted Prof. Hale's invitation are invited by the Astronomical and Astrophysical Society of America to attend a meeting of that society which will be held at Harvard College Observatory on August 17. At the end of this meeting the astronomers will be taken from Boston to California by the train leaving Boston on August 20. One day will be spent at Niagara Falls, and another at Chicago, where, however, the time will not be sufficient to visit the Yerkes Observatory. The journey from Chicago to Pasadena will be made by the southern route, and a visit will be paid on the way to the Lowell Observatory at Flagstaff, while two days will be spent at the Grand Canyon. The party will reach Pasadena on August 27.

After the meeting, it has been arranged that visitors who may wish to join shall travel by way of Santa Barbara and Monterey to San José, from whence the Lick Observatory may be visited.

Those intending to travel with the party from Boston to Pasadena, or join the party at any point on the way, are requested to send in their names to Prof. S. I. Bailey, Harvard College Observatory, Cambridge, Mass., at as early a date as possible, in order that the necessary railway arrangements may be made.

As regards the meeting itself, it is proposed that the visitors should stay in Pasadena until Tuesday, September 13, on which day they will leave for Mount Wilson, the journey occupying about seven hours. The meeting will be held during the four remaining days of the week, and the return journey will take place on Sunday, September 4.

On September 6 it is intended to make an excursion to Los Angeles, and the meeting will conclude with a banquet after returning to Pasadena.

MODERN SUBMARINE TELEGRAPHY.[1]

THIS lecture relates to modern submarine telegraphy, and, therefore, I shall omit the historical part of the subject and start with the cable itself, as we deal with it now. The signals to form the messages are sent over the submarine cable as electric currents. The cable consists of a central copper wire; this is the conductor for the current, and to prevent the electricity escaping from the wire it is insulated along its entire length by gutta-percha.

Gutta-percha is chosen for submarine work because of its very high insulating properties and its not being acted on, or suffering chemical change, under water. The gutta-percha-covered wire is called the core; this core, before it can be laid at the bottom of the sea, must be surrounded by jute serving and steel wires for protection when being laid and during its existence after.

When dealing with the electrical properties of a cable, the core only is considered, and for all practical purposes it may be taken that the return conductor to the current is the water immediately outside the gutta-percha. A core of any given length has a certain time rate of signalling; that is to say, when a voltage is applied at one end, the effective current, that as a consequence flows in the wire, does not arrive at the distant end instantaneously, but takes time to grow.

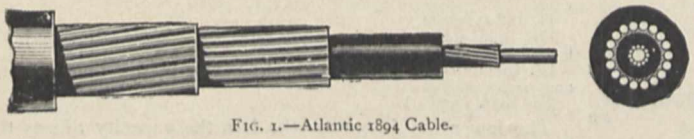


FIG. 1.—Atlantic 1894 Cable.

The time rate of signalling is inversely proportional to the product of the resistance of the wire and the electrostatic capacity of the core. This is termed the "K.R." or capacity resistance law, a law first pointed out by Lord Kelvin. It follows from this law that if you double the length of any given kind of cable you reduce its speed for signalling to one-quarter.

The time rate is inversely proportional to the resistance multiplied by the capacity. If you make a certain sized core (size of gutta-percha) with a large copper, up to a certain point you decrease the resistance and increase the capacity; but there is a critical value giving the minimum K.R. This critical limit, or the point when the size of the copper is reached to give the lowest K.R., is when the diameter of the copper is to the diameter of the core as 1 : 1·65.

There is another advantage in keeping the resistance low for any K.R.; the time constant only determines the time when the current at the far end reaches a certain percentage of the possible maximum after the application of the voltage at the sending end. Of course, the quantity of current after any given time is determined again by the voltage of the sending battery, and is inversely as the resistance of the cable.

For instance, if two cables were constructed of equal K.R., but one had a larger copper of half the resistance of the other, with equal sending batteries, the one with the lower resistance would deliver twice the current at the receiving end, at the ends of equal times, and could therefore be made to work at a faster rate. It should also be a cheaper cable, because copper is less expensive than gutta-percha.

Against these electrical advantages should be placed several mechanical disadvantages; the reduction of the thickness of the insulation might result in a greater liability to faults developing after the cable was laid. With such a heavy wire, which would naturally have to be well stranded, to reduce the stiffness, the liability of the decentralisation during manufacture would be greater than with existing cores.

These mechanical difficulties could, I feel sure, be overcome, say, by greater care being taken in the manufacture or by substitution for the present yielding gutta-percha of dry cotton or similar material well impregnated with gutta-percha compound.

[1] Discourse delivered at the Royal Institution by Mr. Sidney G. Brown.

I take an Atlantic cable laid in 1894 (Fig. 1) as having the greatest size of copper for size of core; I take this core to illustrate the improvement that might result by increasing the copper up to the largest size electrically permissible:—

1894 Cable.

Diameter of core	... ...	0·466 inch
Diameter of copper	... ...	0·202 inch
Resistance per nautical mile	...	1·684 ohms
Capacity per nautical mile	...	0·420 microfarad

The cable is 1852 nautical miles long and its K.R. is 2·41, and its speed of working under the capacity block system of duplex, about 205 letters per minute.

The Ideal Core. (FIG. 2.)

Diameter of core	... ...	0·466 inch
Diameter of copper	... ...	0·282 inch
Resistance per nautical mile	...	0·864 ohm
Capacity	... ...	0·700 microfarad
K.R. for 1852 nautical miles	...	2·06

The speed of working with the same duplex system is about 240 letters per minute, and the current received with this speed would be twice as strong as in the actual cable, so that a still greater speed than that given would result, perhaps a speed of 260 letters per minute, a sending battery of 40 volts to be used on both cables.

The copper conductor offers resistance to the electric currents that flow along it; this resistance by itself would, with sufficiently sensitive receiving instruments, not affect the speed of signalling; it produces what is termed "attenuation," or a weakening of the signalling current.

There is also a lateral storage of electricity along the outside of the copper due to the capacity of the insulating material to absorb a charge of electricity; this property is termed the electrostatic capacity of the core.

To allow this to be more fully understood, I shall take mechanical analogies. *Resistance* in electricity is equivalent to *friction* in mechanics, *capacity* to *elasticity* of a spring, and *self-induction* to *inertia*. If I force water through an iron pipe, the friction in the pipe offers resistance to the flow of water; the same quantity that is forced in flows out at the receiving end, but the energy accompanying the flow of water suffers attenuation, as part is wasted in overcoming the frictional resistance.

Suppose that, instead of taking an iron pipe, I take a soft india-rubber pipe, a new kind of phenomenon will be noticed. As I force the water in, the resistance that the water encounters in flowing along the pipe causes the rubber to swell, and the rubber will continue to swell until it has acquired sufficient strain to press with sufficient force on the water to overcome the friction of the pipe.

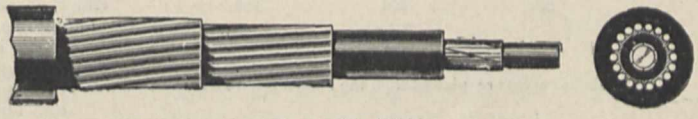


FIG. 2.—Ideal Cable.

At the sending end, that is, the end where we are forcing in the water, the pipe will swell the most, because the pressure on the water is there the greatest and the frictional resistance offered by the pipe to its flow also the greatest. As we move along, the swelling will be less, being least at the far end, that is, at the receiving end where the water escapes.

At the instant that we start forcing the water in, practically none escapes at the receiving end, the pipe commences to stretch and the water begins to flow out, continuously increasing in quantity, until it obtains a steady value; this steady value is reached when the pipe has ceased to expand.

The time taken for the pipe to expand and for the water to reach a steady value is termed the variable period. The less the elasticity of the pipe and the less the resistance to water flowing through it, the less the time taken to reach the steady value. This is equivalent to our sub-

marine cable, where the less the capacity and the less the resistance, the less the time constant, or the quicker the rate of signalling.

Now the swelling of the pipe or the capacity effect of the cable does not destroy the energy in the water or of the electricity respectively; this is very different from the waste of energy through resistance, and if by some method we could compensate for the capacity we could signal

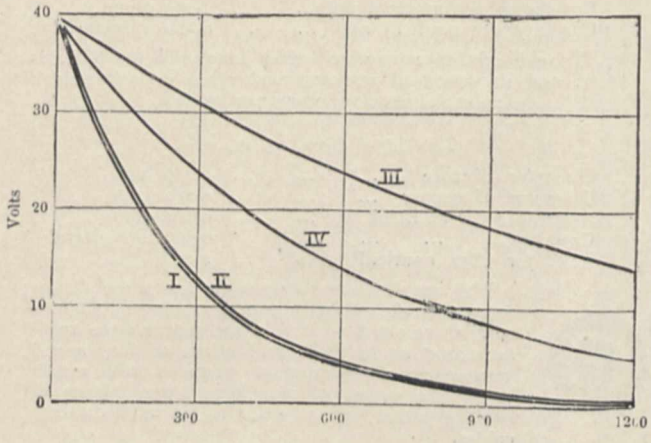


FIG. 3.

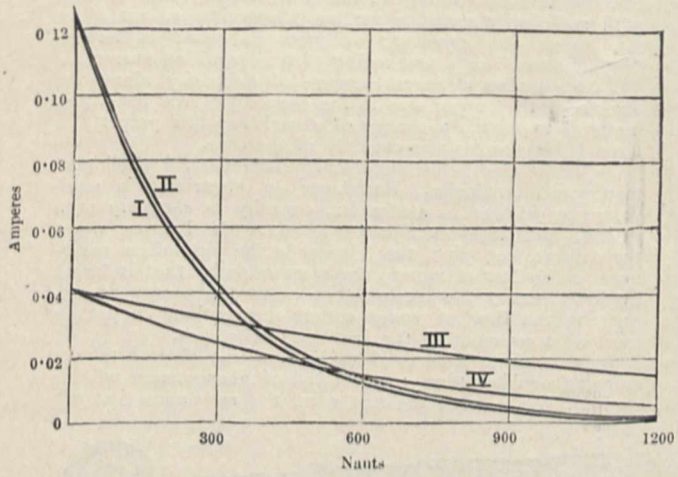


FIG. 4.

The above curves are plotted from the results given in Table I.

through the conductor at any rate we liked, being limited only by the strength of our battery and the sensitiveness of our receiver. I may say that the current usually received would be 1000 times greater if we had no capacity but only the resistance to deal with.[1]

As before stated, the cable has resistance; the current therefore suffers attenuation. It also possesses capacity; the signalling currents through it therefore suffer distortion. Before dealing with this distortion, I must refer you to the diagram of the signals as they are sent into the cable (Fig. 5) and received from it on the siphon recorder. You will notice that the signals, arranged to form the alphabet in the cable code, are of varying lengths, being 1, 2, 3, 4, and 5 times the length of the individual or shortest signal. Sending and receiving on this principle is electrically equivalent to working the cable with varying electrical frequencies of 6, 3, 2, &c., complete periods per second.

[1] I must here refer to the fact that Mr. Heaviside twenty years ago showed that by giving series inductance to a cable we could greatly increase our rapidity of signalling.

This will be understood from Table I. and Figs. 3 and 4 showing curves.

Unfortunately, we see no practical method of carrying out Mr. Heaviside's suggestion, so that I must go on considering the submarine cable as it really is.

TABLE I.

Nauts (x)	I.		II.		III.		IV.	
	Volts.	Amps.	Volts.	Amps.	Volts.	Amps.	Volts.	Amps.
0	40·0	0·1264	40·0	0·1264	40·0	0·0408	40·0	0·041
300	12·25	0·039	12·7	0·042	31·0	0·0316	23·7	0·0244
600	3·8	0·0125	4·4	0·0137	23·9	0·0244	14·2	0·0147
900	1·1	0·005	1·5	0·0055	18·5	0·0189	8·3	0·0088
1200	0·35	0·0012	0·48	0·00155	14·2	0·0146	5·1	0·0051
1500	0·15	0·00065	0·2	0·00083	11·0	0·0112	3·04	0·0031
1825	0·0453	0·000143	0·0418	0·000132	8·32	0·0085	1·71	0·00175
Total lag behind V_0	371°		392°		1717°		1714°	

Except in Case I. (near its end), the lag in every case is proportional to x.

Frequency, 6·36 per second.

Submarine telegraph cable $-r = 1·684$ ohms per naut, $k = 0·42$ mfd. per naut. The current received by recorder would be 82 times this if we had no capacity.

At x nauts from sending end these are the volts and amperes:—

I. There is a recorder with 317 ohms resistance at the end of 1825 naut cable.

II. Infinite cable.

III. Infinite cable, 0·4 henrys per naut; no leakance. Not much distortion.

IV. Infinite cable, 0·4 henrys per naut; leakance, $1·768 \times 10^{-6}$ ohms per naut to give *no* distortion.

(See Figs. 3 and 4.)

The lower the frequency the less the capacity affects the current, so that the higher frequencies of 6 and 3 a second are more attenuated than those of 2 and less. The signals that form the letters in the alphabet are differentially attenuated; the quicker signals, such as those forming a C, are much weaker when they arrive to operate the receiving instrument than the slower signals that form the letters M, O, and so on for the other and longer signals.

Submarine cable signalling of the present day affords us an electrical illustration of the fable of "the tortoise and the hare" or the principle of "more haste, less speed."

As the slower signals get through the cable with more vigour than is necessary, the ingenuity of experimenters is to retard them and to assist as much as possible the quicker ones so that all the signals, whatever their period, shall arrive with exactly the same strength.

Cromwell Varley in 1862 patented a system for the reduction of distortion on cables by inserting condensers of suitable capacity in series with the conductor at each end of the cable.

The reason for the abolition of distortion is obvious; the condenser absorbs the signals of slow frequency, while the cable transmits them. The condenser allows the signals of high frequency to pass through it, although the cable has attenuated them. It is therefore possible so to arrange the condensers at each end of the line that the condensers and the cable together will more or less correct one another and the distortion be reduced.

Unfortunately, the absorption of a series condenser is relative, and is inversely proportional to the frequency; it absorbs more of the slow than the quick signals; at the same time it does absorb some of the quick, and so far as that is concerned it is harmful; it diminishes distortion, but at the same time it adds to the attenuation.

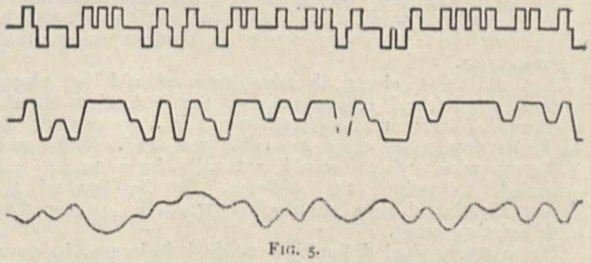


FIG. 5.

Now "distortion" means something more than the differential transmission of various electrical frequencies; it also means the "phase relation" of the current to the voltage, and this "phase relation" varies with the various frequencies, so you see that "distortion," looked at from

all sides, is rather a complicated phenomenon. By "phase relation" we mean the position of the current with regard to the voltage producing it. To understand what "phase relation" means, let us take the analogy of a pendulum in motion.

The force keeping the pendulum swinging is a maximum at the end of each swing, while the greatest velocity resulting from this force is at the middle of the swing; obviously the times of greatest speed and greatest force are not coincident; the one is out of phase with the other by what mathematicians would determine, in the case of the pendulum, as 90°, or a quarter period.

Now the current leads the voltage at the sending end of the cable by 45°. If a series condenser is introduced to diminish distortion, it still further increases the lead, and reduces the effective power into the cable. The effective power can only be a maximum when the current and voltage are exactly in step, or in other words, when there is no "phase relation."

A receiving condenser is also harmful for the same reason as a sending condenser. By abolishing the sending condenser and replacing the receiving one by a magnetic shunt placed across the suspended coil of the siphon recorder or relay in 1898, the speed and accuracy of signalling were materially increased.

A magnetic shunt, as employed on the cables, consists of an insulated copper wire wound round a closed circuited iron core. The resistance of the shunt is about 30 ohms; its inductance varies up to a maximum of from 20 to 40 henrys, and its weight from 1 to 3 cwt. In the case of a siphon recorder used as the receiver, the shunt short-circuits the suspended coil and the series condenser is abolished. In the case of a cable relay, the series condenser is usually retained, to ensure that earth currents are effectually stopped, but the condenser is made large.

A shunt inductance has a similar time action on the incoming current to that of a series condenser, but with this improvement—that it helps to reduce the phase distortion of current with voltage rather than accentuate it, as is the case with the condenser.

Having obtained the best value of the shunt alone, the following curious effect was discovered: that adding a condenser as an additional shunt, the size of the signals on the recorder got larger and more distinct. The mathematical reason for this is as follows: that for any particular frequency, say the highest frequency of the cable signalling, the shunts of inductance and capacity when properly proportioned act as a shunt of infinite resistance. For frequencies much below this it is as if we had no condenser at all. For frequencies much above this, it is as if we had no inductance, but only a condenser.

To reduce still further the harmful effect of phase displacement, series inductances have lately been introduced at the ends of cables, particularly at the sending end. By placing an inductive coil of low resistance in series with the battery at the apex of the duplex bridge, not only has the speed of signalling been increased, but the effect of what is known as "jar" on the duplex balance has also been greatly reduced.

Before proceeding to describe the instruments that work the cables, I will say a few words about "duplexing." All cables are now duplexed, that is to say, are arranged so that messages can be sent and received, at the same time, at each end simultaneously. The first cables were duplexed by Stearns, and later ones by Muirhead and Taylor. Duplex reduces the speed of simplex, or of working one way only, by 20 per cent., but the total carrying power of the cable, irrespective of direction, is raised by some 70 per cent., and is for this reason valuable, and repays the trouble in maintaining the balance.

Cables are duplexed by arranging an artificial or imitation cable, which is an exact electrical copy of the real, in parallel with the real cable. The current from the sending battery flows through two equal arms of capacity or inductance of a Wheatstone bridge arrangement and into the real and artificial cables.

The inductive or magnetic bridge which I have applied lately is, I think, the best to employ, because it gives in practice higher speeds than any other form of bridge. The receiving instrument is joined to the commencement of the cables, and is thus not interfered with by the sending currents, because there is no tendency for the current to flow one way or the other, the real and artificial cables having exactly the same electrical properties and acting on the sending current in the same way; but the current that is received flows only from the real cable, and is not balanced by any from the artificial, so that the receiving instrument is worked by it.

When duplex is properly adjusted it is said to be in balance, from its similarity to the adjustment of an ordinary balance used for weighing goods. Take the ordinary balance as an illustration of the electrical one. Let one scale-pan represent the cable, the other the artificial; if equal weights are placed in each pan the beam will not turn, but the beam will turn if, while equal weights are or are not in the pan, a small weight is added or placed on one pan.

In the cable "duplex," the receiving instrument will not be affected by the sending current, because the voltage is always the same on each side of the instrument, but will turn to indicate a signal when a voltage is received or is added to or subtracted from the voltage already on the cable side, due to a voltage being applied to the cable at the far end.

In Fig. 6 is shown the simplest diagram of a cable "duplex," and Fig. 7 illustrates its mechanical equivalent; the lettering is similarly related.

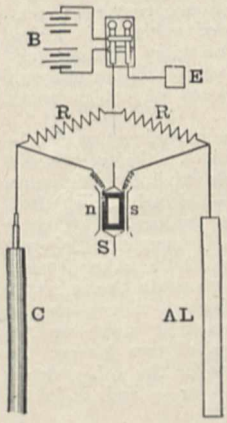


FIG. 6.

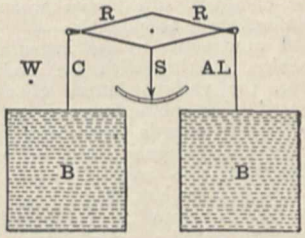


FIG. 7.

RR are the two resistances or the arms of the balance; S is the receiver or indicator, which shows a difference of voltage or weight; B is the battery voltage or weights in the pan; C and AL are cable and artificial line respectively, or the two pans of the balance.

If the battery B sends equal currents into cable and artificial line, as it should do if there is a perfect balance, no current will flow through S, and thus the receiver S is unaffected by the sending voltage; or, if the pans of the balance have equal weights B placed on them, the indicator S will not move. On the contrary, if a voltage is received from the cable C, this voltage is added to or subtracted from whatever voltage may be in C at the time, due to the sending battery, and thus there will be a difference of potential across S, and the receiving instrument will be worked from currents sent from the far end of the cable, and from these currents only.

In the mechanical analogy a small weight W is added to or taken from one of two equal weights in the pans C and AL, and the beam will be tilted and will be moved by this weight only however the weights B B are varied.

The voltage of the battery as applied to the sending end of a cable is very much greater than that received from the cable to work the instrument, say in the relation of 40 volts to 1/20 volt in the case of a moderately long cable, or as 800 is to 1, and the sending and received currents resulting from the same follow a similar proportion.

In the mechanical illustration I have therefore indicated the weights B and W as squares having this proportion to give a visual indication of what this means in the balance. The proportion I have given is only the relation of the sending voltage to that received. If the balance were out

to this proportion, the sending voltage would affect the receiver with disturbances equal in size to those due to the receiving voltage; the duplex would then be very badly indeed out of balance.

To receive properly, the sending voltage must produce no movement of the receiver whatever; that is to say, any disturbance due to this cause must certainly be less than one-tenth of that due to the arrival current.

Taking the figures I have given, we see that the balance must be obtained and maintained so that, applying 40 volts to the cable and artificial line, the two currents dividing must not vary more than what will produce 1/200 volt; that is, must be balanced to an accuracy of 8000 to 1.

If, after the duplex has been established, the artificial line varies in its electrical properties as much as 1/8000 of its value, the balance would require adjustment so as to keep it useful for receiving. The sensitiveness under these conditions may be considered as equivalent to the sensitiveness of an ordinary metal balance that with 8 grams in each pan must turn accurately with 1 milligram.

It is now found necessary to maintain still more perfect balances for my new method of "high-speed working of cables"; in fact, a balance that must be maintained to within the proportion of 72,000 to 1. To do this, the very greatest care has to be directed to questions of insulation and temperature correction, and special appliances are supplied to obtain this high degree of accuracy. In fact, the future of "high-speed working of cables" is locked up very much with this question of more delicate and accurate balances; and if still more perfect balances could be obtained, still higher working speeds of cables would immediately be possible.

I now come to the instruments employed to work the cables, starting with the sending end. As before pointed out, the various letters of the cable alphabet are composed of combinations of + and − electrical impulses, or of the records that these impulses produce. The letter *e* is a + impulse, *t* a − one; *a* is composed of two impulses, a + and −, and so on for all the other letters. The operator has, therefore, first to translate the message to be sent into the cable code, and then to tap on the sending-key the order of the impulses that make up the code message. A sending-key consists of two levers; the depression by the finger of either one or the other determines which end of the battery, the + or − end, is joined to the cable.

Sending messages by hand is open to two objections: one the want of speed, the other the want of accurate spacing of the letters. A good trained clerk can send at the rate of about 140 letters per minute; but as most cables are capable of being worked at greater speeds, automatic or machine transmission has now become universal.

An automatic transmitter is an instrument that does the work of the clerk in sending; the two levers of the hand key are now operated upon by mechanism driven by a motor, through the agency of a perforated ribbon. Everyone who is acquainted with the pianola or automatic piano-player knows that the music to be played is punched as holes in a broad paper strip; this strip is run through the machine, and determines which levers are to press upon the keys of the piano.

The operation of the automatic transmitter is precisely like this, only instead of the extended keyboard there are two keys, a + and −, and the paper strip is a narrow ribbon with only two rows of holes to work the levers.

To send a message, the clerk first of all, by means of a hand perforator, punches the message as combinations of holes in the paper ribbon; this ribbon, after being perforated, is fed through the automatic transmitter.

The automatic transmitter is a motor-driven instrument, adapted to feed the perforated ribbon over the ends of a pair of blunt needles. These needles are kept perpetually moving up against and away from the moving ribbon, but if there is a hole in the paper, that particular needle over which it is fed will find it, and the needle will move a little way through the hole. Attached to the two needles are contact levers which connect the cable with one or the other pole of the sending battery.

When there are no holes in the paper ribbon, the needles move up against the paper, the further movement is arrested, and the contact with the battery is not closed, but the battery circuit is closed when there is a hole in the paper, because there is nothing now to block the needle, and the further movement through the hole enables the contact lever to close the battery circuit and thus send the signal.

The sending levers do one or other of two things: they join the cable to earth (in other words, they short-circuit the cable end) or they disconnect the cable from earth and connect it to the battery, so that the battery may send a signal. At the end of each signal the cable is automatically put to "earth."

Every signalling impulse due to each hole in the paper is, therefore, divided into two parts, the battery or signalling and the earthing portion. These two portions are adjustable relatively to one another; when the best relationship has been found, it is maintained at that adjustment. The object of earthing the cable after the battery contact is to allow the cable to discharge itself, and thus clear itself for the next signal. Automatic transmitters constructed on this principle are called "plain" automatics, and are in universal use.

The "curb" was a device applied to an automatic transmitter to sharpen the signalling impulse, and thus gain greater definition and increased speed by reversing the battery at the termination of every battery period. The reverse battery voltage helped to neutralise the charge already in the cable, and thus discharge the cable in quicker time than by simply earthing the cable, as in the "plain" automatic.

Unfortunately, the use of the "curb" results in a greater voltage stress on the sending end of the cable, for the reason that the reverse voltage of the "curb" is added to the voltage already in the cable ready to discharge, and the rapid reversal of current resulting upon the application of the "curb" is liable to cause "jar" disturbances on the duplex balance. For these reasons "curb" automatics are not now employed.

Instruments adapted to receive messages at the end of long submarine cables must of necessity work at the highest possible speed that the cable will allow, and are of extreme sensitiveness, and as a consequence are of great delicacy.

There are two kinds of receivers now commonly employed, viz. the siphon recorder and the "drum" cable relay. The siphon recorder, invented by Lord Kelvin in 1867, is an instrument that inks the message as received on a moving band of paper. The "drum" cable relay, by means of an electric contact-making device, brings in a fresh source of energy from a local battery, so that the electric signalling impulses are multiplied many times over in power, and are thus enabled to do many useful things besides inking the message, such as working signalling keys to re-transmit the message on to another line, or to guide the levers of an automatic punching machine to perforate the message. The siphon recorder requires the constant attention of a clerk, the "drum" cable relay does not.

The siphon recorder consists of a bent glass siphon tube nearly as fine as a human hair. The siphon is suspended by a fine bronze wire; one end of the tube dips in a reservoir of blue aniline ink, the other end can move across the surface of a travelling band of paper, upon which it inks its movement. If the end of the siphon touched the paper, the friction thus introduced would be fatal to the proper working of the instrument, because of the loss of sensitiveness; it is therefore kept in a state of constant vibration by attaching the tube near its end by means of a silk fibre to an electromagnetic vibrator. The message is thus recorded as a close row of ink dots on the moving paper, and the glass tube is quite free to swing sideways under the action of the received signals.

The siphon tube is joined by two silk fibres to a rectangular suspended coil of fine insulated copper wire, which coil hangs in a strong magnetic field. The currents from the cable flow through the wire of the suspended coil, and the reaction of these currents with the magnetic field causes the coil to oscillate to one side or the other, depending upon the direction of the current. The motion of the coil is transmitted by means of the two fibres to the siphon, and thus the signals are recorded as received.

Ever since the invention of the siphon recorder, efforts have been made to turn it into a relay, but two difficulties had to be faced. The extreme feebleness of the received signalling currents was such that they were incapable of opening and closing a battery circuit so as to do useful work in that circuit.

The reason for this is that a certain force is required to press the relay contacts together to complete the circuit and a certain force to break the circuit when formed; these forces of "make" and "break" are too great for the cable relay to supply under normal working conditions.

The second difficulty was the want of definition in the signals received to operate a relay; they were too ill-defined, and the zero line wandered too greatly to ensure that a relay with a fixed mechanical zero would work satisfactorily.

These two difficulties were overcome by the invention of my "drum" cable relay and my magnetic shunt. The drum cable relay (Fig. 8) is very similar to the siphon recorder. It is the same, so far as the suspended coil and connecting fibres are concerned, but in place of the siphon tube a relay contact arm is provided.

The end of this arm is arranged to press upon the surface of a revolving drum. The outer drum surface of gold or silver is divided into three parts: a central insulated portion, upon which the end of the contact arm normally rests when no signals are received, and portions one on each side of the central one. These outer divisions are included in the circuit of a local battery and two post-office pattern relays.

When the relay arm is deflected to one side or the other, upon the receipt of the signal, it slides or skates into contact with one or other of the outer portions of the drum, and thus closes circuit of the battery through one or other of the post-office relays; this second relay is thus operated, and in turn works a "sounder" key to re-transmit the signal into a second cable.

To reduce the electrical resistance that is found to exist in the contact between the relay pointer and the revolving drum, and to allow a large current to pass, condensers are placed across to short-circuit the contact.

These short-circuiting condensers are very important to the proper working of the relay, as without their aid very little current indeed could be obtained in the local circuit to do useful work. The cable relay is a delicate instrument, and mechanical effects had to be produced by means of energy four-millionths of that required to produce one candle-power of an ordinary carbon lamp. The operation of the relay throughout is quite automatic and trustworthy, and no clerk is required to supervise.

The drum relay has two properties that peculiarly fit it for cable work:—(1) the relay contact is always made, because the contact arm never leaves the surface of the drum; (2) by the rotation of the drum, the friction between the arm, to side motion, and the surface of the drum is reduced in a most wonderful way, so that the arm may be moved by the extremely feeble forces received at the end of the cables.

The relay has a fixed mechanical zero, the centre of the insulated portion, to which the end of the arm must return after every signal or group of signals, and the zero of the electrical signals has been made by electrical adjustment to coincide with the mechanical zero. If there were not this coincidence there would be mutilation of the re-transmitted signals.

The working of the relay is complicated by the requirements of the service, which demand that a condenser should be included in the suspended coil circuit. The object of this condenser is to exclude the possibility of interference from "earth" currents, which sometimes flow along the cable.

The presence of the "earth" current is due to outside electrical influences, atmospheric or celestial.

Now these "earth" currents, if allowed to flow through the suspended coil, would produce deflections that would interfere with the proper working of the relay.

The magnetic shunt which is always placed across the coil does shunt the "earth" current to a very great extent, but does not always get rid of it, and so to make matters sure the "unshunted" series or Varley condenser is included in the system.

The condenser, unfortunately, polarises or charges up under a series of signalling impulses of the same polarity or sign, and for this reason itself causes a wandering of the electrical zero of the signals. We are therefore trying to stop one kind of variable zero effect by a device that produces another one of its own.

The effect of the wandering zero due to the series condenser can be cured, because the wandering, unlike that of the "earth" currents, follows a regular law, viz. the law of the signals themselves. The relay produces the signals and combination of signals in its local circuit, precisely the same as the signals or combination sent through the cable that work it, and are at the same time causing the variable zero. Current is therefore taken from the local circuit and passed through an electrical retarding device, which is called the "local correction circuit," consisting of a series of inductances and shunting resistances. The local circuit is so adjusted in its value that the current at the far end rises exactly as there is a drop in the received signalling current through the series condenser.

The correction current is passed through a separate winding on the suspended coil of the relay, and produces an effect on the coil exactly opposite to that produced on the main winding by the variable zero itself, that is to say, two variable zeros of equal strength but of opposite

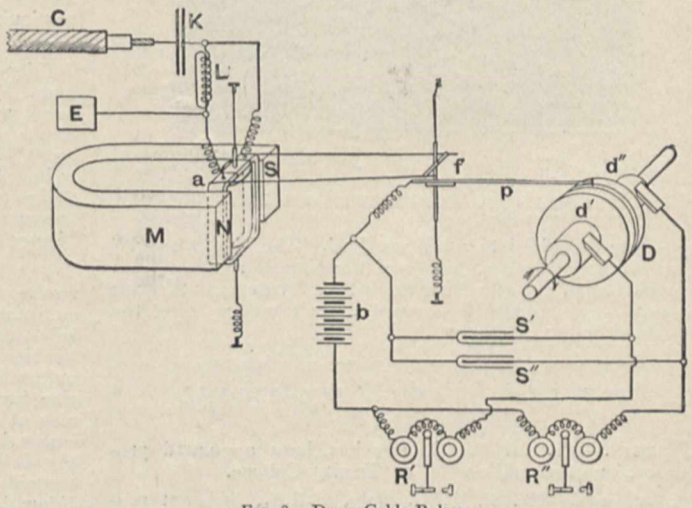


FIG. 8.—Drum Cable Relay.

directions are superimposed on the suspended coil, and thus neutralise one another. The variable zero of the signals themselves is thus eliminated.

Local correction is a very important part of the relay adjustment, and cannot very well be dispensed with.

The Eastern Telegraph Company generously lent me their lines for a trial of my "high-speed" system of working. The cable over which the tests have taken place stretches from Porthcurnow in Cornwall to Gibraltar, and is normally worked at 170 letters per minute, each way, with the siphon recorder as receiver. With the new method, using a special relay (Fig. 9), traffic has been carried continuously, duplex, at 230 letters per minute. On special trial runs, not carrying traffic, and not sending into the cable at the receiving station, although on duplex conditions, a speed of 280 letters per minute has been obtained.

The principle of operation is as follows. When a submarine cable is forced much beyond its normal speed of working, the quick-changing signals, such as make up the letter *c*, are the first to fail, or in other words, do not arrive with sufficient strength to work the receiver.

It was found on trial that allowing more of the current from the cable to flow through the receiver, say by increasing the size of the receiving condenser, the first and

last signal of a series of reversals could be obtained with sufficient strength efficiently to work the relay.

The relay, once started, is arranged to bring in fresh energy from its local battery, through a special retarding circuit, to add to the strength of the quick-changing currents, on its own coil, and thus the reversals are made strong enough to give a record, which without this aid they would have been unable to do.

By these means weak signals are built up at the receiving end of the cable, and the speed of working can thus be materially increased.

It is fortunate that the class of signal that has the greatest difficulty in getting through the cable is the

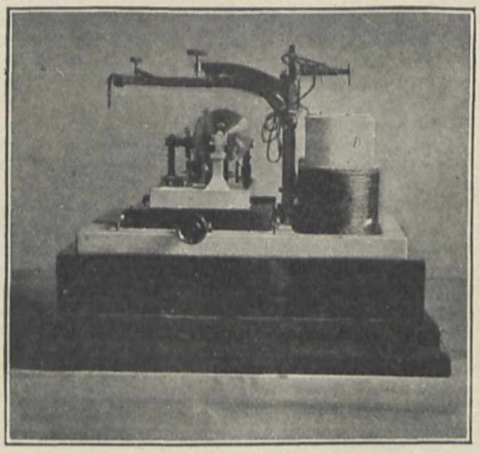


FIG. 9.—High-speed Relay (side view). The pointer is constructed of quartz fibres kept in tension by a thin copper wire, the whole weight of the pointer being not more than one or two grains.

easiest to be added to when received. The "high-speed" relay works, therefore, not from the signals received from the cable only, but also from those that it transmits through its own local circuit, the record that it makes being the combined action of the two.[1]

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DUBLIN.—Mr. M. W. J. Fry has been appointed professor of natural philosophy at Trinity College.

LIVERPOOL.—Mr. E. C. C. Baly, F.R.S., assistant professor of chemistry and lecturer on spectroscopy at University College, London, has been appointed Grant professor of chemistry at the University of Liverpool in succession to the late Prof. Campbell Brown.

LONDON.—Miss H. L. M. Pixell, demonstrator in zoology at the Bedford College for Women, has been elected by the Reid trustees to a Reid fellowship, tenable for two years. Miss Pixell proposes to spend some months next year in Vancouver, investigating the marine fauna of the Georgian Straits.

OXFORD.—Mr. R. R. Marett, secretary to the committee for anthropology, has been appointed reader in social anthropology.

Mr. C. H. Manley has been elected to a Bracegirdle exhibition, following on an examination in chemistry. The exhibition is tenable for three years.

THE honorary degree of Doctor of Science has been conferred upon Sir John Murray, K.C.B., F.R.S., by Harvard University.

A PROFESSORSHIP of commercial geography has recently been established at the Export-Akademie of the Imperial Austrian Handelsmuseum at Vienna, and Dr. F. Hiederich has been appointed the first holder of the chair.

[1] A man of science of my acquaintance tells me that I ought to put things in this way. A fluttering current arrives too weak to make a signal, but all it can do is *just to hint* that it wishes to make a signal, the hint is recognised, and the local battery makes the signal required.

DR. A. C. CRAWFORD has been appointed professor of pharmacology at Stanford University, and Prof. G. H. Cox has been placed in charge of the department of geology and mineralogy at the Missouri School of Mines, Prof. L. S. Griswold having vacated the chair of geology at that institution.

THE United Services' College at Windsor possesses an aviation workshop, built and furnished by Mr. P. Alexander, in which instruction is given in the making of model aëroplanes. Hitherto the use of the workshop made by the students has been voluntary, but in the next term aviation is to be made a special subject of instruction.

AN annual prize (to be known as the "Howard T. Ricketts prize") has been established at Rush Medical College, of the University of Chicago, in memory of Dr. H. T. Ricketts, who recently died in Mexico of typhus fever while investigating that disease. The prize will be awarded to the student presenting the best thesis embodying the results of original investigation on some topic relating to dermatology.

IN continuation of the successful evening courses in aëronautics at the Northampton Polytechnic Institute, Clerkenwell, during the session 1909–10, extended courses of a more complete and practical nature are being arranged for next session, and Mr. F. Handley Page has been appointed to take charge of them. The institute has under consideration the establishment of full-time day courses in aëronautical engineering extending over four years, further particulars of which will be published later.

THE model for the memorial in the Medical School of Trinity College, Dublin, to the late Prof. D. J. Cunningham, F.R.S., is now completed, and the bronze portrait panel will, it is hoped, be placed in position by the time of the opening of the school for the coming winter session. As it is proposed shortly to close the subscription list, it is hoped that friends and pupils of Prof. Cunningham who desire to contribute will communicate with the honorary treasurer or honorary secretaries of the Cunningham Memorial Fund, Trinity College, at an early date.

THE Essex Education Committee has arranged for a twelve days' visit (ranging from July 14 to 26) of agriculturists and horticulturists to Ireland. The programme is a comprehensive one, and will afford the party opportunities of seeing the organisation and practice of agriculture and horticulture on farms and holdings varying in size from four or five up to three hundred and fifty acres; also of studying the schemes of instruction and agricultural institutions of the Department of Agriculture, the work of the Congested Districts Board, and the Irish Agricultural Organisation Society. This is the first time the Essex Education Committee has organised a visit to Ireland, but successful tours in Denmark, Holland, Hungary, and Scotland have been undertaken under its auspices in recent years.

THE Secretary of State for the Colonies has selected Dr. Joseph Pearson as director of the museum at Colombo, Ceylon, in succession to Dr. Arthur Willey, now appointed professor of zoology at McGill University, Montreal. Dr. Pearson has for some years held the post of chief demonstrator and assistant lecturer in the zoological department of the University of Liverpool, and previous to that he had held appointments on the zoological staffs at Cardiff and at Belfast. His original work has been chiefly in marine biology, including several reports upon Holothuroidea of tropical seas, and an exhaustive memoir upon Cancer, the edible crab. Dr. Pearson's removal has created a vacancy in the zoological staff at the University of Liverpool which will be filled by the appointment of Mr. R. Douglas Laurie as senior demonstrator and assistant lecturer, while Dr. W. J. Dakin will join the staff as second demonstrator.

EARLY in the present year University College, Reading, appointed a deputation to visit certain universities of Canada and of the United States with the object of investigating methods of agricultural education and research, and also other aspects of university development. The deputation left England on May 6, and was absent six weeks. The tour included the McGill University at Montreal, the Macdonald College, St. Anne de Belle Vue,

the State Experimental Farm at Ottawa, the University of Toronto, the Ontario College of Agriculture at Guelph, Cornell University, Wisconsin University, and Harvard University. In each case the members of the deputation made it their principal object to acquaint themselves with the agricultural activities of the institution visited, and their work was greatly facilitated by the cordial assistance of the Government and other authorities both in Canada and in the United States. It is hoped to publish a report during the course of the ensuing autumn containing the substance of the information gained and emphasising certain conclusions.

THE 1910 report of the council of the City and Guilds of London Institute to the members of the institute is now available. As usual, full particulars are provided of the work done during the previous year at the Central Technical College, the Finsbury Technical College, the other schools and colleges in connection with the institute, and the department of technology. In the section of the report dealing with the department of technology, it is pointed out that the preliminary education of candidates who enter technical classes is evidently very often the reverse of satisfactory. It was noted in the last report that the institute, in conjunction with the Board of Education, was taking active steps to encourage the attendance of young persons engaged in different trades at evening continuation classes, with the view of their acquiring a competent knowledge of English, arithmetic, drawing, and elementary science before entering upon their first year's course of training in technology. The committee regrets, however, to state that it has been found very difficult to enforce the regulations introduced in 1908, by which, in certain textile subjects, students of registered classes in technology were only to be admitted to the first year's examination on satisfying the institute that they possessed the necessary preliminary knowledge. Notwithstanding the growth of group courses and the increased facilities for the attendance of students at evening continuation classes, it has not been found possible to insist on evidence of attendance at continuation classes prior to the admission of students to a technical school. It has proved necessary to decide that the full enforcement of the regulations in question should be postponed until 1912. Commenting on the results of the examinations conducted throughout the country by the institute, the report says the independent criticisms from examiners in wholly distinct subjects show that many teachers, while undoubtedly using their best efforts to acquaint the students with the technical details of their trade, fail to obtain good results owing to their giving instruction on wrong lines, paying too much attention to description and too little to the theory of the subject and to the principles underlying the work in which they are engaged. This may be partially due to lack of experience in teaching and failure to realise the difficulties of their students. The institute concurs in a suggestion made by its inspectors that if the education authority could send a comparatively inexperienced teacher to visit some of the schools at which successful classes are conducted and see their methods of work, such a visit would amply repay its cost.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society. June 15.—Prof. W. W. Watts, F.R.S., president, in the chair.—Dr. W. **Cross**: The natural classification of igneous rocks. The author reviewed the various systems of classification which have been proposed. He discussed the origin of the difference of composition of igneous rocks due to:—(1) primæval difference, (2) magmatic differentiation, (3) assimilation, and pointed out that differentiation and assimilation are in a measure antithetical processes. The following general conclusions were formulated:—The scientific logical classification of igneous rocks must apparently be based on the quantitative development of fundamental characters, and the divisions of the scheme must have sharp artificial boundaries, since none exist in nature. Chemical composition is the fundamental character of igneous rocks, but it may be advantageously expressed for classificatory purposes in terms of simple compounds, which represent either rock-making minerals or molecules entering into isomorphous mixtures in known minerals. It is probable that the magmatic solution consists of such molecules, and that the norm of the "quantitative system" is a fairly representative set of these compounds. The actual mineral and textural characters of igneous rocks are variable qualifiers of each chemical unit, and should be applied as such to terms indicating magmatic character.—H. **Bury**: The denudation of the western end of the Weald. There are two main theories of Wealden denudation:—(1) attributing the removal of most of the Chalk to marine planation; and (2) denying planation, and relying solely on subaërial denudation. Prof. W. M. Davis's suggestion of a subaërial peneplain forms a sort of connecting link between the two. The evidence in favour of planation which Ramsay and Topley brought forward is inconclusive, and might plausibly, if it stood alone, be attributed to pre-Eocene causes. On the other hand, Prestwich's arguments against planation are equally weak, while the Chalk plateau to which he directs attention strongly supports Ramsay's views. The distribution of chert is fatal to Prof. Davis's hypothesis, and very difficult to account for, except on the marine theory. In the case of the river Blackwater it can be proved that, long after the Hythe beds of Hindhead were uncovered, the river-system remained extremely immature, and this affords very strong grounds for the acceptance of the marine hypothesis. The evidence of the other western rivers is less conclusive, though the Wey and the Mole both provide minor arguments pointing in the same direction. The anomalous position of the Arun, at the foot of the northern escarpment of the Lower Greensand on either side of the Wey, is almost certainly due to comparatively recent captures from the latter river, and affords no ground for assuming a river-system of great age matured on a Miocene peninsula. There is no proof that any of the existing connections between rivers and longitudinal folds are of a primitive character, and, on the other hand, there are many alleged examples of transverse disturbances having served as guides to consequent rivers. This again, on the whole, supports the marine hypothesis, especially if, as there are reasons for believing, the longitudinal folds are older than the transverse.—Dr. J. W. **Evans**: An earthquake model. This model is designed to show the successive conditions that result in an earthquake shock:—(1) slow relative movement between two extensive portions of the earth's crust lasting over a long period, and causing (2) a state of strain in the intervening tract, leading to (3) fracture which relieves the strain and allows (4) the adjoining portions of the rock on either side to fly back by virtue of their elasticity, so as to resume, so far as possible, their original relation to the rock-masses with which they are still connected. This movement of release may give rise to two kinds of periodic disturbance: (5) short-period vibrations, due to a sudden arrest by an obstacle and constituting the earthquake properly so called, and (6) a slower backward and forward swing of the rock about the position of equilibrium.

Royal Microscopical Society. June 15.—Prof. J. Arthur Thomson, president, in the chair.—Prof. J. Arthur **Thomson**: Some alcyonarians collected by Mr. J. Murray, of Sir E. Shackleton's Antarctic Expedition. The species, of which there were four, were *Clavularia rosea*, Studer, *C. chuni*, Kükenthal, *Alcyonium paessleri*, May, and *Ceratoises delicatula*, Hickson.—E. M. **Nelson**: Apparatus for increasing the power of an achromatic condenser.—E. B. **Stringer**: The use of the mercury vapour lamp in observing the rings and brushes in crystals.

Linnean Society. June 16.—Dr. D. H. Scott, F.R.S., president, in the chair.—Dr. R. N. **Salaman**: Male sterility in potatoes, a dominant Mendelian character, with remarks on the shape of the pollen in wild and domestic varieties. The paper was based upon experiments made by the author in his own garden at Barley, near Royston, Herts, during the past four years; but on this occasion the author confined his remarks to the pollen, leaving other points for some future occasion. He pointed out that "dead" pollen-grains, or none, were usually associated with flowers of heliotrope colour.

Royal Anthropological Institute, June 28.—Sir H. Risley, president, in the chair.—W. J. Lewis **Abbott**: The classification of the British Stone age, and some new and little known horizons and cultures. After pointing out that the implementiferous deposits have not always been laid down in an unbroken chronological sequence, so that the number of feet at which an implement is found above Ordnance Datum is not always enough in itself to determine its age, the author urged that none of the systems of classification which have been formulated upon the conditions which obtain on the Continent are applicable in this country, where the conditions do not necessarily obtain. He suggested that nature in the first instance furnished man with the prototypes of his tools, and that subsequently he discovered new methods of working flint, and these gave rise to new sets of shapes. In the author's opinion, therefore, these groups of implements, representing various cultures or industries, must enter as basal units in the classification. The author then went into details of two such industries, which he has named the Prestwichian and Ebbsfleetian respectively. Each of these is characterised by a set of special implements worked in a special manner. Although the author had been working at this industry for many years, it was only recently that a large deposit of them was found; this was at Northfleet, where the deposit fills a hollow some six acres in extent. The principal implement of this industry is a large weapon, weighing sometimes as much as 7 lb., and resembling a gigantic spear-head. For this implement the author proposed the name Prestwich. The great peculiarity of this implement was that, when finished, another implement was struck off it without impairing its efficacy. This latter the author has named after Sir John Evans. The author suggested that these may have been used as tallies in a bargain, as it seems clear that they were religiously kept. The implements occur in enormous numbers, and include large axes, with a rounded edge and triangular, heavy side choppers, spear-heads of peculiar type and of large size, and knives, many of which are more than a foot long.

EDINBURGH.

Royal Society, June 6.—Prof. Hudson Beare, vice-president, in the chair.—Dr. R. A. **Houston**: Two relations in magnetism. By a simple application of the two laws of thermodynamics, relations were established between each pair of the quantities, magnetic force, stress, and temperature. The chief novelty lay in the manner in which the relations were deduced.—A. D. **Ross**: A new method of differentiating between overlapping orders in mapping grating spectra. The method consisted in photographing the Zeeman effect in the spectrum, a thin plate or lens of optically active quartz or other allogyric substance being introduced between the source of light and the slit. The plane of polarisation of the components was thus rotated by amounts depending on the wave-length. Owing to the selective or polarising action of the grating itself, the intensity ratios between the components in triplets, quartets, &c., gave an indication of the approximate wave-length. The method had been successfully applied to the mapping of spectra of certain rare elements. It greatly reduced the cost of the work, and might be expected to reveal, incidentally, series among the spectrum lines.—Dr. H. **Walker**: The variation of Young's modulus under an electric current, part iii. In this continuation of previous papers a number of new results were given. In particular, the effect of increasing tension on the phenomenon was investigated. The peculiar law of variation of Young's modulus under increasing currents, as shown in the cases of the four metals iron, nickel, copper, and platinum, gradually changed as the tension was increased, until, finally, all peculiarity vanished.—Prof. W. **Peddie**: Continuous and stable isothermal change of state. James Thomson's form of continuous isothermals was discussed, and was shown to be inapplicable below the triple point. For example, water free from ice-nuclei and vapour-nuclei must pass either to the solid or to the vapour state. If it follows the paths of Thomson's curves, two such paths must exist; but no physical distinction remains to determine which shall be selected. A modification of Thomson's form of isothermal was suggested, in which no unstable part occurred. In the liquid state, under decreasing pressure, the volume would increase until, without change of density, a molecular re-arrangement would take place and the substance become solid. Under increasing pressure the volume of the solid would decrease until, by molecular re-arrangement, the vapour state would be reached. The applicability of this representation above the triple point, when solid does not exist, was shown to be complete.

CALCUTTA.

Asiatic Society of Bengal, June 1.—Dr. L. L. **Fermor**: A Palæolithic implement of manganese ore. The paper gives a description of a Palæolithic implement which is unique in that it is made of manganese ore.—F. D. **Ascoli**: Rivers of Dacca district. The paper deals with the changes that have taken place in the courses of the rivers of the Dacca and Faridpur districts since the desertion by the Brahmaputra of its old channel north of Dacca. The author attributes the origin of these changes to the incursion of the Teesta into the Brahmaputra in 1787, and shows that the principal changes now going on are not, as Fergusson anticipated, in the Ganges at and above the confluence at Goalundo, but further to the south in the Rajnagur area.—D. **Hooper**: Medicinal lizards. The dried lizard sold in the bazaars of northern India is *Scincus mitranus*, Anderson, and not, as quoted by writers on Indian materia medica, *Lacerta scincus*, Linn. References are given to the uses of this lizard in medicine, and to the use of other saurians in Europe and China.

DIARY OF SOCIETIES.

FRIDAY, JULY 8.

PHYSICAL SOCIETY, at 5.—A Thermo-electric Balance for the Absolute Measurement of Radiation: Prof. H. L. Callendar, F.R.S.—The Convection of Heat from a Body cooled by a Stream of Fluid: Dr. Alexander Russell.—On Hysteresis Loops and Lissajous' Figures, and on the Energy wasted in a Hysteresis Loop: Prof. S. P. Thompson, F.R.S.—The Energy Relations of certain Detectors used in Wireless Telegraphy: Dr. W. H. Eccles.

CONTENTS.