Nature Octr 27, 1881.

James Clerk Maxwell

Engraved by G. J. Stodart from a Photograph by Fergus of Greenock.

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NATURE

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

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

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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

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

THURSDAY, MAY 5, 1881

EVOLUTION

Evolution, Expression, and Sensation. By John Cleland, M.D., F.R.S., Professor of Anatomy in the University of Glasgow. (Glasgow: James Maclehose, 1881.)

PROF. CLELAND is so well known as a skilled anatomist who holds some views of his own on the subject of evolution, that we are glad to welcome in this book a definite statement of what these views are. The work, moreover, is throughout very interesting. It is a collection of six essays, of which the first is on Evolution, the second on Expression, the third on Vision, the fourth on a Theory concerning the relations of Body and Mind, the fifth on Theories of the Cell, and the sixth a reprint of an address to medical students on Truth, Pathology, and the Public. These essays display a good deal of original and suggestive thinking, though not always of a kind with which we are disposed to agree.

The first essay, on the "Evolution of Organisations," expresses the view that gradual development has been the law of organic nature, but that this law has always been subservient to, or expressive of, supernatural design. After some introductory paragraphs the author clearly enough strikes his key-note thus. The fact of evolution being granted, it "may be conceived of variously, both in respect of character and cause. In its character it may be conceived of as a growth without aim, forming altogether an indefinite aggregation like the sum of the branches of a tree; or the view may be held that it is an orderly arrangement, like some vast temple in which every minaret and most fantastic ornament has got its own appointed place and harmonies, while the central tower ascends to its pre-ordained completeness." He then goes on to complain that "the name of Evolutionist has, with curious obliviousness, been assumed as a distinctive title by those who believe that the evolution is merely indefinite. . . . Had they called themselves Demolitionists, on account of their disbelief in morphological design, the name might possibly have been more expressive."

From this quotation the tone of the whole essay may be inferred. The essay, however, is written in the most temperate style, and by a man who certainly has a good right to be heard on all matters pertaining to morphology. We shall therefore offer a few remarks upon his general position as indicated by the above extract.

As regards the mere name appropriated by evolutionists of the naturalistic school, we cannot see that there is much ground for complaint. It is intended to signify belief in gradual development by natural causes as distinguished from sudden changes due to supernatural intervention. The name therefore has really no direct reference to any ulterior belief or opinion as to whether behind the natural causes producing evolution there is any supernatural design—provided only that this design is not supposed to display itself by breaking out into miracle, or interference with these natural causes. Therefore Prof. Cleland has quite as much right as Prof. Häckel, whom he rightly enough regards as a representative of the thorough-going "Demolitionists," to call himself an evolutionist, and we do not see that Häckel could properly deny him this right; they both believe in evolution as a process, much as they may differ in their views on all that lies behind that process. And the only reason why the term evolutionist has in many minds become identified with extra-theistic opinion, is simply because the theory of evolution has been for the most part developed by minds unfettered by any preconceived ideas on "the Method of Divine Government." If we had had to wait for the natural theologians to teach us the theory in question, Prof. Cleland's essay would not yet have been conceived. It nevertheless remains perfectly true that now when it has been conceived, written, and printed, he is as much an evolutionist as anybody else.

But when we pass from this question of mere terminology to the more important matter with which the essay is concerned, we are brought face to face with a question which it is useless in these columns to discuss. This question is whether the new light which science has shed on biology by the theory of descent is compatible with the older theory of design, and if so, to what extent. It is useless in these columns to discuss this question, because it is one upon which opinions differ, and may legitimately differ, through all points of the intellectual compass; there being here no general medium of knowledge to direct opinion, every man's judgment rests in whatever position it may be brought to rest by the particular circumstances of his temperament and education. Thus it is that to Prof. Cleland it appears most reasonable to conclude that "in the evolutions of organisation there is a non-material impulse," to which virtually we may refer all difficulties that we cannot solve in our contemplation of the natural process; while to Mr. Darwin this method of relegating any special question in science to an ultimate theory of things amounts simply to "a re-statement of the question." As a question of science no explanation is furnished by this method, and whether or not in particular cases any such explanation is possible, men of science, *as such*, must never assume, as by following the method in question they would assume, that such explanation is impossible.

Therefore, so long as men of science are watchfully careful never, as Prof. Cleland phrases it, "to make final do the duty of efficient causes," so long it matters not to science what views her individual cultivators may hold on super-scientific questions. Only it is certain that a man strongly imbued with belief in final causes is apt to incur the danger of confusing them with efficient causes, and a striking instance of this fact is displayed by Prof. Cleland himself, where he says, "If evolutions are definite, or, in other words, if morphological designs exist, the necessity for explaining *all* affinity by genetic relationship disappears." This we understand to mean that wherever affinity cannot at once be seen due to "efficient causes," we are at liberty forthwith to ascribe it to "final causes." And this presents in as bad a form as ever the doctrine which for centuries has paralysed the movements of science. If a scientific man of to-day wishes to retain his belief in "morphological design," it must be as a belief in some wholly transcendental principle with which science has nothing whatever to do. Otherwise he fails in scientific method, as for instance Prof. Cleland fails where he points to "sex and symmetry" as due to design, only because he does not see how they can be due to natural selection. It makes not an atom of difference to the logical position of science whether or not the fact of sex or symmetry, or any other fact to which any writer can point, is inexplicable by natural selection. The logical position of science is that if such facts are not due to natural selection, they must be due to some other natural causes which we may reasonably hope some day to *ascertain*. And if it is asked what is the justification of this logical position to which science has been raised, the answer is supplied by the history of science itself. Let any one go through the writings of Paley, Bell, or Chalmers, and strike out all the instances of "morphological design" which he plainly sees can now be explained by natural selection, and he must be a very dull man if he continues to repose any confidence in the residue as evidence of causes other than strictly natural. In the face of so immense an analogy the burden of proof lies with the teleologists to show that any special cases to which they may point as still requiring explanation are to be regarded as inexplicable; and this burden most assuredly is not discharged by Prof. Cleland when he seeks to strike at the heart of natural selection as a natural cause by saying of heredity that in it he "can only recognise a phenomenon the origin of which demands an explanation." No doubt this explanation is demanded but is demanded at the hands of observation and experiment—not from the cloudlands of "spirit which pervades the whole."

We have thought it well to devote the main part of this review to the essay on Evolution, because the occasion seems a suitable one to raise our voice against the pernicious habit of flirting with final causes which still lingers among a certain section of scientific workers. Let any one who so may wish continue to believe in final causes; but if he does not also wish to clog the wheels of science, let him cease to throw his final causes into any gap which the roads of inquiry may present. Science, as such, requires no *deus ex machinâ*, and those of her votaries who feel that *they* require him will best consult her interests by laying the strongest possible emphasis upon the *ex*.

The most interesting of the other essays is that on Expression. In a section devoted to "Permanent Expression," it is observed that while in many respects the physical peculiarities of permanent expression admit of being explained by obvious causes, in other respects this is not so. Thus, for instance, "a massive chin is so distinctly a physiognomic representation of firmness, that an artist would in vain attempt to exhibit the resolution of a Cromwell in a face with a small and narrow jaw, or with one of those pretty chins like a bagatelle ball, not uncommon in certain localities. . . . Yet the chin has no physical function whatever, so far as I am aware."

In a section on the "Expression of the Emotions," Dr. Cleland argues in favour of an active principle which may be defined as unconscious symbolism, and certainly in the course of a few interesting and suggestive pages he makes out a strong case. It is first shown that language serves, as it were, to stereotype a number of symbolic ideas, so that, for instance, words signifying elevation come also to signify greatness, goodness, &c., while we likewise "associate impressions derived through the organs of sense with impressions from the moral world similarly pleasant or otherwise, as in the case of sweetness, bitterness, brightness, and gloom." Such associations having become firmly established, the way is prepared for their expression by gesture; so that at last "the workings of the mind are expressed by attitudes, gestures, and movements of body of a nature correlative with them." Thus "slight movements of the arms express the hugging of an idea to the bosom when nothing but what is thoroughly impersonal is thought of, and the fingers bend as if to keep a something in the hand when nothing but delightful sentiment is conceived." And similarly the gesture of sweeping away, backwards, and downwards a repulsive object from before the eyes, "is a gesture applied to the intangible and invisible; by it the cleric puts away false doctrine, and the fastidious sublimely brands a notion as vulgar."

This theory, of which many other illustrations are given, is to some extent the same as that which Mr. Darwin calls "serviceable associated habits," seeing that the principle of association is concerned in both; but as in Dr. Cleland's theory the association need not be "serviceable," and as it is concerned with an unconsciously symbolic representation of ideas, we think with him that it deserves to be considered as a distinct theory, and we can scarcely doubt that the principle with which it is concerned has played an important part in the development of emotional expression in man.

The remaining essays, which we have no further space to consider, are likewise entertaining, and we therefore recommend the book to all who are interested in the sundry biological theories of which it treats.

GEORGE J. ROMANES

LEGGE'S "BIRDS OF CEYLON"

A History of the Birds of Ceylon. By Capt. Vincent Legge, R.A. Part III., concluding the Work. 4to. (London: Published by the Author, 1880.)

THE ornithologists are certainly active at the present time. We have just recorded the commencement of an important work on the Birds of New Guinea, we have now to notice the conclusion of an excellent volume on the Birds of Ceylon. Capt. Legge's book will, we are sure, be much valued by the numerous European residents in the coffee-districts of the island, who cannot fail to have their attention attracted by the beautiful forms of ornithic life which surround them, and as yet have had no ready means of becoming acquainted with what is known of them. Jerdon, singularly enough, did not include Ceylon in the area of his "Birds of India," and although Blyth, Layard, and Holdsworth have worked long and laboriously on the Ceylonese avifauna, their memoirs on the subject are dispersed about in various serials and other publications, which it is not possible for a coffee-planter to have at his command. A general *résumé* of the Ceylonese ornithology, with full descriptions of all the species, with excellent illustrations of the peculiar forms, and with every necessary detail required for the instruction of the local student and collector, is therefore likely to be a most acceptable piece of work to the resident in the island. At the same time Capt. Legge has produced an elaborate and scientifically exact Monograph of a local Avifauna, which will be received with welcome by naturalists of every class, and is well worthy to take its place on their shelves alongside such works as Dresser's "Birds of Europe" and Buller's "Birds of New Zealand," with which it corresponds in size and character.

As regards the general features of the Ceylonese Ornis Capt. Legge observes that the island, "although it contains none of those remarkable forms which characterise the birds of some of the Malay islands, undoubtedly possesses a rich avifauna; and, considering its geographical area (about five-sixths of Ireland), the number of species is very large. The tropical position of Ceylon, coupled with its location in the path of the monsoon winds and rains, fosters the growth of luxuriant vegetation and verdant forests, which, as a matter of course, teem with all that wonderful insect-life necessary for the sustenance of birds. Hence the large number of resident species inhabiting it; whilst the fact of its being situated at the extreme south of an immense peninsula makes it the finishing point of the stream of waders and water-birds which annually pass down the coast of India. Lastly, the prevalence of a northerly wind at the time of migration of weak-flying warblers brings these little birds in numbers to its shores."

The total number of species of birds included in Capt. Legge's work is 371, of which two have been introduced by man's agency, and about eighteen others are somewhat doubtful. The authentically determined birds of Ceylon may therefore be stated at about 350, of which forty-seven are peculiar to the island; this indicates a very large amount of individuality. The relationship of the Ceylonese Ornis, Capt. Legge tells us, is, as might have been expected from the geographical position of the island and its separation from the mainland merely by a shallow strait, "closer to that of South India than to the avifauna of any other part of the peninsula. Wallace, in his great work on the 'Distribution of Animals,' considers the island of Ceylon and the entire south of India as far north as the Deccan as forming a subdivision of the great 'Oriental Region.' It is however in the hills of the two districts, which possess the important element of a similar rainfall, where we find the nearest affinities both as regards birds and mammals; and this is exemplified by the fact of some of the members of the Brachypodidæ and Turdidæ (families well represented in both districts) being the same in the Nilghiris and in the mountains of Ceylon, while many of the Timaliidæ and Turdidæ in one region have near allies in the other.

"But though this strong similarity in the avifauna of the mountains in question, as well as their geographical characters, indicate a contemporaneous upheaval and enrichment with animal life of their surfaces, a similar connection is found between the northern parts of the island and the low country of the Carnatic.

"Here, again, we have in the fossiliferous limestones of the two regions an undoubted connection, and also an affinity in their avifaunas, which differ totally from that of the mountain-districts on either side of the straits."

In concluding our notice of this admirable volume we must not fail to call special attention to the plates which have been drawn by Mr. Keulemans, and are excellently coloured. They are devoted to the illustration of the species peculiar to Ceylon. Nor must we forget the map, which forms the frontispiece and shows the five zoo-geographical regions into which the author divides the island, besides the various localities referred to in the course of the work.

OUR BOOK SHELF

A Manual of Ancient Geography. Authorised Translation from the German of H. Kiepert, Ph.D. (London: Macmillan and Co., 1881.)

THE name of Kiepert is in itself a sufficient guarantee of the thoroughness and accuracy of a book on geography. That writer, in his "Lehrbuch der Alten Geographie"—from which the present work is abridged, though he himself describes the "Lehrbuch" as a "Werkchen"—has brought together a vast amount of well-digested information respecting ancient geography, so that the book excites the student's admiration from the grasp it displays of the many sides—geological, ethnographical, philological, historical, climatological, &c.—of that wide-reaching subject, and the discernment and critical spirit which characterise it. To the English reader the smaller work, which has been excellently translated by G. A. M., supplies a want that has long been felt. We possess no satisfactory book on the subject intermediate between primers and elaborate treatises, and the present one has all the advantage of being the condensation of a larger book, so that in reading it we feel all through that the author draws on a wide field of knowledge. What is most needed in such a manual is that it should be clear, interesting, suggestive, and not overladen with such details as clog the memory while they make no permanent impression on the mind. In the present work the statistical form is avoided, and the dry bones of geography are clothed with such information as gives them life and colour. The vegetation and products of the different countries, their inhabitants and history, are all noticed in connection with the configuration of the ground. Thus of Italy we are told that, "besides the oak forests which covered the lower slopes, and the beeches and firs which covered the higher parts of the mountains up to 5000 feet, and far more densely in ancient times than now, a large part of the mountain region, especially of the Apennines, owing to the steep and rocky character of the ground, remains unsuited for any other purpose but cattle-feeding, and this in the higher regions is confined, as in the Alps, to the summer months. A regular interchange of cattle and sheep according to the seasons, such as is now usual, already went on in antiquity, as, for instance, between Samnium and Apulia." So too, when the volcanic system of Italy is mentioned, we are told that "the lava flowing from these volcanoes afforded in old Roman times, as it does still, the hardest material for binding together the great military roads (*silex*), while the conglomerate of tufa, consisting of the lighter masses thrown down, which was spread over the plain, was the commonest material for building, and its weather-worn surface made the most fertile soil for tillage." In a similar geological sketch of Greece, the various centres of volcanic action are noticed, and the metals which are found in different parts of the country. In respect of the history and politics of the several districts a large amount of useful information is brought together. For instance, we find a clear statement of the names by which the ancient Greeks were known at different times and by different peoples, and the history of the name Italia is discussed in the same manner. Nor are outlying nations neglected. Under the headings "The Scythians" and "The Sarmatae" we get the results of a large amount of research and discussion, and the Carthaginian province in Sicily is duly noticed. Philology again, which is now no unimportant handmaid of geography, is made to add its contribution of information; as when we are told that the names Asia and Europe "are derived from the *açu* and *irib* of the lately-deciphered Assyrian monuments, meaning east and west, and answering to the Homeric expression πρὸς ἠῶ ἠελιόντε and πρὸς ζόφον, to the later Greek names of countries, Ἀνατολή and Ἑσπερία, to the modern *Orient* and *Occident* (borrowed from the Latin), or to the Italian *Levante* and *Ponente*." Sometimes a name is connected with the features of the ground, as where the Jordan, with its steep descent down a deep valley, is explained to mean "the down-flowing"; or where Zancle is said to be called "the Sickle" from "the form of the tongue of land which incloses the natural harbour." So, too, the student is incited to further research when he learns that Mount Atabyrion in Rhodes bears in reality the same name as Mount Tabor, and that other Greek names have undoubtedly Semitic appellations; and his appetite for history is whetted by discovering that Cappadocia is the Old Persian *Katpatuka*, and that Marsala is the mediæval Arabian name for Lilybæum. Numerous points like these are illustrated by geography, and M. Kiepert gives his readers the full benefit of them. But this is not to the neglect of the more substantial part of the subject, which is amply and clearly expounded. H. F. TOZER

Lehrbuch der organischen qualitativen Analyse. Von Dr. Chr. Th. Barfoed. Dritte Lieferung. (Kopenhagen: Andr. Ferd. Höst und Sohn, 1881.)

DR. BARFOED'S work on organic qualitative analysis is completed by the issue of the present part. The author is to be congratulated on producing so valuable a book of reference for the laboratory worker. The present part contains a full account of the tests for the commoner alkaloids, and for a few of the more fully examined vegetable colouring matters. A general method for the examination of organic substances, whether free from, or mixed with, inorganic compounds, is also given. This general plan is not however arranged in cut-and-dry tabular form, but is rather a guide which in the hands of the experienced student will prove of much value. We can but repeat what we said in noticing the first part of this book, that every student who is desirous of obtaining a real knowledge of qualitative organic analysis, ought to possess Dr. Barfoed's work.

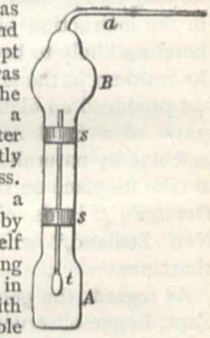
LETTERS TO THE EDITOR

[*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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Hot Ice

THAT the experiments of Dr. Carnelley on hot ice have excited much interest is not to be wondered at. His statement, however, that ice could be raised to a temperature of 180° without melting was so amazing that many a one could not accept it without repeating the experiments. Soon after the first short notice of Dr. Carnelley appeared in NATURE we took up the matter, but as the method used by Dr. Carnelley seemed to us to be somewhat troublesome, we made use of quite a different method. In the axis of a glass tube A B, 16 mm. in diameter, and 56 c.m. in length was fixed a thermometer *t* by means of two strips *ss* of elastic brass sheet. One of the ends of the tube was 22 mm. in diameter, while the other end had the shape of a bulb, and was drawn out in a narrow tube, *a b*, about 50 c.m. in length. The tube was placed in an inclined position with the end *b* in a glass filled with water that was kept boiling. The bottom of the glass was covered with a layer of mercury. Next the tube was heated by a Bunsen burner; a part of the air was driven out, and, after retiring the burner, the tube was partly filled with the boiling water of the glass. The water in the tube was then boiled, a still greater part of the air escaped, and by removing the burner the tube filled itself nearly entirely. The heating and cooling were repeated three or four times, and in this manner the tube could be filled with the boiling water, not a single air-bubble being left. The end *b* of the narrow tube



was now dipped in the mercury, and by heating the tube so much of the water was driven out that the remainder filled the enlarged part A for three-fourths. The tube being now slowly cooled, the mercury rose in the tube *a b*, and it was very easy to seal the tube at *a* with the blowpipe. The water in A was now frozen, and by gently warming with the hand the ice-cylinder was loosened from the tube; by inverting the tube the molten ice was brought into the bulb B, where it was fixed by freezing. This part of the process presents some difficulty. When the heating by the hand was not stopped in time, too much of the ice was converted into water. However, by placing the bulb B in a freezing mixture of snow and salt the melting can be almost instantly arrested. The bulb of the thermometer being in this way surrounded with an ice-cylinder 12 mm. in diameter, the bulb B had only to be placed in the freezing mixture to have the apparatus ready for the appliance of heat. The results of our experiments confirm those of Dr. Carnelley, inasmuch as the ice did not melt, notwithstanding the heating of the tube at A was in one instance so strong that the glass was softened and gave way to the external pressure of the air. They differ, however, as regards the temperature of the ice, which remained generally at −7°. By very strong heating the thermometer rose to 0°, but *never exceeded that point;* when not, the bulb of the thermometer, by the volatilising of the ice, was partly laid bare. As it appears by the detailed description of Dr. Carnelley's experiments in NATURE, vol. xxiii. p. 341, that the success depends for a great part on the size of the condenser, we have made another apparatus with a condenser of half a litre; the results we may obtain therewith will be related shortly.

We have also made some experiments on naphthalene. The pressure of the naphthalene vapour at the melting-point, nearly 80°, being ± 9 mm., as was found by a preliminary proof, it was expected that it would not be very difficult to obtain and to maintain a vacuum sufficient to observe the demeanour of naphthalene under similar circumstances as ice. The apparatus we used resembles in its principal features that we made use of in experimenting on ice; alone, the condensing surface was much greater. The thermometer bulb being imbedded in a cylinder of pure naphthalene 13 mm. in diameter, the thermometer was fixed in the axis of the glass tube, and this latter drawn out. A small quantity of water being brought in the tube, the pressure was reduced by means of an ordinary air-pump to 5 mm., and the drawn-out end of the tube melted through. In another instance the tube was several times filled with carefully-dried carbonic acid and exhausted, and lastly, when the pressure had been reduced to 7 mm., sealed. To remove the remaining carbonic acid and aqueous vapour a certain quantity of caustic potash and some pieces of oxide of calcium were inclosed in the tube. In what manner the tube had been prepared, the results when heat was applied, the upper part of the tube being cooled in a freezing-mixture or simply in snow, were always the same. The thermometer rose very rapidly to about 79°, and *stayed at that point* as long as no part of the thermometer bulb was denuded of naphthalene. At the same time the naphthalene sublimed very regularly, covering the sides of the tube next to the heated part with a beautiful layer of naphthalene crystals.

C. J. E. BRUTEL DE LA RIVIÈRE
A. VAN HASSELT

Assen (Netherlands), April 14

Sound of the Aurora

THE interesting communications which have lately appeared in your periodical regarding the supposed connection between "sound" and the "aurora" (NATURE, vol. xxiii. pp. 484, 529, 556), lead me to suppose that the following notes may be considered by you and your readers worthy of record. They were copied last autumn by myself from the Strangers' or Visitors' Book at the Hotel on the Æggischorn, and bore the date July 10, 1863:—

"Visit to the Col de la Jungfrau described: On descent surrounded by thunderclouds evidently charged with electricity. At 12.15 a sound similar to that made by a boiling kettle was heard to issue from one of the alpenstocks, and very soon a similar sound issued from all the bâtons. On shaking the hands similar sounds issued from the fingers. Observing that the veil of one of the party stood upright on his hat, one of the gentlemen and one of the guides, who had experienced prickly sensations on the crown of the head, removed their hats, when their hair stood up as if under a powerful electrical machine. Whenever there was a peal of thunder all of the phenomena ceased, to be speedily renewed when the peal was over. At such times all the members of the party felt severe shocks in the parts of the body which were most affected; and one gentleman had his right arm paralysed and rendered useless for several minutes. The clouds passed away and the phenomena finally ceased at 12.30. The guides with us were Joseph Marie Claret of Chamouni, and Smith of this house, and they were as much affected by the electricity as we were. At the top of the Col the aneroid barometer stood at 18·83."

I believe the above statement, clear and pointed as it is, was signed by the names of Watson, Sowerby, and Adams.

It will be seen that other phenomena are mentioned, in addition to the sounds heard in connection with the electrical ones, which are worthy of regard. I would, among other points, draw attention to the effect produced on the arm of one of the travellers, and should be glad to know from any of your correspondents whether they have met with other like results of electrical interference with the actions of muscles in mountain travelling.

I may mention in passing that in the same Visitors' Book at the Æggischorn Inn I found notes to the effect that the Jungfrau and the Aletschorn were first ascended by a lady in August of the year 1863.

JOHN W. OGLE

30, Cavendish Square, W.

A PRESUMPTION as to the true character of the sound of the aurora is perhaps offered by the fact that to many persons a flash of lightning is accompanied by a distinct *whishing* sound. As this is simultaneous with the flash, and therefore evidently subjective, it seems to offer evidence merely of the close connection existing between the senses of seeing and hearing.

April 30 E. HUBBARD

Symbolical Logic

IN my recent letter on Symbolical Logic (see NATURE, vol. xxiii. p. 578) I said that Prof. Peirce's symbol of inclusion, as defined by him in his "Logic of Relatives," was equivalent to the words "is not greater than." This however is not quite correct; for though Prof. Peirce speaks of this symbol as equivalent to the words "is as small as," he also speaks of it as denoting "inclusion," and his illustration $f -\!\!< m$ may be read, *The class f is included in the class m.* In my notation the analogous composite symbol $f : m$ may be read, *The statement f implies the statement m.* If for f in my notation we read *He belongs to the class f,* and for m we read *He belongs to the class m,* then my $f : m$ will coincide in meaning with Prof. Peirce's $f -\!\!< m$; but this does not alter the fact that my f differs in meaning from his f, that my : differs from his $-\!\!<$, and my m from his m. Mr. Venn, in his recent paper in the *Proceedings* of the Cambridge Philosophical Society, speaks of these distinguishing features of my method as unimportant, and he regards my definitions of my elementary symbols as "arbitrary restrictions of the full generality of our symbolic language." But Mr. Venn overlooks the fact that all accurate definitions are more or less arbitrary restrictions of language, and he also seems to me, in this particular case, to mistake *vagueness* for *generality.* Philosophical investigations that begin with *Let* x = *anything* commonly end with x = *anything,* a result which, whatever may be thought of its generality, does not add much to our knowledge.

HUGH MCCOLL

73, Rue Siblequin, Boulogne-sur-Mer, April 26

The Formation of Cumuli

THIS afternoon the air to a great distance above the surface of the earth has been filled with fluttering dry leaves. For some weeks no rain has fallen in this vicinity, and a cold northerly wind has prevailed. To day, for the first time during the continuance of this cold and rather clear weather, the hill-sides having a southern exposure have begun to be sufficiently warmed to cause upward currents of air along their surface. The effect has been curious: piles of cumuli have formed persistently in certain quarters of the sky, and eddying masses of leaves caught up along the hill-sides have been falling apparently from the under surface of the dense masses of cloud. My attention was first caught by the fall of chestnut and other varieties of leaves, which must have traversed a long distance, as there are no trees of the sort near at hand in the direction from which the wind was blowing at the time. Whilst walking near an elevated ridge of ground an hour later it was my fortune to catch sight of a thick mass of leaves rushing directly up its side and pouring apparently into the bosom of a dark cloud which overhung the hill. This cloud remained almost stationary, although there appeared to be a lively breeze along its under surface, the leaves darting forward very swiftly. The entire phenomenon was quite interesting as affording an illustration of the method of formation of clouds of the variety named.

M. A. VEEDER

Lyons, New York, March 20

"The Oldest Ocean Post Office"

IN NATURE, vol. xxiii. p. 254, just received here, it is stated that in Magellan Straits there has been for some years past, chained to a rock there, a barrel from which passing ships take letters for the direction they are going in, leaving others for the opposite quarter; it is added that up to the present no abuse of the privileges of this primitive post-office has been reported.

In Victor Hugo's romance, published in English, some fifteen years ago, as "The Toilers of the Sea," a tale of the first quarter of this century, he makes one of his sailors tell another about such an "Ocean Post Office" at Cape Famine in Magellan Straits. Cape Famine was the scene of an early settlement which—in that bleak place—was entirely dependent on the outside world for means of subsistence, and when these, on one occasion, failed, through delay in the arrival of a ship, the colonists died; the circumstance giving the place its present name. The existing colony in Magellan Straits, about twenty miles from Cape Famine, is a Chilian settlement called Punta Arenas, or Sandy Point. Its trade is in guanaco and emu skins, brought to it by the Patagonian Indians. The colonists do a little also in agriculture, coal-mining, and gold washing.

Sailing-ships invariably now go round Cape Horn; the narrowness of the Straits at some points, their strong currents, and the alternating fogs and wild winds that prevail making the passage a very risky one for such vessels as are now employed in ocean navigation. There are however two steamship companies, a Liverpool and a Hamburg one, whose vessels pass through the Straits, and, touching at Sandy Point, insure nearly weekly communication between that place and the east and west. But the oldest commanders of these steamers know of no such institution as an ocean post office in Magellan Straits. Indeed at Sandy Point there have long been the usual facilities for postage, and the plan of the barrel is therefore not needed in the Straits.

That plan is adopted in "Post Office Bay," in one of the uninhabited Galapagos Islands, and possibly that fact, or the adoption of some similar device in the Straits at a time, long ago, when there was no settlement there, and of which a tradition may still remain, may have suggested Victor Hugo's narrative, which again may have been the origin of the paragraph quoted in your columns. ARCH. ROXBURGH

Valparaiso, March 23

JOHN DUNCAN, THE ALFORD WEAVER-BOTANIST

THE subscriptions spontaneously sent for the purpose of forming a fund to raise this deserving old botanist above the need of accepting parochial relief have now reached the handsome sum of 322*l.* 19*s.* 10*d.* Of this sum there were sent through NATURE 73*l.* 6*s.* 9*d.*; to Mr. Jolly, Inverness, 223*l.* 10*s.* 10*d.*; to Alford direct, 90*l.* 19*s.* 7*d.*; through the *Free Press*, Aberdeen, 12*l.* 9*s.*; and through the *People's Journal*, Aberdeen, 1*l.* The names of the subscribers to the NATURE Fund have already been published here. The list of the others is much too long to be inserted, the very length showing the wide-spread interest excited by the case. It includes above 300 separate subscriptions, ranging from 30*l.* from Mrs. Alfred Morrison of London, to 1*s.* from a working man and from a child botanist, and the names of many of our most eminent scientists. Some interesting details might be given of the warm sympathy expressed in the case; the wording of special subscriptions, some large sums from nameless donors, and the plans adopted by different persons in different parts of the country interested in the old botanist, to gain the help of the generous: but want of space prevents these being entered on. One item deserves mention, namely, the interest manifested in the case by several scientific societies already mentioned in NATURE; though it must be added that the absence of the names of some societies especially devoted to Botany, and of the University of Aberdeen, which received the gift of John's herbarium, is not a little strange. The action of these generous societies is no doubt a not unimportant means of assisting scientific inquiry and "endowing research." As already stated, Her Majesty was graciously pleased to present a gift of 10*l.*

A trust-deed has now been formally executed and signed by John Duncan, disposing of the money thus subscribed, and his books and other possessions, during his life and after death, vesting all powers, with certain discretionary liberties, in seven trustees, provision being made for their permanent continuance. These trustees consist of Mr. William Jolly, H.M. Inspector of Schools, Inverness, whose sketch of Duncan in *Good Words* in 1878 first drew attention to the old man, and whose recent appeal in his behalf has resulted in the present ample provision for his comfort, Mr. Farquharson of Haughton, near Alford, chairman of the School Board of Alford, the Rev. Mr. Gillan, and the Rev. Mr. Brander, the Established and Free Church clergymen of Alford, and three other gentlemen personally interested in Duncan; the permanent trustees of his property, if any remain, to be the ministers of the Established and Free Churches of Alford and the Chairman of the School Board of Alford, with power to add to their number, so that the full number shall never be under five. It is provided, that he agrees to the provision made for him during his life, which is ample, and that whatever sum remains at his death shall be vested in safe securities and the interest arising therefrom devoted to the foundation of scholarships or prizes for the promotion of science, especially Botany, in schools in certain parishes named, in the Vale of Alford; his books, which are numerous and good, especially those on Botany, being gifted to the parish of Alford, for the same object. Meantime the greater part of the money in hand will be invested at good interest.

It must be gratifying to the subscribers to know that not only will the comfort of the old botanist be secured for the remainder of his life, but that any surplus, which is almost certain to be considerable, will promote for all time the pursuit of those studies that have made Duncan famous, among the children, male and female, of the district in which he has achieved his own scientific work. The worthy man, now in his eighty-seventh year, is frail, and the past severe winter has been hard upon him, as upon all aged people; but he may, and probably will, survive for some years to come. His gratification and gratitude at the kindness recently shown him are expressed with childlike depth and sincerity. Any remaining subscriptions offered should be sent without delay to Mr. Jolly, Inverness, in order that all requisite arrangements may be completed.

ELECTRIC LIGHTING

I.

ONE of the greatest experiments ever made in street illumination by means of the electric light was commenced on March 31 in the City of London. The enterprise of the City authorities in this direction is the more commendable, inasmuch as they had previously tried electric lighting on the Holborn Viaduct and in Billingsgate Market with very poor success. In fact, in these two instances the experiment was a decided failure.

Now however, gaining experience from the advances that have been made in other directions, and especially from the great success attending the illumination of several railway stations, the City authorities determined to divide the City into three districts for the purpose of experiment.

1. The London Bridge district: embracing London Bridge, Adelaide Place, King William Street, the front of the Royal Exchange and Mansion House, the Poultry, a part of Cheapside as far as King Street, the upper part of Queen Street, King Street, and the Guildhall Yard.

2. The Blackfriars Bridge district: embracing Blackfriars Bridge, New Bridge Street, Ludgate Circus, Ludgate Hill, St. Paul's Churchyard (north side), and the remaining portion of Cheapside beyond King Street.

3. The third district has not been lit up, and therefore we need not refer to it.

The first district is being lit up by Messrs. Siemens Brothers at a total cost of 3725*l.* for the twelve months, replacing 138 gas-lamps. The other district has been lit up by the Anglo-American Electric Light Company, on the Brush system, for a total cost of 1410*l.*, replacing 150 gas-lamps.

Before drawing any comparison between these two systems it will be just as well to describe how each has been carried out.

The Messrs. Siemens have applied to their (No. 1) district six powerful lights, fixed at a height of 80 feet from the street level upon tall latticed iron masts similar to those which are used on many railways for signalling purposes. They have also twenty-eight smaller lights, carried upon special iron posts, considerably higher than the ordinary lamp-posts, being 20 feet from the pavement. The powerful lights, fixed high up in air, are used more for the illumination of open spaces, and this system—a special feature of Dr. Siemens'—has been very extensively adopted at the Albert Docks, Blackpool, and other places. The central station of the Siemens system is in Old Swan Lane. Here three engines, supplied by Messrs. Marshall of Gainsborough, of their semi-portable type, and of 10-horse power each, fitted with an admirable automatic expansion gear (Hartnell's) specially applicable to engines used for electric lighting purposes, are fixed. Two of these engines are always at work during the time of lighting, but one is kept in reserve, ready at a moment's notice to replace either that may fail. These engines, by means of beltings and a counter-shaft, apply their power to various dynamo-machines of the well-known Siemens type. Each of the high lights is worked by a separate and distinct dynamo-machine, with which it is connected by separate conducting-wires. The wires throughout the whole of the City are of thick copper, very well insulated, and laid under ground after the customary manner of laying down wires for telegraphic purposes. The smaller lights are worked by alternating currents on the system with which we are familiar on the Thames Embankment applied to the Jablochkoff candle. In Swan Lane there are two alternating current machines each working two circuits of seven lights each, the lamps being arranged so that consecutive lamps are not in the same circuit, and by that means, if any accident should occur to one set of lamps it would only extinguish one out of two lights in a street, and not throw the whole district into darkness, which would be the case if all the lights were worked on one circuit. The field-magnets in all the large dynamo-machines are excited by a similar dynamo-machine, while the magnets of the alternating current machines are fed by currents from a smaller continuous dynamo-machine. Each large machine absorbs between 4- and 5-horse power, but the alternating machines require much less. The furthest light from the generating centre —Old Swan Lane—is that in front of the Guildhall, which is nearly three quarters of a mile distant, involving a length of wire of 2500 yards (a return wire being used), whose total resistance does not exceed one Siemens' unit. The illuminating power of the high lights is estimated to be 6000 candles, but it is well known that this estimate of the illuminating power of an electric light is a very wild one. There is no doubt that the lights are very powerful, and a stream of brilliant illumination is thrown all over such an area as that in front of the Royal Exchange. The Siemens' lamps burn for eighteen consecutive hours, owing to the size and length of the carbons used. They are provided with reflectors which throw a bright cone of light down in a very peculiar way, giving to this experiment a very marked feature.

There is no doubt whatever that where it is required to illuminate a large area this is very much more efficiently and economically done by using one single powerful light high up in air, than by distributing several smaller lights over the surface. In the former case the light is more evenly, uniformly, and perfectly diffused, in fact it acquires the character of bright moonlight, while in the latter case the light is distributed in patches of intensity and darkness over the whole space.

When streets are dealt with the conditions are different, and it is here quite easy to show that economy and efficiency are provided for by properly distributing smaller lights along the street. The Messrs. Siemens have set to work to solve this problem in a scientific way, and Mr. Alexander Siemens, under whose control and management the system has been carried out, can show mathematically that to distribute light uniformly and properly a certain definite proportion should exist between the height of the posts and the distance at which they are apart. That this has been carried out is abundantly evident by the very even way in which light is distributed along Queen Street, King William Street, and Cheapside. Indeed it is difficult to see any break in the intensity of the light along the route—a proof that the practical application of the law very nearly approaches its theoretical limit. The theoretical point to be aimed at is that the height of the poles should be to half the distance between them as 1 is to the square root of 2. This has not been absolutely obtained, but a very close approach to it. The small lights only give an illuminating power, according to Messrs. Siemens, of 300 candles, and this probably is well within the mark. Comparisons between lights of low intensity are very easily and accurately measured; it is only when a power equal to thousands of candles is arrived at that the failure of comparison with a standard candle becomes evident.

The high lights have not been burning uniformly with that steadiness that success demands. Instances of failure are not numerous, though they have been frequent. The smaller lights, on the other hand, have worked more uniformly, and have given considerable satisfaction. The strong shadows thrown by the high lights have a very weird-like effect in certain positions, and the vibration of the lamp gives to the shadow of the pole that supports it an unsteadiness that has led the unwary to imagine in many instances that the pole itself was shaking. Could the shadows be removed from the effects of these high lights the effect would be very fine; as it is they detract enormously from the beauty of the lamps. The effect of the high lights to those standing below is excessively pleasing, and doubtless in warmer weather will be more highly appreciated than it has been during the past week. It is when crossing streets, and especially when crossing such a busy thoroughfare as that in front of the Mansion House that these lights show their efficiency to advantage. It is quite amusing to see how the *gamins* of London have taken advantage of the combination of electric lighting and asphalte road to convert the whole City into a gigantic skating-rink. Hundreds of boys are to be seen every night disporting themselves on their roller-skates.

(*To be continued.*)

WEATHER WARNINGS

IN a lecture on Solar Physics delivered at South Kensington on Friday last Prof. Balfour Stewart stated that he believed one great cause of weather changes to be solar variability in which we have periods of short length, as well as others extending over many years.

These weather changes, it is sufficiently well known, are propagated from west to east after they have once appeared.

Again there are variations in the diurnal declination range which may be said to constitute magnetic weather.

These are also caused by solar variability, and it is suspected that they are likewise propagated from west to east, although more quickly than the well-understood changes of meteorological weather.

It would thus appear to be at least possible that British magnetical weather of to-day may be followed by corresponding meteorological weather five or six days hence.

Prof. Stewart has made a preliminary trial, which induces him to think that this is the case, and that it may ultimately be possible to forecast British meteorological weather by means of magnetic weather some five or six days previous to it.

BAROMETRIC GRADIENT AND WIND

I HAVE often felt surprised that the superiority in force of northerly and easterly as compared with southerly and westerly winds accompanying any given amount of barometric gradient has, at least until recently,[1] excited but little attention, seeing that the superiority in question is almost sufficient to suggest itself to any student of daily weather-charts. The comparison of anemometric records for the elucidation of this subject can only be imperfectly made, owing to the fact that there are very few situations at which an instrument can be erected which shall have a really equal exposure to winds from all points of the compass; neither is it possible, as I think, in comparing anemographic records from stations at our different coasts to eliminate the various effects of local inequalities of the earth's surface upon the force of the winds. There are two methods which can be employed in the investigation of this question, which seem to yield reliable, though necessarily somewhat rough and imperfect, results. One of these is to examine separately the anemographs of our imperfectly, but moderately well-exposed, inland stations, in relation to various values of barometric gradient in different directions. The other method is to discuss the means of estimated wind forces in relation to amount and direction of gradient for a large number of years and at a large number of stations. I have hitherto but partially and tentatively employed these two methods, but the results arrived at may possibly be of interest to some readers of NATURE. The mean wind velocities at Stonyhurst Observatory, obtained by me from the hourly readings published by the Meteorological Committee for the years 1874 to 1876 inclusive, for different moderate amounts of atmospheric gradient are as follows:—

Gradient per fifteen nautical miles.	Mean velocity in miles per hour of winds from points between S.S.E. and N.W. (inclusive).	Mean velocity in miles per hour of winds from points between N.N.W. and S.E. (inclusive).
·006	4·31	5·53
·009	5·90	6·82
·012	7·79	9·63
·015	11·09	13·97
·018	13·03	15·29

The mean wind velocities at Kew Observatory for the same period for similar gradients are as follows:—

Gradient per fifteen nautical miles.	Mean velocity in miles per hour of winds from points between S.S.E. and N.W. (inclusive).	Mean velocity in miles per hour of winds from points between N.N.W. and S.E. (inclusive).
·006	4·14	6·88
·009	6·41	8·63
·012	8·37	10·93
·015	11·21	14·27
·018	13·56	16·98

This shows that for any given (moderate) gradient winds from north and east points are stronger than those from south and west points at these stations. The second method, in which the estimated wind-forces have been employed, has been tried by me in the cases of twelve of our English stations for periods varying from ten to three years. The stations examined have been Shields, York, Nottingham, Liverpool, Hurst, Scilly, Dover, London, Oxford, Cambridge, Yarmouth, and Jersey. At all these stations, excepting Liverpool and Jersey, with very low gradients (viz. from ·001 to ·005 inch for fifteen miles), mean estimated wind forces from points between north-north-west and south-east, inclusive, have been higher than those from points between south-south-east and north-west inclusive. With the higher gradients we necessarily find results opposed to this in the cases of stations having a good exposure on the west or south and a bad exposure on the north or east, just as, on the other hand, we find the result above mentioned unduly heightened at stations which have only a good east or north exposure. If however we take stations whose exposure, though not unexceptionable, seems tolerably fair, we find that with somewhat steep as well as with low gradients, north and east winds accompanying any given amount of gradient have a higher estimation than south and west winds accompanying the same. The following table shows results at which I have arrived from an examination of the reports from three stations, viz. the two inland stations of Nottingham and London and the one sea station of St. Mary's, Scilly, which last, while very well exposed to all winds, is perhaps most perfectly so to those from the Atlantic.

	Gradient in inches per fifteen nautical miles.	Mean estimated force of equatorial winds (Beaufort scale).	Corresponding approximate velocity (miles per hour).	Mean estimated force of polar winds (Beaufort scale).	Corresponding approximate velocity (miles per hour).
Nottingham	·001 to ·005	0·43	5·2	1·06	8·3
	·005 to ·010	1·88	12·4	2·26	14·3
	·010 to ·015	2·99	17·9	4·06	23·3
	·015 to ·020	3·64	21·2	4·61	26·0
	·020 to ·025	4·41	25·0	5·35	29·9
London	·001 to ·005	0·91	7·5	1·31	9·5
	·005 to ·010	1·45	10·2	2·00	13·0
	·010 to ·015	2·24	14·2	2·93	17·6
	·015 to ·020	3·01	18·0	4·18	23·9
	·020 to ·025	3·64	21·2	4·85	27·2
Scilly	·001 to ·005	2·42	15·1	2·49	15·4
	·005 to ·010	4·24	24·2	4·86	27·3
	·010 to ·015	5·45	30·5	5·68	31·7
	·015 to ·020	6·40	36·4	6·49	36·9

The suggestion which I offer in explanation of this difference of force in the two classes of winds is made with some diffidence, since it involves a hydrodynamical question, the solution of which is somewhat difficult. Since the atmosphere is of greatest density near the poles, while barometric pressure is less near the poles than over the tropics, the pole-ward, and, under the effects of the earth's rotation, eastward movements of the atmosphere, at any given considerable altitude above the earth's surface, must necessarily greatly exceed the corresponding movements at the surface of the earth. "The planes of equal pressure receive," in short, "an ellipsoidal form, the major axis of which is perpendicular to the axis of the earth."[1] Thus the polar areas of low pressure must be far more permanent and far better marked in the upper than in the lower regions of the atmosphere; consequently gradients for westerly winds when occurring at the earth's surface must commonly extend into the higher regions of the atmosphere; while gradients for easterly winds must, on the contrary, be usually accompanied by gradients for westerly winds at no great distance above them. Observations of the movements of the upper clouds, and also of the winds experienced at the summits

[1] Sprung, "Studien über den Wind und seine Beziehungen zum Luftdruck," ii. p. 6.

[1] Hann, "Zeitschrift der österreich. Ges. für Meteorologie," vol. xiv. p. 35.

of high mountains, fully establish this fact. Observations of the upper clouds further indicate that when a cyclonic disturbance travels eastward in our latitudes, the passage of its centre is usually accompanied (or, more strictly, followed) only by a temporary backing and subsequent veering of the westerly upper-currents, showing that where we have circular isobars at the earth's surface, we should find in the region of the cirrus merely a loop or bend in the isobars for that altitude, could such isobars be drawn. Could we in short have a weather-chart confined to the region of cirrus, we should see in it, in lieu of a deep cyclone, a shallow "secondary" travelling round a portion of the great polar area of depression.

It is true that north-easterly winds may thus be subject to more retardation due to friction at their upper surface than south-westerly winds. But in a fluid like the atmosphere the whole effect of this retardation must be conceived as almost insignificant.

The question, then, that I would ask is this:—May not the fact that any given gradient for an east wind is wholly contributed by the strata of atmosphere near the earth's surface, while a similar gradient for a west wind is contributed by the whole mass of atmosphere overhead, be imagined, consistently with what we know of the mechanics of the atmospheric currents, to give a greater force of wind in the former than in the latter case, at the surface of the earth?

There is one other point to which I may be here permitted to call attention, though it relates to language alone. I have employed above, consistently with common usage, the expression "gradient for" a particular wind; but this expression appears liable to the objection that it involves a hypothesis, and one which is moreover not in accordance with fact. "A gradient for a south-west wind" signifies a distribution of pressure in which isobars lie south-west and north-east, and in which the lowest pressure is in the north-west and the highest in the south-east. But it is only in the higher latitudes, and on a level surface such as the sea, that this distribution is actually accompanied by a south-west wind. In inland localities, even as far north as the latitudes of the British Isles, it is accompanied by a wind between south-south-west and south; in lower latitudes by a wind still more from the higher to the lower pressures, and finally at the equator such a distribution of pressure would be accompanied by a south-east wind. Further, the expression leads to the needless ignoring of the more local deflections of the winds produced by irregularities of the earth's surface. Would not the expression "north-west*ward*" gradient, simply indicating that barometric pressure decreases most in a north-westward direction, be more correct and equally intelligible? Such a gradient would be one for winds between south-west and south in our northern latitudes, for winds between north-east and east in corresponding southern latitudes, and for winds from the intermediate points over intermediate portions of the globe. "North-west*ward*," "north*ward*," and "north-east*ward*," &c., gradients, are moreover slightly shorter expressions than gradients "for south-west," "for west," "for north-west winds," &c.

W. CLEMENT LEY

SCIENCE IN CHINA[1]

I.

THE Department for the Translation of Foreign Books at the Kiangnan Arsenal, Shanghai, which has for its object the translation and publication of books relating to the arts and sciences of the West, was established towards the close of the year 1869, mainly through the instrumentality of Messrs. Hsü and Hwa, natives of Wuseih, and who at that time were on the staff of officials at the Kiangnan Arsenal. The causes which led to the commencement of this important undertaking are, however, traceable to a much earlier date. In fact, to find a suitable starting-point for its history, it is necessary to go back to the earlier portion of the lives of these two Chinese gentlemen.

Wuseih is an important city on the borders of the Ta Hu, or Great Lake, in the province of Kiangnan, and has long been noted for its industrial pursuits, as well as the energy and enterprise of its inhabitants, many of whom have emigrated to Japan at various times. It was in this busy place that a little *coterie* of intelligent scholars was formed, all deploring the hollow and unsatisfying nature of the ordinary routine of Chinese studies. They determined to push their investigations in a more useful and promising field by endeavouring to become acquainted with the great laws of nature, and to gather as much information as they possibly could respecting the various branches of science and art.

Without organising themselves into a society, these aspirants for intellectual light used to have occasional meetings of an informal kind for mutual improvement, each person explaining any new facts or ideas he had acquired. The works of the early Jesuit fathers on mathematics, astronomy, and kindred subjects were carefully read, as well as original native works. But at last, during a visit to Shanghai, they found a valuable prize in Dr. Hobson's translation of a treatise on Natural Philosophy, published at the London Mission Hospital in Canton in the year 1855. This book, though of a very elementary character, was like the dawn of a new era upon their minds, enabling them to leap at one bound across the two centuries that had elapsed since the Jesuit fathers commenced the task of the intellectual enlightenment of China, and bringing them face to face with the results of some of the great modern discoveries. Apparatus was extemporised at their homes to perform the various experiments described in its pages, and every new theory or law was put to the test as far as their limited means would permit. Frequent papers were written and circulated from one to another, while queries were continually started by individuals asking for more information on difficult subjects. A pile of such manuscripts accumulated in the house of Mr. Hsü, who, with his son, formed a sort of centre for this little oasis in the midst of a vast desert of ignorance and superstition. Unfortunately, however, these manuscripts were all destroyed when the Taiping rebels captured the city, and the little company were glad to escape with their lives to the neighbouring hills, among which they found a temporary refuge. Even in these trying circumstances they were able to turn their knowledge to good account in different ways so as to alleviate their own hardships as well as those of their fellow-sufferers.

In the third moon of the first year of Tung-che, or 1862, an Imperial edict called upon the Governor-General of the "Two Kiang" provinces to search throughout his jurisdiction for men of talent and ingenuity, and versed in the arts and sciences, who should assist in improving the condition of the Empire. H. E. Tsêng Kwo-fan accordingly selected six men, whose names were duly forwarded to Peking. Among the number were Messrs. Hsü and Hwa, whose reputation as scientists had by this time extended far beyond their native town. They were afterwards invited to an interview with the Governor-General at Anching, and were at once retained on his staff, with the view of their being able to study and perfect themselves in the more useful branches of the foreign arts, sciences, and manufactures.

At that time the rebels were in possession of Nanking, and the surrounding country was in a most unsettled state, so that little could be done in the direction of improvement or study. Mr. Hwa, however, was engaged with others in collecting and preparing such scientific books as China then possessed. This work was after-

[1] By Mr. John Fryer, Chief Translator to the Chinese Arsenal.

wards continued at Nanking, where, under the auspices of the Viceroy, an establishment was commenced for the publication of useful books. Many valuable works, such as Mr. Wylie's translation of Euclid, the Differential and Integral Calculus, Dr. Edkin's translation of Mechanics, and similar treatises, have already been republished there, and the establishment is still in existence.

While Mr. Hwa was engaged in this kind of labour, Mr. Hsü was called upon to perform a task of a very different kind. The Viceroy required him to build a steamboat, and reluctantly he consented to make the attempt. He first made a model of an engine from the somewhat rough illustrations in Dr. Hobson's work before referred to. This proving to be a success, he was encouraged to proceed with the more difficult task assigned him. By means of Chinese tools and materials, and such ideas as he contrived to get through looking carefully over a small steamer at Anching, he managed to prepare his designs, and commenced his work with no foreign assistance whatever. He met with a most determined opposition from local officials, but, assisted by his son and encouraged by the Viceroy, who took a lively interest in the proceedings, the work was at length completed; not, however, without at least one entire failure. The steamer, which was of twenty-five tons measurement, was able to make 255 *li*, or about 85 miles, in fourteen hours, and to do the return journey in less than eight hours at her trial trip on the Yang-tse in 1865. The Marquis Tsêng, now ambassador to England, also took great interest in this little craft, giving her the highly classical name of *Wang-kao* or *Yellow Swan*, and making several trips in her on the Yang-tsze.

It will be readily granted that the experience gained under so many difficulties ought to have given Mr. Hsü and his son somewhat of an insight into foreign arts and sciences, and to have raised them far above the level of the best of their fellow-countrymen. Not contented, however, with the small stock of knowledge they felt they possessed, they made several visits to Shanghai, in some of which they were joined by Mr. Hwa, with a view to making new mental acquisitions. During these visits they made the acquaintance of Mr. Li Shan-lan, the celebrated native mathematician, who was then translating with the Rev. J. Edkins and Mr. Wylie such works as Whewell's "Mechanics," Herschel's "Astronomy," Euclid, the Calculus, &c., at the London Mission. On these occasions they added largely to their intellectual attainments. They also gained many new ideas from other well-known Sinologues, such as the Revs. Messrs. Muirhead and John, and Dr. Williamson, for whom they often express much respect.

At length deciding to settle in Shanghai for the convenience of carrying on their investigations and studies in the vicinity of foreigners, they obtained from H. E. Tsêng Kwo-fan a mandate attaching them to the staff of officials at the Kiangnan Arsenal, which had recently been commenced. Here they arrived in the beginning of the year 1867, and soon endeavoured, in connection with the Arsenal directors, Fung and Shen, to organise methods by which their long-cherished hopes might be realised and their thirst after knowledge satisfied. Their aspirations finally resolved themselves into a definite form, and led them to devise a plan for the translation and publication of a series of treatises on the various branches of Western learning that should bear some resemblance to the *Encyclopædia Britannica*, of which they had ordered a copy from England. In this manner they hoped not only to instruct themselves, but to diffuse the knowledge they had acquired with so much pains among their fellow-countrymen, and leave behind them a lasting name throughout the Empire. It was also imagined by them that such a series of treatises would prove especially useful as text-books in various educational establishments of a high order, which it was then hoped would soon be instituted in the different provinces.

This scheme was warmly taken up by the directors of the Arsenal, who easily obtained the permission of the Viceroy to begin to carry it out on a small scale by way of experiment. Various foreign gentlemen were applied to for their services, but without success, till at last a commencement was made by Mr. Fryer, who at that time was editing the Chinese newspaper published at the *North China Herald* Office in Shanghai. He was asked to purchase a collection of suitable European books, and to begin at once to translate a work on Practical Geometry with Mr. Hsü, jun. Subsequently Mr. A. Wylie's services were secured for a treatise on the Steam Engine, with Mr. Hsü, sen., while Dr. Macgowan undertook the translation of a work on Geology with Mr. Hwa. These three books, which formed the beginning of this large undertaking, were translated at the residences of the Europeans above named. It soon became manifest, however, that it would be impossible to carry on the work successfully except at the Kiangnan Arsenal, where the books were to be printed and published, and which is distant about four miles from the foreign settlement. Here Mr. Fryer was pressed to give his whole time and attention to translation, and in June of 1868 commenced his labours in a building which was set apart for that purpose. The earliest publications gave such satisfaction to the Viceroy at Nanking that he ordered the operations of the translation department to be extended; the immediate result of which was the addition of Mr. (now Dr.) Kreyer to the regular staff. Subsequently when the Government school for interpreters had been removed from inside the Chinese city to the arsenal, Mr. (now Dr.) Allen's services were re-engaged to conduct it, and he was further asked to give a portion of his time to the work of translation. Dr. Kreyer, after rendering effective service as a translator for some time, left his post for that of interpreter to the Taotai of Shanghai, much to the loss of the department. The vacancy was afterwards filled by Dr. Suvoong, a Chinese graduate of the United States, who has begun to enrich the collection of books by translations of medical and other works, for which task his long residence and studies in America have well qualified him.

The number of the native members of the staff has been subject to frequent changes. At present there are five Chinese gentlemen who are engaged either in writing the translations or in preparing the various books for publication. Among this number Mr. Hsü, sen., is the only one who has remained constantly at his post from the commencement, and whose desire for knowledge does not yet appear to abate, although he is now well advanced in years. Others have worked for longer or shorter periods, and then have either grown tired of such monotonous labour, or have accepted official appointments that were offered to them. This continual changing has not been without injurious effects in some cases. Either important books have been left half finished, no one liking to take up another's work, or if finished the manuscripts have been taken away or passed from one to another, so that after the lapse of a year or two they cannot be found.

Among the officials who have left the work for higher appointments may be mentioned H. E. Li Fung-pao, the present Minister to Berlin; Mr. Hsü, jun., who has just started to join him as secretary, and who was lately Director of the Shantung Arsenal; Mr. Hwa, who has been Director of the Tientsin Powder Works, and now is Resident Curator of the Chinese Polytechnic Institution; Mr. Wang, who is a director of the Tientsin Arsenal; and Mr. Hwang, an *attaché* of the Chinese Legation in London. The names of several other gentlemen in important positions might also be added, all of whom were at one time or another on the staff, and manifestly derived benefit from carrying on work which brought them into daily contact with Europeans. Viewed, therefore, merely in the light of an educational establishment, this department has been of much benefit to the Government by supplying so many intelligent and well-informed officials, all more or less imbued with favourable notions respecting foreigners and a desire to see foreign intercourse extended.

The history of Mr. Ka Pu-wei, who has for several years worked in connection with this department, is almost as remarkable as that of Messrs. Hsü and Hwa. From his childhood he had a strong leaning to mathematical studies; but not being in independent circumstances, he was obliged to support himself by keeping a rice-shop inside the city of Shanghai. Here he prosecuted his studies with such success that he was able to calculate eclipses and to prepare an almanac giving particulars respecting the movements of the heavenly bodies, which he ventured to publish. The Government alone having the authority to publish almanacs, and the country being at the time unsettled by the Taiping rebellion, he was charged with having designs against the Imperial throne, and cast into prison. He narrowly escaped with his life, but suffered imprisonment for above a year, till his friends could procure his release. He is now chiefly engaged in compiling and publishing a nautical almanac, calculated for the longitude of Shanghai instead of Peking or Greenwich, and in preparing various books of mathematical tables, for all of which his past studies have been an excellent means of preparation.

Equally interesting is the history of Mr. Li Shan-lan, who was for a short time connected with the Translation Department before his removal to Peking, as Professor of Mathematics in the University of that city. He is a native of the Province of Chekiang, and from his earliest years manifested a remarkable genius for the science of numbers. In the year 1845 he began to publish original treatises embracing different problems in the higher mathematics. On one occasion when at Shanghai he went to a chapel where Dr. Medhurst was preaching to a Chinese congregation, and showed him one of these works. This resulted in his being engaged in the London Mission, where Mr. Wylie took him in hand and translated with him several mathematical works of the highest order, as well as Herschel's "Outlines of Astronomy." With Dr. Edkins he translated Whewell's "Mechanics." Nothing in the way of science seemed to come amiss to him. Eventually he commenced Newton's "Principia" with Mr. Wylie, of which he only translated a small portion of the first book. The remainder of the first book he finished at the Kiangnan Arsenal with Mr. Fryer during the few months of his connection with the Translation Department. He seemed to enter into the most intricate of its problems with the greatest zest and enthusiasm, and often expressed his intense admiration for Newton's genius. His skill in solving the most difficult mathematical questions that could be given him was truly remarkable. Of course there are not many men of his calibre to be found in China; but still no doubt others will be brought to light through the impulse which foreign intercourse is bringing to bear upon the stagnant minds of this long-isolated nation. Now and then a lesser light than Li Shan-lan appears among the various visitors at the Arsenal, and it is reported that Ku Shang-chih, a native of Chiu-shan, is in advance of him; but this needs confirmation.

The establishment where the books are printed in the old-fashioned way from wooden blocks was first merely a small room, but has now grown into a separate range of buildings, and employs upwards of thirty hands as block-cutters, printers, bookbinders, &c., and is superintended by an under-official. Another under-official has charge of the books when printed, and is responsible for the money derived from their sale. About half-a-dozen copyists complete the *personnel* of the department.

The library of foreign books consists now of several hundred volumes, and forms probably the best collection of the kind in China. It is contemplated to make extensive additions shortly of recent important publications.

It may be mentioned that, as a mark of Imperial favour, various honorary degrees of rank have been conferred upon the native and foreign members of the Translation Department, in acknowledgment of the value of their services. Mr. Fryer, Dr. Kreyer, and Dr. Allen received diplomas entitling them to the third, fourth, and fifth degrees of civil rank respectively.

On various occasions some of the highest officials in the Empire have sent requests for books to be translated, bearing on subjects in which they took particular interest. Notably this has been the case with H. E. Li Hung-chang. Among the high dignitaries who have expressed their satisfaction at the results attained by this department, it may be mentioned that on one occasion, when staying at the Arsenal, H. E. Ting Jih-chang expressed himself in strong language as to the importance which he attached to the translation of books, compared with the work carried on in other departments. The Marquis Tsêng, who resided for a few days at the Arsenal in 1877, and has from the first been in favour of the undertaking, gave Mr. Fryer a Chinese fan, on which he had written by way of compliment a verse of Chinese poetry of his own composition, and which may be freely translated as follows:—

> "Nine years have elapsed since our last conversation;
> But your translations have been forwarded to me from time to time.
> May your fame surpass that of Verbiest and Schaal,
> As the electric light exceeds the spark of the glowworm."

(*To be continued.*)

THE GREAT VIENNA TELESCOPE

THE political and social disturbances in Ireland have of late somewhat diverted attention from the literary and scientific work done in that country. Such work has nevertheless proceeded on its quiet way despite land agitation, failure of crops, or even commercial distress; and Ireland is to be congratulated on the completion of the fine 27-inch refracting telescope, designed and constructed by Mr. Howard Grubb of Dublin for the Imperial and Royal Observatory of Vienna.

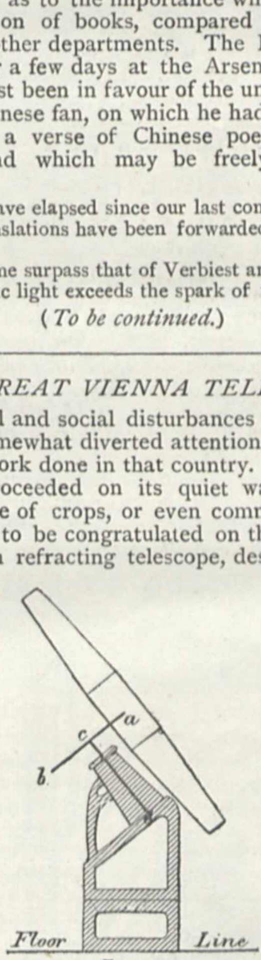


FIG. 1.

This telescope is the largest equatorial refractor at present in existence. In the year 1873 Director Littrow, of the National Observatory of Vienna, induced the then Austrian Minister of Public Construction (R. von Stromayer) to consent to the removal of the Observatory from the old site in the Vienna University grounds to a more favourable site, consisting of a level piece of ground of some fifteen acres in extent, about 200 feet over the general level of the city, and nearly three miles to the north of the cathedral of St. Stephen's. On this plateau a magnificent edifice has been erected, which measures from north to south 330 feet, and from east to west 240 feet. The general plan of the observatory is that of a

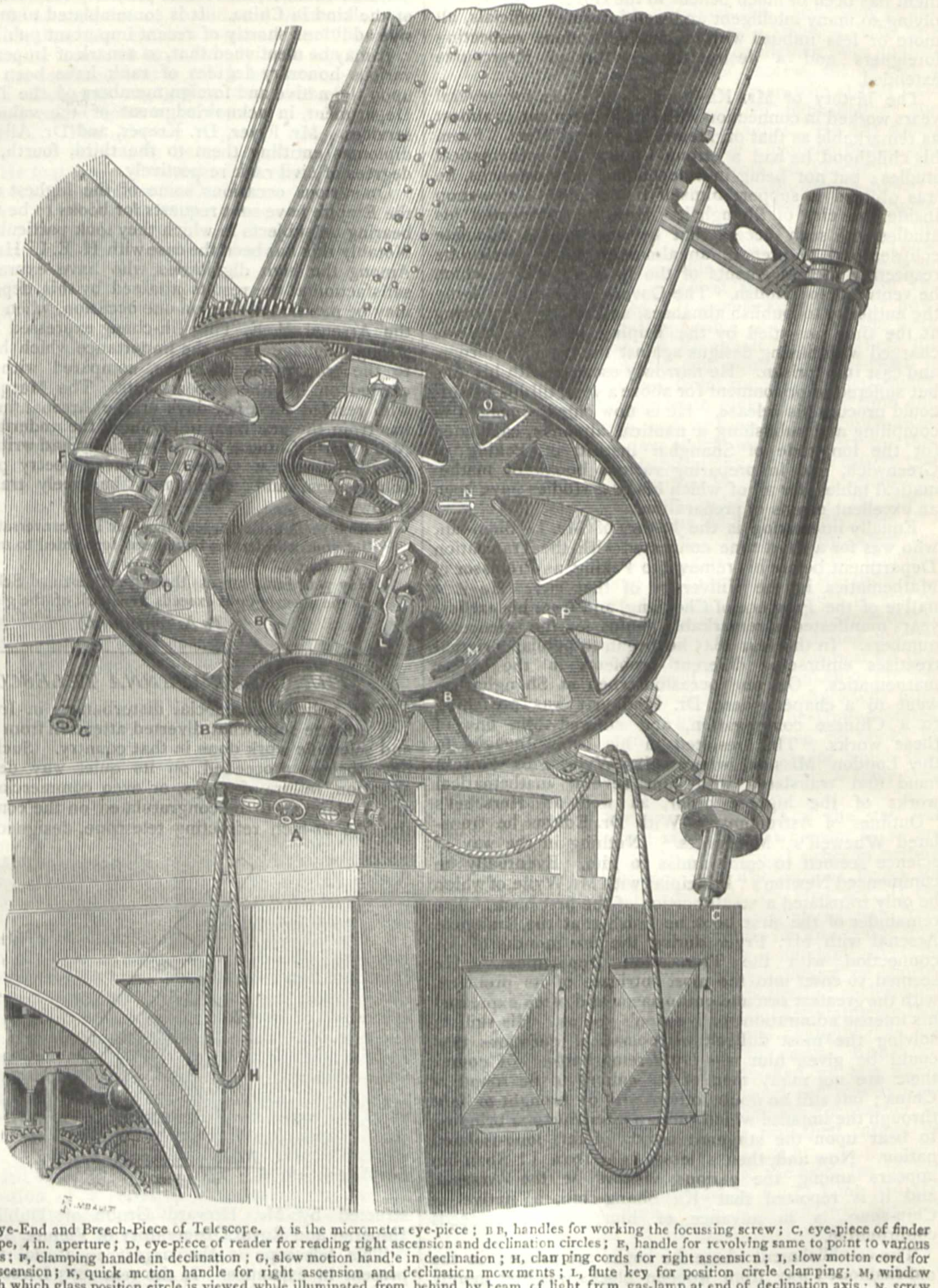


FIG. 2.—Eye-End and Breech-Piece of Telescope. A is the micrometer eye-piece; B B, handles for working the focussing screw; C, eye-piece of finder telescope, 4 in. aperture; D, eye-piece of reader for reading right ascension and declination circles; E, handle for revolving same to point to various verniers; F, clamping handle in declination; G, slow motion handle in declination; H, clamping cords for right ascension; I, slow motion cord for right ascension; K, quick motion handle for right ascension and declination movements; L, flute key for position circle clamping; M, window through which glass position circle is viewed while illuminated from behind by beam of light from gas-lamp at end of declination axis; N, screw for slow motion in position angle; O, key for throwing into position a set of illuminators for "dark field" illumination of micrometer; P, handle for throwing into position an arm carrying one central mirror for "bright field" illumination of micrometer.

Latin cross. One great dome forms the centre, three smaller domes terminate the extremities of three of the short arms, while the fourth arm, looking south, contains the library and lecture-rooms, &c. The south *façade* is very imposing, and in it are the rooms for the director of the Observatory. In one of the smaller domes (each 27 feet in diameter) is placed a 12-inch refractor by Alvan Clark, and it is intended to have in the other two an equatorial for photographic work, and an altazimuth or comet-seeker. It seems a pity that the use of so magnificent a building should in some measure be sacrificed to architectural display, for the splendid south *façade* being devoted to domestic purposes, an enormous proportion of the observations will of necessity be made over the chimneys of the dwelling-house. The great central tower is 45 feet in diameter, and its dome and the revolving machinery to work it have been supplied by Mr. Howard Grubb, who has also put up all the domes of the smaller towers. The great dome is of a very peculiar construction. It is formed of two thin shells of steel plate varying in thickness; these are riveted on the inside and outside of a very light set of steel plate girders 18 inches deep at base and 9 inches at crown, the whole forming a cellular construction like the top and bottom of the Britannia Tubular Bridge. This form gives enormous stiffness for the amount of material used, besides possessing several points of peculiar usefulness for astronomical work, such, the more specially, as keeping the temperature of the dome wonderfully constant, even under most trying circumstances. The total weight of this steel dome, with its ribs and girders, the cast-iron sole plate, and fitting, is about 15 tons, and as the result of a series of very ingenious mechanical contrivances thought out by Mr. Grubb, the tractive force necessary to pull round this huge drum, even when resting, as at Dublin, on a temporary support and insufficiently levelled, was only 70 lbs. All these domes were constructed, so far as the framework went, in Dublin, and they have been placed for some time past *in situ* at Vienna, under the superintendence of Mr. W. K. Davis, Mr. Grubb's engineer.

The new Observatory having been well advanced in 1874 Director Littrow sent his first assistant (now the General Director), Dr. Ed. Weiss, on a tour of inspection to all the great observatories and astronomical workshops of Europe and America, with the result that Dr. Weiss recommended to his Government that an instrument of at least 26-inch aperture should be ordered from the establishment of Mr. Howard Grubb, and in the year 1875 the contract between the Austrian Government and Mr. Grubb was signed for a 27-inch refractor. The mechanical parts were nearly finished in the year 1878, but the greatest difficulties were experienced by the Messrs. Feil of Paris in obtaining perfect disks of glass for the objective, and it was not until after several trials and towards the close of 1879 that this firm succeeded in sending to Dublin disks that ultimately proved perfect. These had to be worked into the objective at Mr. Grubb's establishment, and on several occasions serious flaws were only discovered at a time when but for them the object-glass would have been complete.

The general form of the equatorial may be described as a modification of the German form. In designing it Mr. Grubb kept in view the fact that while circumpolar motion was very desirable—indeed almost necessary—for objects from the horizon to, or approaching to, the zenith, it was by no means so essential for objects beyond that to the pole. This will be evident on consideration, for nineteen-twentieths of the objects usually under observation in these latitudes are between the zenith and south horizon, and if one be observed north of the zenith its apparent rate of progression is so slow that a very little motion of the telescope takes place for any given duration of observation. Keeping this in view, Mr. Grubb has adopted the form shown (Fig. 1), in which the intersection of the axes *c* is placed, not over the centre of the pier, but over the north end nearly, and this allows the telescope circumpolar motion for all objects up to the zenith. It should also be observed that this circumpolar motion gives another advantage besides that of non-reversal, viz. that it allows choice of two positions of the telescope in observing almost any object. In observing near the meridian the telescope may be used *either* to the east or west of the pier, and in observing towards the east or west the telescope can be used either over the polar axis or under. This is sometimes found to be a great convenience. The above considerations were those which influenced Mr. Grubb in deciding on the particular form for the Vienna instrument, and the result is that almost all the advantages of circumpolar motion are obtained without any serious counterbalancing disadvantages.

To enter into full details of all the various parts of this magnificent telescope would far exceed the space at our command. Up to this it has been thought impossible to apply to large equatorials those many important contrivances to save time and labour which all first-rate

Fig. 3.

instrument-makers would adapt to small instruments, but in this one all such contrivances and many novel adaptations of such have been utilised. To enable our readers to form some idea of the resources within the ready reach of the observer, we, through the kindness of the proprietors of our contemporary, *Engineering*, give an illustration (Fig. 2) of the eye-end of the tube.

In the largest telescope until now in existence, the great 26-inch refractor at Washington, the oft-recurring operation of reading the circle involved the sending of an assistant with a hand-lamp to climb up some twenty feet of the instrument, and the vernier not being in a fixed place, but moving about with the telescope, the labour and difficulty of this operation are great. In the Vienna instrument Mr. Grubb has so contrived it that the observer sitting in his chair can read the right ascension and declination circles through one single reader, all being illuminated by one gas-lamp hung on the end of the declination axis.

Another wonderful convenience is enabling an assistant to easily turn and set the instrument to right ascension. This can be understood from Fig. 3, which is from a photograph. In the case of an instrument of the size of the Vienna equatorial, the observer requires an elaborate stage or platform of variable height and position in order to reach the eye-end, and if he has to move to another object he must descend from his chair or platform and move *it* before he can move the instrument, and then he has not the facility of sighting objects, but must adopt a sort of tentative process, climbing up and down his stage and moving it and the telescope alternately. To avoid this labour and save time an arrangement is supplied by which the assistant from the ground floor can set the instrument in right ascension, and once set in one direction, the other (declination setting) can be readily managed by the observer. The assistant is supposed to stand at the south end of the pier. He has there before him a desk on which his catalogue and paper can rest, a sidereal clock-face let into the south end of the pier, a reader telescope by which he can read the lower right ascension circle, and a hand-wheel, which by means of shafts and gearing communicate motion to the instrument in right ascension, and finally a handle which is keyed on to a screw forming the toe-bearing of the quick motion driving-shaft. By giving this handle one turn, the driving-shaft is allowed to drop down out of gear with the rest of the wheelwork, so that the clock when driving the instrument may not have the additional work to do of driving this shaft, which is necessarily a quick one as compared to the motion of polar axis itself. A lamp is attached to pier at west side, which serves to throw light on sidereal clock-face, catalogue, &c., on desk, and also to send a beam of light up through a long tube directed to the vernier of the right ascension circle which is visible through the reader. The assistant has therefore full power of setting the instrument roughly, or if desired with any degree of accuracy, in right ascension, or reading off the right ascension of an object which requires to be identified.

The tube of the telescope is made of steel plate about one-eighth of an inch thick in the centre, and tapering to about one-twelfth of an inch at the ends, the points being all lapped and riveted; it is $33\frac{1}{2}$ feet in length, and lessens from $36\frac{1}{2}$ inches in diameter in the centre to 27 inches at the one and 12 inches at the other end. The weight of the moving parts is between six and seven tons, and still the whole is under easy control of the muscular power of one arm.

The Commissioners appointed by the Austro-Hungarian Government to report on this telescope consisted of Prof. Ball, Astronomer-Royal for Ireland, Earl of Crawfurd and Balcarres, Mr. Huggins, Prof. J. Emerson Reynolds, Earl of Rosse, Prof. Stokes, Dr. G. J. Stoney, and Mr. Walsh, the Austro-Hungarian Consul at Dublin. On March 16 this Commission forwarded to the Austro-Hungarian Embassy in London their full approval of the performance of the instrument, thus marking the successful completion of the largest refracting telescope in existence.

It will be remembered that Mr. Grubb has built among other fine instruments the great Melbourne Reflector, the largest equatorially-mounted telescope known. He has not rested on his laurels, but is now to be cordially congratulated on a still greater accomplishment.

WHEWELL ON COLOURING GEOLOGICAL MAPS

ONE of the subjects to be brought forward for discussion at the International Geological Congress to be held this year at Bologna is the *unification des figurés;* that is to say, an attempt will be made to come to some agreement as to the signs and colours to be used on geological maps. Two things have to be indicated: *succession, i.e.* the stratigraphical position of the rock; and *formation*, by which, adopting a terminology now in much favour on the Continent, we mean the lithological character and origin of the rock, and not, as is generally understood by the word in this country, a subdivision of the stratigraphical series. I have found among Prof. Sedgwick's papers a scheme drawn up by Dr. Whewell nearly half a century ago, which I have thought might be of use to those who are considering this question, and of interest to many besides. It is dated from Dublin, 1835, where he was attending the meeting of the British Association, and it was probably suggested by the publication of Griffiths' map.

William Smith shaded up to the lowest beds of the various groups into which he divided the strata, in order by contrast to mark more strongly the coming in of a new series, but he does not seem to have adopted any system beyond sometimes taking such tints as were suggested by the predominant colours of the rocks represented. Salter, I remember, proposed a scale of colours founded on the spectrum, but the scheme proposed by the late Master of Trinity I do not remember to have seen put forward before. THOS. MCK. HUGHES

Trin. Coll., Cambridge, April 26

Proposal for a Systematic Scale of Geological Colours

THE objects which it would be desirable to secure in fixing the scale of colours for a geological map appear to be the following:—

1. That the different members of the geological series should be coloured in a manner somehow depending on their *place in that series*, so that successive rocks are distinguished.

2. That *this* distinction (of succession) should be governed by some *general principle*, and should not be merely arbitrary; so that without referring to the index list the colour itself should show the difference of older and younger in the rock.

3. That the colours should also show the great leading differences of the material of the strata (limestone, sandstone, clay), so that without referring to the scale these differences should be known from the colour.

4. That *igneous* rocks should by some general circumstance in the colour be distinguished from sedimentary.

5. That the colours which are brought near each other by proximity of succession should be strongly *contrasted*.

The following method would, I think, secure these objects. It proceeds on the supposition that there are three primary colours—Red, Yellow, Blue—and that any two of these mixed in considerably different proportions make several shades of intermediate colour; thus between red and yellow we have many shades of orange, proceeding from pure red, through reddish orange, to orange, yellowish orange, and pure yellow; in like manner we have many shades of green between yellow and blue, and many shades of purple between red and blue. Our scale can be subdivided as far as these shades are distinguishable. We have also black, which can be combined in various proportions with each of the simple colours; thus black with successive doses of red makes brown more and more red.

The general principles which I propose are these:—

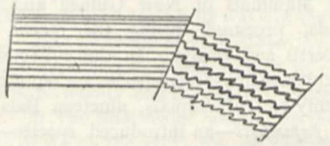
1. Let one of the above four simple colours represent the material and another the order of succession, and let successive mixtures represent successive strata of the same material. Thus let the oldest *limestone* be pure *blue*, let doses of yellow be added to mark newer and newer limestones, the chalk being a very yellow green; thus all the oolite series will be green of different shades.

2. Let the simple colour which represents succession be different for different materials, thus let *blue* represent succession for the *clays*, and let all the clays be *purple*, the oldest therefore being the reddest, and the newest the bluest purple.

In the same way let black represent *sand* strata, and let *red* represent *succession* in such strata; then the sandstones will be represented by *browns*, the oldest being the blackest, and the newest the reddest brown.

3. Let igneous rocks be represented by a general colour, as *red*, and let any order which obtains among them (succession, for example, if succession can be traced) be marked by doses of another colour, as yellow; then the igneous rocks will be all red or orange, the newest being the yellowest.

4. Let other differences (as mineralogical differences) be represented by other means, as by *hatching*. Thus granite and quartz rock, if contemporaneous, may be marked by red with the addition of lines—



According to these principles the English strata would be represented by the following colours, which may thus be denoted by letters; let Red, Yellow, Blue, *Black*, be marked by R, Y, B, *A*, and let mixtures be represented by combinations of the letters. Then we have—

Orange, R R R Y, R R Y, R Y, R Y Y, R Y Y Y.
Green, Y Y Y B, Y Y B, Y B, Y B B, Y B B B.
Purple, B B B R, B B R, B R, B R R, B R R R.
Brown, A R R R, A R R, A R, R A A, R A A A.
Unstratified rocks (primary), R.
" " (trap), R R Y, R Y, R Y Y, &c.
Clay slate, B R.
Oldest limestone, B, B B B Y, B B Y.
Oldest sandstone, A, A A A R, A A R.
Secondary limestone (Mountain), B Y.
New red sandstone " A R.
Oolites " B Y Y, B Y Y Y.
Green sand " A R R.
Chalk " B Y Y Y Y.

Observations:—1. The method here proposed would answer the objects above stated, for the material and order of succession are marked by their proper colours; and the sands, clays, and limestones which occur near each other would be very distinct. Thus the green sand is reddish brown (A R R) and the chalk is yellow green (B Y Y Y Y).

2. Perhaps it may appear an inconvenience that contiguous members of a formation of the same material are proximate shades of the same colour: thus the oolite beds would be successive shades of green (B Y Y, B Y Y Y), and might be difficult to distinguish. I answer, that the beds themselves are often difficult to distinguish, so that our language is most indistinct when our knowledge is most indistinct; again, that the inconvenience, when it is one, may be remedied by marking or hatching those strata; again, that no systematic method can be devised which will not be open to this objection.

3. The above principles being adopted, the whole range of the colours, as modified by the *succession-colour*, might be different according to the different object of the geologist. Thus if he had to exhibit the whole geology of England, *all* limestones whatever must come in between B and Y (Blue and Yellow). But if he take the secondary period only, he may use all the possible shades of green for members of that part of the series alone, and may thus make his terms more numerous.

4. If the *whole* range of the *succession-colour* be employed and exhausted on a *part* only of the geological series of strata, the strata which occur beyond this part will, in the scale used on such occasions, be without representative colours. This is an inevitable evil. We cannot combine the extremes of detail and generality. If we use all our means in expressing a part, we must for the time omit to express the remainder. We must do this when our purpose requires and justifies it.

5. When we use all our colours for part of the geological series, we still preserve the principles above proposed and the advantages which they secure, namely, that the material and the succession are both exhibited in an intelligible way without reference to the index.

6. If we thus make a part of the geological succession to occupy the whole power of our successive colour, we have different colours from those which we have when we represent the whole succession. The partial map has a different index from the general one. This is a serious evil, and must not be incurred without strong necessity.

7. It may be mentioned as an advantage of the proposed notation that many of the colours which are used in it agree very nearly with colours commonly used: as red for granite, blue for older limestones, yellow, or yellow-green for chalk, brown for some sandstones, purple for clays. The main novelties are that the oolites are green, and the coal-fields not black; but as to the latter point, query, whether a *coal* stratum be a proper geological distinction? If the coal-measures be sand or clay beds, they should be brown or purple, according to the material which is taken as characteristic.

In a given case we may have to determine the question above suggested, whether we should employ the whole range of our succession colours on a limited geological period, as, for example, the transition-period. In order to decide this consider what you want. How many limestones have you? How many sandstones, how many clay-rocks, which are to be distinguished? If the oldest limestone be pure blue, and mountain limestone pure green (B Y), we can easily interpose three or four limestones, as (B B B B Y, B B B Y, B B Y); is this a sufficient number of terms for you? and so of the rest.

Summary.—Let there be in all cases a *material colour* and a *succession colour*, namely—

	Material.	Succession.	
Limestone	B ...	Y ...	(Green)
Sandstone (black) ...	A ...	R ...	(Brown)
Clay	R ...	B ...	(Purple)
Igneous Rocks	R ...	Y ...	(Orange)

The latter two lines lead to no confusion, for though R in the clays indicates the material, it is never to be used without B, and R in igneous rocks is never used with B.

It may be observed that in the preceding scheme I have not exhausted the power of colour, for I have not used either the combinations of *black with blue* or of *black with yellow*, or the combination of *three* simple colours. W. W.

Dublin, August 17, 1835

NOTES

We are glad to learn that the Italian Government has decided on having a deep-sea expedition in the course of this summer to explore the Mediterranean. The necessary arrangements are now being made by Prof. Giglioli, the eminent zoologist, at Florence, who will take charge of the biological part of the work. Capt. Magnaghi will be intrusted with the physical part of the work, as well as with the command of the vessel. The scientific results may be expected to be of especial interest, because nothing has been done to explore the depths of the Mediterranean beyond the short cruise in H.M.S. *Porcupine* in 1870.

Prof. Tyndall has written to the *Times* of yesterday a letter of great interest on the attitude of the late Mr. Carlyle towards modern science, which it has been taken for granted was purely hostile. But according to Prof. Tyndall, not only was Mr. Carlyle deeply interested in some of the latest researches of science, but he took great and successful pains to understand them, and was even open to accept some of the latest developments of scientific thought. At first, for example, his attitude to Darwinism was decidedly hostile, but later on, Prof. Tyndall states, "he approved cordially of certain writings in which Mr. Darwin's views were vigorously advocated, while a personal interview with the great naturalist caused him to say afterwards that Charles Darwin was the most charming of men."

WE learn from the *American Naturalist* that a proposal will be made at the next meeting of the American Association to invite the British Association to hold its meeting in 1883 in America in conjunction with its American sister. The proposal deserves consideration.

ACCORDING to the *Frankfürter Zeitung*, at Nakkoo, in the Island of Lapland, an eagle was shot on the 15th ult., which measured 6½ feet between the tips of the wings. Round its neck it had a brass chain to which a little tin box was fastened. The box contained a slip of paper on which was written in Danish, "Caught and set free again in 1792 by N. and C. Andersen.—Boetod in Falster, Denmark."

WE regret to learn that the printing of the "International Bulletin" issued by the U.S. Signal Office will hereafter be twelve months after date, instead of six months as at present. This seems to us a step backwards from the energetic and liberal policy of the late General Myer.

PROF. GEGENBAUR, the well-known Heidelberg comparative anatomist, is said to be dangerously ill with blood-poisoning, contracted while dissecting.

THE Davis Lectures for 1881 will be given in the lecture-room in the Zoological Society's Gardens in the Regent's Park, on Thursdays at 5 p.m., commencing June 16. The following are the subjects and lectures:—June 16, Whales, Prof. Flower, F.R.S.; June 23, Dolphins, Prof. Flower, F.R.S.; June 30, Extinct British Quadrupeds, Mr. J. E. Harting; July 7, The Limbs of Birds, Prof. W. K. Parker, F.R.S.; July 14, Birds Ancient and Modern, Mr. W. A. Forbes; July 21, Zoological Gardens, Dr. P. L. Sclater, F.R.S.; July 28, Chameleons, Prof. Mivart, F.R.S. These lectures will be free to Fellows of the Society and their friends, and to other visitors to the Gardens.

AT the fifty-second anniversary of the Zoological Society the report of the Council on the proceedings of the Society during the past year was read by Mr. Sclater, F.R.S., the Secretary. It stated that the number of Fellows on December 31, 1880, was 3309 against 3364 at the same date of the previous year, 153 new Fellows having been elected, and 208 removed by death or other causes during the year. The total receipts for 1880 had amounted to 27,388*l*. against 26,463 for 1879. The ordinary expenditure for 1880 had been 24,753*l*., and the extraordinary expenditure 1825*l*., besides which the sum of 1000*l*. had been devoted to the repayment of part of the mortgage-debt due on the Society's freehold premises, which had thus been reduced to 7000*l*. This had left a balance of 879*l*. to be carried forward for the benefit of the present year. The total assets of the Society on December 31 last were estimated at 27,852*l*., and the liabilities at 9078*l*. Amongst the works carried out in the Society's Gardens in 1880 were specially noticed the completion of the insectorium (which had just been opened to the public, and contained a collection of living insects), and the thorough repair and reconstruction of the parrot-house. The number of visitors to the Society's Gardens in 1880 had been 675,979, gainst 643,000 in 1879. The zoological lectures having been well attended during the past year, would be continued during the present season. The number of animals in the Society's collection on December 31 last was 2372, of which 703 were mammals, 1438 birds, and 231 reptiles. Special attention was called to the increasing number of presents to the menagerie received by the Society of late years, the number thus acquired having now so increased as to usually exceed the number of those obtained by purchase. Col. J. A. Grant, C.B., F.R.S., Dr. Günther, F.R.S., Prof. Newton, F.R.S., Osbert Salvin, F.R.S., and the Right Hon. George Sclater Booth, M.P., were elected new Members of Council. Prof. W. H. Flower, LL.D., F.R.S., was re-elected President, Mr. Robert Drummond, Treasurer, and Mr. Philip Lutley Sclater, M.A., Ph.D., F.R.S., Secretary to the Society.

A NEWLY issued part of the Annals of the "Museo Civico" of Genoa is devoted to a memoir by Dr. Peters and Marquis G. Doria on the Mammals of New Guinea and the adjoining Papuan Islands, procured during the recent researches of Beccari, D'Albertis and Bruijn. In the collection amassed by these ardent explorers fifty-seven species are represented, amongst which are twenty-two Marsupials, nineteen Bats, and thirteen Rodents; *Sus papuensis*—an introduced species—was the only Ungulate met with. It will be seen, therefore, that, as in Australia, the Mammal-fauna of the Papuan sub-region may be said to consist nearly entirely of Marsupials, Bats, and Rodents. Its affinity to Australia is further shown by the presence of a Monotreme (*Tachyglossus bruijnii*), and by the occurrence of such genera as *Macropus*, *Dasyurus*, and *Dromicia*. The memoir is illustrated by eighteen excellent plates.

MR. THISELTON DYER writes to the *Daily News* in reference to a suggestion "that the labels of ferns, flowering and other plants in Kew Gardens should bear not only scientific but popular names." Mr. Dyer states that as far as such popular names can be ascertained they are carefully indicated on the Kew labels. "There is some misapprehension," Mr. Dyer states, "about the popular names of plants. Your correspondent seems to have proceeded on the assumption that there is a popular botanical nomenclature co-extensive with the scientific. This is very far indeed from being true even of a vegetation so thoroughly investigated as that of the British Islands. Of the plants of foreign (especially tropical) countries it is obviously, with the exception of some useful or medicinal plants, not true at all. But, as you will observe from the accompanying copy of the popular guide to the Royal Gardens, where anything like a genuine popular name exists, great prominence is given to it at Kew. . . . The popular tongue is by no means ready in finding acceptable names for the foreign plants of our gardens, and is quite content to accept from botanists Dahlia, Petunia, Phlox, Pelargonium, Gladiolus, Calceolaria, and the like."

WE take the following from the May number of the *American Naturalist*:—The Kansas Academy of Science, at their November meeting, appointed a Commission to memorialise the Legislature in reference to a State Survey. Two preliminary surveys under Professors Mudge and Swallow have already been made. A more extended and thorough scientific survey is now needed. The most active geologist now in the field in this State is Prof. O. W. John, who for two years past has studied the stratigraphical geology of Eastern Kansas. Last summer Prof. F. H. Snow, with several assistants, spent over a month in Santa Fé Cañon, New Mexico, as well as in Colorado, and made important entomological collections; among them were twelve new species of coleoptera and an interesting collection of geometrid moths, comprising a number new to the Colorado plateau region. Prof. A. Hyatt, the curator of the Boston (U.S.) Society of Natural History, announces that a sea-side laboratory will be opened this year under his direction at Annisquam, Mass., three miles from Gloucester, from June 5 to September 15.

WE have received copies of handy and cheap guides to the New Natural History Museum; penny guides are furnished for each of the departments, and a guide to the whole place costs only threepence. This is as it should be.

FROM Gustav Wolf, the Leipzig publisher, we have received a copy of a most useful "Naturwissenschaftlich-mathematisches Vademecum." The catalogue is really an index, both of subjects and authors, to all recent publications of importance in physical and natural science, and is likely to prove of real service to all scientific workers.

AT the meeting on April 26 of the Institution of Civil Engineers, Mr. Walter R. Browne, M.A., M.Inst. C.E., read a paper on "The Relative Value of Tidal and Upland Waters in maintaining Rivers, Estuaries, and Harbours." The author, while declining to lay down any universal rule, held as a general principle that the main scouring agent was not the tidal but the low-water flow. This principle was supported by the following line of argument:—1. The silt, which tended to choke up tidal channels, was almost wholly due to the tidal water, and not to the fresh water. 2. The tidal water brought up more silt on the flow than it took down on the ebb; *i.e.*, on the whole it tended to choke the channel, not to scour it. 3. The low-water flow, if left to itself, scoured away the deposit and kept the channel open 4. Hence it was concluded that where the two acted together, the scour must be due mainly, if not entirely, to the low-water flow, and not to the tidal flow. It was added that low-water scour was in its nature self-regulating, whilst tidal scour, if it once began, would tend to increase indefinitely. But the essential point was to discover the ratio of the bottom to the surface velocity under all possible circumstances, since it was obvious that the former alone had any scouring effect. Tables were given showing that the ratio of bottom to surface velocity diminished rapidly with an increase of depth; but their application to tidal channels was doubtful, because then the river, instead of being (in a theoretical point of view) indefinitely long, fell at a short distance into an estuary whose waters might be considered at rest. The author had conducted two series of experiments on the surface and bottom velocities of the River Avon, in the course of an ebb-tide. Both series of experiments showed that during the greater part of the ebb the bottom velocity was actually *nil*. When about two thirds of the ebb was over, the bottom layers of water appeared to start into activity, and to assume a velocity about two-thirds of that at the surface. This is shown by the following extract from the tables:—

Position of meter.	Time after ebb began. h. m.	Depth of water. ft. in.	Velocity, feet per sec.
Surface	1 0 ...	22 8 ...	3·57
Bottom	1 10 ...	21 0 ...	0·00
Surface	1 53 ...	14 10 ...	4·60
Bottom	2 4 ...	13 6 ...	0·00
Surface	3 45 ...	5 8 ...	3·07
Bottom	3 54 ...	5 7 ...	1·91

The following conclusions were drawn from these and other experiments:—In the largest rivers the bottom velocity is for practical purposes the same as the surface velocity. In ordinary rivers the bottom velocity bears to the surface velocity a ratio which is about three-fourths at 5 feet depth, one-half at 15 feet, and one-third at 25 feet. In tidal channels, such as the Avon, during two-thirds of the ebb the slope of the surface is exceedingly small; and while the surface velocity is large the bottom velocity is *nil*. During this period no scour, but rather deposit, is going on. For the remainder of the ebb the conditions approximate to those of an ordinary river; scour does go on, but its amount is insufficient to sweep away the silt which has been deposited, not only at the top of the tide, but also during two-thirds of the ebb. Embankments had frequently proved beneficial rather than the reverse; a fact explained by the author's experiments, since the level of the ebb tide would in consequence fall more rapidly, and the point at which the water at the bottom began to move would be reached at an earlier period. Again, the process called "dockising," or damming a river at its mouth, had frequently been condemned on account of supposed injury to the river itself, or even to the estuary in which it flowed, but, as would appear from this paper, without foundation. The results would exercise an important influence on other cases, both of theory and practice.

A SHOCK of earthquake is reported on the night of April 28 from Sicily and the province of Reggio di Calabria, and as far as Catanzaro and Monteleone.

WE learn that M. Alphaud, the Director of Public Works in Paris, has in his hands the tender of Siemens and Co. for constructing an electrical railway from the Place de la Concorde to the interior of the Electrical Exhibition. M. Alphaud has given his adhesion to the request, which will be sent with his recommendation to the Commission of Sewers appointed by the Municipal Council, that when the Exhibition shall be closed, the railway will be kept running in the Champs Elysées.

MR. PREECE has been spending a few days in Paris in order to report on the electric establishments and experiments which are being made in that city. He inspected the electric conductors of several large monuments, visited the telephonic exchanges, the Méritens factory, where are being built the magneto-electric engines ordered by the French Lighthouses Administration and the Trinity House, &c., &c.

THOSE interested in sanitary matters should see the Preliminary Report to the U.S. National Board of Health on the Relation of Soils to Health, in the supplement to the *Bulletin* of the Board for April 16. The special point reported on is the Filtering Capacity of Soils, by Messrs. R. Pumpelly and G. A. Smith.

A MEETING of the Yorkshire Geological and Polytechnic Society was held on April 27 at the Royal Institution, Hull, under the presidency of Mr. A. K. Rollit, LL.D., F.R.A.S., &c., ex-president of the Hull Literary and Philosophical Society. There was a fair attendance, including representatives from several parts of Yorkshire. A brief introductory address on recent advances in physical science was made by Dr. Rollit, after which Mr. G. W. Lamplugh, F.G.S., read a paper on "The Peculiar Intermingling of Gravel and Boulder Clay in some Sections near Bridlington." Mr. J. W. Davis, F.G.S., hon. sec., then read and remarked upon papers by Mr. A. G. Cameron of H.M. Geological Survey, on "The Subsidences above the Permian Limestone between Hartlepool and Ripon," and Mr. J. E. Clark, B.A., on "A Deep Glacial Section at the Friends' Retreat at York." Dr. James Geikie, F.R.S., was present at the meeting, and made some observations on the subject of geology generally. In the afternoon the Society made a geological excursion to the east coast at Withernsea and to the gravel-pits at Kelsey Hill near Burstwick, at the former of which places Dr. Geikie delivered a geological address.

ABOUT twenty minutes to eleven on Monday night, owing to some accident at present unexplained, the electric lights on the Brush system, one of the three with which experiments are at present being made in the City, were suddenly extinguished, leaving a large portion of the City in total darkness. The area over which the Brush light has been placed extends from Blackfriars Bridge, up Ludgate Hill, to St. Paul's Churchyard, and down Cheapside as far as Queen Street and King Street. Fortunately the old gas-lamps remain in their places while the electric light experiments are being made, and orders were quickly given for these to be lighted. Every attempt was made by those in charge of the Brush light to restore the connection, and for a few minutes it seemed as though they had succeeded; but this only lasted for a very short time, and it was soon seen that something had gone hopelessly wrong.

THE following excursions have been arranged for by the Geologists' Association:—To Croydon, Shirley and the Addington Hills, May 7; to Grays, Essex, May 14; Sheppey, May 23.

MR. LANT CARPENTER asks us to state that in his article on Niagara in NATURE, vol. xxiii. p. 511, he attributed the article on the "Music of Niagara," in *Scribner's Magazine* for February, 1881, to Mr. Eugene Schuyler, whereas the author was Mr. Eugene Thayer, of Tremont Street, Boston, Mass.

THE additions to the Zoological Society's Gardens during the past week include a Silver Fox (*Canis fulvus*, var. *argentata*) from North America, presented by Mr. Robert Hunt L. B. Lydston Newman; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mrs. J. S. Henderson; a Goldfinch (*Carduelis elegans*), British, a Snow Bunting (*Plectrophanes nivalis*), European, presented by Mr. John Fletcher; an Eyed Lizard (*Lacerta ocellata*), South European, presented by Mr. James Wellford; an Indian Cobra (*Naia tripudians*) from India, presented by Mr. A. H. Jamrach; a Ludio Monkey (*Cercopithecus ludio*) from West Africa, on approval; two Humboldt's Lagothrix (*Lagothrix humboldti*), two Matamata Terrapins (*Chelys matamata*) from Upper Amazons, a Green-billed Toucan (*Ramphastos dicolorus*) from Guiana, three Saddle-billed Storks (*Xenorhynchus senegalensis*) from West Africa, three Roseate Spoonbills (*Platalea ajaja*) from South America, a Japanese Teal (*Querquedula formosa*) from North-East Asia, three Magellanic Geese (*Bernicla magellanica*) from the Falkland Islands, purchased; a Reeves' Muntjac (*Cervulus reevesi* ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE INTRA-MERCURIAL PLANET QUESTION.—It may be remembered that when the late Prof. Watson claimed to have seen an unknown object near the star θ Cancri during the totality of the eclipse of July 29, 1878, it was objected with respect to his supposition as to its being an intra-Mercurial planet, that he had not anywhere mentioned his having seen the object at the same time as the star, or as well as the star, consequently that his circle-reading may have really applied to the latter. From Prof. Watson's official report on his observations, just published with many others, by the Superintendent of the Naval Observatory at Washington, it appears that this objection is no longer valid. Prof. Watson writes: "Between the sun and θ Cancri, and a little to the south, I saw a ruddy star whose magnitude I estimated to be 4½. It was fully a magnitude brighter than θ Cancri, which I saw at the same time, and it did not exhibit any elongation, such as might be expected if it were a comet in that position. The magnifying power was 45 and the definition excellent. My plan did not provide for any comparison differentially with a neighbouring star by micrometric measurement, and hence I only noticed the relation of the star to the sun and θ Cancri." It is difficult to understand how the observation can be explained, except by admitting the existence of an unknown body in the vicinity of the star, or by imputing to the deceased astronomer a want of *bona fides*, for which we do not believe there is the slightest excuse; he was too well known and respected to allow of such an imputation.

The solar eclipse of May 17, 1882, will afford the next opportunity of repeating observations of the kind made by Prof. Watson in 1878, but the duration of totality will nowhere exceed 1m. 48s., and in the most accessible portion of the central line will amount to 1m. 15s. only.

THE TRANSIT OF MERCURY, NOVEMBER 7, 1881.—With the positions of the Sun and Mercury given in the *Nautical Almanac* from Leverrier's Tables, and the diameters of those bodies obtained by the same astronomer from the discussion of former transits, the following will be the geocentric Greenwich times and the reduction-formulæ for the internal contacts during the transit of Mercury on November 7 in the present year:—

First internal contact, Nov. 7, 10h. 18m. 15s.·8 + [1·4205] $r \sin l$ − [1·5404] $r \cos l \cos (L + 55° 34'·2)$.

Last internal contact, Nov. 7, 15h. 35m. 28s.·2 + [0·9136] $r \sin l$ + [1·6302] $r \cos l \cos (L - 35° 23'·2)$.

Where r is the radius of the earth at the place, l its *geocentric* latitude, and L the longitude from Greenwich, reckoned towards the east. The quantities in square brackets are logarithms of seconds of time.

It will be seen that the transit will be invisible in this country, and will be best observed from the Australian observatories. At the Cape of Good Hope the sun will not rise till about four minutes after the second internal contact has taken place. At Madras he will be above the horizon before the middle of the transit, which ends there about 20h. 59m.

As an example of the use of the above formulæ we may compute the local mean time of first internal contact for the Observatory at Melbourne. The longitude of this observatory is 9h. 39m. 54s.·8 E., or in arc 144° 58′·7, and the geographical latitude is − 37° 49′·9. From Bessel's Table in the *Berliner Jahrbuch* for 1852, we find log. r = 9·9999, and the reduction of latitude, 11′·1, so that l = − 37° 38′·8.

Constant	+1·4205	Constant +	55° 34′·2	Constant	−1·5404
r	9·9999	Long. ...	144° 58′·7	r	9·9999
$\sin l$ ...	−9·7859			$\cos l$ ...	+9·8986
		A... ...	200° 32′·9	cos A ...	−9·9715
	−1·2063				
					+1·4104
	−16s.·08				
					+25s.·73
					−16s.·08
					+ 9s.·65

Geocentric time ...	10	18	15·8
G.M.T.	10	18	25·5
Longitude E.	9	39	54·8
Melbourne mean time	19	58	20·3

A NEW COMET.—The Smithsonian Institution telegraphs the discovery of a comet by Mr. Lewis Swift on the morning of the 2nd inst. in the constellation Andromeda; motion slow, southwards.

GEOGRAPHICAL NOTES

WE understand that the Council of the Geographical Society have recently voted a contribution of 100*l*. towards the expenses of the Palestine Exploration Fund's Expedition to Eastern Palestine.

THE May number of the Geographical Society's *Proceedings* contains Mr. James Stewart's paper on Lake Nyassa and the water-route to the lake-region of East Africa, with a map of the north end of Nyassa. A note afterwards given embodies recent information from Livingstonia as to a serious depression in the level of the lake, which threatens to make the south end, as well as the Upper Shiré, unnavigable, and by consequence detract very seriously from the value of this route. Col. Tanner's paper on Kafiristan is also given, with a map of that and the adjacent region. Some account is furnished of Dr. Junker's journey in the Nyam Nyam country from the traveller's letters to Dr. Schweinfurth and Signor Gessi. Reference is again made in the Geographical Notes to the late Capt. Wybrants' expedition to South-East Africa, but complete details of its diastrous ending are still wanting, which seems the more remarkable as the lamented leader died as far back as November 29, 1880. An interesting note deals with Dr. Kirk's recent visit to the Dar-es-Salaam district of East Africa, and it is also stated that the Rev. T. J. Comber is about to make another attempt to reach Stanley Pool by the Makuta route, while one of his companions will follow the line of the Congo. The remaining notes refer to Major J. Biddulph's work on the tribes of the Hindu Kush, and Père Desgodins' labours in the cause of geography on the eastern and southern frontier of Tibet.

AT the evening meeting of the Geographical Society on Monday next Mr. E. Whymper will read a paper describing the geographical results of his journey among the Andes of Ecuador.

THE new volume of the *Geographisches Jahrbuch* is of great value to scientific geography in its most comprehensive acceptation. Dr. Behm has been compelled to retire from the editorship, and is succeeded by Prof. H. Wagner of Göttingen, who, we have no doubt, will maintain the *Jahrbuch* at its previous high standard. The first part is devoted to the various geographical sciences. The first paper is by Prof. Zöppritz, "On the Present Standpoint of Physical Geography." This is followed by an account of recent researches in geographical meteorology by Dr. Haan; and papers on the Geographical Distribution of Animals and of Plants by Dr. Schwarda and Dr. Oscar Drade respectively. Prof. Bruhns summarises recent work in Europe in the measurement of degrees, and Herr Auwers gives the latitudes and longitudes of 144 astronomical observatories. Prof. F. v. Fritsch brings together recent investigations on the geographical distribution of geological formations all the world over; while Dr. v. Scherzer has his usual account of the world's commerce, and Dr. Gerland summarises recent advances in ethnological research. In the second part, which deals with general matters, Dr. Wagner has a thoughtful and useful article on the development of *Methodik* in geography; while, along with Herr Wichmann, he brings together a good deal of information on geographical societies, congresses, and journals. Thus it will be seen the new volume contains much matter of permanent interest.

WE have received Nos. 6, 7, and 8 (in one thick volume) of the *Bulletin* of the Union Géographique of the North of France. M. Leon Lacroix has a long paper describing a plan for the exploration of Central Africa, by the Wellé, a project we should much like to see carried out. M. Alf. Renouard, in a paper on the Geography of Flax, brings together much curious and useful information. Dr. Harmand's paper on the Races of Indo-China ought to interest ethnologists. Among the other contents are papers on the French in Indo-China, by M. Suerus; Syria in 1860, by M. Huberdeaux; and a note on the Isthmus of Panama, by M. V. Duburcq.

THE principal paper in the January number of the *Bulletin* of the Paris Geographical Society (just received) is one of much research, by M. Dutreuil de Rhins, on the routes between China and India.

THE *Mittheilungen* of the Vienna Geographical Society contain an account of a botanical excursion in the north of the Caucasus, by M. P. Muromtzoff, and a paper on the Floods of the Winter of 1880–81, by Baron Stefanovic von Vilovo.

UNDER the title of "Istruzioni Scientifiche dei Viaggiatori," the Italian Ministry of Agriculture, Industry, and Commerce have issued a very full and carefully compiled manual of information and instruction for travellers, edited by Signor Arturo Issel, with the collaboration of several specialists. The manual seems to us to combine the best features of all its predecessors in other languages, and ought to be of real service to all travellers who know Italian. It includes astronomy, meteorology, geography, and topography, deep-sea exploration, geology and palæontology, anthropology and ethnology, zoology, botany, and mineralogy. It is published under the auspices of the Italian Geographical Society.

HEFT 4 of Band ii. of the *Mittheilungen* of the German African Society contains communications from Dr. Büchner and Herr Flegel. The former has been doing a considerable amount of exploration between the capital of Muato Janvo's kingdom and the Congo, though his progress has been hindered by the usual African difficulties. His collections have been very numerous; unfortunately several boxes of them have been lost in the vessel in which they were being brought home, which was wrecked during the recent gales in the Channel. Herr Flegel has been doing some successful work on the lower and middle Niger.

PROF. GIUSEPPE DALLA VEDOVA has published the address he gave on the inauguration of the Chair of Geography at the University of Rome in November last. The subject is the Popular and the Scientific Conception of Geography. He shows that while the popular idea has its uses, the scientific conception is the only basis on which the subject can be studied with profit. He insists on the fact which has been frequently expounded in these pages, that geography has really become a sort of meeting-place for all the sciences, and that while topography may form the groundwork, it requires a knowledge of most of the physical and biological sciences to understand how the surface of the earth has reached its present condition.

DR. OSCAR LENZ has arrived in Berlin, where he has been lecturing on his journey across the Sahara to Timbuctoo.

AFTER all there seems to be little doubt that the news of the massacre of Col. Flatters and the other members of the Trans-Saharan Expedition is too true. Of course the project of a railway across the Sahara must be abandoned, in the meantime at least.

FROM *Les Missions Catholiques* we learn that news has at length been received respecting Père Law's expedition from Gubuluwayo, in Matabele Land, to Umzila's country, which was known to have met with some misfortune on the road. After passing the Insimbi Mountains the party reached the Great Sabi River, on the lower course of which we presume that Capt. Phipson-Wybrants died. The expedition journeyed, with their heavy waggon, along the left bank of the Sabi, meeting with country so difficult to traverse that in some parts they had to hew out of the rock a road for their waggon. Progress in this manner was terribly slow, and when that part of the Mashona country which owns some sort of allegiance to Umzila was reached, difficulties increased, as the natives did all they could to hinder their passage. Eventually on August 7, in a rugged pass where, surrounded by Mashonas, the missionaries were all doing their utmost to cut a road for the waggon, Père Wehl, by an accident not very clearly explained, got separated from his companions and was never seen again, though later news seems to have reached Gubuluwayo of his safety among a friendly tribe. Père Law and the rest of the party not unnaturally took fright at this, and leaving their waggon, escaped from their savage tormentors in the night. After about a fortnight's march they contrived to reach Umzila's kraal in a state of great exhaustion from fever and fatigue. They of course had to abandon almost all their property with the waggon, but further supplies have since been sent to them from Gubuluwayo.

PÈRE DEPELCHIN, the head of the mission station at Gubuluwayo, has been for some time absent on an expedition beyond the Zambesi, and from his long silence it was thought that he too must have met with some serious accident. He appears, however, to have reached in safety an out-station at Tati in Matabele Land, but no account of his adventures has yet been received.

MR. MCCALL, of the Livingstone (Congo) Inland Mission, is said to have formed a station at Manyanga, some 200 miles up the Congo, above the Yellala Falls, and he has no doubt about being able to reach Stanley Pool this year. The comparatively rapid progress thus made by following the right bank of the Congo will probably induce the Baptist Missionary Society's party at San Salvador to alter their tactics and follow the line of the river, instead of wasting their energies in fruitless attempts to make their way by land through the hostile Makuta towns to Makwekwe, on the left bank of the Congo, above Manyanga, and so on to Stanley Pool.

THE French Geographical Society held its annual meeting on Friday, April 29, when Admiral La Roncière le Noury was elected president. On the occasion of a proposal to erect a monument to Col. Flatters and his companions it was resolved to inscribe on tablets the names of all the martyrs of geography who have lost their lives in any exploration in which the French Geographical Society has been interested.

DR. O. F. VON MÖLLENDORFF has just published separately at Berlin (Reimer) two maps which have been drawn from his surveys by Dr. Kiepert for the Berlin Geographical Society's *Zeitschrift*. One is an original map of the hill-country north and west of Peking, while the other embodies routes in the Chinese province of "Dshy-li," and environs of Tientsin. Dr. Möllendorff, as we have before mentioned, claims to be an authority on the subject of the transliteration of Chinese sounds, but we doubt if many people in this country will recognise in "Dshy-li" the name of the metropolitan province (Chihli), and yet the maps are issued with English titles.

THE FUTURE DEVELOPMENT OF ELECTRICAL APPLIANCES[1]

THE lecturer began by referring to our obligations to laboratory workers and the necessity for a larger endowment of original research. The applied science of the future lies in-

[1] Abstract of a lecture delivered by Prof. John Perry at a meeting of the Society of Arts, March 24.

visible and small in the operations of men who work at pure chemistry and physics, and it is especially true of laboratory work in electricity that every day a man sees new lines of research opening up before him which his resources do not allow him to follow up.

In the applied science of electricity certain fixed laws tell us much about the future which is not generally known; and it is first necessary to become acquainted with these laws if we would speak of this future. By numerous experiments the lecturer showed that electricians are dealing with measurable things, and he gave in wall-sheets such information as seemed sufficient to give exact ideas in this matter to a popular audience. These wall-sheets had also been put in a printed form and circulated among the audience. The following is an example:—

WALL-SHEET II.—ELECTRICAL MAGNITUDES (SOME RATHER APPROXIMATE)

Resistance of

One yard of copper wire, one-eighth of an inch diameter	0·002 ohm.
One mile ordinary iron telegraph wire	10 to 20 ohms.
Some of our selenium cells	40 to 1,000,000
A good telegraph insulator	4,000,000,000,000

Electromotive force of

		Volts.
A pair of copper-iron junctions at a difference of temperature of 1° Fahr.	=	0·000,01
Contact of zinc and copper	=	0·75
One Daniell's cell	=	1·1
Mr. Latimer Clark's standard cell ...	=	1·45
One of Dr. De La Rue's batteries ...	=	11,000

Lightning flashes probably many millions of volts.

Current measured by us in some experiments:—

Using electrometer	= almost infinitely small currents.
	Weber.
Using delicate galvanometer	= 0·000,000,000,040
Current received from Atlantic cable, when twenty-five words per minute are being sent	= 0·000,001
Current in ordinary land telegraph lines	= 0·003
Current from dynamo machine ...	= 5 to 100 Webers

In any circuit, *current* in webers ... = *electromotive force* in volts ÷ *resistance* in ohms.

WALL-SHEET III.—RATE OF PRODUCTION OF HEAT CALCULATED IN THE SHAPE OF HORSE-POWER

In the whole of a circuit = *current* in webers × *electromotive force* in volts ÷ 746.

In any part of circuit = *current* in webers × *difference of potential* at the two ends of the part of the circuit in question ÷ 746.

Or, = square of current in webers × resistance of the part in ohms ÷ 746.

The distinction which must be made between *electricity* and *electrical energy* was dwelt upon. A miller does not merely speak of the quantity of water in his mill-dam; he has also to consider the height through which it can fall. A weight of one thousand pounds falling through a distance of one inch represents the same energy, that is, gives out the same amount of work in falling as one pound through one thousand inches. A mere statement then of the quantity of electricity given out by a machine is insufficient; it is also necessary to state what is the height or difference of potential through which it is falling. The quantity of electricity in a thunder-cloud is comparatively small, but the difference of potential through which this quantity passes when discharge occurs is exceedingly great. So it is with the two factors of the electrical energy developed by this glass machine. The quantity of electricity obtainable from this machine is comparatively small, but it is like a small quantity of water at an exceedingly great height, whereas in all these other machines we have, in the analogy of the miller, a very great quantity of water and a very small difference of level. I put this water analogy before you because you have all more or less exact notions about water, and because, within certain limits, the analogy is a very true one. I have traced it more fully in the wall-sheet. Of this and the other wall-sheets each of you possesses printed copies.

WALL-SHEET I.

We Want to Use Water.	*We Want to Use Electricity.*
1. Steam-pump burns coal and lifts water to a higher level.	1. Generator burns zinc, or uses mechanical power, and lifts electricity to a higher level or potential.
2. Energy available is, amount of water lifted × difference of level.	2. Energy available is, amount of electricity × difference of potential.
3. If we let all the water flow away through channel to lower level without doing work, its energy is all converted into heat because of frictional resistance of pipe or channel.	3. If we let all the electricity flow through a wire from one screw of our generator to the other without doing work, all the electrical energy is converted into heat because of resistance of wire.
4. If we let water work a hoist as well as flow through channels, less water flows than before, less power is wasted in friction.	4. If we let our electricity work a machine as well as flow through wires, less flows than before, less power is wasted through the resistance of the wire.
5. However long and narrow may be the channels, water may be brought from any distance, however great, to give out almost all its original energy to a hoist. This requires a great head and small quantity of water.	5. However long and thin the wires may be, electricity may be brought from any distance, however great, to give out almost all its original energy to a machine. This requires a great difference of potentials and a small current.

After showing, by passing currents from two large Gramme machines through certain resistances and lamps, that electrical energy may be sent to a distant place and there converted into heat and light, the methods taken at the City and Guilds of London Institute for simultaneously measuring mechanical work, currents of electricity, resistance, the candle-power of electric lamps, &c., were described, the dynamometers, photometers, &c., being exhibited, as well as diagrams showing their construction. Actual measurements were made of the strengths of currents and the candle-power of an electric light. Many of the contrivances in use were invented by the lecturer and his friend Prof. Ayrton.

The transmission of mechanical power to a distance through the agency of electricity was illustrated by a number of experiments; the driving of a lathe and other machines, and proof that the motor which gives out power at the distant place produces a back electromotive force opposed to that of the generator.

"Now what do these examples show you? They show that if I have a steam-engine in my back yard I can transmit power to various machines in my house, and if you were to measure the power given to these machines you would find it to be less than half of what the engine driving the outside electrical machine gives to it. Further, when we wanted to think of the heating of buildings and the boiling of water, it was all very well to speak of the conversion of electrical energy into heat, but now we find that not only do the two electrical machines get heated and give out heat, but heat is given out by our connecting-wires. We have then to consider our most important question. Electrical energy can be transmitted to a distance, and even to many thousands of miles, but can it be transformed at the distant place into mechanical or any other required form of energy, nearly equal in amount to what was supplied? Unfortunately I must say that hitherto the practical answer made to us by existing machines is 'No'; there is always a great waste due to the heat spoken of above. But fortunately we have faith in the measurements, of which I have already spoken, in the facts given us by Joule's experiments and formulated in ways we can understand. And these facts tell us that in electric machines of the future, and in their connecting-wires, there will be little heating, and therefore little loss. We shall, I believe, at no distant date, have great central stations, possibly situated at the bottom of coal-pits, where enormous steam-engines will drive enormous electric machines. We shall have wires laid along every street, tapped into every house, as gas-pipes are at present; we shall have the quantity of electricity used in each house registered, as gas is at present, and it will be passed through little electric machines to drive machinery, to produce ventilation, to replace stoves and fires, to work apple-parers, and mangles, and barbers' brushes, among other things, as well as to give everybody an electric light.

"Probably you think it very strange that I should show you the inefficiency of electric transmission of energy, and then make this very bold assertion. Well, the fact is that the ordinary electrical machines in use have not been constructed with a view to economy. They have been constructed to show that brilliant lights and considerable power may be produced from small machines. They have, at a comparatively small cost, attracted attention to the fact that electricity is an important agency. In so far they have done well; but on the other hand they gave rise to the well-known assumption that 50 per cent. of the mechanical power given to the generator was the maximum amount which could be taken from the motor. The true solution of the problem of transmission of power was, I believe, first given by Prof. Ayrton in his Sheffield British Association lecture. It had been supposed that to transmit the power of Niagara Falls to New York a copper cable of enormous thickness would be needed. Mr. Ayrton showed that the whole power might be transmitted by a fine copper wire, if it could only be sufficiently well insulated. He also showed that instead of a limiting efficiency of 50 per cent., the one thing preventing our receiving the whole of our power, is the mechanical friction which occurs in the machines. He showed, in fact, how to get rid of electrical friction. I will briefly give you our reasons. A machine at Niagara receives mechanical power, and generates electricity. Call this the generator, and remember that Wall-sheet III. teaches us that the mechanical power is proportional to the electromotive force produced in the generator, multiplied into the current which is actually allowed to flow. Let there be wires to another electric machine in New York, which will receive electricity, and give out mechanical work, as this machine does here. Now I showed you a little while ago that this machine, which may be called the motor, produces a back electromotive force, and the mechanical power given out is proportional to the back electromotive force multiplied into the current. The current, which is of course the same at Niagara as at New York, is proportional to the difference of the two electromotive forces, and the heat wasted is proportional to the square of the current. You see then, from Wall-sheet III., that we have the simple proportion—power utilised is to power wasted, as the back electromotive force of the motor is to the difference between electromotive forces of generator and motor. This reason is very shortly and yet very exactly given in Wall-sheet IV., a printed copy of which you all hold in your hands."

WALL-SHEET IV.

Let electromotive force of generator be E; of motor F. Let total resistance of circuit be R. Then if we call P the horse-power received by the generator at Niagara. Q the horse-power given out by motor at New York, that is, utilised. H the horse-power wasted as heat in machines and circuit. C the current flowing through the circuit.

$$C = \frac{E - F}{R}$$

$$P = \frac{E(E - F)}{746 R}$$

$$Q = \frac{F(E - F)}{746 R}$$

$$H = \frac{(E - F)^2}{746 R}$$

$$Q : H :: F : E - F.$$

"To put it more shortly still, the power wasted is proportional to the square of the current flowing, whereas the power utilised is proportional to the current, and also to the electromotive force of the motor. The greater, then, we make the electromotive forces, the less is the loss of power in the whole operation. Perhaps you will see this better from the water analogy. A small quantity of water flowing through a water-main may convey a large amount of energy, if it only has sufficient head. The frictional loss of power is independent of the head, but depends very much on the quantity of water. In the model before you is the water analogy. Here is a reservoir, which I shall call A, kept filled with water by a steam pump, which draws the water from the sea-level, which I shall call K. Water flows from reservoir A to distant reservoir B, where it drives a turbine giving out work due to its head B K. The current from A to B, through the communicating pipe, is the same always, so long as A and B are at the same difference of level, and therefore the frictional loss of energy is always the same, whereas the work utilised from B, by driving the turbine, increases proportionally to the height of B above sea-level. The result, then, to which the above laws led us was that for the future development of the transmission and distribution of electric energy it will be necessary to use electric machines of great electromotive force. Indeed so important must this principle become that we believe there is a future in this direction for the employment of even plate electrical machines, such as that of Holtz."

Then followed a discussion of methods of obtaining great electromotive force. Mr. Perry's own ways of carrying out these ideas are shown in his own dynamo-machine, which is large, has great speed, has no iron in its movable part, and has a commutator of small frictional resistance. Electric lighting and heating, telephones, and electric railways of the future were all spoken of as illustrations of the transmission of energy by electrical means, and as such they must be governed by the above principle.

It was then shown experimentally that electrical energy may be stored up in considerable quantities in an available form for future use, and the bearing of this fact on the future utilisation of great but variable natural sources of power, such as the wind and tide, was dwelt upon.

The remainder of the lecture was devoted to the importance of the principle of recurrent effects; one illustration was given as follows:—"If I very much alter the magnetic field in this telephone, by bringing a powerful magnet near it, with great care in listening I hear the faintest sigh, due to the diaphragm settling itself into a new position, its vibrations dying away as it does so; and if I brought a small magnet near, I should hear nothing. And yet the change of magnetism which produces the loud telephonic effects which we listen to is almost infinitely smaller. Why is this? It is due to the rapid recurrence of the effects. Now you are all aware of the importance of the telephone as a method of communication; I believe that a much greater importance is in store for it as a laboratory appliance."

The photophone and the method by means of which Messrs. Ayrton and Perry determined the index of refraction of ebonite, finding its square to be roughly the same as the mean value of its measured specific inductive capacities: the use of a powerful sub-marine source of musical sound as a coast-warning, which might be heard in a ship well above all other sounds, and the experiments which have been made by the lecturer and his colleague in this direction: these and other matters were discussed as examples of the use of the principle of recurrent effects. The lecture concluded by an account illustrated by experiments of Mr. Edward Bright's method of de-electrifying woollen yarn, and of Messrs. Ayrton and Perry's plan for seeing by electricity what is occurring at a distant place. A selenium cell moving over an image at, say, York, gave corresponding light and shade to corresponding parts of a screen at, say, London. Mr. Perry's York image was very simple, being a series of black, grey, and white squares, which were faithfully reproduced on the distant screen.

MECHANICAL RESEARCH

IT will be remembered that some time ago the Institution of Mechanical Engineers appointed a Committee to examine into three selected questions of research in matters pertaining to their profession. These researches are still in progress, but preliminary reports have been issued by the Committee, of which we propose to give a brief account.

The Hardening and Tempering of Steel.—One or two letters on this subject have lately appeared in our columns, and allusion has been made to the report by Mr. Wm. Anderson, presented to the Committee who were appointed specially to investigate this difficult question. Mr. Anderson's report, which contains much useful information in a comparatively small compass, is itself too long for our pages. We therefore give the following *résumé* of the question, taking Mr. Anderson's report as our basis:—

Whilst the theory of this subject is in a very vague and uncertain condition, the facts are exceedingly well known, and are daily applied in almost every department of arts and manufactures. Wherever steel tools are used it is necessary that they should be hardened and tempered; since the ordinary tool-steel, as supplied chiefly from Sheffield, is too soft for cutting and abrading purposes. It is known however that if a piece of this steel be heated, and then suddenly cooled (generally in a bath of water or oil) it becomes much harder, not only on the surface, but throughout, provided its thickness be not excessive. The greater the range of this cooling (in other words, the difference between the temperatures of the steel and the bath at the first moment of "quenching") the more intense is the hardening, but at the same time the greater the brittleness of the piece. Hence it is always desirable that the range of cooling should be as small as is consistent with the steel acquiring that degree of hardness which is essential for the work it has to do. This condition is secured by the further operation of tempering. In this process the steel is first hardened to excess by rapid cooling, then re-heated with great care to a certain temperature corresponding to the purpose for which it is intended, and then quenched again from that temperature. The particular point at which to stop the re-heating is recognised by one particular hue in what are called "the colours of tempering," *i.e.* a fixed range of colours, commencing with pale yellow and ending with dark blue, which the steel is always seen to assume in succession as its temperature gradually rises. Thus, if the article in question be a sword it is heated to a bright blue; if it be a cold chisel it is stopped at a brownish orange.

The various attempts to explain these singular facts (at least on the part of French and English metallurgists) are set forth in the Committee's Report. In the first place it seems now to be generally held that pure steel is a compound of iron and carbon only, and that these two elements exist, not in a state of chemical combination (forming some definite carburet of iron), but of intimate mechanical mixture, such as chemists call by the name of "solution." The question next arises, What is the exact condition of each of these independent elements. In the case of very soft, or "grey," cast-iron, it is known that the carbon is not wholly in solution, but occurs partly in molecules of pure graphite. Following this hint M. Jullien has advanced the theory that molten cast-iron, or molten steel, is a solution of liquid carbon in liquid iron; that under slow cooling part of the carbon separates as graphite, while the remainder continues in solution; but that with rapid cooling this separation does not take place, and the whole of the carbon crystallises, forming, when cool, a "solution" of crystallised carbon in amorphous iron. This view of the difference between hard and soft cast-iron, or hard and soft steel, is accepted by Caron, Åkerman, and others, partly on the ground that hardened steel dissolves completely in hydrochloric acid, while the same steel, after annealing, will leave a residue of insoluble carbon. Jullien, however, goes beyond this, and would explain the whole phenomena of hardening on the same principle. He holds that carbon liquefies in presence of red-hot iron, and is absorbed by it; that if the mixture is cooled slowly the carbon remains amorphous, but if cooled quickly the carbon crystallises in the diamond form; and thus hard steel is iron set in a matrix of diamond. This theory, though ingeniously supported, labours under the difficulty that the liquefaction of carbon has never been otherwise achieved; and also that it gives no explanation whatever of the phenomena of tempering, especially the characteristic colours. On the other hand, Barba and Åkerman hold that the hardening of steel is due to the severe compression produced in the outer layers by the contraction in rapid cooling; this compression at once retaining a greater proportion of carbon in solution, and rendering the whole mass more physically dense and compact. But the Report points out that the outside layers, which are the hardest, are brought into a state of tension, not compression, owing to their inability to contract over the hotter mass inside.

For these reasons the Committee have rejected both these theories, and propose one of their own, due apparently to Mr. William Anderson, but suggested by the experiments of Edison on platinum wire, an account of which appeared in NATURE, vol. xx. p. 545. They refer to the generally-accepted fact that ordinary steel contains a certain proportion of occluded gases (consisting, according to Müller, of hydrogen, nitrogen, and carbonic oxide). They suggest that the application of heat causes these gases to be expelled through minute fissures which open in the steel, as they opened, according to Edison, in the platinum wire observed by him; and that sudden cooling prevents the re-absorption of what has been expelled, perhaps actually tends to expel the remainder. By the loss of these gases the metal becomes denser and harder than before. If the metal be now expanded by gentle heating, the fissures open, re-absorption begins; and the various changes which the surface undergoes during this process are marked by the succession of colours which are characteristic of tempering.[1] The Committee propose to make a series of experiments to test the truth of this theory, which is certainly ingenious, and if confirmed would go far to remove the difficulties which beset this important subject.

Form of Riveted Joints.—The second Report is written by Prof. W. C. Unwin, of Cooper's Hill, and is on "the best form of riveted joints to resist strain in iron or steel, or in combination." It may be well to explain that by a "riveted joint" is meant the mode of fastening together the strips, or plates, out of which boilers, tanks, girders, and other structures in wrought iron or steel are built up. This mode in its simplest form is as follows:—A row of holes is punched or drilled along the edge of the two plates to be united, and these edges are then made to lap over each other so that each hole in one plate comes fair with a hole in the other. A red-hot rivet (that is a pin with a rounded head) is then passed through both holes, and the end is flattened down by hammering or pressure, so as to form a second head. The two plates are thus pinned together by the rivets, and so long as these remain entire they cannot be separated without tearing across. Such a joint is called a "single-riveted lap-joint." It is obvious that the plate must be greatly weakened by the piercing of the holes; and as a matter of fact it appears that such joints cannot be arranged to give more than about half the strength of the solid plate. To increase this "proportion of strength," as it is termed, the rivets are sometimes arranged in two or three rows, and of course more widely spaced in each row; or the edges of the two plates are simply brought up against each other and secured by either one or two "cover-strips" fitting over and riveted to both.

Each of these forms demands a separate investigation in order to fix its design. Thus a single-riveted lap-joint under a tensile stress may fail in any one of the following ways: (1) the rivet may cut into the plate, enlarging and injuring the hole; (2) the plate may cut into the rivet, and finally shear it off; (3) the part of the plate between the rivet and the edge may break through, allowing the rivet to come away from the plate; (4) the plate may simply tear across along the line of rivets. It is clear that in a perfect joint the dimensions must be such that the resistance to each of these modes of fracture should be the same, and should have its greatest possible value. This could be easily arranged if the absolute resistance of the material to these various forms of stress were accurately known. But the values of these resistances are of course very different for steel and for iron; they also vary considerably, whether in steel or iron, according to the quality, and to some extent according to the thickness. Hence experiments on these values become absolutely necessary before any correct design can be made out.

The course which such experiments should take is fairly sketched out by the author of the Report now before us. A good and uniform quality of iron or steel, as the case may be, should first be selected, both for plates and rivets. The resistance of this material to the various forms of stress should then be carefully ascertained by experiments made both with simple bars or plates, and also with actual riveted joints, so designed that they shall be certain to fail in one particular way. These constants once settled, it is easy to calculate for any description of joint the dimensions which will give the highest proportion of strength. A joint should then, and not till then, be prepared, having exactly these dimensions, and a few others having dimensions varying slightly from these in each direction. If, on testing, the first joint proves to gives the highest breaking strain of the set, the correctness of the whole investigation will be established.

Unfortunately the method thus sketched out has not hitherto been adopted. The immense practical importance of the subject (for the money expended yearly on riveted structures may be counted by millions) has indeed brought forward a host of experimenters; and the mere classification and abstracting of their results occupies no less than sixty octavo pages of this Report. But almost without exception they seem to have begun at the wrong end, *i.e.* they started with making a riveted joint of what they chose to consider to be the best design, and then pulled it asunder. In addition, scarcely any of their experiments have been made with the care and accuracy, or on the scale, which the subject demanded. In fact it is not going too far to say that 90 per cent. of these experiments are only injurious, as

[1] The Report supposes that the colours of tempering are due to diffraction, not to interference: this does not seem to be in accordance with the facts, but it also does not seem to be absolutely required by the explanation.

cumbering the ground, and that the remaining 10 per cent., if useful, are very imperfect. One instance of the evil done by such means will suffice. Sir Wm. Fairbairn, to whom is due the credit of being the earliest labourer in this field, experimented on certain single- and double-riveted joints, and found that the "proportion of strength" in the case of the former was 56 per cent., and in the latter 70 per cent. of the solid plate. These figures, which of course applied only to the particular designs tested, have been repeated in almost all manuals of engineering as if they were universally true; disregarding the obvious fact that a double-riveted joint could be made just as weak as a single-riveted one, by simply spacing the holes in the outside row at the same distance.

The Committee wisely determined to throw aside the voluminous labours of their predecessors, and begin *de novo* a connected series of experiments, based on the true and scientific method described above. We cannot find space to consider the many collateral points with which these experiments will have to deal, much less to give any account of the results which they are to supersede. These, as embodied in this Report, will remain a singular instance of the lamentable waste of money so continually incurred in engineering experiments. There can be little doubt that less than a tenth of this money, if applied on the scientific and proper method, would have set the whole question long ago at rest, and would now be saving the world, through increased economy of construction, many hundreds per annum for every pound so expended.

Friction.—The last of the three subjects under consideration is that of Friction at High Velocities, the Report on which has been prepared by Prof. Kennedy, of University College, London. This subject offers a curious instance of the influence exercised by a distinguished experimenter, and how his conclusions are pushed, by those who blindly follow his guidance, much further than he himself would attempt to go. About fifty years ago the late General Morin made an important series of experiments, from which the well-known "Laws of Friction" were deduced. One of these laws is that the friction between solid bodies in motion, or dynamical friction, is independent of the velocity. It was overlooked, by those who announced this law, that the experiments were only conducted with certain substances under small pressures and at moderate speeds. General Morin himself, in an interesting letter published in the present Report, expressly states that he had himself always regarded his results, "not as mathematical laws, but as close approximations to the truth *within the limits of the data of the experiments themselves.*" Unfortunately others did not imitate this caution: they asserted everywhere that the law was universal, and by many it is asserted to be so still.

That it is not universal has however been sufficiently proved. At the time of the launch of the *Great Eastern* the late Mr. Froude showed, by experiments on a large scale, that the friction of a vessel on the launching-ways decreased rapidly as the velocity increased. In 1851 Poirée and Bochet showed that the coefficient of friction of railway wheels sliding on rails diminished very rapidly with increase of speed (between limits of 900 and 3600 feet per minute). Recently Capt. Douglas Galton and Mr. Westinghouse made a long series of experiments on the friction of railway-brakes (cast-iron blocks on steel tyres), and their results showed a marked decrease of friction, with increase of speed, within the very large range of 400 to 5300 feet per minute. Prof. Kimball has made experiments at much lower speeds (about 1 to 100 feet per minute), both with pieces of wood and with wrought-iron spindles in cast-iron bearings; and he also finds a rapid decrease of friction with increase of speed. At the lowest possible speeds (0·0012 to 0·6 feet per minute) Prof. Fleeming Jenkin finds a similar decrease, pointing to the supposition that the change from statical to dynamical friction is not sudden, but continuous. Lastly, Prof R. H. Thurston has made an elaborate set of experiments on the frictional resistance of lubricated bearings. He arrives at the conclusion that for cool and well-lubricated bearings the coefficient of friction decreases up to a speed of about 100 feet per minute, and afterwards increases with the speed approximately as its fifth root. The details of these experiments do not seem to have been published, so that it is not certain how far this curious result may be taken to hold.

It will be seen that none of these various experiments confirm the universal law deduced from Morin's results, viz. that dynamical friction is independent of velocity. On the contrary, it may be taken as proved for *unlubricated* surfaces (such as railway brakes) that the coefficient of friction diminishes rapidly with increase of velocity; although the exact law of variation and its relation to the pressure on the surfaces is not fully determined. With *lubricated* surfaces the same fact may be assumed to be true at speeds up to 100 feet per minute; but above this, if we accept Prof. Thurston's results, the result is the opposite. It seems clear that the question is ripe for further investigation, which might take the form, first of repeating and extending Thurston's experiments with lubricants, and secondly of ascertaining the law of variation with unlubricated surfaces more exactly than could be done by the aid of the experiments hitherto carried out.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—At the Downing College Examination in June, 1881, one Foundation Scholarship of the annual value of 80*l.* will be thrown open to all members of the University who have not kept more than six terms. The subjects of this Examination will be Chemistry (Theoretical and Practical), Physics (Heat, Electricity, and Magnetism), Comparative Anatomy, Physiology, and Botany. The Examinations for Minor Scholarships, which are open to all persons who have not entered at any college in the University or who have not resided one entire term in any such college, will be held in Downing College on Tuesday, May 31, and three following days. Further information will be given by Mr. J. Perkins or by the Rev. J. C. Saunders, tutors of the College.

AT a special meeting of the Fellows of Gonville and Caius College, held on the 30th ult., Dr. Paget, F.R.S., Regius Professor of Physic in the University, and Mr. Pattison Muir, Hon. M.A. (Cantab.), were elected Fellows of the Society. Dr. Paget was formerly a Fellow of Caius College.

OXFORD.—In addition to the courses of lectures in Natural Science enumerated last week, the following courses will be held during this term in the University Museum:—Prof. Price will lecture on physical optics, and Prof. Westwood will lecture on the orders of the Arthropodă. In the absence of Prof. Rolleston, who is abroad on account of ill-health, Mr. Jackson will form classes for general catechetical instruction, while classes will be formed by Mr. Robertson for practical microscopy, and by Mr. Thomas for the study of the developing chick.

At the Botanical Gardens Prof. Lawson will lecture on elementary botany (development), and will continue his course on the dissection of plants.

In the Geological Department under Prof. Prestwich, lectures will be given on s me of the secondary and quaternary strata. The Professor will have excursions to inspect the sections of the several formations around Oxford, commencing on Saturday, April 30, and to be continued through May. On each preceding Friday he will lecture on the subject of the following Saturday's excursion, or on some other subject of which notice will be previously given. Notice will also be given in the Gazette of the preceding week, and in the Museum, of the places to be visited, hours of meeting, &c.

In a congregation holden on Tuesday, May 3, the proposal to allow selected candidates for the Indian Civil Service to obtain the B.A. degree after two years' residence, was thrown out. An amendment to excuse selected candidates from responsions only was carried by 63 votes to 49.

THE scheme for the establishment of a University College in Liverpool is now almost matured, and it is expected that the College will open for its first session in October next. The donations have reached the sum of 100,000*l.*, and the task of drafting a constitution for the College is now being performed by a special committee. The Earl of Derby has accepted the office of president, the vice-presidents being Mr. Christopher Bushell and Mr. William Rathbone, M.P.

SCIENTIFIC SERIALS

Journal de Physique, April.—Theory of machines with alternating currents, by M. Joubert.—On radiophony (second memoir), by M. Mercadier.—Application of Talbot's fringes to determination of the refractive indices of liquids, by M. Hurion.—Apparatus for projecting images at any distance with a variable enlargement, by M. Crova.—Strong and constant voltaic pile, furnishing residues capable of regeneration by electrolysis, by M. Reynier.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xiv. fasc. vi.—On Chætognatha, by Dr. Grassi.—On the stratigraphical position of the phyllitic zone of Rotzo, and the marine limestones which comprehend it, by S. Taranelli.—On a Cremonian quadratic correspondence between the elements of two ruled spaces, by S. Archieri.—The last introduction of fishes into our lakes, by Prof. Pavesi.—On a freshwater sponge new to Italy, by the same.

SOCIETIES AND ACADEMIES

LONDON

Photographic Society, April 12.—J. Glaisher, F.R.S., president, in the chair.—The following papers were read:—On a Swiss tour with gelatine plates, by W. Dillworth Howard.—On art and photography, suggestions for bringing them into closer connection, by H. B. Berkeley.—On the natural camera, and on uncorrected lenses in photography, by Capt. Abney, R.E., F.R.S. This paper described the natural camera as being the means of taking a photograph without an optical glass—a pin-hole producing the picture, although at a long focus—also that an uncorrected or non-achromatic lens, say an ordinary spectacle lens, if its aperture be reduced to one-fifth of an inch, would bring the wave-lengths of all colours into one perfect focus, but which, being very long, would necessitate prolonged exposures; at the same time this could be met by the use of the modern rapid gelatine plate.

Victoria (Philosophical) Institute, May 2.—A paper upon philosophy as advocated by Mr. Herbert Spencer was read by the Rev. W. Ground. The aim of the paper was to show that the philosophy in question is hopelessly illogical, the "analysis" in direct contradiction to the "synthesis."

GÖTTINGEN

Royal Society of Sciences, January 8.—On a proposition of the maintenance of the algebraic relation between the integrals of various differential equations and their differential quotients, by Herr Königsberger.—Report on the polyclinic for ear diseases, by Dr. Bürkner.—On the motion of an electric particle in a homogeneous magnetic field and the negative electric glow, by Herr Riecke.—On the quantity of electricity furnished by an influence-machine of the second kind and its relation to moisture, by the same.—Measurement of the force exerted by earth-magnetism on a linear current conductor capable of rotation, by the same.

February 5.—Influence of heat on the optical properties of boracite, by Herr Klein.—On electrical shadows (third paper), by Herr Holtz.—New representation of spherical functions and related functions by determinants, by Herr Henn.—Remarks on a memoir, by Herr Warburg, on some actions of magnetic coercive force, by Herr Fromme.—Observations in the magnetic observatory, by Herr Schering.

March 5.—On the irreducibility of differential equations, by Herr Königsberger.—Contributions to a knowledge of the optical properties of analcim, by Herr Ben Saude.

PARIS

Academy of Sciences, April 25.—M. Wurtz in the chair.—The following papers were read:—On a question of ancient metrology; origin of the English mile, by M. Faye. He inquires into the error (long current) of supposing the mile equivalent in length to a terrestrial arc of one minute. The mile has been probably deduced from Ptolemy's measure, and the error of one-sixth seems to arise from the English geographers having supposed that Ptolemy used the Greek foot, which Eratosthenes used 400 years before, whereas he used the Phileterian foot, which is about 0·36m., the earlier one being 0·27m. Eratosthenes counted 700 stadia to a degree; Ptolemy only about 500.—Examination of materials from the vitrified forts of Craig Phadrick, near Inverness (Scotland), and Hartmannswillerkoff (Upper Alsace), by M. Daubrée. Like the forts in France, that at Craig Phadrick must have undergone heat intense enough for the mica to entirely disappear and the felspar to be in great part fused. The minerals produced at cost of the mica and felspar present evident similarities. The Alsace fort seems to have been composed of brown porphyry, but the crystalline products of heat are similar to those in the other case. The ingenious method of heating was probably transported, not invented independently in different countries. The phenomena elucidate metamorphism.—Meteorite which fell at Louans (Indre-et-Loire) on January 25, 1845, and the fall of which was not published, by M. Daubrée.—Researches on piperidine, by M. Hofmann.—Nodule of chromite in the interior of the meteoric iron of Cohahuila (Mexico), by Prof. Lawrence Smith. He obtained, on analysis, oxide of chromium 62·61, ferrous oxide 33·82. While chromite has long been known in association with meteoric stones, the form of its occurrence here is new. The meteorite contained distinct nodules of two chromiferous minerals.—Observations on phenomena of absorption in lower vegetable organisms, by M. Syrodot. Studying Batrachospermeæ, he has found the organs of absorption to present parallel phases to those better known in the higher groups.—M. Sire presented an instrument for demonstrating Foucault's law of the apparent deviation of the pendulum's plane of oscillation. The apparatus may be used in any latitude.—General theory of transmissions by metallic cables; practical rules, by M. Leauté. The author determines, *inter alia*, the coefficient of working (*fonctionnement*) in telodynamic transmissions, a coefficient which fixes the manner in which a cable behaves under a variation in the force exerted. The idea of equivalence of two transmissions as to working is thus reached. The limits of transmission of force by cables are investigated.—On the essence of licari kanali, or essence of female rosewood, by M. Morin. The composition of this essence from French Guyana appears to be identical with that of Borneo camphor.—On the winter-egg of phylloxera, by M. Mayet. About Montpellier the hatching of the egg has occurred during the whole month of April, and even in the end of March. — Results obtained in phylloxerised vines by a mixed treatment with sulphide of carbon and sulphocarbonate of potassium, by M. Laugier.—M. Faye, presenting the first volume of *Annales de l'Observatoire de Toulouse*, edited by M. Baillaud, said it marked a new era in the history of the provincial observatories, great activity being indicated. The researches of M. Tisserand (predecessor of M. Baillaud) on Saturn's satellites are given. M. Perrotin works out the theory of Vesta; while the zodiacal light, the eclipses of Jupiter's satellites, Saturn's rings, &c., are also studied.—On a class of linear differential equations with doubly periodic coefficients, by M. Appell.—Normal production of three systems of fringes of rectilineal rays, by M. Croullebois.—Causes of disturbance of telephonic transmissions, by M. Gaiffe. Two rods from the same piece of steel (capable of being strongly polarised without being tempered) were placed in a telephone circuit, one of them being first magnetised as much as possible. Striking them similarly produced strong currents from the magnetised rod, but very little current from the other.—On the renal origin of nefrogymase, by MM. Bechamp and Baltus.—On the absorption of mineral waters by the cutaneous surface, by M. Champouillon. The absorption of iron and manganese from the waters of Luxeuil was proved in examination of the urine. It is only after a period of mineral saturation that the minerals appear in the urine.—Remarks on the anatomy of pyrosoma, by M. Joliet.

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