THURSDAY, SEPTEMBER 11, 1884

## DESCRIPTIVE MINERALOGY

*Text-Book of Descriptive Mineralogy.* By Hilary Bauerman, F.G.S. 8vo; pp. vi. 399; 237 figures. (London: Longmans, Green, and Co., 1884.)

THIS is the companion volume to the "Systematic Mineralogy," by the same author, published in 1881. As far as space admits Mr. Bauerman endeavours to describe all the more important mineral species. His remarks about the names of minerals and their derivations are well chosen; and both mining students and teachers of mineralogy should note the following paragraph:—"In the case of minerals worked as metallic ores, the ordinary commercial names should always be used where possible. Thus for all purposes copper pyrites, tinstone, and zinc blende are preferable to chalcopyrite, cassiterite, and sphalerite."

The classification adopted by the author "is in the main similar to that of Rammelsberg's 'Mineral-Chemie.'" Each description gives the form, the structure, the composition, and chemical characteristics, and concludes with the occurrence and distribution of the mineral. The crystallographic form is indicated both by Miller's notation and that of Naumann; and the figures of crystals are from the excellent wood blocks used originally for Brooke and Miller's "Mineralogy."

As might be expected from the author's wide experience as a traveller, the parts relating to occurrence are generally quite as complete as is compatible with the size of the volume; but strange to say, under the head of copper pyrites, the author omits all mention of the great mines of the provinces of Huelva in Spain, and Alemtejo in Portugal. It is true that they are not forgotten by him when speaking of iron pyrites; but Rio Tinto, which produces more copper than any other mine in the world, surely deserves notice quite as much as Devon Great Consols, Mellanear, or South Caradon. We must here correct an error of the author, who places Buitron in Portugal, whereas it is in Spain; and the great Portuguese mine is at San Domingos, not at Pomaron, which is simply the port of shipment, about eleven miles from the actual workings.

The author's acquaintance with Cornwall is not so exact as might be expected, for we find him making the statement that "in Cornwall" the tourmaline "is almost invariably known by the old German miners' name of *Schorl*"; in reality the Cornish term is *Cockle*. Fluor is omitted from the list of minerals associated with tinstone, and it is by no means so certain, as the author thinks, that kaolin has been produced by the action of atmospheric agencies upon the felspars of granite. There is, on the contrary, much to be said for the theory that the decomposing agents came from below. The remark that copper pyrites has been found in Dolcoath and neighbouring mines "in zones alternating in depth with tin ore," would lead one to suppose that there were several copper ore zones in the mines, which is not the case. The published section of Dolcoath shows only one copper zone, including, roughly speaking, the upper half of the workings, and one tin zone, comprising the lower half. No doubt tin ore was obtained also from the *gossan* or ferruginous capping of the vein, and it might therefore be said that there were two tin zones with an intermediate copper zone, but this is not what is stated by the author. Under pyrites we read:—"In Cornwall the common term is Mundick, the varieties being distinguished as sulphur, copper, or arsenical mundic, according to the prevailing constituents." Does the author mean by this that a Cornish miner would call copper pyrites "copper mundic"? If so, he is surely mistaken.



We regret that there are occasional errors of spelling in the names of minerals and places. Thus "Freieslebenite" appears several times without the second "e," though it stands correct in the Index, and "Me*c*onite" might puzzle the novice who had never heard of Meionite. However these are slight blemishes, and both they and the few other mistakes can easily be corrected in a second edition, which no doubt will be required, as Mr. Bauerman's manual is clear, compact, and handy, and is likely to be a favourite with students of mineralogy.

## THE MOSSES OF NORTH AMERICA

*Manual of the Mosses of North America.* By Leo Lesquereux and Thos. James. 8vo, pp. 447, with Six Plates Illustrative of the Genera. (Boston: S. E. Cassino and Co.; London: Trübner and Co. 1884.)

WE have much pleasure in calling the attention of bryologists on this side of the Atlantic to this excellent handbook of the "Mosses of North America." Many contributors have aided in its preparation, and a series of unfortunate disasters have delayed its publication at least ten years beyond what was expected, a delay which, however, has brought with it the compensation of greater completeness. Its foundation was laid by W. S. Sullivant, who contributed to the first edition of Gray's "Manual of the Plants of the Northern United States" in 1848 a synopsis of the mosses then known within the same territory, which were not more than about 200 species. In the second edition of the "Manual," published in 1856, the number of species was doubled, and five plates were given to show the essential characters of the genera. Of both these two treatises a few separate copies were also struck off. At that time there were four excellent bryologists resident in the country who were working actively—Sullivant, Lesquereux, Austin, and James—so that rapid progress was made. When the third edition of the "Manual" was issued, it was planned that Sullivant, in cooperation with Lesquereux, who worked at mosses with Schimper before he emigrated to America, where he has done such excellent work in fossil botany, should undertake an improved handbook of the mosses as a separate publication. Sullivant died in the spring of 1873 without this being carried into effect. His collection of specimens, drawings, and manuscript notes was bequeathed to the herbarium of Harvard University, which under the charge of Prof. Gray has for many years been the main centre for botanical work in the United States. It was planned that Mr. T. P. James, who belonged to Philadelphia, but who removed to live at Cambridge, and who was excellently qualified for the task, should take Sullivant's place in the undertaking, but he died in 1882, and Lesquereux, in old age with his sight failing, was again left alone. The book might have altogether collapsed if it had not been for the kind intervention of Dr. Sereno Watson, who now has charge of the Harvard Herbarium, and who, although not specially a bryologist, has taken upon himself the needful critical and editorial labour that was required to complete it.

The book as now published includes all the mosses which are known on the North American continent within the limits of the United States and northwards. There is already a "Manual of the Mosses of Tropical America," by Mitten, in the twelfth volume of the *Journal* of the Linnean Society, and there are special monographs by Bescherelle on the mosses of Mexico and the West Indies. Sullivant has published figures of most of the endemic types, and Drummond, Austin and Sullivant and Lesquereux have issued extensive sets of dried specimens with numbers and printed labels. In the present work 900 species are included. A very large proportion of them are European, and as the close identity of the moss-flora of the temperate zone in the two continents is so interesting and important from a geographical point of view, we should have been glad if the example of Dr. Gray in marking those species which are common to Europe and America had been followed. Of the six plates five are those which were sketched out by Sullivant, and the sixth is devoted mainly to the sections of Hypnum. The classification does not differ materially from that of Bruch and Schimper, familiar to us in England from being used in Wilson's "Bryologia." The definitions of species and genera are commendably full and clear, and in not establishing or admitting species upon a slender foundation of differential character, the authors have followed the excellent example that has made Dr. Gray's manual, which has now reached its fifth edition, one of the most popular and practically useful of botanical handbooks.

At the end there is a useful glossary of the technical terms used in the descriptions. As it is such a good and cheap book and includes such a large proportion of the British species, it is well worthy of the attention of our home collectors. J. G. BAKER

## 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 insure the appearance even of communications containing interesting and novel facts.*]

### The Diffusion of Species

DURING a recent cruise among the Hebrides two circumstances came before me, both of which are of some interest in natural history—one of them illustrating the curious conditions attending the diffusion of species, and the other illustrating the not less curious conditions affecting the multiplication of particular species in particular seasons.

The celebrated Island of Iona is separated from the nearest part of the Isle of Mull by a sound which is three-quarters of a mile wide. It is the channel of very strong tidal currents, and when the winds blow in certain directions a heavy sea runs through it. This sound has been an effectual isolater of Iona from the access of several species common in Mull. Among others are to be numbered snakes and other reptiles. Tradition ascribes the immunity of the sacred isle to the blessing of St. Columba. Certainly it has been complete. Yet, strange to say, this immunity has been this year endangered. During the late very hot August an adder attempted the passage to Iona, and was in the act of effecting a successful landing, when, fortunately, it was seen by a boy and a girl who were occupied among the stones on the sea-shore. The adder was tired by its long swim, and the boy killed it without difficulty by stamping on its head. This is surely a very curious case of migration; and it is difficult to conceive the impulse under which the snake committed itself to the tides and currents of a channel so broad and dangerous. The hot weather of this year has no doubt developed in all reptiles an abnormal activity; and I saw a youth in Mull who had recently very nearly lost his life from the bite of an adder. The description given me of his condition for many hours brought home to my mind almost for the first time that we have in our own island a veritable member of the terrible "Thanatophidia." But it seems quite unaccountable why such a reptile should have attempted to cross the Sound of Iona.

The other circumstance to which I have referred is the marvellous development of the Salpidæ this year in the Hebridean seas. I have cruised on those seas every year for fifteen years regularly, and I have been often on the look-out for these curious organisms; yet I have never seen them at all except once, and then only rarely and locally. Whereas this year the water was laden with them almost everywhere, and in some places it was rendered almost foul with their enormous quantity. In the Sound of Iona my tow-net was soon half filled with them; and the long chains of beautiful pattern which passed under the yacht lent an additional charm to the exquisite colour of that pure oceanic water. In the Sound of Raasay, near Portree, the number was still greater. But the maximum development appeared in Loch Scavaig, where, as far down as the eye could reach, there was nothing to be seen but Salpæ in every variety of concatenation and decatenation—long chains, short chains, and countless myriads of separated individuals—making the whole sea little more than a thick soup of Salpæ.

On being placed in a glass of water the muscular contractions of their bodies were beautifully exhibited, and their darting movements were very striking. Their exquisite crystalline material allowed every detail of structure to be seen; and on being placed in numbers in a bucket of water, and on being stirred at night, their phosphorescence was brilliant.

I should be glad to know from any of your correspondents whether there is any explanation of this exceptional development of these creatures. ARGYLL

Inveraray, September 6

### Meteor- Moon- and Sun-Shine

DESCENDING the Calton Hill from the Royal Observatory on Tuesday night, I was much struck with the appearance, though momentary only, of a fine meteor of Venus-like brightness, passing in a short course from south-east to north-east nearly horizontally, and at a height of about half a degree above the Pleiades, at 3 minutes past 12 G.M.T. The yellowness of the meteor's light was very conspicuous, contrasted with the blueness of the faint stars and of the sky about them in that direction, shimmering in pale blue reflected moonlight; and seemed to speak of abundance of sodium, as well as a low temperature of incandescence, in that particular meteor.

But very different was the colour in the opposite quarter of the sky, or just west of south, where the moon, within a day of the full, was shining brilliantly, in white light immediately around and above it, but producing between it and the horizon, and for a considerable distance on either side, exactly and most perceptibly that faintly claret-coloured haze, which I have been remarking about and beneath the sun all this year. Precisely too as with the sun, the colour was shown on this occasion with the moon to be in the very highest regions of the atmosphere by any cumulus clouds, at heights of 3000 or 4000 feet, that floated past, being pre-eminent on that warm-coloured backing, by the pearly whiteness of their lights and blueness of their shadows. In so far quite agreeably with Mr. Backhouse's recent and very interesting letter in NATURE (p. 359), stating that he had found a solar dust-halo, with effects like the above, more and more visible the higher he ascended amongst the Alps.

That such appearances were produced by solid particles in a cold state, and not by any new gas introduced into the atmosphere, seems to be borne out by three sets of rather extensive solar spectroscopings which I have lately carried out; for while there does not seem to be a single new line amongst the thousands of old ones, so far as I have yet examined the observations, there is only too abundant evidence of a continued dulling of the light of the sun's continuous spectrum all along its range.

This effect is of course more conspicuous in the faint regions at either end than in the bright middle, and would appear to be testified to undeniably by the following differential observation, viz. that with a prismatic apparatus, wherewith I could see lines in the bright regions, say of B, C, and D, rather better than I could with somewhat similar, but darker, prisms in 1877,—I could not see Brewster's line Y and its companion groups in the very faint ultra-red so well as I did then; and could not see the further-away line X at all, though in 1877 it was not only clear enough, but far fainter lines on either side of it were visible and micrometrically measurable. Neither in 1884 have I been able with the same eye and instrument to see anything at the violet end of the spectrum of the grand banded lines H and K, though they formed a daily subject of observation in 1877.

In 1856 I remarkably appreciated that an ascent to 11,000 feet of altitude on the Peak of Teneriffe enabled H and K to be seen with peculiar distinctness and fine resolution of much of their haze at lower levels into sharp lines; but would that have been equally the case this year, when the inhabited regions of the earth, and the lower clouds too, are covered in by a widespread blanket of dust in most anomalous extent and density?

C. PIAZZI SMYTH

Astronomer-Royal for Scotland

15, Royal Terrace, Edinburgh, September 6

## Pons' Comet—Pink Glow

THIS comet was visible here up to the beginning of June. I saw it on fourteen nights in April and eighteen in May, including the last eleven nights of the latter month. It could be seen with an opera-glass up to April 3; my last sight of it was with a 4-inch telescope on June 1, or rather at 12.30 a.m. of June 2 (= June 1d. 1h. G.M.T.). On April 24, and again and particularly on May 24 it seemed to me to have become suddenly fainter, though there seemed nothing in the state of the sky to account for it; indeed, on the last-named night I have noted, "sky very clear." Up to at least May 28 its motion in two or three hours could be plainly seen. On that night, though "very diffused and faint," it was visible before the moon had set. It had not, I think, on June 2 reached the *minimum visibile*, but as I had no ephemeris subsequent to that (to the middle of April) given in NATURE, it would have been quite useless to have looked for it again after the moon had passed.

I may add that the "pink glows" have not yet left us; on the last two evenings (July 1 and 2), which were clear, they were very distinct.

A. S. ATKINSON

Nelson, N.Z., July 3

## Alternation of Generations in Salpa

WHILE we are indebted to Prof. W. K. Brooks for having enunciated his views on this subject clearly in NATURE for August 14 (p. 367), I should like to point out that the misquotations which he has called attention to in an article of mine published in May (p. 67) do not invalidate the strength of the counter-arguments, although I must apologise for their having been allowed to appear.

He does not acknowledge that the question at issue is one not of fact but of the explanation of accepted fact, *i.e.* it is a question of theory. Undoubtedly an egg migrates from the body of the solitary Salpa to that of the chain form, but Kowalevsky, who himself describes this, does not agree with Prof. Brooks' conclusion drawn therefrom.

Prof. Brooks pointed out at greater length than I did that the phenomena found in Pyrosoma and Composite Ascidians culminate in those in Salpa. Beginning in Pyrosoma with "an indefinite series of hermaphrodite buds," he shows how the reproductive cell becomes marked out earlier and earlier, until in Salpa it is fully developed in the body of the gemmating individual. Then, instead of showing by his nomenclature that Salpa is the end of a series, he prefers to break loose from any attempt at continuity and to call the solitary Salpa a true female.

I, however, prefer to follow in the steps of Prof. Moseley, who says of similar changes in the Hydromedusæ, that "it would lead to great confusion if the old way of regarding the matter was upset. The past history of the gonophores must be taken into account, and the fact that the sexual elements, though now developed at a greater or less distance in many species, formerly undoubtedly originated within the gonophore."

As Prof. Brooks does not use language in this way, it is not remarkable that he criticises me for using the term "hydroid" in regard to Cunina at a stage *comparable* to the hydriform and gemmating person of a Sertularian, although I pointed out that it is a Medusa in both generations.

The fault of Prof. Brooks' argument is that he is not consistent. He says: "Very many chain Salpæ are produced at one time. As these have no power to reproduce by budding, they have *lost their ovaries*, although each of them when it is born contains, like the bud of Pyrosoma, a single unfertilised egg."

If this means that the egg is the sole remnant of the ovary, it admits all that I contend for; but if, on the other hand, it means that in a less modified condition these must have an ovary proper to the bud as well as the ovum received from the solitary Salpa, it follows that Salpa cannot be differentiated from a form like Pyrosoma, where there is, so to speak, a migrating ovary, but no trace of ovary independently formed in the bud. The second ovary described by Salensky cannot be a trace of this, for it is simply another ovum with follicular covering precisely like the first.

R. N. GOODMAN

St. John's College, Cambridge

## Forked Lightning

BY papers received by last mail I see that Mr. W. C. Gurley claims to have shown, by photographing a flash of lighthing, that the ordinary notion of *forked* lightning must be given up. I do not know whether this conclusion has been drawn from the photograph of a single flash or not, but you will see from the inclosed photographs that the conclusion is an entirely false one. An examination of my photographs will show that all the flashes except one had the zigzag form, and that some of them are magnificently forked. They resemble very closely the photographs of sparks from a Holtz electrical machine, taken by Mr. A. Matheson in Prof. Tait's laboratory, and published in vol. xxvii. Part 3, of the *Transactions* of the Royal Society of Edinburgh. The amount of detail shown in the photograph of the tree illuminated by the flash gives one a very good idea of the brightness, when we consider that exposure cannot have exceeded the millionth part of a second. I may add that my first photograph was taken on October 16, 1883, and was circulated amongst friends immediately afterwards.

C. MICHIE SMITH

Madras Christian College, Madras, August 9

## Sun-Glows

As one of the first to draw attention in the *St. James's Gazette* of October 1, and November 9, 1883, and many subsequent occasions, to those strange phenomena about the sun last autumn, will you kindly allow me space in your valuable columns to ask how it is possible to refer such effects any longer (as Mr. Backhouse does in your paper of August 14, p. 359) to volcanic dust from, I presume, the Krakatoa eruption, when we know now that in south latitudes these phenomena were observed by Mr. Neison of the Natal Observatory as early as the spring of 1883? He says that "they increased in intensity from February until June, when they were strongly marked." I have watched the sky as an artist (out of London) for quite forty years, and feel sure that this corona, or blanching of the sun, has been a more persistent feature of late years than formerly. It is still there, and may be seen without leaving England, or even London in clear weather, by looking for it from about an hour to half an hour before or after sunset and sunrise. The last very mild winter and the preceding one could have had no connection with the Krakatoa eruption, and I think that we must now seek for an explanation of the present and past atmospheric phenomena in some increase of solar energy, and consequent lifting of vapour higher than usual.

ROBERT LESLIE

6, Moira Place, Southampton, August 24

### Fireballs

IN addition to the occurrences recently recorded in your columns, it may be well to quote a further observation communi cated in a letter, by Lady Borthwick, to the *Morning Post* for August 16, dated from Derculich, Ballinlaig, Perthshire, from which I extract the following particulars :—

As several curious phenomena of a like kind had been described as having occurred in Edinburgh during a terrific thunderstorm on Tuesday, August 12, the writer proceeds to detail what had been witnessed by herself and some others in her neighbourhood. The storm began at 10 o'clock in the morning and continued with unabated violence till past 10 at night. It appeared to be at its height from about 3 till 7 p.m., when as many as three flashes of lightning occurred to one peal of thunder. In many cases they were of a vivid pink colour. At about 6 o'clock a loud noise was heard, unlike any preceding it : "the heavens seemed to open, and there issued from the clouds what appeared like a ball of fire, about the size of a man's head, which exploded with a terrific crash, emitting quantities of sparks." It then appeared to descend at a distance of not more than twenty yards from the house. Mr. J. K. Laughton, commenting upon the phenomenon in the next issue, states that "ball lightning" is not solid, but yet in "passing along the surface of soft land it ploughs it up in a way that no cannon ball could do," and refers to an instance of this mentioned by Scott in his "Elementary Meteorology."

At a recent meeting of the Paris Academy of Sciences, M. Gaston Planté illustrated some remarks upon globular electric bolts by producing artificially effects analogous to those of fireballs, and it would be interesting to know more respecting their nature. As they appear to occur only very occasionally, on account of the rare conditions of the atmosphere producing them, it is certainly advisable to collect all the evidence respecting them that is obtainable. By such means it may in the course of time become possible for those who are competent to deal with the facts, to arrive at some definite conclusions concerning this little understood phenomenon. WM. WHITE

September 2

### Deep-Sea Corals

PROF. H. N. MOSELEY, F.R.S., in his masterly address to the Biological Section of the British Association at Montreal, dealt, amongst other matters, with the zoological position of the remarkable genera of deep-sea corals named *Guynia*, *nobis*, and *Haplophyllia* and *Duncania*, of Pourtalès. He states that he has found, after examing sections of the last-named genus, that the soft parts indicate that it and the others are *Hexactinia*, and have the construction of *Caryophyllia* and of all other corals of that group. These genera were placed amongst the Rugosa, the first-mentioned by myself fourteen years since, and the others by Pourtalès later on. On April 3 of the present year I read a communication to the Linnean Society, entitled "A Revision of the Families and Genera of the Madreporaria," and this revision is published. As Prof. Moseley left England before I could send him a copy, he and some other naturalists who study the corals will be perhaps interested by knowing that I have placed those genera where Prof. Moseley has located them subsequently. They form an alliance in the family Turbinolidæ, and I was led to alter the classificatory position on account of a careful examination of the hard parts.

August 30 P. MARTIN DUNCAN

### Iridescent Lunar Halos

ON the evening of July 4, from 5.30 p.m. to 7 p.m., the moon, eleven days old, was surrounded with a series of extraordinary halos consisting of a succession of concentric rings ; fine, clear starlight ; very light airs from south-west and west-south-west ; thermometer, 42°.

At 5.30, very light fleecy scud from south-west, the moon surrounded with a halo of about three times its diameter, of dullish white within a ring of orange ; rapid changes ensued : the moon appeared within an opaque circle intensely white, surrounded with chromatic rings in the following order—yellow, orange, red, indigo, a broad ring of blue, yellow, orange, red, indigo, deep blue, bordered by a faint ring of orange. At this time the moon appeared as a bright boss on a many-coloured shield ; changes rapidly followed : at 5.35 the rings were as follows—white, yellow, orange, red, indigo, blue, yellow, orange ; for some moments the outer ring of orange became blurred, the broad ring of blue very deep and beautiful ; at 5.50 all of the halo had disappeared ; sky clear, bright starlight all round, except where a few light fleecy clouds lay to the north-east. At 6.10 light scud from south-west ; at 6.12 halo again formed, as follows—white, yellow, orange ; in a few moments were added red, indigo, blue, orange ; soon a mass of whitish scud, light and fleecy, seemed to gather round the moon widely, in a huge irregular oval, changing almost to a circle with uneven edges. At 6.20 the halo had disappeared ; then came a bow-shaped yellowish coloration on the south-west of the moon, changing instantly to orange, red, indigo, faint indistinct orange ; at 6.22 all clear again ; at 6.29 bright almost dazzling rays immediately surrounded or jettied from the moon. At 6.30, north of the moon, orange appeared on some light scud ; soon changes again took place : immediately on the edge the moon, where the rays were so brilliant, was now very dark with jagged edges within an intensely white ring, surrounded with a series of sharply-defined chromatic rings in the order they appeared at 5.35. At 6.35 another mass of whitish scud widely surrounded the moon as before described ; at 6.48 all clear again ; instantly after an orange patch appeared on scud to the north ; at 6.56 orange on east ; at 7 p.m. all was again clear ; rays as dazzling as at an earlier period ; temperature sensibly lower ; frost at night. T. H. POTTS

Ohinitahi, N.Z., July 5

### Sextants

IN your review of the "Encyclopædia Britannia" published last week I notice that reference is made to an article on navigation by Capt. Moriarty, and attention is called to the very serious error in sextants arising from false centering. Having had some experience in the examination of these instruments, I can practically testify to this most important defect. Only a week or so since two sextants were received here for trial, one of which belonged to a captain of the mercantile marine. In both instances, although the mirrors and shades were good, yet the arc error due to false centering was excessively large, increasing from 0 at 0° to + 7′ at 60°, while at 90° it amounted to 10′. Surely this must be a serious matter to navigators, but, as you point out, for the small fee of five shillings persons ordering a sextant may direct the maker to send it to the Observatory, where suitable apparatus is arranged not only for examining the arc but also the mirrors and shades. It is only fair, however, to say that when instruments are sent direct from the makers we do not often have occasion to reject one. Indeed, superior sextants by first-class makers rarely have an error exceeding 1′ of arc, and often not more than 30″, but how few these are in comparison with the hundreds of inferior instruments that pass into the hands of the public without being tested. T. W. BAKER

The Kew Observatory, Richmond, September 2

### Electrical Rainbow

I WAS one of a deputation of River Tyne Commissioners who visited the South Foreland, to see the experimental lights now on trial there, on Saturday night, August 30. We were walking across the fields from the lights towards the observing hut No. 2, a distance of about a mile and a half. There was a fog more or less, and a shower of rain as we were approaching the hut, and every time the electric light from A tower revolved, a rainbow, very like a faint lunar bow, made its appearance. I could not see any prismatic colour, and the bow was only produced by the large electric light, with carbons of 1¼ inch in diameter. There was no bow visible from the old light, which has carbons of about ⅞ inch square, and none from either the gas or oil lights. I was informed that this was the first time such a phenomenon had been observed. R. S. NEWALL

Ferndene, September 3

### Rainbow on Spray

A CURIOUS appearance, which I have never observed before, was visible here for a few minutes this forenoon. Large breakers were rolling in to the bay, and their fronts (covered with foam) were brilliantly white in the sunshine. But, as each passed a particular spot, directly opposite to the sun, the spray blown back from its crest took a bright reddish-brown colour. *This was the apex of the primary rainbow.* When observed from a more elevated point, the apparent colour of the spray became bluish. G. H.

September 5

### Circular Rainbow seen from a Hill-top

NOTICING a communication in NATURE (p. 361) regarding the phenomenon of a circular rainbow, I thought it worth while to mention a case which lately came under my observation. Standing on a point of rock just opposite the beautiful falls of Montmorenci, Quebec, I was surprised to see a rainbow in the form of a circle passing through my feet. The spray from the falls was being blown into a deep cove in front of me, and the sun was high in the heavens behind. The primary was well defined and very beautiful; the secondary was faint. I understand that the conditions for seeing this circular rainbow are not often favourable at Montmorenci; still it may not be amiss to advise intending visitors *not* to stop at the bottom of the steps which lead down below the falls, but to clamber over the rocks as near the water as possible. W. L. GOODWIN

Montreal, August 28

### Intelligence in Frogs

A FRIEND in Scotland has a small lake in his grounds, which are surrounded by a high wall. At the bottom of the lake is a sluice by which the water can be let off into a burn below the grounds. A few weeks ago the lady of the house was walking down the road outside the wall towards the burn when, to her astonishment, she met a multitude of frogs making their way up the road, which makes a considerable detour, to the gate leading into the grounds. On inquiry she found that the lake had that morning been emptied through the sluice, and it was plain that these were frogs which, having been carried down with the water to the burn, were now making their way back to their old home. By what instinct did they know that the long road led to the point from which the short one had started? B. W. S.

September 3

## THE TEMPERATURE OF THE SOLAR SURFACE

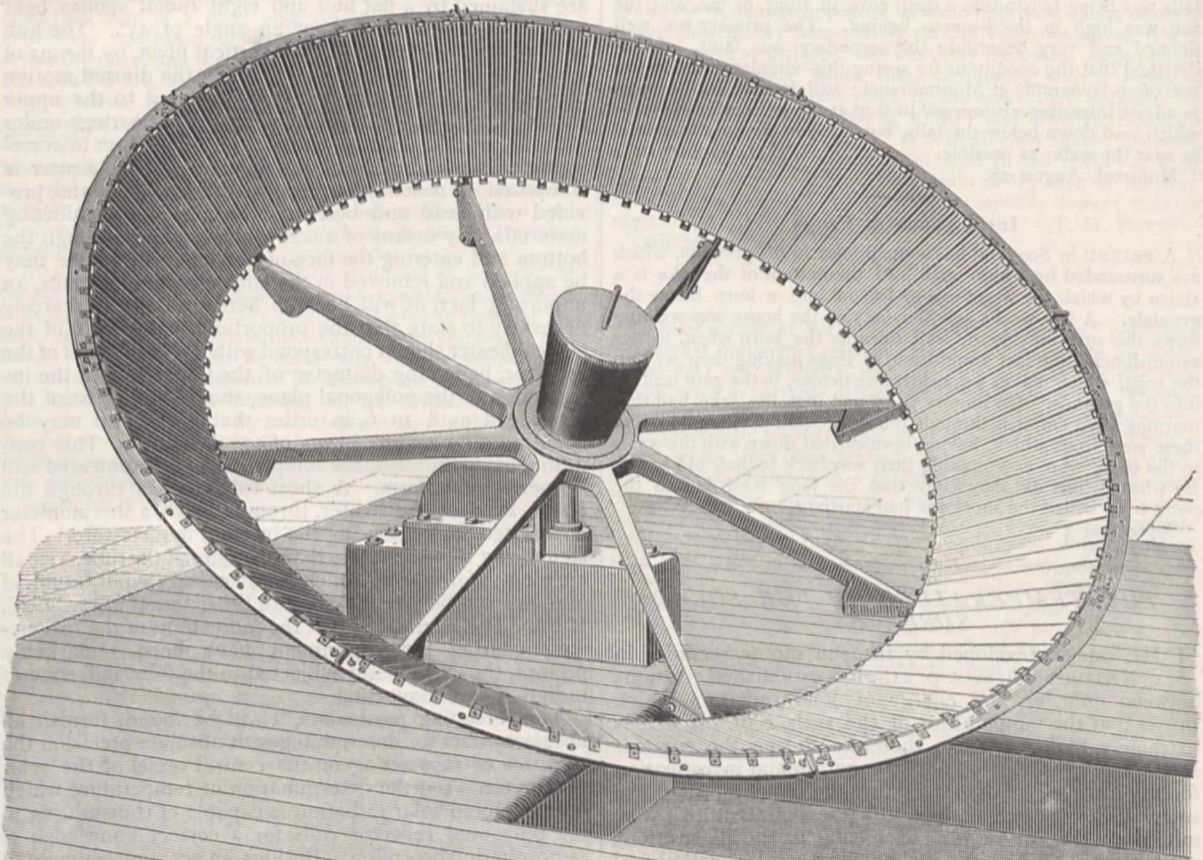
THE power developed by the sun motor, recorded in NATURE, vol. xxix. p. 217, has established relations between diffusion and energy of solar radiation which prove that the temperature of the surface of the sun is extremely high. I have, therefore, during the summer solstice of 1884, carried out an experimental investigation for the purpose of demonstrating the temperature of the solar surface corresponding with the temperature transmitted to the sun motor. Referring to the illustrations previously published, it will be seen that the cylindrical heater of the sun motor, constructed solely for the purpose of generating steam or expanding air, is not well adapted for an exact determination of the amount of surface exposed to the action of the reflected solar rays. It will be perceived on inspection that only part of the bottom of the cylindrical heater of the motor is acted upon by the reflected rays, and that their density diminishes *gradually* towards the sides of the vessel; also that owing to the imperfections of the surface of the reflecting plates the exact course of the terminal rays cannot be defined. Consequently, the most important point in the investigation, namely, the area acted upon by the reflected radiant heat, cannot be accurately determined. I have accordingly constructed an instrument of large dimensions, a polygonal reflector (see Fig. 1), composed of a series of inclined mirrors, and provided with a central heater of conical form, acted upon by the reflected radiation in such a manner that each point of its surface receives an equal amount of radiant heat in a given time. The said reflector is contained within two regular polygonal planes twelve inches apart, each having ninety-six sides, the perimeter of the upper plane corresponding with a circle of eight feet diameter, that of the lower plane being six feet. The corresponding sides of these planes are connected by flat taper mirrors composed of thin glass silvered on the outside. When the reflector faces the sun at right angles, each mirror intercepts a pencil of rays of 32·61 square inches section, hence the entire reflecting surface receives the radiant heat of an annular sunbeam of $32·61 \times 96 = 3130$ square inches section. It should be observed that the area thus stated is 0·011 less than the total foreshortened superficies of the ninety-six mirrors if sufficiently wide to come in perfect contact at the vertices. Fig. 2 represents a transverse section of the instrument as it appears when facing the sun; the direct and reflected rays being indicated by dotted lines. The reflector and conical heater are sustained by a flat hub and eight radial spokes bent upwards towards the ends at an angle of 45°. The hub and spokes are supported by a vertical pivot, by means of which the operator is enabled to follow the diurnal motion of the sun, while a horizontal axle, secured to the upper end of the pivot, and held by appropriate bearings under the hub, enables him to regulate the inclination to correspond with the altitude of the luminary. The heater is composed of rolled plate iron 0·017 inch thick, and provided with head and bottom formed of non-conducting materials. By means of a screw-plug passing through the bottom and entering the face of the hub the heater may be applied and removed in the course of five minutes, an important fact, as will be seen hereafter. It is scarcely necessary to state that the proportion of the ends of the conical heater should correspond with the perimeters of the reflector, hence the diameter of the upper end, at the intersection of the polygonal plane, should be to that of the lower end as 8 to 6, in order that every part may be acted upon by reflected rays of equal density. This condition being fulfilled, the temperature communicated will be perfectly uniform. A short tube passes through the upper head of the heater, through which a thermometer is inserted for measuring the internal temperature. The stem being somewhat less than the bore of the tube, a small opening is formed by which the necessary equilibrium of pressure will be established with the external atmosphere. It should be mentioned that the indications of the thermometer during the experiment have been remarkably prompt, the bulb being subjected to the joint influence of radiation and convection.

The foregoing particulars, it will be found, furnish all necessary data for determining with absolute precision the *diffusion* of rays acting on the central vessel of the solar pyrometer. But the determination of temperature which uninterrupted solar radiation is capable of transmitting to the polygonal reflector calls for a correct knowledge of atmospheric absorption. Besides, an accurate estimate of the loss of radiant heat attending the reflection of the rays by the mirrors is indispensable. Let us consider these points separately.

*Atmospheric Absorption.*—The principal object of conducting the investigation during the summer solstice has been the facilities afforded for determining atmospheric absorption, the sun's zenith distance at noon being only 17° 12′ at New York. The retardation of the sun's rays in passing through a clear atmosphere obviously depends on the depth penetrated; hence—neglecting the curvature of the atmospheric limit—the retardation will be as the secants of the zenith distances. Accordingly, an observation of the temperature produced by solar radiation at a zenith distance whose secant is *twice* that of the secant of 17° 12′, viz. 61° 28′, determines the minimum atmospheric absorption at New York. The result of observations conducted during a series of years shows that the maximum solar intensity at 17° 12′ reaches 66°·2 F., while at a zenith distance of 61° 28′ it is 52°·5 F.; hence, minimum atmospheric absorption at New York, during the summer solstice, is $66°·2 - 52°·5 = 13°·7$ F., or $\frac{13·7}{66·2} = 0·207$ of the sun's radiant energy where the rays enter the terrestrial atmosphere.

In order to determine the loss of energy attending the reflection of the rays by the diagonal mirrors, I have constructed a special apparatus, which by means of a parallactic mechanism faces the sun at right angles during observations. It consists principally of two s nall mirrors, manufactured of the same materials as the reflector, placed diagonally at right angles to each other; a thermometer being applied between the two, whose stem points towards the sun. The direct solar rays entering through perforations of an appropriate shade, and reflected by the inclined mirrors, act simultaneously on opposite sides of the bulb. The mean result of repeated trials, all differing but slightly, show that the energy of the direct solar rays acting on the polygonal reflector is reduced 0·235 before reaching the heater.

In accordance with the previous article, the investigation has been based on the assumption that, *the temperatures produced by radiant heat at given distances from its source are inversely as the diffusion of the rays at those distances. In other words, the temperature produced by solar radiation is as the density of the rays.*



Captain Ericsson's Solar Pyrometer, erected at New York, 1884.

It will be remembered that Sir Isaac Newton, in estimating the temperature to which the comet of 1680 was subjected when nearest to the sun, based his calculations on the result of his practical observations that the maximum temperature produced by solar radiation was one-third of that of boiling water. Modern research shows that the observer of 1680 underrated solar intensity only 5° for the latitude of London. The distance of the comet from the centre of the sun being to the distance of the earth from the same as 6 to 1000, the author of the "Principia" asserted that the density of the rays was as $1000^2$ to $6^2$ = 28,000 to 1; hence the comet was subjected to a temperature of $28{,}000 \times \frac{180^\circ}{3} = 1{,}680{,}000^\circ$, an intensity exactly "2000 times greater than that of red-hot iron" at a temperature of 840°. The distance of the comet from the solar surface being equal to one-third of the sun's radius, it will be seen that, in accordance with the Newtonian doctrine, the temperature to which it was subjected indicated a solar intensity of $\frac{4^2 \times 1,680,000}{3^2} =$ 2,986,000° F.

The writer has established the correctness of the assumption that "the temperature is as the density of the rays," by showing practically that the *diminution* of solar temperature (for corresponding zenith distances) when the earth is in aphelion corresponds with the increased diffusion of the rays consequent on increased distance from the sun. This practical demonstration, however, has been questioned on the insufficient ground that "the eccentricity of the earth's orbit is too small and the temperature produced by solar radiation too low" to furnish a safe basis for computations of solar temperature.

In order to meet the objection that the diffusion of the rays in aphelion do not differ sufficiently, the solar pyrometer has been so arranged that the density, *i.e.* the diffusion of the reflected rays, can be changed from a ratio of 1 in 5040 to that of 1 in 10,241. This has been effected by employing heaters respectively 10 inches and 20 inches in diameter. With reference to the "low" solar temperature pointed out, it will be perceived that the adopted expedient of increasing the density of the rays without raising the temperature by *converging* radiation, removes the objection urged.

Agreeably to the dimensions already specified, the area of the 10-inch heater acted upon by the reflected solar rays is 331·65 square inches, the area of the 20-inch heater being 673·9 square inches. The section of the annular sunbeam whose direct rays act upon the polygonal reflector is 3130 square inches, as before stated.

Regarding the diffusion of the solar rays during the investigation, the following demonstration will be readily understood. The area of a sphere whose radius is equal to the earth's distance from the sun in aphelion being to the sun's area as $218·1^2$ to 1, while the reflector of the solar pyrometer intercepts a sunbeam of 3130 square inches section, it follows that the reflector will receive the radiant heat developed by $\frac{3130}{218·1^2} = 0·0658$ square inch of the solar surface. Hence, as the 10-inch heater presents an area of 331·65 square inches, we establish the fact that the reflected solar rays, acting on the same, are *diffused* in the ratio of 331·65 to 0·0658, or $\frac{331·65}{0·0658} = 5040$ to 1; the

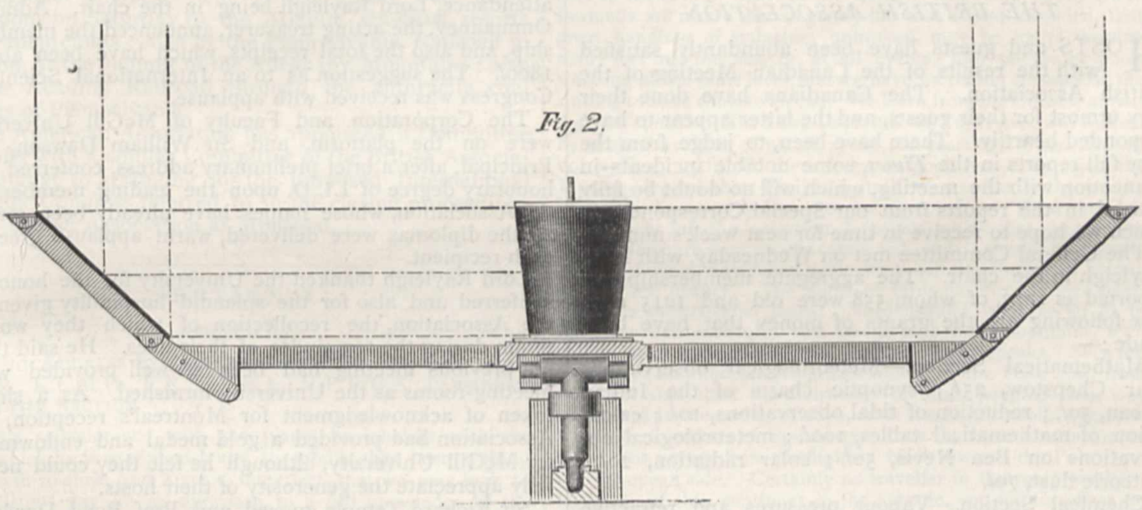


Fig. 2.

diffusion of the rays acting on the 20 inch heater being as 673·9 to 0·0658, or $\frac{673·9}{0·0658} = 10,241$ to 1.

The atmospheric conditions having proved unfavourable during the investigation, maximum solar temperature was not recorded. Accordingly, the heaters of the solar pyrometer did not reach maximum temperature, the highest indication by the thermometer of the small heater being 336°·5, that of the large one being 200°·5 above the surrounding air. No compensation will, however, be introduced on account of deficient solar heat, the intention being to base the computation of solar emperature solely on the result of observations conducted at New York during the summer solstice of 1884. It will be noticed that the temperature of the large heater is proportionally higher than that of the small heater, a fact showing that the latter, owing to its higher temperature, loses more heat by radiation and convection than the former. Besides, the rate of cooling of heated bodies increases more rapidly than the augmentation of temperature.

The loss occasioned by the imperfect reflection of the mirrors, as before stated, is 0·235 of the energy transmitted by the direct solar rays acting on the polygonal reflector, hence the temperature which the solar rays are capable of imparting to the large heater will be 200°·5 × 1·235 = 247°·617; but the energy of the solar rays acting on the *reflector* is reduced 0·207 by atmospheric absorption, consequently the ultimate temperature which the sun's radiant energy is capable of imparting to the heater is 1·207 × 247°·617 = 298°·87 F. It is hardly necessary to observe that this temperature (developed by solar radiation diffused fully ten-thousandfold) must be regarded as an *actual* temperature, since a perfectly transparent atmosphere, and a reflector capable of transmitting the whole energy of the sun's rays to the heater, would produce the same.

The result of the experimental investigation carried out during the summer solstice of 1884 may be thus briefly stated. The diffusion of the solar rays acting on the 20-inch heater being in the ratio of 1 to 10,241, the temperature of the solar surface cannot be less than 298°·87 × 10,241 = 3,060,727° F. This underrated computation must be accepted unless it can be shown that the temperature produced by radiant heat is not inversely as the diffusion of the rays. Physicists who question the existence of such high solar temperature should bear in mind that in consequence of the great attraction of the solar mass, hydrogen on the sun's surface raised to a temperature of 4000° C., will be nearly twice as heavy as hydrogen on the surface of the earth at ordinary atmospheric temperatures; and that, owing to the immense depth of the solar atmosphere, its density would be so enormous at the stated low temperature that the observed rapid movements within the solar envelope could not possibly take place. It scarcely needs demonstration to prove that extreme tenuity can alone account for the extraordinary velocities recorded by observers of solar phenomena. But *extreme tenuity* is incompatible with low temperature and the pressure produced by an atmospheric column probably exceeding 50,000 miles in height subjected to the sun's powerful attraction, diminished only one-fourth at the stated elevation. These facts warrant the conclusion that the high temperature established by our investigation is requisite to prevent undue density of the solar atmosphere.

It is not intended at present to discuss the necessity of tenuity with reference to the functions of the sun as a radiator; yet it will be proper to observe that on merely dynamical grounds the enormous density of the solar envelope which would result from low temperature, presents an unanswerable objection to the assumption of Pouillet, Vicaire, Sainte-Claire Deville, and other eminent *savants*, that the temperature of the solar surface does not reach 3000° C.

J. ERICSSON

## THE BRITISH ASSOCIATION

HOSTS and guests have been abundantly satisfied with the results of the Canadian Meeting of the British Association. The Canadians have done their very utmost for their guests, and the latter appear to have responded heartily. There have been, to judge from the very full reports in the *Times*, some notable incidents in connection with the meeting, which will no doubt be fully noticed in the reports from our Special Correspondents, which we hope to receive in time for next week's number.

The General Committee met on Wednesday, with Lord Rayleigh in the chair. The aggregate membership was reported as 1773, of whom 558 were old and 1215 new. The following are the grants of money that have been made:—

Mathematical Section.—Meteorological observations near Chepstow, 25*l.*; synoptic charts of the Indian Ocean, 50*l.*; reduction of tidal observations, 10*l.*; calculation of mathematical tables, 100*l.*; meteorological observations on Ben Nevis, 50*l.*; solar radiation, 20*l.*; meteoric dust, 70*l.*

Chemical Section.—Vapour pressures and refractive indices of salt solutions, 25*l.*; chemical nomenclature, 5*l.*; physical constants of solutions, 20*l.*

Geological Section.—Volcanic phenomena of Vesuvius, 25*l.*; Raygill fissure, 15*l.*; earthquake phenomena of Japan, 75*l.*; fossil Phyllopoda of the Palæozoic rocks, 25*l.*; fossil plants of British Tertiary and Secondary beds, 50*l.*; *Geological Record*, 50*l.*; erosion of seacoasts, 10*l.*; circulation of underground waters, 10*l.*

Biological Section.—Table at Naples Zoological Station, 100*l.*; *Zoological Record*, 100*l.*; migration of birds, 30*l.*; exploring Kilimanjaro and adjoining mountains of Equatorial Africa, 25*l.*; recent Polyzoa, 10*l.*; marine biological station at Granton, 100*l.*; biological stations on coast of United Kingdom, 150*l.*

Geographical Section.—Exploring New Guinea, 200*l.*; exploring Mount Roraima, 100*l.*

Mechanical Section.—Patent legislation, 5*l.*

Anthropological Section.—Investigating the characteristic physical and other features of north-west tribes of Canada, 50*l.*; physical characteristics of the races in the British Isles, 10*l.* Total, 1525*l.*

In the case of the following Committees no money grants were voted:—Committees on practical standards for use in electrical measurements, for promoting tidal observations in Canada, for calculating tables of fundamental variations of algebraic forms, for securing harmonic analysis in reducing tidal observations, for comparing and reducing magnetic observations, for investigating the rate of increase of underground temperatures, for securing an international geological map of Europe, for reporting on erratic blocks of England, Wales, and Ireland, for examining marine life on coasts and rivers of North America, for survey of Palestine, and for science teaching in elementary schools. A vote was passed that the Council be recommended to request the Admiralty to adopt an harmonic analysis for the reduction of tidal observations. This is already being done in Germany, France, India, and elsewhere. A letter was read on the subject prepared by Sir William Thomson and Prof. G. H. Darwin to send to the Admiralty. The Council was also recommended to request the Canadian Government to adopt measures for investigating the physical character, languages, social and artistic condition of the native tribes of the Dominion. Various American members having suggested that an International Scientific Congress be formed, this subject was referred to the Committee by several Sections.

The General Committee adjourned to meet in London on November 11.

The closing meeting of the Association was held in Queen's Hall the same afternoon. There was a large attendance, Lord Rayleigh being in the chair. Admiral Ommanney, the acting treasurer, announced the membership, and also the total receipts, which have been about 1800*l.* The suggestion as to an International Scientific Congress was received with applause.

The Corporation and Faculty of McGill University were on the platform, and Sir William Dawson, the Principal, after a brief preliminary address, conferred the honorary degree of LL.D. upon the leading members of the Association, whose names have already been given. As the diplomas were delivered, warm applause greeted each recipient.

Lord Rayleigh thanked the University for the honours conferred and also for the splendid hospitality given to the Association, the recollection of which they would retain during the remainder of their lives. He said that no previous meeting had been so well provided with meeting-rooms as the University furnished. As a slight token of acknowledgment for Montreal's reception, the Association had provided a gold medal and endowment for McGill University, although he felt they could never fully appreciate the generosity of their hosts.

Sir Richard Temple moved, and Prof. Boyd Dawkins seconded, a resolution expressing cordial sympathy with the popular movement set on foot in Montreal to establish a public library worthy of the great city to properly mark the occasion of the first meeting of the British Association in Canada. Both made brief addresses, urging the members to aid the project. Sir William Thomson spoke in its advocacy, saying that a good library would be of vast importance to Montreal and to this portion of North America, that it would be an excellent basis for the subsequent establishment of a good scientific school. He urged the members to give liberal subscriptions. The resolution was adopted amid applause.

Sir Lyon Playfair moved, and General Lefroy seconded, a resolution of cordial thanks to the Dominion Government for the aid, support, and sympathy shown in promoting the Montreal meeting of the British Association, and for the warm interest felt in its success, which was adopted. Mr. J. White, a member of the Canadian House of Commons, responded for the Dominion Government.

Sir William Thomson moved, and Sir Frederick Bramwell seconded, a resolution of thanks to the McGill University, the Corporation of Montreal and its citizens, with a long list of other bodies who aided in promoting the objects of the meeting. Sir James Ferrier responded, saying, in the course of a felicitous address, that already the projected public library had been fairly started by a proposed gift to McGill College for this purpose, by a benevolent gentleman of Montreal, of $50,000.

Other votes of thanks were passed to railway, steamer, and telegraph companies, and others who have aided the meeting. Mr. Hugh M'Lennan and Mr. Andrew Robertson responded for them.

The final vote of thanks to the President was moved by Prof. Daniel Wilson and seconded by Prof. Robert Ball and Sir William Dawson. After a brief appropriate reply by Lord Rayleigh, the British Association adjourned, to meet at Aberdeen in 1885.

About 300 British and Canadian members of the Association have arrived in Philadelphia from Montreal to attend the meetings of the American Association for the Advancement of Science. A local hospitality committee received them at the railway stations, providing homes for them with citizens or in hotels. They were formally welcomed to Philadelphia at a large meeting at the Academy of Music on Friday night. Mr. John Welsh, formerly Minister to England, delivered an address as chairman of the local committees, and Provost Pepper, of the University of Pennsylvania, made a special address of welcome, to which Prof. Robert S. Ball replied for the British Association. A members' promenade reception and banquet followed. The British guests were given excursions on Saturday to the Atlantic sea-coast resorts near Philadelphia; also by the Pennsylvania Railroad to Cresson, at the summit of the Alleghany Mountains; also by the Reading Railroad through the anthracite coal regions of Pennsylvania.

The American Association has appointed a Committee to confer with a similar Committee of the British Association relative to arranging for the proposed International Scientific Congress referred to in the closing proceedings of the British Association at Montreal.

## SECTION E

### GEOGRAPHY

Opening Address by General Sir J. H. Lefroy, R.A., C.B., K.C.M.G., F.R.S., F.S.A., V.P.R.G.S., President of the Section

Man's acquaintance with the planet he inhabits, with the earth which he is to replenish and to subdue, has been a thing of growth so slow, and is yet so imperfect, that we may look to a far distant day for an approach to a full knowledge of the marvels it offers, and the provision it contains for his well-being. He has seen, as we now generally believe, in silent operation, the balanced forces which have replaced the glacier by the forest and the field; which have carved out our present delights of hill and dale in many lands, and clothed them with beauty; and it may be that changes as great will pass over the face of the earth before the last page of its history is written in the books of eternity. But it is no longer before unobservant eyes that the procession of ages passes. Geography records the onward m rch of human families; often by names which survive them it rears enduring monuments to great discoverers, leaders, and sufferers; it is an indispensable minister to our every-day wants and inquiries; but beyond this it satisfies one of the most widely diffused and instinctive cravings of the human intelligence, one which from childhood to maturity, from maturity to old age, invests books of travels with an interest belonging to no other class of literature. If "the proper study of mankind is man," where else can we learn so much about him, or be presented with such perplexing problems, such diversity in unity, such almost incredible contrasts in the uses of that noble reason, that Godlike apprehension, which our great poet attributes to him? or see the "beauty of the world, the paragon of animals" (*Hamlet*, Act. ii. Sc. 2) in conditions so unlike his birthright? Geography, then, is far from being justly regarded as a dry record of details which we scarcely care to know, and of statistics which are often out of date.

It is scarcely necessary to do more than allude here to the intimate relations between geography and geology. The changes on the earth's surface effected within historical times by the operation of geological causes, and enumerated in geological books, are far more numerous and generally distributed than most persons are aware of; and they are by no means confined to sea-coasts, although the presence of a natural datum in the level of the sea makes them more observed there. A recent German writer, Dr. Hahn, has enumerated ninety-six more or less extensive tracts known to be rising or sinking. We owe to Mr. R. A. Peacock the accumulation of abundant evidence that the island of Jersey had no existence in Ptolemy's time, and probably was not wholly cut off from the Continent before the fourth or fifth century. Mr. A. Howarth has collected similar proofs as to the Arctic regions; and every fresh discovery adds to the number. Thus the gallant, ill-fated De Long, a name not to be mentioned without homage to heroic courage and almost superhuman endurance, found evidence that Bennett Island has risen a hundred feet in quite recent times. Nordenskjöld found the remains of whales, evidently killed by the early Dutch fishers, on elevated terraces of Martin's Island. The recent conclusion of Prof. Hull, that the land between Suez and the Bitter Lakes has risen since the Exodus, throws fresh light on the Mosaic account of that great event; and to go still further south, we learn from the Indian Survey that it is "almost certain" that the mean sea-level at Madras is a foot lower, *i.e.* the land a foot higher, than it was sixty years ago. If I do not refer to the changes on the west side of Hudson's Bay, for a distance of at least six hundred miles, it is only because I presume that the researches of Dr. Robert Bell are too well known here to require it. Any of my hearers who may have visited Bermuda are aware that so gently has that island subsided, that great hangings of stalactite, unbroken, may be found dipping many feet into the sea, or, at all events, into salt-water pools standing at the same level, and we have no reason to suppose the sinking to have come to an end. We learn from the Chinese annals that the so-called Hot Lake Issyk-kul, of Turkestan, was formed by some convulsion of nature about 160 years ago (*Proc. R.G.S.* vol. xviii. p. 250), and there seems no good reason to reject the Japanese legend that Fusiyama itself was suddenly thrown up in the third century before our era (B.C. 286). These are but illustrations of the assertion I began with, that geography and geology are very nearly connected, and it would be equally easy to show on how many points we touch the domain of botany and natural history. The flight of birds has often guided navigators to undiscovered lands. Nordenskjöld went so far as to infer the existence of "vast tracts, with high mountains, with valleys filled with glaciers, and with precipitous peaks," between Wrangel Land and the American shores of the Polar Sea, from no other sign than the multitudes of birds winging their way northward in the spring of 1879, from the *Vega's* winter quarters. The walrus-hunters of Spitzbergen drew the same conclusion in a previous voyage from the flight of birds towards the Pole from the European side. Certainly no traveller in the more northern latitudes of this continent in the autumn, can fail to reflect on the ceaseless circulation of the tide of life in the beautiful harmony of Nature, where he finds that he can scarcely raise his eyes from his book at any moment, or direct them to any quarter of the heavens, without seeing countless numbers of wild fowl, guided by unerring instinct, directing their timely flight towards the milder climates of the South.

To address you on the subject of geography, and omit mention of the progress made within these very few years in our knowledge of the geography of this Dominion, might indeed appear an unaccountable, if not an unpardonable, oversight; nevertheless, I propose to touch upon it but briefly, for two reasons: first, I said nearly all I have to say upon a similar occasion four years ago; secondly and chiefly, because I hope that some of those adventurous and scientific travellers who have been engaged in pushing the explorations of the Geological Survey and of the Canada Pacific Railway into unknown regions will have reserved some communications for this Section. Canada comprises within its limits two spots of a physical interest not surpassed by any others on the globe. I mean the pole of vertical magnetic attraction, commonly called the magnetic pole; and the focus of greatest magnetic force, also often, but incorrectly, called a pole. The first of these, discovered by Ross in 1835, was revisited in May 1847 by officers of the Franklin Expedition, whose observations have perished, and was again reached or very nearly so by McClintock in 1859, and by Schwatka in 1879; neither of these explorers, however, was equipped for observation. The utmost interest attaches to the question whether the magnetic pole has shifted its position in fifty years, and although I am far from rating the difficulty lightly, it is probably approachable overland, without the great cost of an Arctic expedition. The second has never been visited at all, although Dr. R. Bell, in his exploration of Lake Nipigon, was within 200 miles of it, and the distance is about the same from the Rat Portage. It is in the neighbourhood of Cat Lake. Here then we have objects worthy of a scientific ambition and of the energies of this young country, but requiring liberal expenditure and well-planned efforts, continued steadily, at least in the case of the first, for, perhaps, three or four years. Of objects more exclusively geographical, to which it may be hoped that this meeting may give a stimulus, I am inclined to give a prominent place to the exploration of that immense tract of seventy or eighty thousand square miles, lying east of the Athabasca River, which is still nearly a blank on our maps, and in connection with such future exploration I cannot omit to mention that monument of philological research, the "Dictionary of the Languages of the native Chipewyans, Hare Indians, and Loucheux," lately published by the Rev. E. Petitot. The lexicon is preceded by an introduction, giving the result of many years' study among these people of the legends or traditions by which they account for their own origin. M. Petitot, who formerly was unconvinced of their remote Asiatic parentage, now finds abundant proof of it. But perhaps his most interesting conclusion is that in these living languages of the extreme north, we have not only the language of the *Nabajos*, one of the Apache tribes of Mexico, which has been remarked as linguistically distinct from the others, but also the primitive Aztec tongue, closely resembling the language of the Incas, the Quichoa, still spoken in South America. I need not say how greatly these relations, if sustained by the conclusions of other students, are calculated to throw light upon the profoundly interesting question of the peopling of America.

This is perhaps a proper occasion to allude to a novel theory proposed about two years ago, with high official countenance, upon a subject which will never cease to have interest, and perhaps never be placed quite beyond dispute. I mean the landfall, as it is technically called, of Columbus, in 1492. The late Captain G. V. Fox, of the Admiralty, Washington, argued in a carefully-prepared work, that Atwood's Key, erroneously called Samana on many charts, is the original Guanahari of Columbus, renamed by him S. Salvador, also that Crooked Island and Acklin Island are the Maria de la Concepcion of Columbus and the true Samana of succeeding navigators in the sixteenth century. The last supposition is unquestionably correct. Crooked, Acklin, and Fortune Islands, which from the narrowness of the channels dividing them may have been, and very probably were, united four centuries ago, are plainly the Samana of the Dutch charts of the seventeenth century, and are so named on the excellent chart engraved in 1775 for Bryan Edwards's "History of the West Indies," but the view that Atwood's Key is identical with Guanahari is original, and is neither borne out by any old chart, nor by Columbus's description. This small island is conspicuously wanting in the one physical feature by which Guanahari is to be identified "*una laguna en medio muy grande*." There is no lake or lagoon in it, nor does its distance from Samana tally at all with such slender particulars as have been left us by Columbus respecting his proceedings. The name S. Salvador has attached, not to Atwood's Key, but to Cat Island, one of the Bahamas; it is true that modern research has shifted it, but only to the next island, and on very good grounds. Cat Island is not *muy llana*, very level; on the contrary, it is the most hilly of all the Bahamas, and it has no lake or lagoon. Watling Island, a little to the south-east of Cat Island, and now generally recognised as the true Guanahari or S. Salvador, is very level; it has a large lagoon, it satisfies history as to the proceedings of Columbus for the two days following his discovery, by being very near the numerous islands of Exuma Sound, and I think few impartial persons can doubt the justice of the conclusion of the late Admiral Becher and of Mr. Major as to its identity; there are difficulties in the interpretation of Columbus's log on any hypothesis, but there is one little "undesigned coincidence" which to my mind goes far to carry conviction. Columbus, when he sighted land, was greatly in want of water, and he continued cruising about among the small islands in search of it for some days. Clearly, therefore, the *laguna* on Guanahari was not a fresh-water lake; nor is the lagoon on Watling Island fresh water, and so it exactly meets the case.

The report of Lieut. Raymond P. Rodgers, of the United States Navy, on the state of the Canal Works at Panama so lately as January 25 last, which has doubtless been eagerly read by many present, leaves me little to say on that great enterprise. Perhaps the following official returns of the amount of excavation effected in cubic metres (a cubic metre is 1·308 cubic yards) will enable the audience to realise its progress:—

| | | Total excavated | In each month |
|---|---|---|---|
| 1883 | October ... ... | 2,042,034 ... ... | |
| 1883 | November ... | 2,375,534 ... ... | 333,300 |
| 1883 | December ... | 2,760,534 ... ... | 385,000 |
| 1884 | January ... ... | 3,340,534 ... ... | 580,000 |
| 1884 | February ... ... | 3,974,191 ... ... | 633,657 |
| 1884 | March ... ... | 4,590,022 ... ... | 615,831 |

The total quantity of excavation to be done in a length of 46·6 miles is estimated at 100,000,000 cubic metres, but the rapid augmentation of quantity shows that the limit has not been attained. This is no place to speak of the stimulus given by this great work to mechanical invention or the gigantic power of the machines employed, which will probably receive attention in another Section, but I may mention the two great problems which still await solution. The first is how to deal with the waters of the River Chagres; the second is how to manage a cutting nearly 400 feet deep (110 m. to 120 m.). The Chagres is a river as large as the Seine, but subject to great fluctuations of volume; it cuts the line of the canal nearly at right angles, and for obvious reasons it is impossible to let it flow into it. It is proposed to arrest the stream by an enormous dyke at Gamboa, near the divide. It will cross a valley between two hills, and be 1050 yards long at the bottom, 2110 yards at the top, 110 yards thick at the base, and 147 feet in greatest height. Out of the reservoir so constructed it is proposed to lead the overflow by two artificial channels, partly utilising the old bed. The cutting will be nearly 500 feet wide at the top (150 m.), with the sides at a slope of ¼. It is proposed to attack it by gangs or parties working on twelve different levels at the same time, one each side of the summit, dividing the width at each level into five parallel sections. Thus there will be 120 gangs at work together, and it is confidently hoped that the whole will be really finished in 1888, the date long since assigned for its completion by M. de Lesseps. There is practically no other project now competing with it: for the proposed routes by the Isthmus of Tehuantepec, the Atrato, and San Blas, may be regarded as almost universally given up; both the latter would involve the construction of ship tunnels on a scale to daunt the boldest engineer. The so-called Caledonia route has not stood the test of examination. There remains but the Nicaragua route, and this, while practicable enough, has failed to attract capitalists, and is environed by political and other difficulties, which would leave it, if completed, under many disadvantages as compared with its rival. Among the latter must be named the necessity for rising by locks to the level of the Lake of Nicaragua (108 feet).

It is very tempting to speculate on the probable consequences of bringing the Hispano-Indian Republics bordering on the Pacific into such early contact with the energies of the Old World, but these speculations belong to politics rather than geography; moral transformations, we know, are not effected so easily as the conquest over physical difficulties.

Sir J. H. Lefroy then alluded at some length to recent progress in African exploration; then turning to Central Asia he went on:—

The Russian project for diverting the Oxus or Amu Darya from the Sea of Aral into the Caspian, remains under investigation. We learn from the lively account of Mr. George Kennan, a recent American traveller, that there is more than one motive for undertaking this great work, if it shall prove practicable. He states that the lowering of the level of the Caspian Sea, in consequence of the great evaporation from its surface, is occasioning the Russian Government great anxiety, that the level is steadily but slowly falling, notwithstanding the enormous quantity of water poured in by the Volga, the Ural, and other rivers. In fact, Col. Venukof says that the Caspian is drying up fast, and that the fresh-water seals, which form so curious a feature of its fauna, are fast diminishing in number. At first view there would not appear great difficulty in restoring water communication, the point where the river would be diverted being about 216 feet above the Caspian; but accurate levelling has shown considerable depressions in the intervening tract. As the question is one of great geographical interest we may devote a few minutes to it. It is not to be doubted that the Oxus, or a branch of it, once flowed into the Caspian Sea. Prof. R. Lenz, of the Russian Académie Impériale des Sciences, sums up his investigation of ancient authorities by affirming that there is no satisfactory evidence of its ever having done so before the year 1320;

passages which have been quoted from Arab writers of the ninth century only prove, in his opinion, that they did not discriminate between the Caspian Sea and the Sea of Aral. There is evidence that in the thirteenth and fourteenth centuries the river bifurcated, and one branch found its way to the Caspian, but probably ceased to do so in the sixteenth century. This agrees with Turcoman traditions. Even so late as 1869 the waters of the Oxus reached Lake Sara Kamysh, 80 or 90 miles from their channel, in a great flood, as happened also in 1850, but Sara Kamysh is now some 49 feet lower than the Caspian, and before they could proceed further an immense basin must be filled. The difficulties then of the restoration by artificial means of a communication which natural causes have cut off, are (*a*) the disappearance of the old bed, which cannot be traced at all over part of the way; (*b*) the possibility that further natural changes, such as have taken place on the Syr-Daria, may defeat the object; (*c*) the immense expenditure under any circumstances necessary, the distance being about 350 miles, which would be out of all proportion to any immediate commercial benefit to be expected. We may very safely conclude that the thing will not be done, nor is it at all probable that Russian finances will permit the alternative proposal of cutting a purely artificial canal by the shortest line, at an estimated expense of 15,000,000 to 20,000,000 roubles.

We have had, I think, no news of the intrepid Russian traveller, Col. Prjevalsky, who started from Kiakhta on November 20, of later date than January 20, when he had reached Alashan, north of the Great Wall. He had for the third time crossed the great Desert of Gobi, where he experienced a temperature below the freezing-point of mercury, and was to start for Lake Kuku-nor (+ 10,500 feet) the following day, thence to proceed to Tsaidam, where he proposed to form a depot of stores and provisions, and, leaving some of his party here, to endeavour to reach the sources of the Yang-tse-kiang, or Yellow River. It was his intention to devote the early part of the present summer to exploration of the Sefani country, situated between Kuku-nor to the north and Batan to the south—a country likely to yield an abundant harvest of novelty in natural history—afterwards to transfer his party to Hast, in Western Tsaidam, which may be reached next spring. From this point the expedition will endeavour first to explore Northern Thibet, which is his main object, in the direction of Lhasa and Lake Tengri-nor, and then returning northward, cross the Thibet plateau by new routes to Lake Lob-nor. After the reassembly of the expedition at this point, it will probably regain Russian territory at Issyk-kul. Col. Prjevalsky is accompanied by two officers, an interpreter, and an escort of twenty Cossacks.

As you are aware, we have been chiefly indebted to natives of India for several years past for our knowledge of the regions beyond the British boundary. Mr. McNair, of the Indian Survey Department, who received the Murchison premium of this year, is the first European who has ever penetrated so far as Chitral, which is only 200 miles from Peshawur. In various disguises, however, natives, carefully instructed, have penetrated the neighbouring but unneighbourly regions of Afghanistan, Kashmir, Turkestan, Nepaul, Thibet—in almost every direction—and these achievements were crowned by one of them, known as A-k, reaching Saitu or Sachu, in Mongolia, in 1882, and thence returning in safety to India, after an absence of four years. His route took him to Darchendo or Tachialo (lat. 31°), the most westerly point reached by the late Capt. W. J. Gill, R.E., in 1877, and thus connects the explorations of that accomplished and lamented traveller with Central Asia. A-k has brought fresh evidence that the Sanpoo and the Brahmapootra are one; the quite modern opinion that the former flows into the Irrawaddy being shown to be groundless. After draining the northern slopes of the Himalayas, the Brahmapootra makes a loop round their eastern flanks where it has been called the Dehang, and thence, as everybody knows, flows westerly to join the Ganges; the maps have been shown in this instance to be right. The travels of these native explorers, their stratagems and their disguises, their hazards and sufferings, their frequent hair-breadth escapes, are teeming with excitement. One of them describes a portion of his track at the back of Mount Everest, as carried for a third of a mile along the face of a precipice at a height of 1500 feet above the Bhotia-kosi River, upon iron pegs let into the face of the rock, the path being formed by bars of iron and slabs of stone stretching from peg to peg, in no place more than 18 inches, and often not more than 9 inches, wide. Nevertheless this path is constantly used by men carrying burdens.

One of the finest feats of mountaineering on record was performed last year by Mr. W. W. Graham, who reached an elevation of 23,500 feet in the Himalayas, about 2900 feet above the summit of Chimborazo, whose ascent by Mr. Whymper in 1880 marked an epoch in these exploits. Mr. Graham was accompanied by an officer of the Swiss army, an experienced mountaineer, and by a professional Swiss guide. They ascended Kabru, a mountain visible from Darjeeling, lying to the west of Kanchinjunga, whose summit still defies the strength of man.

And here I may refer to that great work, the Trigonometrical Survey of India. The primary triangulation, commenced in the year 1800, is practically completed, although a little work remains to extend it to Ceylon on one side and to Siam on the other. Much secondary triangulation remains to be executed, but chiefly outside the limits of India proper. The Pisgah views, by which some of the loftiest mountains in the world have been fixed in position, sometimes from points in the nearest Himalayas, 120 miles distant, only serve to arouse a warmer desire for unrestrained access. The belief long entertained that a summit loftier than Mount Everest exists in Thibet is by no means extinct, but it is possible that the snowy peak intended may prove eventually to be the Mount Everest itself of the original Survey. Still, however, science, in spite of fanatical obstruction, makes sure advances. The extraordinary learning and research by which Sir H. Rawlinson was enabled a few years since to expose a series of mystifications or falsifications relating to the Upper Oxus, which had been received on high geographical authority, can never be forgotten. That river has now been traced from its sources in the Panjab, chiefly by native explorers, and to them we may be said to be indebted for all we know of Nepaul, from which Europeans are as jealously excluded as they are from the wildest Central Asian Khanate, although Nepaul is not so far from Calcutta as Kingston is from Quebec.

Carrying their instruments to the most remote and inaccessible places, and among the most primitive hill tribes, the narrative reports of the officers of the Indian Survey are full of ethnographic and other curious information. Take for example the account given by Mr. G. A. McGill, in 1882, of the Bishnoies of Rajpútana, a class of people, he says, who live by themselves, and are seldom to be found in the same village with the other castes. "These people hold sacred everything animate and inanimate, carrying this belief so far that they never even cut down a green tree; they also do all in their power to prevent others from doing the same, and this is why they live apart from other people, so as not to witness the taking of life. The Bishnoies, unlike the rest of the inhabitants, strictly avoid drink, smoking, and eating opium; this being prohibited to them by their religion. They are also stringently enjoined to monogamy and to the performance of regular ablutions daily. Under all these circumstances, and as may be expected, the Bishnoies are a well-to-do community, but are abhorred by the other people, especially as by their domestic and frugal habits they soon get rich, and are the owners of the best lands in the country."

In one particular the experience of the Indian Survey carries a lesson to this country. "A constantly growing demand," says Gen. Walker, "has risen of late years for new surveys on a large scale, in supersession of the small-scale surveys which were executed a generation or more ago. . . . The so-called topographical surveys of those days were in reality geographical reconnaissances sufficient for all the requirements of the Indian atlas, and for general reproduction on small scales, but not for purposes which demand accurate delineation of minute detail." We have in the Canadian North-West a region which has not yet passed beyond the preliminary stage, and it would probably be possible to save much future expenditure by timely adoption of the more rigorous system. There is perhaps no region on the globe which offers conditions more favourable for geodesy than the long stretch of the western plains, or where the highest problems are more likely to present themselves in relation to the form and density of the earth. The American surveyors have already measured a trigonometrical base of about 10·86 miles in the Sacramento Valley, the longest I believe as yet measured in any country (the Yolo Base) and reported to be one of the most accurate.

The President then referred to Australian exploration, the International Polar Expeditions, deep-sea research, and railway extension, and concluded as follows:—

I have now touched lightly upon all the points which appear to me to be most noticeable in the recent progress of geographical science ; but before I resume my seat I cannot deny myself the pleasure of alluding to that important measure of social reform, so simple in its application, so scientific in its basis, for which you are indebted to the perseverance and enthusiasm of my friend Mr. Sandford Fleming, C.E. I mean, of course, the agreement to refer local time on this continent to a succession of first meridians, one hour apart. There are many red-letter days in the almanac of less importance than that memorable November 18, 1883, which saw this system adopted, whether we consider its educational tendency or its influence on the future intercourse of unborn millions. It is a somewhat memorable evidence also that agreement upon questions of general concern is not that unattainable thing which we are apt to consider it. The next step will not be long delayed ; that is the agreement of the civilised world to use one first meridian—Paris, Ferrol, Washington, Rio de Janeiro, gracefully, as I venture to hope, giving that precedency to Greenwich which is demanded by the fact that an overwhelming proportion of the existing nautical charts of all nations, and of maps and atlases in most of them, already refer their longitudes to that meridian ; no other change would be so easy or so little felt.

## SECTION G

### MECHANICAL SCIENCE

### Opening Address by Sir F. J. Bramwell, F.R.S., V.P.Inst.C.E., President of the Section

In a family of seven children there are two who are of paramount importance : the eldest, at the one end of the scale, important because he is the heir, the first-born ; and at the other end of the scale, the little Benjamin, important because he is the last, the youngest, and the dearest. The position of little Benjamin is not, perhaps, quite as honourable as that of the heir, and not, when the family breaks up, by any means as good ; but while the family holds together, Benjamin receives an amount of attention and consideration that does not fall to the lot of any one of the intermediates, not even to the heir himself. But there is one risk about Benjamin's position, a risk that cannot appertain to the post of the first-born ; little Benjamin may be deposed by the advent of a lesser Benjamin than himself, whereas the first-born becomes (if possible) still more the first-born for each addition to the family. Perhaps some of you may say, Be it so ; but what has this to do with the address of the President of Section G ? Those who make this inquiry, however, certainly have not present to their minds the change that has this year taken place. Up to and including the Southport meeting, Section G was the little Benjamin among the seven sons of the B.A. (I will not waste your time by giving the name of the Association in full, nor will I affront you by using an abbreviation which is occasionally improperly applied), but at Montreal appears Section H, and G becomes relegated among those uninteresting members of the family who are neither the important head nor the cherished tail. I grieve for Benjamin, and I think the present occasion an apt one for magnifying Section G. Apt for two reasons : the foregoing one, that H has deposed it from its position ; the other, that we are meeting in Montreal—and in reference to this latter reason let me ask, Is it not the fact that to the labours of the men who have been, or are (or ought to be) members of Section G is due the possibility of the meeting taking place on this side of the Atlantic ?

At our jubilee meeting at York, I called the attention of the Section to the fact that in 1831, when the Association first met in that city, they arrived there laboriously by the stage-coach, and that practically the Manchester and Liverpool, the Stockton and Darlington, and some few others, were the only railways then in existence. I also called their attention to the fact that in 1831 there were but very few steamers. I find the total number registered in the United Kingdom in that year was only 447. If under this condition of things the proposition had been made in 1832 at Oxford, as it was made in 1882 at Southampton, that the next meeting but one of the Association should take place in Montreal, the extreme probability is that the proposer would have been safely lodged in a lunatic asylum for suggesting that that which might have involved a four-weeks' voyage out, and a four-weeks' voyage back, could ever be seriously entertained. Further, to give once more the hackneyed quotation, some few years after this, *i e.* in 1836, Dr. Lardner established, to his own satisfaction conclusively, that no vessel could ever steam across the Atlantic the whole way—a striking instance of the mistakes made by scientific speculation—a branch of science widely differing in the value of its results from those branches which deal with absolute demonstration. Undeterred, however, by such adverse opinion, the engineers "kept on pegging away," experimenting, improving, and progressing, until the scientific speculation was met with the hard fact of the Atlantic voyage steamed the whole way by the *Sirius* and by the *Great Western* in 1838. The impossible was proved to be the possible, and from that day to this the advancement of steam ocean navigation has continued. The six-weeks' voyage, sailing westward, of the year 1831, has become converted into but little over six days. And thus it is that that which would have been a mad proposition in the year 1832 became a perfectly rational one in 1882 ; and the deliberations of the General Committee on the proposition were not directed as to whether it would be possible to convey the members with certainty, expedition, and economy across the Atlantic, but as to whether it was expedient or not on general grounds to hold for the first time a meeting of the British Association elsewhere than in some city of the United Kingdom. I say again that the possibility of such a meeting is absolutely due to the engineer, and that therefore, on this ground, the present is an appropriate occasion to magnify G, the Mechanical Section of this Association.

It is true that the man who looks only at that which is on the surface may say, "You arrogate too much to yourselves. You ignore (to which I say, Heaven forbid !) the skill and daring of your sailors. You ignore commercial enterprise. You ignore the development of iron and steel manufacture, which have enabled you to build the steamers of the present day. You ignore the increased output of the best steam coal in the world, and you attribute the whole result to the engineer." Such an objector would be in the condition of that man who, in answer to George Stephenson's question, "What is causing that railway train to move ?" said, "Why, I suppose the coal that is burning in the locomotive ;" and who was met by that grand and comprehensive answer, that it was the "Sun," for the coals were a consequence, and not a first cause. Similarly I venture to say that the mechanical engineer may lay claim to be the central source which has vivified and given rise to the improvements in the manufacture of iron and steel, in the construction of engines, and in the development of our collieries.

There are those I know who object that Section G deals too little with pure science, too much with its applications. It may be, as the members of Section G might retort, that it is possible to attend so much to pure science as to get into the unchecked region of scientific speculation, and that, had the members of Section G been debarred from the application of science, the speculation of Dr. Lardner might to the present day have been accepted as fact.

I have quoted it before, but it has so important a bearing on this point, and comes from a man of such high authority, that I cannot refrain from once more giving you Dr. Tyndall's views on this question :—

"The knowledge of Nature and the progressive mastery over the powers of Nature imply the interaction of two things—namely, thought conceived and thought executed ; the conceptions of the brain, and the realisation of those conceptions by the hand. The history of the human intellect hardly furnishes a more striking illustration of this interaction of thought and fact than that furnished by the Association of Physics and Engineering. Take for instance the case of steam. Without knowing its properties, the thought of applying steam could not have arisen, hence the first step was physical examination. But that examination suggested practice, and the steam-engine at last saw the light ; thus experimental physics was the seedling from which the steam-engine sprang. But the matter did not end here ; the positions of debtor and creditor were soon reversed, for the stupendous operations of the steam-engine forced men of thoughtful philosophic minds to inquire into the origin of the power of steam. Guess succeeded guess, inspiration succeeded inspiration ; the ever-present fact of our railways, and our power-looms, and our steamships gave the mind no rest until it had answered the question, How are heat and steam, its instruments, related to mechanical power ? Had the works of the engineer not preceded the work of the natural philosopher, this question would never have been asked with the emphasis, nor pursued with the vigour, nor answered with the success, which have attended it. It was the intellectual activity excited by the work which the civil engineers of England had accomplished that gave to philosophy the theory of the conservation of energy, including the dynamical theory of heat. . . . The engineering genius of the future is certain to derive from this theory strength and guidance. Thus necessarily has thought originated fact, and fact originated thought. In the development of science these two powers are coequal; each in turn ceasing to be a consequence, and becoming a creative cause. The Atlantic cable also had its small beginnings in the laboratory of the physical inquirer. Here, as before, experimental physics led the way to engineering facts of astounding magnitude and skill. But here also the positions of debtor and creditor have been reversed, for the work of the engineer has caused the physical inquirer to pursue his investigations with a thoroughness and vigour, and has given to those investigations a scope and magnitude, which, without the practical stimulus, would have been impossible. The consequence is that the practical realisation of sending electric messages along the bottom of the Atlantic has been an immense augmentation of our knowledge regarding electricity itself. Thus does the human intelligence oscillate between sound theory and sound practice, gaining by every contact with each an accession of strength. These two things are the soul and body of science. Sever sound theory from sound practice, and both die of atrophy. The one becomes a ghost and the other becomes a corpse."

I think all men, even although they be followers of science in its purest and most abstract form, must agree that these words are words of sound sense, well worthy of being borne in mind and of being acted on, and will, therefore, concur in the propriety of Section G dealing with engineering subjects generally as well as with abstract mechanical science. Once admitting this, I may ask—certain what the answer must be—whether there is any body of men who more appreciate and make greater use of the applications of pure science than do the members of this Section. Surely every one must agree that we engineers are those who make the greatest practical use not only of the science of mechanics but of the researches and discoveries of the members of the other Sections of this Association.

Section A, *Mathematical and Physical Science*. The connection between this Section and Section G is most intimate. With any ordinary man I should have referred, in proof of this intimate connection, to the fact that the President of A this year is a member of the Council of the Institution of Civil Engineers, but when I remind you that it is Sir William Thomson who fills this double office, you will see that no deduction such as I have hinted at can be drawn from his dual functions, because the remarkable extent and versatility of his attainments qualify him for so many offices, that the mere fact of his holding some one double position is no certain evidence of the intimate connection between the two. But setting aside this fact of the occupancy of the chair of A by a civil engineer, let us remember that the accomplished engineer of the present day must be one well grounded in thermal science, in electrical science, and for some branches of the profession in the sciences relating to the production of light, in optical science, and in acoustics; while, in other branches, meteorological science, photometrical science, and tidal laws are all-important. Without a knowledge of thermal laws, the engineer engaged in the construction of heat-motors, whether they be the steam-engine, the gas-engine, or the hot-air engine, or engines depending upon the expansion and contraction under changes of temperature of fluids or of solids, will find himself groping in the dark; he will not even understand the value of his own experiments, and therefore will be unable to deduce laws from them; and if he makes any progress at all, it will not guide him with certainty to further development, and it may be that he will waste time and money in the endeavour to obtain results which a knowledge of thermal science would have shown him were impossible. Furnished, however, with this knowledge, the engineer, starting with the mechanical equivalent of heat, knowing the utmost that is to be attained, and starting with the knowledge of the calorific effect of different fuels, is enabled to compare the results that he obtains with the maximum, and to ascertain how far the one falls short of the other; he sees even at the present day that the difference is deplorably large, but he further sees in the case of the steam-engine, that which the pure scientist would not so readily appreciate, and that is, how a great part of this loss is due to the inability of materials to resist temperature and pressure beyond certain comparatively low limits; and he thus perceives that unless some hitherto wholly unsuspected, and apparently impossible, improvement in these respects should be made, practically speaking the maximum of useful effect must be far below that which pure science would say was possible. Nevertheless, he knows that within the practical limits great improvements can be made; he can draw up a debtor and creditor account, as Dr. Russell and myself have done, and as has been done by Mr. William Anderson, the engineer, in the admirable lecture he gave at the Institution of Civil Engineers in December last, on "The Generation of Steam and the Thermodynamic Principles involved." Furnished with such an account the engineer is able to say, in the language of commerce, I am debtor to the fuel for so many heat-units, how, on the credit side of my account, do I discharge that debt? Usefully I have done so much work, converted that much heat into energy. Uselessly I have raised the air needed for combustion from the temperature of the atmosphere to that of the gases escaping by the chimney; and he sets himself to consider whether some portion of the heat cannot be abstracted from these gases and be transmitted to the in-coming air. As was first pointed out by Mr. Anderson, he will have to say a portion of the heat has been converted into energy in displacing the atmosphere, and that, so far as the gaseous products of the coal are concerned, must, I fear, be put up with. He will say, I have allowed more air than was needed for combustion to pass through the fuel, and I did it to prevent another source of loss—the waste which occurs when the combustion is imperfect; and he will begin to direct his attention to the use of gaseous or of liquid fuel, or of solid fuel reduced to fine dust, as by Crampton's process, as in these conditions the supply may be made continuous and uniform, and the introduction of air may be easily regulated with the greatest nicety. He will say, I am obliged to put among my credits—loss of heat by convection and radiation, loss by carrying particles of water over with the steam, loss by condensation within the cylinder, loss by strangulation in valves and passages, loss by excessive friction or by leakage; and he will as steadily apply himself to the extinction or the diminution of all such causes of loss as a prudent Chancellor of the Exchequer would watch and cut down every unproductive and unnecessary expenditure. It is due to the guidance of such considerations as these that the scientific engineer has been enabled to bring down the consumption of fuel in the steam-engine, even in marine engines such as those which propelled the ship that brought us here, to less than one-half of that which it was but a few years back. It is true that the daily consumption may not have been reduced, that it may be even greater, but if so it arises from this, that the travelling public will have high speed, and at present the engineer, in his capacity of naval architect, has not seen how—notwithstanding the great improvements that have been made in the forms of vessels—to obtain high speed without a large expenditure of power. I anticipate, from the application of thermal science to practical engineering, that great results are before us in those heat-motors, such as the gas-engine, where the heat is developed in the engine itself. Passing away from heat-motors, and considering heat as applied to metallurgy, from the time of the hot blast to the regenerative furnace, it is due to the application of science by the engineer that the economy of the hot blast was originated, and that it has been developed by the labours of Lowthian Bell, Cowper, and Cochrane. Equally due to this application are the results obtained in the regenerative furnace, in the dust furnace of Crampton, and in the employment of liquid fuel, and also in operations connected with the rarer metals, the oxygen furnace, and the atmospheric gas furnace, and, in its incipient stage, the electrical furnace. To a right knowledge of the laws of heat and to their application by the engineer, must be attributed the success that has attended the air-refrigerating machines, by the aid of which fresh meat is, at the end of a long voyage, delivered in a perfect condition; and to this application we owe the economic distillation of sea-water by repeated ebullitions and condensations at successively decreasing temperatures, thus converting the brine that caused the Ancient Mariner to exclaim, "Water, water everywhere, nor any drop to drink," into the purest of potable waters, and thereby rendering the sailor independent of fresh-water storage.

With respect to the application by the engineer of electrical science, it is within the present generation that electricity has passed from the state of a somewhat neglected scientific abstraction into practical use: first, by the establishment of the land telegraph, then by the development into the submarine cable, by means of which any one of us visitors here in Canada may be in instant communication with his own country, and may be so without a selfish exclusive occupation of the cable, for once more the application of science has solved that apparently impossible problem of employing a single wire to be at one and the same time the transmitter of multiple electric messages, and messages in opposite directions. Then, thanks to the application of Faraday's great discovery of induced electricity, there has been, during the last quarter of a century, the progressive development of the dynamo machine, whereby the energy of ordinary motors, such as steam-engines, is converted into electrical energy, competent to deposit metals, to (as has already been said) fuse them, to light not only isolated buildings but extensive areas of towns and cities, and to transmit power to a distance, whether for manufacturing purposes or for the railway or tramcar; and thus the miracle is performed of converting a waterfall into a source of light, as at Sir William Armstrong's house, or into the origin of power for a railway, as at the Giant's Causeway. To the application of electrical science is due the self-exciting of the dynamos and the construction of secondary batteries, enabling a development of electricity to be continued for many hours. In the United Kingdom general electric lighting, that is to say, the lighting of large sections of a town from a central station, has been stopped by the most unwise, because most unjust, conditions imposed by the Government General Electric Lighting Act of 1882. A new and meritorious industry, which should have been granted the same privileges as are accorded to other industrial undertakings needing Parliamentary powers, was subjected to this most unjust condition: that at the end of twenty-one years the public authority of the town or place lighted should have the option of buying the undertaking for the then value of the mere materials, and that, if the authority did not choose to purchase (for it was not bound to buy), at every subsequent five-year period this option should re-arise; that is to say, that a new undertaking, which would require years for its general acceptance (for the public is slow to take up a novelty), was, after the experimental and non-paying stage had been passed, to be practically forthwith taken away for a mere fraction of the capital that had been outlaid if the undertaking paid, but was not to be taken away if it did not pay. Such, in spite of the teaching of Section F, is the condition to which our Government has arrived in respect of economic science. The next electrical matter I have to touch upon, that of the telephone and microphone, with which will for ever be associated the names of Graham-Bell, Edison, and Hughes, has, as regards the public use of the telephone, been all but similarly treated in the United Kingdom. It has been declared to be within the telegraphic monopoly given by Parliament to the Post Office nine years before the telephone was invented, and the power to use it depends entirely upon the grace and favour of the Post Office, a grace and favour not always accorded; and even when accorded, coupled with limitations as to distance, and coupled with a condition of payment of 10 per cent. of the gross receipts by the companies to the Post Office as a royalty; and all this because Government has become a trader in electrical intelligence, and fears the competition of the telephone with its telegraphs.

No one in the ship-loving countries of England, Canada, and the United States can refrain from feeling the warmest interest in all connected with navigation, and we know how frequently, alas! the prosperous voyage across the wide and fathomless ocean ends in shipwreck and disaster when the wished-for shore is approached, and when the sea is comparatively shallow. Except for the chance of collision, there is in a staunch ship little danger in the open ocean, but on nearing the shore, not only is the liability to collision increased, but shoals and sunken rocks render navigation perilous, and it is on the excellence of the lighthouses and lightships that (coupled with soundings) the sailor relies. These structures and appliances are confided to the engineer, and to be efficient they require him to be able to apply the teachings of Section A in optical science, and in the case of fogs, or as regards buoys at night-time, the science of sound. I parenthetically alluded to soundings as one (indeed a principal one) of the safeguards of ships when approaching shore. It is important in these days of high speed that these should be made with ease and without the necessity of stopping the ship, or even of diminishing its velocity. Sir William Thomson, by the application of the science of pneumatics, has enabled this to be done. Again, most important is it that the compass, amidst all the difficulties attendant upon its being situated on an iron or steel structure, should be trustworthy. And here Sir William has applied the science of magnetism in his improved compass to the practical purposes of navigation.

To go to another important branch of engineering—water-supply. The engineer dealing with a district to be fed from the surface will find himself very deficient if he have not the power of applying the science of meteorology to the work that he has in hand; he must know, not the average rainfall, for that is of but little use to him, but the maximum, and, most important of all, the minimum, rainfall over a consecutive period of years: the maximum, so that he may provide sufficient channels and by-washes for floods; the minimum, so as to provide sufficient storage. He must know what are the losses by evaporation, what are the chances of frost interfering with his filters and with his distributive plant.

Coming to the mathematical side of Section A—whether we consider the naval architect preparing his design of a vessel to cleave the waves with the least resistance at the highest speed, or whether we consider the unparalleled series of experiments of that most able Associate of Naval Architects, the late William Froude, carried out as they were by means of models which were admirable in their material, their mode of manufacture with absolute accuracy to the desired shape, and their mode of traction and of record, we must see that both architect and experimenter should be able to apply mathematical science to their work, and that it is in the highest degree desirable that they sh uld possess, as Froude did, those most excellent gifts, science and practical knowledge.

Again, the mathematical side of Section A has to be applied by engineers when considering the strength and proportion of boilers, ships, bridges, girders, viaducts, retaining walls, and in short the whole of the work with which an engineer is intrusted. Notable instances of great bridges will occur to all our minds, especially meeting as we are in this continent of grand streams, Eads' St. Louis Bridge, Roebling's Niagara Bridge, and his and and his sons' East River Bridge, Gzowski's International Bridge, and, going back to our own land, Fowler and Baker's Bridge over the Forth.

Passing from Section A to Section B, there is evidently so much overlapping of these Sections that a good deal that I have said in reference to Section A might properly have been reserved for Section B. The preparation from the ore of the various metals is in truth a branch of engineering; but to enable this to be accomplished with certainty, with economy, involving the not throwing away of that which is called the waste product but which is frequently a valuable material, it is essential that the engineer and the chemist should either be combined in one and the same person, or should go hand in hand. In the manufacture of pig iron it is absolutely necessary that the chemical constituents of the ore, the fuel, and the flux should be thoroughly understood, and that the excellence of the process followed should be tested by an analysis of the slag. For want of this chemical knowledge, thousands upon thousands of tons of bad pig iron have been made, and thousands upon thousands of tons were formerly left in the issuing slag. Similar remarks apply to the production of lead and of copper from the ores, and still more do they apply to that great metallurgical manufacture of the last few years—"steel." In the outset steel was distrusted, because of the uncertainty of its behaviour, but the application of chemical science now enables the manufacturer to produce with precision the material required to fulfil the physical tests imposed by the engineer.

Reverting to the water engineer, the chemist and the microscopist have their sciences applied to ascertain the purity of the intended source, and, as in the case of Clarke's beautiful process, by the application of chemistry, water owing its hardness to that common cause, carbonate of lime, is rendered as soft as the water from the mountain lake. Taking that other branch of engineering commonly coupled with water, viz. the supply of gas, the engineer is helpless without the application of chemistry. From the examination of the coal to be used to the testing of the gas to be supplied, there is not one stage where chemical science is not necessary. The consumer requires gas which shall be as nearly as possible a pure hydrocarbon of high illuminating power, and it might well have been that a person to whom was delivered the crude gas as it issued from the retort would have said, "Certain things may be separated out more or less, but to practise on a wholesale scale the delicate operations which will be needed to cleanse the illuminating gas from its multifarious accompanying impurities is a hopeless undertaking, and must be so, if for no other reason than this—the excessive cost that would be entailed." But what are the facts? Although I for one do not like to sit in a room where gas is burnt, unless special provision is made for taking away the products of combustion, the engineer of the present day, thanks to the application of chemical science, delivers gas to the consumer in a state of comparative purity (although it may have been made from impure coal) which but a few years ago would have been deemed impossible; and so far is this improvement from being attended with extra cost, that the residual products not now uncommonly all but pay the whole cost of the coal, and in some rare instances even leave a slight profit to go towards the charge of labour. Again, it is by the application of chemical science in the dynamite and the gun-cotton of the present day that the engineer is enabled to prepare submarine foundations, to blast away shoals, and to drive tunnels through rock of a character that cannot be dealt with by mere cutting machines. Equally to the application of chemistry is it due that there are hopes, by the employment of lime cartridges, of breaking down coal without that risk of igniting fire-damp which is attendant upon the use of gunpowder. I need hardly observe that much more might most pertinently be said on the way in which the engineer applies chemical science. In fact, those ways are so multifarious that a volume might be written upon them, but I must pass on and ask you to consider how the engineer applies geological science, the science treated by Section C.

I have already spoken of the engineer supplying towns by water collected from the surface; even he, however, must have a knowledge of geology, for without it he will not know what places are apt for the huge reservoirs he constructs, nor where he can in safety make his enormous embankments. In this continent of vast lakes one feels it must excite a sensation of the ridiculous when a "Welsh lake" is spoken of, but I must ask you to believe you are in Liliput, and to imagine that the "Bala Pond" of 1100 acres in extent, is really "Bala Lake," as it is called. Within a few miles of that, our friends at the other end of the Atlantic steam ferry, the inhabitants of Liverpool, are now constructing under the engineering and advice of Mr. Hawksley, a waterworks which will involve the formation, I believe one may say the re-formation, of a lake, practically the same area as that of Bala, of some 80 feet in depth, and containing between the overflow and the point of lowest discharge nearly twelve thousand million gallons. This lake will be made by the throwing from side to side of the valley of a solid stone bank, 100 feet above the ground, 140 feet above the deepest part of the foundations, and 113 feet thick at its thickest part. Contrasted with Lake Superior this new lake will be small, a thing demanding a microscope even, but the bursting of the wall would liberate a body of water sufficient to carry death and ruin throughout a considerable district. It is, therefore, in the highest degree important that whether he be constructing the solid stone wall, or the more common earthen embankment with a puddle trench, the engineer should so apply geological science as to insure the safety of his work. But in those cases where the waterworks engineer has to derive the supply from underground sources, the application of this science is still more necessary; he must know whether he is likely to find a water-bearing stratification at all—if so, where it receives the rain from heaven, and the extent of the area which receives it; in what direction the water travels through it, what is the varying height of water in the different parts of the stratification giving the "head" to produce that travel; how far this height is likely to be affected by the pumping of the desired quantity; whether, if near the outflow into the sea, the pumping is likely to reverse the direction of the current, and to bring back brackish water, and whether the rocks are of such a character as to be liable to yield a water impregnated with iron or with lime, and whether these water-bearing rocks are accessible from the surface without the execution of costly and laborious work in passing through overlying stratifications of an unfit or it may be even of a dangerous character. It need hardly be said that the engineer when engaged in metalliferous mining, or in the extraction of coal or of petroleum, unless he applies the science of Section C, is but a haphazard explorer whose work is more likely to end in disaster than in success. Again, the engineer, when laying out a railway, has to consider the geological features of the country in determining the angles of his cuttings, and to determine where it becomes more economical to tunnel than to cut. Indeed, without the application of that science to engineering there are some enterprises on the feasibility of which the engineer would not be able to pronounce an opinion—a notable instance, the Channel Tunnel. The engineers, of whom I am one, said there is a material, the compact non-water-bearing grey chalk, which we have at a convenient depth on the English side and, is of all materials the most suitable; if that exist the whole way across, success is certain. Then came geological science, and that told the engineer that in France the same material existed; that it existed in the same position in relation to other stratifications as it existed in England; that the line of outcrop of the gault lying below it had been checked across; and that taken together these indications enabled a confident opinion to be expressed that it was all but certain this grey chalk stratification did prevail from side to side. The engineers believed it, an intelligent section of the public believed it, and came forward with their money; large sums were expended in England and in France on the faith of the repeated declaration of the English Government (of both sides of politics), that so long as the nation was not called on to contribute towards the cost of the work, it would hail with satisfaction the improved means of communication between England and the Continent; the experimental works were carried on from both sides with the happiest results, and then, when success appeared certain, the whole work was stopped by the incredible suggestion that in the event of a war the soldiers of England, and the science of England, could not defend a couple of rat-holes, holes 14 feet in diameter and 20 miles long, situated far below the surface of the sea, having a rapid dip from the shore to a low point, gradually rising from there to the centre of the length of the tunnel, so that the English end could be flooded with sea-water in twenty-five minutes up to the soffit of the arch at the dip; and in consequence of this incredible and much-to-be-ashamed-of scare it is due that one of the finest instances of civil engineering work in connection with the science of geology, and as I believe one of the most useful works that has ever been proposed, has been put a stop to.

To come to Section D, the botanical side of it is interesting to the engineer as instructing him in the locality and quality of the various woods that he occasionally uses in his work. With regard to that most important part of the work of D, which relates to "germs" and their influence upon health, the engineer deals with it thus far: he bears in mind that the water-supply must be pure, and that the building must be ventilated, and that excreta must be removed without causing contamination; thus the waterworks engineer, the warming and ventilating engineer, and the sewage engineer can (and do) all of them profit by the labours of Section D, and can by their works assist in giving practical value to the pure science of that section.

Section E, *Geography*. Probably in these days, when our kingdom at home and the old countries near us are all but full of the works of the engineer, there are few who take a greater interest in geography than he does, and I am quite sure there are none who make a more useful application of geographical knowledge for the benefit of mankind at large than does the engineer. Almost at the outset of this address I claimed to magnify Section G, on the ground that without the aid of its members we should not have had that practical lesson in geography which we have received by our visit here, a lesson that no doubt will be continued and amplified by many of us before we return to our homes. Whether it be by the ocean steamer or by the railway train, the enterprising geographical explorer is carried to or through countries which now, thanks to the engineer, are well known and settled, up to the beginning of the unknown and not settled; and thus his labours are lightened, he consumes his energies only upon his true work, brings back his report, which is, as I have said, studied by the engineer with a view to still further development, and thus, turn by turn, the geographer and the engineer carry civilisation over the face of the world.

Now to come to Section F, which treats of Economic Science. The matters with which this Section deals—birth-rate, death-rate, the increase or the diminution of populations, the development of particular industries in different localities, the varying rates of wages, the extent and nature of taxation, the cost of production, the cost of transport, the statistics of railway and of marine disasters, the consumption of fuel, and many matters which come within the purview of F, are of impo tance to the engineer. Guided by the information given him by the labours of this Section, he comes to the conclusion that a work having a particular object in view should or should not be undertaken. With the information derived from the past he judges of the future; he sees what provision should be made for prospective increase of population or of industries; he sees the chances of the commercial success of an undertaking or of its failure, and he advises accordingly.

I do not propose to say anything about Section H, for I have dealt with it as being still included within D.

I trust I have now established the proposition with which I set out, viz. that not only is Section G the Section of Mechanical Science, but it is emphatically the Section of all others that applies in engineering to the uses of man the several sciences appertaining to the other Sections: an application most important in the progress of the world, and an application not to be lightly regarded, even by the strictest votaries of pure science, for it would be vain to hope that pure science would continue to be pursued if from time to time its discoveries were not brought into practical use.

Under ordinary circumstances I should have closed my address at this point, but there is a subject which at this, the first meeting of Section G after the meeting at Southport, must be touched upon. It is one of so sad a character that I have avoided all allusion to it until this the very last moment, but now I am compelled to grapple with it.

In the course of this address I have had occasion to mention several names of eminent men, many of them happily still with us, some of them passed away; but I doubt not you have been struck by the absence of one name, which of all others demands mention when considering physical science, and still more does it come vividly before us when considering the application of science to industrial purposes. I am sure I need not tell you that this name, which I can hardly trust myself to speak, is that of our dear friend William Siemens, whose contributions to science, and whose ability in the application of science, have for years enriched the transactions of this Section, and of Sections A and B, for in him were combined the mechanic, the physicist, and the chemist.

But a brief year has elapsed since he quitted the Presidential chair of the Association, and, with us at Southport, was taking his accustomed part in the work of this and of other Sections, apparently in good health, and with a reasonable prospect of being further useful to science for many valuable years to come. But it was not to be; he is lost to us, and in losing him we are deprived of a man whose electrical work has been second to none, whose thermic work has been second to none, and whose enlarged views justified him in embarking in scientific speculations of the grandest and most profound character. Whether or not his theory of the conservation of the energy of the sun shall prove to be correct, it cannot be denied that it was a bold and original conception, and one thoroughly well reasoned out from first to last.

I feel that, were I to attempt anything like the barest summary of his discoveries and inventions, I should set myself a task which could not have been fulfilled had I devoted the whole of the time I had at my command to the purpose. I had indeed thought of making his work the subject of my address, but I felt that his loss was so recent that I could not trust myself to attempt it. There is no need for me to dwell further upon this most painful topic. He was known to you all, he was honoured and loved by you all, and by every member of this Association he had so faithfully served, and over which he had so ably presided; and he enjoyed the respect and esteem of the best intelligence of England, the land of his adoption; of the Continent, his birthplace; and of Canada, and of the United States, whose populations are always ready to appreciate scientific talent and the resulting industrial progress. It is not too much to say that few more gifted men have ever lived, and that with all his ability and talent he combined a simplicity, a modesty, and an affectionate disposition that endeared him to all.

I am sorry to conclude my address to you in this mournful strain. I have endeavoured to confine my allusions to our dear friend within the narrowest limits, but if I have overstepped these I trust you will forgive me, remembering that "out of the fulness of the heart the mouth speaketh."

## NOTES

WE announce with great regret the death, yesterday, at the age of eighty-three years, of Mr. George Bentham, F.R.S., F.L.S., the eminent botanist.

THE Committee which has been formed for the erection of a statue to the late Jean Baptiste Dumas at his native town, Alais (Gard), is an extensive one. The president is M. Pasteur, and the vice-presidents MM. J. Bertrand, F. de Lesseps, and Cauvet. The members of the Committee include all the names of scientific note in France. Among the foreign members are well-known men of all nationalities; the English members being Sir William Thomson, Dr. W. De La Rue, Prof. Williamson, and Dr. Frankland. There is besides a local Committee at Alais. With such powerful and wide support the monument is sure to be worthy of Dumas' reputation. Subscriptions should be sent to M. E. Maindrin, Palais de l'Institut de France, Paris.

THE National Electrical Conference, convened by the U.S. Congress in connection with the Electrical Exhibition, began its sessions in Philadelphia on Monday. Addresses were made by the President of the Conference, Prof. Rowland of the Johns Hopkins University, Baltimore; also by Sir William Thomson, the Vice-President. The practical work of the Conference began on Tuesday afternoon with a discussion on the work of the United States Signal Office in relation to electrical observation. The Conference will hereafter discuss the necessity for a national bureau of electrical standards, the adoption of an international system of electrical units, and the theory of dynamo-electric machines. Prof. George Forbes of London delivered a lecture on dynamo-electric machinery on Tuesday evening.

THE Iron and Steel Institute holds its annual meeting this year at Chester on September 23 and three following days. Among the papers and subjects for discussion are the following:—On the geology of Cheshire, by Mr. Aubrey Strahan, of H.M. Geological Survey, London; on improvements in the Siemens regenerative gas furnace, by Mr. Frederick Siemens, C.E., London; on recent improvements in the method of the manufacture of open-hearth steel, by Mr. James Riley, Glasgow, Member of Council; on a new form of regenerative furnace, by Mr. F. W. Dick, Glasgow; on the manufacture of crucible steel, by Mr. Henry Seebohm, Sheffield; on the recovery of by-products from coal, more especially in connection with the coking and iron industries, by Mr. Watson Smith, Owens College, Manchester; on the most recent results obtained in Germany in utilising the by-products from Otto and other coke ovens, by Dr. C. Otto, Dalhausen; on the North-Eastern Steel Company's Works at Middlesbrough, and their products, by Mr. Arthur Cooper, Middlesbrough; on the spectroscopic examination of the vapours evolved on heating iron, &c., at atmospheric pressure, by Mr. John Parry, Ebbw Vale.

THE museum recently opened at Newcastle-on-Tyne by the Prince of Wales is a very fine building indeed, and of course is quite unconnected with the public library. The building contains the collections of the well-known Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne, and will cost 42,000*l*. Of this 38,000*l*. have been raised by public subscription.

THE preliminary programme of the Central Institution for Technical Education has been issued. The object of the Central Institution, it states, is to give to London a College for the higher technical education, in which advanced instruction shall be provided in those kinds of knowledge which bear upon the different branches of industry, whether manufactures or arts. The Institution is intended to afford practical scientific and artistic instruction which shall qualify persons to become (1) technical teachers; (2) mechanical, civil, electrical, chemical, and sanitary engineers, architects, builders, and decorative artists; (3) principals, superintendents, and managers of manufacturing works. The main purpose of the instruction to be given in this Institution will be to point out the application of different branches of science to various manufacturing industries; and in this respect the teaching will differ from that given in the Universities and in other institutions in which science is taught rather for its own sake than with the view to its industrial application. The courses of instruction will be arranged to suit the requirements of (1) persons who are training to become technical teachers; (2) persons who are preparing to enter some industrial or professional career; (3) persons who desire to attend special courses, with the view of acquainting themselves with the scientific principles underlying their work. Students intending to go through the complete course of technical instruction with the view of subsequently obtaining a diploma, will be required to pass an entrance or matriculation examination, which will include mathematics, pure and applied, chemistry, physics, drawing, and French or German. On the results of the examination the following scholarships will be awarded to students who are prepared to attend the complete course of instruction in any one department, provided that the merits and circumstances of the candidate justify the Committee in making the award:—(1) The Clothworkers' Scholarship of 60*l.* a year, tenable for two years and renewable for a third year, entitling the successful candidate to free education. (2) The Siemens Scholarship of 50 a year for three years, founded by Lady Siemens in memory of her husband, the late Sir William Siemens, LL.D., F.R.S. This Scholarship will be competed for in October 1885. (3) The Royal Albany Scholarship of 50*l.* a year for three years, founded by the Corporation of London in memory of the late Prince Leopold, Duke of Albany. (4) Two Mitchell Scholarships of 30*l.* a year for two years, one with and one without free education, to be awarded to candidates who have attended a public elementary school within the City of London, or whose parents are or have been resident or engaged in some trade or occupation within the City of London. The Siemens Medal, founded by Lady Siemens in memory of her husband, the late Sir William Siemens, LL.D., F.R.S., will be annually awarded to the student of greatest merit in the department of electrical engineering. The professors in charge of the several departments are:—Chemistry, Prof. H. E. Armstrong, Ph.D., F.R.S.; Engineering, Prof. W. C. Unwin, B.Sc., M.Inst.C.E.; Mechanics and Mathematics, Prof. O. Henrici, Ph.D., F.R.S.; Physics, Prof. W. E. Ayrton, F.R.S., A.M.Inst.C.E.

THE Paris *Journal Officiel* announces the formation of a Commission to investigate all matters connected with mines and mining in Tonquin and Annam. It is composed of various officials of experience in Indo-China, and their instructions are to draw up the programme of work to be executed by the mining party which is about to be sent out from France, and to draw up a draft agreement regulating the management and working of mines in conformity with the treaty of June last with Annam.

A SUBJECT which, according to the *Japan Mail*, is engaging the attention of native scientific men in Japan is the method of translating or transferring into Japanese the technical terms of European science. Hitherto Chinese words and characters have been employed for this purpose; in many cases the translations existed, we believe, in Chinese, and were simply adopted by the Japanese—such as the equivalents for telegraph and railway appliances, but in the great majority of cases a process of manufacture had to be resorted to. Given the sound of the technical term and its meaning, the problem was to find among existing Chinese characters one, two, or three, which suited one or other of these best; and thus a new word was formed. The scientific journal of Tokio attacks this system, saying that, whatever may be said on the score of the unity and adaptability of Chinese in transcribing technical terms, the clumsy and complex graphic system renders it unsuitable for youthful students, as the difficulty of committing to memory so many hundreds or thousands of arbitrary characters is still greater than the pursuit of a scientific or technical course of study. Prof. Yatabe, of the Tokio University, lays special stress on the use of the original foreign technical terms, instead of translating them into Chinese. In a lecture on the subject, this gentleman told the pupils of a normal school near Tokio that, in order to comprehend the scientific achievements of Europe, it was necessary to be conversant with one or more European languages, for, seen through the medium of the Chinese tongue, science lost much of its simplicity, and was at best but clumsily reproduced. Another native Professor of the University argued in a similar strain. The knowledge of some European language was, he said, essential, not only on account of the closer relations now existing between Japan and the West, but also because the study of the technical sciences would thereby be made materially easier than at present. Whatever might be the use of Chinese as a philosophical language, it was certainly most unsatisfactory as a vehicle for the reproduction of Western sciences.

M. F. A. FOREL communicates to the *Journal Suisse* an interesting account of the discovery of the relics of the "Hôtel des Neuchâtelois," an extemporised fastness on the glacier of the Lower Aar, occupied by Agassiz and his scientific friends from 1840 to 1843, while they were investigating the theory of glaciers and the Glacial period in the immediate factory of glaciers. Herr Ritter, from Leipzig, recently on a tour through the region of the Unteraar, found there a block of stone bearing the names of Stengel, Otz, and Martins, with the dates 1844 and 1845. In 1840 Agassiz and his friends, coming across an enormous block of micaceous schist, supported by other rocks, and forming a natural shelter, on the median moraine of the glacier, at the junction of the Lauteraar and Finsteraar, proceeded to complete the cabin thus prepared for them by running up some walls of dry stones. In his "Excursions et Séjours dans les Alpes," Desor gives a lively picture of the enthusiastic scientific life led by Agassiz and his zealous fellow-students of Nature in that simple yet elevated hall of science to which they gave the name of Hôtel des Neuchâtelois during the three years 1840 to 1843. The block, naturally friable, showed, as early as 1841, numerous fissures, and in 1844 split into two pieces. Since then the frost has rent it up into a heap of debris, and it is three pieces of this which have just been identified. They are a blackish micaceous schist of very fine grain. The piece highest situated bears several inscriptions of the colour of minium, but these are mostly illegible, and M. Forel could only make out "1848" thrice repeated, and "Vogt," the present Professor at Geneva; 23 m. lower down is the stone discovered by Herr Ritter, bearing in very legible capitals the inscriptions "STENGEL" (student of engineering under Osterwald), "1844"; "OTZ" (Engineer at Neuchâtel), "1845"; "CH. MARTINS" (Professor at Montpelier), with other letters which are indecipherable. There is also to be read on it "No. 2," a mark which confirms M. Forel's conclusion as to the connection of the stone with the Hôtel, Agassiz having caused certain stones to be distinguished by certain numbers, and their position to be taken by Engineer Wild, the block of the Hôtel der Neuchâtel being distinguished by the number "2"; 55 m. lower still is the third stone with the inscription: "SOLIOZ AUGUSTE, 1842; LIEUTENANT GUNTREN," and a few more words hardly comprehensible. These three blocks are now no longer, as in 1840, at the summit of the moraine, but have been slipping down the incline on the side of the Lauteraar, which merges in the glacial ravine, watered by a beautiful stream. Comparing the position of the Hôtel des Neuchâtelois, as given by Agassiz (797 m. from the promontory of Abscwhung), and as seen in Wild and Stengel's beautiful map of the glacier on the scale of 1 : 10,000, with the position which it now occupies, M. Forel calculates that the block must have glided a distance of 2400 m. from 1840 to 1884, or 55 m. a year. For the easier identification of the three blocks of stone by later explorers, M. Forel has inscribed on them, in fresh red colour, his own name and that of Herr Ritter, with the date 1884.

THE Institution of Civil Engineers send us the lengthy and valuable memoir of the late Sir William Siemens, presented to the Institution by Dr. William Pole. After a few words on the incidents of his life, Dr. Pole abandons any attempt at chronological arrangement as impossible because of Sir William Siemens's "extraordinary faculty of devoting his attention to many different lines of thought, and many different subjects of investigation, at one and the same period"; and accordingly his labours are classified under these heads:—(1) Heat and its applications, particularly to metallurgy; (2) Electrical science and practice; and (3) Miscellaneous engineering, mechanical, and scientific matters not included under the former heads. Dr. Pole then goes over the whole of Sir William Siemens's scientific labours in these fields, and, as might have been expected, produces the fullest and most valuable memoir of this distinguished member of "the creators of the age of steel" which has yet appeared.

THE "Year-Book of the Scientific and Learned Societies of Great Britain and Ireland," published by Messrs. Griffin and Co., will be found useful, and doubtless will be improved from year to year. The societies are arranged in fourteen sections, according to the field they occupy, with a fifteenth section, including some of the leading foreign societies. The compilers might certainly have avoided putting the Royal Society and the Royal Institution side by side, as if they had anything in common.

MR. W. M. MASKELL, F.R.M.S., continues his notes on the *Coccidæ* of New Zealand, and has sent us a lengthy continuation of his former papers, extracted from the *Transactions* of the New Zealand Institute, vol. xvi. That country seems to be especially rich in "scale-insects," and in Mr. Maskell they find an able student of their modes of life and characteristics. Especially curious is the species described as *Rhizococcus fossor*, the female of which does not cover herself with a sac or "scale," but sinks herself bodily in a circular pit in the substance of the leaf, and there lays her eggs; the species feeds on *Santolum cunninghamii* in the North Island. *Icenya parchasi*—a near relative of the "pou à poche blanche" (*I. sacchari*), so destructive in Mauritius, and which has probably been introduced into Queensland and elsewhere—seems to be spreading rapidly, and to be doing much damage, not only to cultivated trees and shrubs, but also to the native forests. Before carrying into effect the radical remedy of cutting down and destroying the infected trees, we would recommend Mr. Maskell to try an application of kerosene, which has certainly proved useful in the case of *Coccidæ* on oranges in America. The weak point of these papers consists in the extreme roughness of the plates; they may be characteristic so far as they go, but a few coarse scratches scarcely sufficiently represent hairs, neither does an open network of crossed lines indicate a solid and probably concave surface.

THE *Kavkaz* newspaper mentions a bolide that was seen on August 3 at Kazakh, in the district of Elizabethpol. It had the shape of a blue globe which broke into two globes of the same colour, and disappeared in the direction of the Caucasus Chain.

WE regret to learn of the death at Montreal, from typhoid fever, of Mr. Walter R. Browne, well known as a writer on the scientific aspects of engineering. Mr. Browne had gone to Montreal to attend the British Association meeting.

THE dangers to public health which lurk in out-of-the-way places appear inexhaustible. This time the danger comes from the matter which collects on coins which have been a long time in circulation, and to which we have already referred. M. Reinsch of Erlangen has devoted much study to this matter, and has investigated old and recent coins of all metals from all the European States. Everywhere he has found micro-organisms of Algæ and Bacteria. Scraping away the matter which accumulates in the interstices of the relief with a needle, and placing it in a drop of distilled water under a microscope of 250 to 300 diameters, he found fragments of textile fibres, numerous starchy granules, especially of the starch of wheat, globules of grease, some unicellular Algæ, &c. But when a microscope of greater power was used Bacteria were found among this detritus. There were long Bacteria with a vibratory or spiral movement, as well as those of a globular shape. Sometimes both forms were found on one coin; but as a rule each form was found separately. When a little glycerine or iodine was introduced into the preparation these ceased their movements. Among the Algæ two kinds were of most frequent occurrence, viz. a small *Chroococcus* and a small unicellular one resembling the *Palmellis*. They were collected in little spherical colonies of four, eight, or a dozen at a time, and were found only on old coins; recent ones contained only the Bacteria. A recent writer in *Science et Nature* refers to this discovery as of great importance from a hygienic point of view.

AT numerous places in Lower Austria several shocks of earthquake were felt on Tuesday last week. The duration of the shocks was from four to nine seconds each.

AT the last meeting of the Seismological Society of Japan, a paper (which is printed in the *Japan Gazette*) was read by Mr. E. Knipping on the meteorology of Japan. It was based on data obtained from twenty-three meteorological stations in Japan during the year 1883, the extreme positions being Kagoshima and Nagasaki in the south, and Sapporo and Nemoro in Yezo in the north. Interesting comparisons are instituted between the variations in temperature and pressure at different times of the year and in different parts of Japan, and similar variations in Europe.

THE additions to the Zoological Society's Gardens during the past week include two Ring-tailed Lemurs (*Lemur catta* ♂ ♀) from Madagascar, presented by Mr. Charles Stewart; a Common Marmoset (*Hapale jacchus*) from Brazil, presented by Mr. J. Henderson; two Peba Armadillos (*Tatusia peba*) from South America, presented by Mr. Frank Parish, F.Z.S.; a Wood Owl (*Syrnium aluco*), British, presented by Mr. J. Baldwin; two Smooth Snakes (*Coronella lævis*) from Hampshire, presented by Mr. W. H. B. Pain; seven Common Crowned Pigeons (*Goura coronata*) from New Guinea, a Victoria Crowned Pigeon (*Goura victoriæ*) from the Island of Jobie, two Brazilian Hangnests (*Icterus jamaicai*) from Brazil, deposited; a Gray-cheeked Monkey (*Cercocebus albigena*) from West Africa, purchased; a Prairie Wolf (*Canis latrans*) from Kansas, U.S.A., received on approval; a Vulpine Phalanger (*Phalangista vulpina*), born in the Gardens.

## GEOGRAPHICAL NOTES

THE present number of the *Bulletin de la Société de Géographie* commences with a paper by M. Duveyrier, on the geographical extent of the Mussulman confraternity of Senousi. This sect, which is distinguished by its austere and fanatical tenets, arose forty-six years ago under an Algerian, and appears to have in a greater or less degree permeated the Mohammedan world, and acquired vast political importance. It flourishes especially in Northern Africa, reaching as far south as Timbuctoo. The details of its precise extent and the nature of its activity are given in the paper. The second paper, which is not signed, records a French hydrographical mission to the coast of Morocco by the French officer M. Vincendon-Dumoulin in 1854. The most interesting part of the paper is the introduction, in which the writer discusses the necessity of having a dictionary of geographical etymology; that is, a work which will explain as far as possible the origin and meaning of geographical names, not only from a philological but also an historical point of view. The names, he says, which, for example, Stanley and De Brazza are giving their settlements in Africa, are explicable now, when everybody knows why Leopoldville is so called; but it may be different fifty years hence. But who knows, he inquires, that the territory called Adélie in the Polar Ocean was so called after the wife of Admiral Dumont d'Urville, or that the capes known as Jagersschmidt and Cotelle were named after the members of the hydrographical expedition to Morocco, which the paper then goes on to describe? From the report of a Committee of the Society appointed for the purpose, we see that three gold medals for geographical work have been awarded this year. The first was granted to M. Alphonse Milne-Edwards for his submarine investigations; the second to M. Thouar for his journey to the Grand Chaco in search of the survivors of the Crevaux Mission; and the third to M. Charnay for his explorations and archæological discoveries in Yucatan. The last paper in the number is composed of a series of extracts from the letters of Abbé Desgodins on the boundary region between Thibet, Burmah, Assam, and China.

THE Danish gunboat *Fylla* returned from the Arctic regions to Orkney last week, having been sent out by the Danish Government on an exploring and surveying expedition. She has had a most satisfactory voyage, occupying nearly four months, and extending along the whole coast of Greenland to 70° N. lat. Her work included a scientific exploration of the inland glaciers in that country, and dredging, trawling, and meteorological observations there and in Davis Straits, Baffin's Bay, and Disco Bay. Many hitherto unknown specimens were brought up by the dredging, the greatest depth being 900 fathoms. Valuable collections have been brought home by the ship in all the scientific sections. The members of the expedition speak in high terms of their collections, which include a meteoric stone estimated to weigh about 2000 lb.

LIEUT. GREELY, in connection with his paper at the British Association, took occasion to say that the fact that had surprised him was the discovery that when the tide was flowing from the North Pole it was found by his observations that the water was warmer than when flowing in the opposite direction. He took trouble to have an elaborate set of observations showing this wonderful phenomenon prepared, which would be eventually published. To him the peculiarities were unexplainable.

A CORRESPONDENT of the *Standard* writes:—"On July 26 the lighthouse-keeper at Cape Reykjanes, the south-west point of Iceland, on scanning the sea with his glass, saw what he at first took for a very large ship, but which a closer inspection showed to be a new island. It had the form of a rounded flattened cone, was of considerable size, and lay, according to his estimate, about fourteen miles north-west of the volcanic island Eldey, or the Mealsack (Melsekken), which lies eight miles off Reykjanes to the south-west. Several earthquake shocks had been felt during the preceding days, and they have since occurred at intervals, but no other volcanic manifestations heralded or attended the rise of the island from the deep. Owing to the danger of approaching the island in an open boat, no one has as yet attempted to land on it. The light-keeper has observed it from day to day when not prevented by foggy weather, and reports no change in its appearance save that a large part of one side of the cone appears to have slipped or fallen down into the sea. From time to time since the colonisation of Iceland, volcanic islands have sprung up out of the waves in the neighbourhood of Reykjanes, only to disappear again after a brief period. In the end of last century an island arose at or near the same place as the present one occupies, and was taken possession of by the Danes, under the name of Nyœ (New Island), but as it consisted only of loose volcanic ash and pumice the action of the waves speedily broke it down, and after little more than a month it disappeared as mysteriously as it had arisen."

## *OUR ASTRONOMICAL COLUMN*

VARIABLE STARS.—Several papers upon these interesting objects have lately appeared in the publications of scientific bodies:—

(1) "A Catalogue of known Variable Stars, with Notes," by Mr. J. E. Gore, in the *Proceedings* of the Royal Irish Academy, vol. iv. Mr. Gore has brought together particulars relating to about 190 stars, including their positions for 1880, the limits of magnitude, mean periods, and epochs of maximum and minimum, for the most part taken from Schönfeld's Catalogue of 1875; indeed, this Catalogue is the source of much of the information contained in Mr. Gore's paper. His summary will be very useful to those who are entering upon the study of the variable stars; some corrections are needed, but they are not of very much importance. Observations by himself of several of the stars are added in the notes following the Catalogue, and others by various observers made since Schönfeld's last Catalogue was published. The positions as printed have a lame appearance, from being given to seconds of time in right ascension and to seconds in declination: if the right ascension of an object is assigned to the nearest second of time, the more legitimate expression of the declination is to the nearest tenth of a minute. The reference to the fancied identity of "the Biblical star of the Magi" with Tycho's celebrated star of 1572 seems out of place.

(2) "Recent Observations of Variable Stars," presented by Prof. Pickering to the American Academy of Arts and Sciences. The author had previously issued a pamphlet and a circular from the Harvard College Observatory, in the hope of promoting a more systematic observation of the variable stars, and in response has received communications from a number of observers who have expressed their willingness to join in his scheme of observations. In the paper in question Prof. Pickering has brought together the results of observations of variable stars for 1883, so far as he had them at hand, to show the nature of the information which he desires to obtain in order to be in a position to issue a further circular early in 1885. It should be mentioned that Mr. S. C. Chandler is preparing a bibliography of the variables, which will eventually furnish the means of forming a catalogue of all the stars now known to be in a state of change, to a much more reliable extent than hitherto; such a work cannot fail to be of vast assistance to any one desirous of looking up the history of particular stars, which is now an operation attended with much trouble and uncertainty. With regard to his next circular, Prof. Pickering hopes that observers of variable stars, whether professional or amateur, will be generally disposed to furnish information on the following subjects—(*a*) the method of observation, if photometric, some account of the instrument, and the manner of using it; if not photometric, whether the observations are made by Argelander's method, or by direct estimation of magnitude; (*b*) stars observed in 1884, with the number of nights on which each was observed; (*c*) the time and form of publication contemplated by the observer; (*d*) plans for 1885, naming the stars selected and the number of nights on which it is proposed to observe them. This information it is desired to receive at Harvard College Observatory by February 1, 1885, as well as any material which may be useful towards making the table for 1883 more complete. Prof. Pickering's first table gives the positions of the variable stars for 1875, with the limits of magnitude and the periods; also the discoverer and year of discovery, with references to observations made in the years 1880-83. In a second table is a list of suspected variables extracted from Mr. Chandler's unpublished catalogue.

3. The Rev. T. E. Espin publishes in the *Transactions* of the Liverpool Astronomical Society "A Catalogue of the Magnitudes of 500 Stars in Auriga, Gemini, and Leo Minor," which have been determined from photographs taken by means of the equatorial stellar camera at the Society's Observatory. The apparatus was placed at the disposal of the Society by Mr. Howard Grubb. The magnitudes determined from the photographs are entirely based on those of Argelander. It is stated that the deduced magnitudes of 341 stars out of the 500 agree within 0·4 m. with those of Argelander, while in twenty-five cases the differences exceed a whole magnitude. The nebulæ M 35 and 51 have been photographed after exposures of 2h. 55m. and 2h. 0m. respectively, as also the cluster Præsepe, of which the photographs show the smallest of Argelander's stars, and some which do not occur in the *Durchmusterung*. Two stars are noted as presenting indications of variability: viz. 41°, 1222 in Auriga, which was 8·6 m. on March 10, but was not found on a plate taken a few nights afterwards; and 33°, 1895 in Leo Minor. Mr. Espin concludes with the remark, "The difficulty of reducing the stars to Argelander's scale is complicated, from the fact that near the *minimum visibile* the bluer stars alone are photographed, the yellowish ones disappearing."

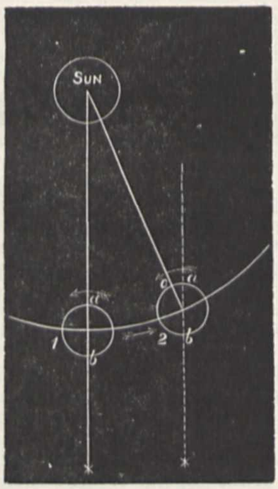
COMET 1884 *b* (BARNARD).—The following positions for Berlin midnight have been calculated by Herr Stechert from his elements (NATURE, p. 431).

| | R.A. h. m. | Decl. ° ′ | Distance from Earth | Light |
|---|---|---|---|---|
| Sept. 15 | 19 21·4 | −29 23 | 0·703 | 0·76 |
| 17 | 19 29·3 | 28 43 | | |
| 19 | 19 37·1 | 28 1 | 0·729 | 0·69 |
| 21 | 19 44·7 | 27 19 | | |
| 23 | 19 52·2 | 26 35 | 0·759 | 0·62 |
| 25 | 19 59·5 | 25 52 | | |
| 27 | 20 6·7 | −25 8 | 0·792 | 0·55 |

## THE MOVEMENTS OF THE EARTH[1]

### VI.

WE have now to consider some of the results of these Movements of the Earth—first round its own axis, its rotation; then round the sun, its revolution—which we have been considering, results to which of course a general interest attaches, and which there will be no difficulty in showing are of very great importance to us. Occasion was taken to point out that the different appearance presented by the sun and the stars was simply due to the fact that the sun was very near to us whilst the stars were very distant, the one, a sun which happens to be near to us, the others, also suns, but happening to be very far removed from us. Now suppose we have a globe in which we have an electric light, to represent the sun, and a little globe to represent the earth, then it will be obvious that that part of the earth which is turned towards the lamp will be bathed in light, while that half which is turned from it will be in darkness, being, so to speak, only under the light of the distant stars. This shows us the reason for that great difference which we call day and night, and we can quite understand how it is that we get the apparent rise of the sun which occurs when the part of the globe on which we live is carried from the darkness into the light, and sunset which of course occurs when the globe is being carried by its rotation from the light into the darkness. This phenomenon of day and night is thus one of the most obvious results of the rotatory movement of the earth, and one which might have been dismissed in two words had we so chosen, but we will dwell




49.—Diagram showing how the difference between the lengths of the sidereal and mean day arises.

upon it for a few moments, because this fundamental difference between day and night furnishes us with a reason why we should discard that sidereal time to which up to the present reference has alone been made.

Fig. 49 will show how it is that under the circumstances in which we thus find ourselves, a new kind of time must take the place of sidereal time. In this diagram we have the earth represented at two positions in its orbit, 1 and 2. It travels in this orbit in the direction of the arrows, rotating on its axis the while in the direction also indicated by arrows. Now let us consider the start-point 1, and suppose that when the earth occupies this position a particular star is on the meridian at midnight. The earth it will be remembered rotates in twenty-four sidereal hours; it will therefore take twelve hours to turn half round, so that if we consider the sun to be directly opposite the star which is south at midnight it is obvious that they are twelve hours apart. Now consider the earth at position 2. Then remembering this fundamental fact, that the distance of the stars is so enormous that a string stretched from the observer to the star at one point of the earth's orbit would be practically parallel to a string stretched to the same star from any other part of the orbit; it is obvious that the star will have the same right ascension in both positions of the earth, and the line pointing to the star will be practically in the same direction. But the sun will no longer lie along the prolongation of the line joining earth and star as it did at 1, for in consequence of the earth's revolution round the sun we shall get a gradually increasing angle as the earth in its orbital course gets farther and farther from its initial position at 1. Now it is obvious if we are going to have our time regulated by the sun instead of by the stars—and that is what we must do for the purposes of civil life—we shall have to arrange our clock so that when we pass from 1 to 2 it must, if it showed 12 o'clock when the sun was due south in the former position, show 12 o'clock also when the sun is due south in the latter position. If this be so, and we have this angle made by the line joining sun and earth and star, we shall have to make our sun-clock go more slowly than our sidereal clock, for the reason that the sidereal clock will have gone round once in less time than the earth will have got round to the same place with regard to the sun. But if we choose, and we do choose, to say that we will have twenty-four hours from sun-southing to sun-southing, then these twenty-four hours and necessarily also their minutes and seconds, will be longer than the hours, minutes, and seconds of sidereal time. Let us take another illustration. Consider the case of the earth in three different positions, represented by three globes round a central lamp. Then suppose that in each of these globes a wire is put to represent the direction in which the transit instrument points at Greenwich when the same star is observed at three consecutive intervals of twenty-four hours of sidereal time. These three wires should therefore be placed parallel to each other. Now let us take the electric lamp to represent the sun, then we shall find that, when the transit instrument on each of the earths

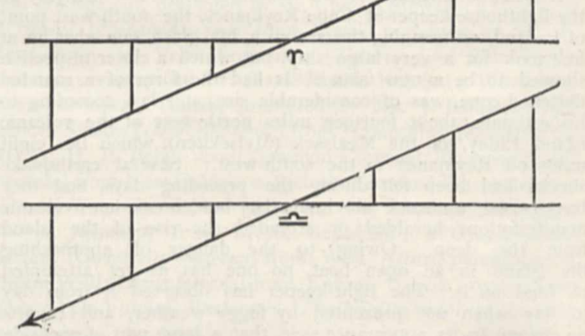



FIG. 50.—Diagram showing how the sun's apparent motion along the inclined lines representing the ecliptic in the direction indicated by the arrowheads is represented by a smaller amount when referred to the earth's equator (the horizontal lines in the figure) at the spring (♈) and autumn (♎) equinoxes.

is brought round to point at the sun, the three wires which represent the instruments will not be parallel to each other but at some angle. At first sight it might seem that we could easily get a sun-time to replace the star-time, but unfortunately when we go a little deeper into it we find, as we often do in other cases, that it is not quite so easy—and for two reasons. We found, it will be remembered, when we came to consider the form of the earth's orbit, that it was not quite circular, that it was in fact what is called an ellipse, and that the radius vector, *i.e.* the imaginary line joining the centres of the sun and earth did not sweep through equal *arcs* in equal times but through equal *areas*, so that, if we want to invent a clock which will show twenty-four hours from the time of sun-southing one day to the time of sun-southing the next, that clock will require to be regulated differently for every day in the year, because the greater or less part of its orbit moved over by the earth will cause the greater or less angle between the lines joining sun, earth, and star.

That I hope is clear. Thus then there is good reason why this arrangement of having a sun-time from noon to noon will not work. We should have to regulate our clock for every day in the year, or rather for every two opposite days. But there is another matter. We are now in full presence of the fact that the equator of the earth is inclined at an angle of about $23\frac{1}{2}°$ to the plane of the ecliptic. Fig. 50 will perhaps enable us to understand this matter more easily. Let the horizontal lines represent the plane of the equator and the inclined lines the

[1] Continued from p. 256.

plane of the ecliptic. Now our clock and all measurements of time must depend upon the earth's rotation, the plane of which always remains parallel to itself, and we have seen that our start-point for geocentric and heliocentric longitude depended upon the fact that at a certain point in its revolution the earth passed through a node, and that the node at which the sun with its apparent motion crossed the equator northward was called the ascending node. In the diagram this is represented by ♈ in the upper figure, and the descending node is indicated by ♎ in the lower figure. It will be seen that if we have equal intervals along the ecliptic the motion along the equator is represented by bases of successive triangles, of which the hypothenuses lie along the ecliptic. Now the hypothenuse must be

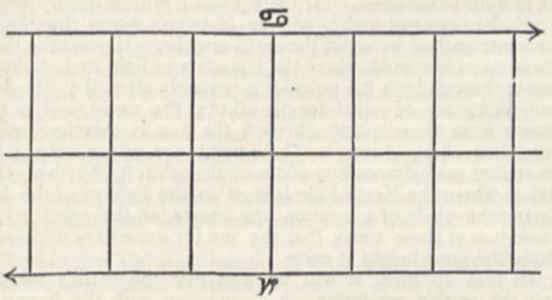



FIG. 51.—Diagram showing how the sun's apparent motion along the ecliptic, now parallel with the earth's equator (the central line of the figure) at the summer (♋) and winter (♑) solstices, is represented by equal intervals along the equator.

greater than the base, so that we have at the ascending node the motion of a body along the ecliptic represented only by the base of a triangle of which the motion itself represents the hypothenuse; and the same thing happens in the opposite manner at the descending node; whereas if we take the other positions shown in Fig. 51, for a short time at all events the motion will be parallel, and motion along the ecliptic will be represented by an equal amount along the equator.

These then are the difficulties we have to face when we come to fix our sun-time, first, the unequal velocity of the earth round the sun; and secondly, those variations which are brought about by the fact that the two motions of the earth—its axial rotation and yearly revolution—take place in different planes. How are these difficulties got over? They are got over by pretending a sun, as a child would say. Astronomers pretend that there is a sun moving along the equator, or, in other words, they pretend that the earth's movement of revolution takes place in the same plane as its movement of rotation. It is further imagined that this imaginary sun travels at precisely that rate which it would if the average of all its rates along the ecliptic during a year were taken, so that we get something like this (see Fig. 52); first of all we have the curve B B B B, which shows the variation which would take place providing we only had to deal with the obliquity of the ecliptic. Where that curve crosses the horizontal line, we get at those moments (if we disregard the elliptic motion) the same time shown by the mean sun as we should get if the true sun had been taken; it will be seen this occurs four times during the year—on March 20, June 21, September 23, and December 22. Then there is another curve, C C C C, which represents another relation between the mean sun and the true sun. Providing that the two planes were coincident, and that the movement of the earth under these conditions were exactly the same as under the present conditions, namely, that she moved in an ellipse and that the radius vector swept over equal areas in equal times, then we should have the true and mean sun coincident on December 31 and July 1 only. Then the algebraic mean of these two curves, B B B B and C C C C, is taken, and we get as a result the lower curve D D D D, which is a compound of the two other curves, and as the result it will be seen that where we got the curve C, giving us a difference of nearly five minutes, and the curve B, giving a difference of about nine minutes in the same direction, we have a very great departure between the motions of the real and mean suns. Above and below the datum line, which is marked zero, we have 5, 10, and 15, which represent the difference in minutes at which the southings of our real and fictitious suns really take place. Early in the month of February we have a difference of very nearly fifteen minutes between the two suns, and it is at this time of the year of course that the sun dial is most in error. At other points where the effect of curve B is to cause a great difference, the effect of curve C will be to minimise that difference, and so in the compound curve D the difference is very slight. About the middle of June we get them together, then towards the end of July we get another separation, and about November 1 we come

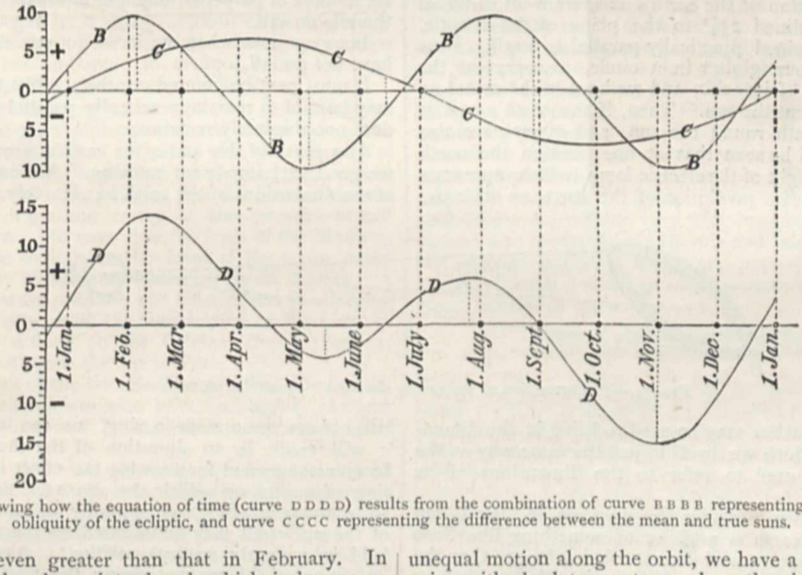



FIG. 52.—Diagram showing how the equation of time (curve D D D D) results from the combination of curve B B B B representing the vairation due to the obliquity of the ecliptic, and curve C C C C representing the difference between the mean and true suns.

to another difference even greater than that in February. In this way a correction has been introduced, which is known as the "equation of time," and this added to the motion of the true sun, or added to that of our imaginary sun, brings them together, and by this means the mean sun is kept as nearly as possible to the average position of the true sun throughout the year. Another diagram (Fig. 53) will enable us to understand some of the considerations which have brought this about. Let F represent the position of the sun in one of the foci of the ellipse, P *e* A, round which the earth is supposed to be travelling. Now while we have the real radius vector going from P to *e*, with its unequal motion along the orbit, we have a fictitious radius vector going with absolute constancy along the circle. We get what is called the true anomaly in the angle P F *e*, and the mean anomaly in P F *e'*, and the difference *e* F *e'* is called the equation of the centre. This equation helps us to determine those curves to which reference has been made, and the chief object in calling attention to this diagram is to explain the meaning of the term anomalistic year, which it will be necessary to introduce presently. It has already been said that it is imperative, if we are to gain any advantage from it, that real sun-time and apparent sun-time should never be widely separated, because if so we might have contented ourselves simply with sidereal time, which would have at least the advantage of being constant, so that it is most necessary if any benefit is to be derived from this mean sun of ours that it should not differ very much from the true sun. The longitude of our mean sun is therefore made equal to the mean longitude of the true sun. This having been premised, the terms "mean time" and "mean noon" will now be clear without any explanation. "Greenwich mean time" of course means time referred to the meridian of Greenwich.

We thus finally discard our sidereal time, and replace it by mean solar time so arranged that the maximum departure of this from true solar time shall be fifteen minutes in the month of February and fifteen minutes at the beginning of November. We have seen that the sidereal day is shorter than a solar day, and that consequently the hours, minutes, and seconds which

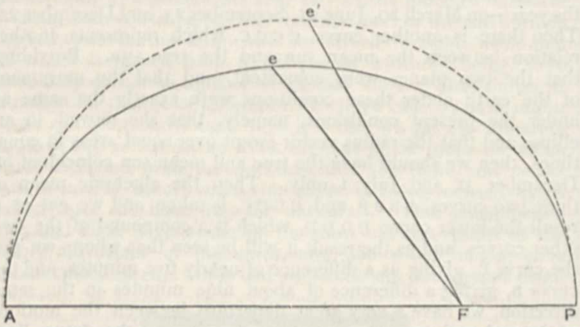


FIG. 53.—Diagram explaining mean anomaly and true anomaly.

make up the sidereal day must be shorter than those which form the solar day. The relation between the seconds of solar and sidereal time may be thus shown.

One sidereal second = ·9973 of a mean-time second.
One mean-time second = 1·0027 of a sidereal second.

We have now got the results of the earth's revolution combined with its rotation, so far as day and night, considered in their more general aspects, are concerned; but we have not done with day and night yet. When we were considering the question of the inclination of the earth's axis, we went so far as to say that it was inclined $23\frac{1}{2}^\circ$ to the plane of the ecliptic, and that it always remained practically parallel to itself. Now suppose we arrange four globes in a circle, to represent the earth in different parts of its orbit, and we have in the centre an electric lamp to represent the sun. Then, if the earth's axis is thus inclined to its path round the sun, and always remains parallel to itself, it will be seen that at one position the north pole will be all in the light of the electric lamp (which represents the sun) during the entire revolution of the earth on its axis. At the point opposite this the reverse happens, for during the entire rotation of the earth the north pole will be in the dark. At the two remaining points the pole will be just on the boundary of light and darkness. We need not consider the case of the south pole; there exactly the reverse will happen to what occurs at the north pole—when the north pole is always in the light, the south pole will be always in the dark, and *vice versâ*, as may be seen by looking at the globes. Now it should be clear that the fact of the earth's axis being inclined to its path causes different lengths of day and night throughout the year. It is simply that, and nothing else. At the poles, which, as we have seen, are sometimes entirely in the light and sometimes altogether in the dark, there will be six months of this light and six months of darkness. At the equator it will be readily understood the days and nights will be of twelve hours' duration at whatever part of her orbit the earth may be. If you take those positions of the earth where the boundary of light and darkness passes through both the poles, it is perfectly clear that the days and nights are of equal length all over the world, and a line drawn from those points through the sun is therefore called the "line of equinoxes." These points are respectively at the ascending and descending nodes of the orbit. The two other points where the North Pole is most in the light or in the dark during the whole of a rotation are known as the solstices, because it is at these times that the sun for some days appears to attain the same height at noon.

To sum up then, it will be seen that the earth's rotation and the earth's revolution, in conjunction with the important fact of the non-coincidence of the planes in which they take place, give us not only our days and our nights, but cause the lengths of them in different latitudes to vary throughout the year. We have in this inclination of these planes to each other, too, the cause of the seasons, because when the northern hemisphere of the earth has been for a long time in that position with the sun longest above the horizon, the temperature will be very different to what it is when the earth is in the other position. In the former position we have summer in the northern hemisphere, in the latter winter. The conditions of life at two such points in the orbit will be vastly different. At the equator, where the days and nights are always of equal length, the course of nature will be very uniform. As the equator is receded from and the poles are approached, this uniformity begins to disappear until, as has been said, at the pole six months of perpetual daylight alternate with six months when there is no sun.

But even now when we have got our day and our year, we have not got all.

It must next be pointed out that, whilst the axis of the earth may be said to remain practically parallel to itself, yet that it does not absolutely remain so.

As a result of this and of the earth's movement round the sun, we get a very important outcome. Although the consideration of the dimensions of the earth has scarcely come within our sub-

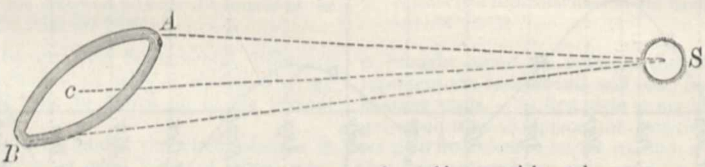


FIG. 54.—The attraction of the sun on the earth's equatorial protuberance.

ject, yet the earth's rotation may be used to bring in the dimensions of the body on which we dwell in just the same way as the velocity of light was used to refer to the dimensions of its orbit.

We need not, however, consider the question in detail, but we may state that the earth is a globe of something like 8000 miles in diameter, the equatorial diameter being longer than the diameter from pole to pole by some twenty-six miles, so that we have, as it were, round the equator a ring of matter some thirteen miles thick and eight thousand in diameter. Now this ring of matter, this equatorial protuberance, is presented to the sun at an angle to the line joining the centres of the sun and earth, as shown in Fig. 54, and the sun's attraction upon it can be resolved into two forces, one parallel to the line joining the centres of the sun and earth, and the other at right angles to this direction; and if we consider what will be the effect of this latter force upon such a ring, we can easily understand that it will result in an alteration of the inclination of the ring. In an arrangement for showing the effect of this attraction, the ring of matter on which the sun acts may be represented by an iron ring attached to a spinning top, and the resolved portion of the sun's pull may be imitated by the attraction of a magnet held in a nearly vertical position. As the ring rotates, the attraction of the magnet draws the ring out of the horizontal, and the poles revolves in a circle. This is what takes place with the earth's axis; hence it is not true to say that it always remains parallel to itself. This revolution is always slowly going on, being completed in a period of about 25,000 of our years. In consequence of this motion, what happens is this: the line of equinoxes which is at right angles to the line of solstices is constantly changing its position along the earth's orbit, producing what is called the precession of the equinoxes. We have to consider, therefore, not merely the sidereal year, the time between which the earth is at one point with reference to the sun and a star, and the time when it is at that same point again; we have not merely to consider the fact that this line of solstices, with its conjoined line of equinoxes, varies with regard to what is called the apse line, that is, the line joining the perihelion and aphelion points of the orbit, or the axis-major of the ellipse—but we get from this another year which is called the tropical year, which, like our mean time, is the one most used, because it brings the year into relation with our seasons. Now that we have got our mean time and know exactly how and why we have got it, we may express the sidereal year in mean time, and say that it consists of 365·256 solar days. The tropical year—the time which elapses between two successive passages through the vernal equinox—is shorter than the sidereal one, owing to the precession along the orbit of the equinoctial points, and consist of 365·242 mean solar days, and the difference between the lengths of this and the sidereal year will of course give the annual amount of precession which takes place. Anomalistic year is the term applied to the period which elapses between two successive passages through the perihelion or aphelion points of the orbit; and as these points have a forward motion along the orbit, this year is longer than the sidereal one, being 365·259 mean solar days.

We may give the exact lengths of these years in days, hours, minutes, and seconds as follows:—

| | Mean solar time d. | h. | m. | s. |
|---|---|---|---|---|
| Mean sidereal year ... ... ... | 365 | 6 | 9 | 9·6 |
| Mean tropical year ... ... ... | 365 | 5 | 48 | 46·054440 |
| Mean anomalistic year ... ... | 365 | 6 | 13 | 49·3 |

The Movements of the Earth are so important to us, and so interesting in themselves, that it is not possible in six lectures to exhaust all that may be said about them or learned from them. I trust however that I have left no point of the first importance untouched. The moral of these lectures is that astronomy has appealed to physics, and has not appealed in vain, for the demonstration of the physical reality of the movements in question.

J. NORMAN LOCKYER

## THE FRENCH ASSOCIATION FOR THE PROGRESS OF SCIENCE

THIS Association began its meetings at Blois on September 3. The financial situation of the Association is very prosperous indeed; the capital has amounted to 20,000*l.*; but the sum spent in scientific researches amounts to only 300*l.*

The President of the Association for this year is M. Bouquet de la Grye, and his inaugural address consisted of a sketch of the history of oceanic hydrography. He dealt with the difficulty of the determinations made on the bottom of the sea, and insisted on a new idea of his own. He believes that the level of the sea presents considerable variations owing to the quantity of salt contained in the water. He says that the level of the Mediterranean ought not to be so high as the level of the ocean owing to the greater quantity of salt and consequently of density. A diminution of temperature produces the same effects as enlarging the density; so an increase of the temperature of the German Ocean would produce a flood on the Belgian, Dutch, German, and French coasts, and bring the sea to Paris.

Dr. Grimaux, a pupil of the late M. Wurtz, delivered a speech on the illustrious Academicians who have died during the past year, among whom Dumas and Wurtz have unquestionably the foremost place.

It is probable that this year the long-hoped-for fusion with the Association Scientifique de France, established by Leverrier, and presided over by Milne-Edwards, will take place, and the two Associations amalgamated in one will take a new start.

One of the principal objects of the present sitting has been the examination of the Thenay geological strata, where Abbé Bourgeois thinks he has discovered Tertiary man. The principal French geologists have arrived in Blois for the excursions. There are very few foreigners at the meeting.

## TRAINING IN NAVAL ARCHITECTURE[1]

AT Govan, the great shipbuilding suburb of Glasgow, on the 4th inst., Prof. F. Elgar, of Glasgow University, addressed the students attending the Science and Art Classes upon the above subject. In the course of his address Prof. Elgar said:—

"All of the students who attend the classes in naval architecture and engineering here are probably much better acquainted with the practical and experimental aspects of the work they are engaged in than they are with the science which underlies it; and their present object is the very vital and praiseworthy one of acquiring such scientific and technical knowledge as will enable them to apply sound principles to the performance of their work, and to assist them in dealing intelligently and successfully with the many difficult and novel questions which are constantly obstructing and puzzling them. There are no branches of mechanical art in which sound scientific knowledge is more essential and useful, or in which it is more necessary for theory and practice to go hand-in-hand together, than those of shipbuilding and engineering. A modern steamer is so complex a machine that no attempts to construct one without calling in the aid of science in some form—either directly or by copying what others have learned by it to do—could possibly end in anything but disastrous failure. Try to imagine a man who had never heard or read of any of the teachings of science attempting to construct a modern steamship—a man who did not know even of the proposition, said to have been demonstrated by Archimedes, that a floating body displaces a volume of water whose weight is equal to its own weight; and who was ignorant of the wonderful discoveries that have been made of the laws by which heat generated by the combustion of coal is converted into mechanical work through the agencies of the boiler and steam-engine. It only requires to state the matter in this bald form in order to show how hopelessly impossible and absurd such an attempt would be, and how vitally dependent shipbuilding and engineering are upon the past achievements and present teachings of science. On the other hand, the highest scientific talent the world has yet produced would be equally unable to arrive at a successful result simply by means of pure theory, however advanced, and by strict *a priori* methods. The course you are pursuing, and which I trust you will not depart from, is the one best calculated to insure for you the greatest success in your work and advancement in your various positions in life; and as in the daily practice of your profession you are perforce kept well abreast of the practical and experimental sides of your work I would now urge you, in the strongest manner possible, to cultivate most diligently and thoroughly a knowledge of the science and of those natural laws upon which the efficiency and success of your efforts depend. Whatever may be the character of your daily work, whether you are employed as engineers, draughtsmen, or mechanics—and I am very pleased to know that there are working mechanics who attend these classes, and who are among the most earnest, intelligent, and capable of the students—never rest satisfied till you know the meaning of all that you do and why you do it. Do not be content with merely learning methods of setting off work and performing calculations, or with copying processes you may have seen others employ. The man who merely does as he sees others do, without very well comprehending why they do it, and who works strictly by rule and line, looking to custom as the supreme authority, will never improve or advance himself, nor be of much real use in such times as these; nor will he find much interest in his work.

> 'Custom, which all mankind to slavery brings,
> That dull excuse for doing silly things.'

Never look to custom as being a sufficient authority for anything, however respectable its antiquity may have made it; but be determined to understand for yourselves whether or not it is based upon sound and intelligible principles. Although we are now meeting under the auspices of the Young Men's Christian Association, I can safely recommend you to indulge freely a spirit of scepticism in this particular department of the Association's work. The region of science and of the pure intellect is not one in which you should be content to accept the mere authority of any one as final, or to test any question except by the standard of your own reason. Do not be too eager to believe that anything you are told is correct until you are able to prove it for yourselves, and till you no longer feel any ignorance or doubt in the matter. The necessity for combining wide scientific knowledge and sound theory with practical experience, in the carrying on of shipbuilding and engineering operations, is daily becoming more and more pressing. If you tried to avoid it you could not. In this age of keen competition and rapid development, increasing demands are made upon all who are engaged in these important

[1] Communicated by Prof. Elgar.

industries. Every success that is achieved by the most advanced and sensational productions creates a demand for still further progress; and in meeting these demands, in the future, the race will be to the swift and the battle to the strong. The speed and the strength that you require in order to enable you to hold your own in this contest are speed and strength of intellect. In other words, you require your intelligence to be cultivated and well informed, and to be made prompt and active, by means of scientific culture; and it is necessary for you to acquire such a firm and comprehensive grasp of sound theoretical principles as will enable you to rely safely upon your own powers of judgment, and to act in difficult cases with certainty and precision. Not only does modern competition ever demand more from you in the way of technical knowledge, skill, and resource, but it also shortens the time at your disposal for supplying it. The huge and complicated engineering structures of the present day, such as are constructed in this district, have to be completed in as short a time as the much simpler and smaller ones of a generation ago. You have thus not only much more to think about in building a ship, and problems of greater number and difficulty to solve than used to be the case, but you have only the same time in which to do it all. You cannot afford to delay the progress of construction for the purpose of trying experiments or brooding over any difficulties you may meet with. It is necessary to decide promptly each question as it arises, and you have to qualify yourselves for doing that. The naval architect and engineer of the present day requires to supplement his practical knowledge by a close and systematic study of various branches of science. An enumeration of some of the chief of them will be sufficient to show how great are the demands thus made upon him. There are the laws upon which the flotation and stability of ships, and their behaviour among waves, depend; those which determine the structural strength of a vessel, and its relation to the forces which may be brought to bear upon her by her own weight and that of her cargo, when she is floating upon a changing wave-surface; the difficult problems connected with the resistance of a ship to motion through the water, the power requisite to drive her at a given speed, and the manner in which this is affected by her outward form and proportions. Then there is the wide field of thermal science, and its application to the means by which the conversion of heat into mechanical work is effected through the agencies of the boilers, cylinders, condenser, and mechanism of the engines; together with the action of the propeller, and the principles upon which its efficiency depends. No man has ever yet succeeded in completely mastering these difficult and complicated problems; and it is perhaps not possible for many of you to advance very far towards their solution. Still it must be borne in mind that it is only by studying the sciences which bear upon them that any real or substantial progress can be effected; and although finality may be unattainable, great advances are possible, and are constantly being made. Hardly a year passes without something considerable being done to improve our knowledge of those natural laws upon which the safety and efficiency of ships at sea depend. There is probably no district in this country which has benefited more in the past than Govan by scientific progress and great mechanical skill in shipbuilding and engineering, or whose prosperity in the future is more dependent upon it. Govan has been placed among the foremost of shipbuilding communities by means of great scientific and practical talent, industry, and enterprise; and it rests with many whom I now see before me to maintain it in the honourable and distinguished position to which it has been raised. The names of Napier and Elder, not to mention others, are alone sufficient to give prestige to any engineering locality; and they insure for Govan a high place in all future records of scientific, mechanical, and industrial progress. Upon you rests the responsibility of worthily walking in the footsteps of those and others among your distinguished men, and of striving to keep erect in this district the noble edifice they have reared."

## *SOCIETIES AND ACADEMIES*

### PARIS

**Academy of Sciences,** September 1.—M. Rolland, President, in the chair.—Some remarks on the subject of the theory of the figure of the planets, by M. F. Tisserand. The author's calculations and estimates of their present form are based on the assumption that the celestial bodies were originally in the fluid state, subject only to the mutual attraction of their constituent elements, and endowed with a rotatory movement with very slight angular velocity. Their outer surface would thus be somewhat that of a revolving ellipsoid.—Researches on the general development of vegetation in an annual plant: functions of the hydrocarbon elements, by MM. Berthelot and André.—Note on the general resolution of the linear equation in matrices of any order, by Prof. Sylvester.—Remarks on the attempts made at various times to solve the problem of aërial navigation, by M. Laussedat. The author supplies a rapid sketch of the progress of aërostatics in connection with the Commission lately appointed by the Academy to examine the claims of priority of various inventors. He considers that General Meusnier was the first to introduce the elongated shape of the balloon, the screw as the propelling agent, and the principle of the "*ballonnet*" or air-bag, rediscovered by M. Dupuy de Lôme. M. Conté is credited with great improvements in the construction of spherical balloons, and M. Alcan is stated to have anticipated M. H. Giffard by several years in the application of steam to aërial navigation.—Comparison between the coloured electro-chemical and thermal rings of Nobili and others, by M. C. Decharme.—Observations of the planet 240 discovered at the Observatory of Marseilles on August 27, 1884, by M. Borrelly.—Determination of the wavelengths of the chief rays and bands of the infra-red solar spectrum, by M. Henri Becquerel. Tabulated results are given for the chief bands in millionths of millimetres.—Remarks on the formation and development of the nervous cellules in the spinal marrow of mammals, by M. W. Vignal.—Note on the recent luminous phenomena observed around the sun in Switzerland (second communication), by M. F. A. Forel. A second trip to the Alps, undertaken towards the end of August, enables the author to confirm and complete the details already communicated to the Academy. Aëronauts are invited to study some of these light-effects, and especially the red corona round the sun, scarcely perceptible from the plains and low elevations, but perfectly visible at altitudes of from 3000 to 6000 feet above the sea-level.—Account of the optical telegraph recently established between the islands of Mauritius and Réunion, by M. Bridet. The telegraph set up on Lacroix Peak in Réunion and Vert Peak in Mauritius was completed on the night of July 12-13, when messages were freely exchanged between the two islands.

## CONTENTS

PAGE