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THE PRESIDENT'S ADDRESS.

BY THE HON. CHIEF JUSTICE DRAPER, C. B.

Read before the Canadian Institute, January 10th, 1857.

My first duty in assuming the Chair of the Canadian Institute, is to thank you for the honour you have done me in electing me to fill a position which has been previously occupied by men justly distinguished, and with such special claims to the honour. Without assuming a forced humility, or that tone of self-depreciation which is ever akin to vanity, I cannot but recognize my own deficiencies, and wish myself better qualified for the duties I ought to discharge. If I have felt hesitation in undertaking these duties, it is from no want of regard for the Canadian Institute, or of desire for its welfare; still less is it from undervaluing those who have assigned to me so conspicuous a place in a body associated together for objects at once so honorable, and so indispensable to the highest interests of this Province. But in accepting the office of President I comfort myself with the assurance that I am surrounded, in the Council, by those selected by you, and well qualified to relieve me of the grave responsibilities which the high aims of this Institute would otherwise impose on me; while I can only assure you that I yield to no member of this Society in earnest zeal for the promotion of its best interests, or in the high estimate of what it is capable of accomplishing for Canada.

The Report of the Council for the year 1856, of the proceedings of the Institute, affords much reason for congratulation. The additions to the number of its members show the increasing sense of the value of the Institute; and this conclusion is strengthened by the observation in the report, that these additions are such as give it "a Provincial rather than a local character," and entitle us to hope for a far more widely extended co-operation than we at first might have reasonably expected. In no respect, perhaps, can that co-operation be more usefully afforded than in communications on the various branches of literature, science, and art, which, read at the meetings of the Institute, may, whenever their novelty or importance justifies it, form part of the published records of our proceedings, in the Canadian Journal. Observation and experience are the sources for enlarging the extent of all our knowledge. The communication of individual observation and experience not only adds to the general mass of what is known, but it furnishes help to the attainment of further knowledge. Every phenomenon, whether the result of physical experiment, or of that class which occur independently of human agency, when properly observed and noted, promotes the knowledge of causes, and aids in the deduction of general laws. I cannot doubt that, among the members of the Institute, there are many capable of responding to the invitation of the Council in this respect, and where the capacity exists I feel less doubt that there will be a readiness shown to co-operate with those who have so strenuously laboured for our advantage, and who devote so much of their time and talents to our service. In no way can a sense of obligation to the Council of the Institute generally, or to the Editing Committee of the Canadian Journal in particular, be more fitly shown than in an endeavour to share in their labours, and to promote the objects to which they are devoted. In so doing we are, in truth, serving ourselves. The influence of science extends alike to agriculture, to commerce, to manufactures, to the administration of justice, to each art of domestic life, and to the prosperity of the Province. The comfort and enjoyment of its inhabitants are dependent on those pursuits. Every advance made in the one is of necessity a corresponding benefit to the other. The time is quickly passing by—in some parts of the Province it has already passed—when all the farmer has to do, after exhausting one portion of his land, is, to leave it to waste, and to clear another. Such a process must very soon bring itself to an end; and those whose whole knowledge of farming has been obtained under such training stand more in need of guidance than the agriculturists of other countries where more advanced systems of husbandry are in vogue, even though their systems have little pretence to a scientific foundation. But now, when the necessity and value of a different mode of farming are fully felt and acknowledged, science has come to the aid of agriculture; and principles, developed and made manifest by chemical research, have been brought within the husbandman's reach.

The knowledge of what food plants require in order to attain the fullest maturity, and consequently what manures are best fitted to an exhausted soil, or to a soil incapable in its natural composition of affording that nutriment, is one of those benefits which agriculture owes to purely scientific research, and which makes the name of Liebig a household word with every farmer capable of appreciating the advantages so derived.

I am more at home in referring to the acknowledgments which are due for the assistance rendered by physical science and observation in Judicial investigations. The past year has afforded one very remarkable instance of its invaluable service in bringing to justice a criminal, whose slow but surely fatal operations on his victim's life would never have been demonstrated but for the aid of chemical analysis. There was a Nemesis in this. The murderer, who availed himself of the discoveries of chemistry—subtilely, and as he hoped so as to defy detection—to inflict death, was discovered and subjected to his well-deserved fate, through the instrumentality of that very branch of science which he had so grossly abused.

It concerns us all that physical science should unite with jurisprudence in increasing our protection against crime, by affording means, unthought-of before its aid was invoked, for the detection of the guilty. The number of criminals would be greatly reduced if there was an assured certainty that crime would be followed by detection, as well as detection by punishment. As one means of securing this I have observed the practice adopted in England, and I believe also in some other parts of Europe, of taking Photographic likenesses of persons charged with crime, and thus depriving them of the chances of escaping identification, which a change of name or of residence might afford. The A. B. of London criminal notoriety may be arrested in Liverpool and known there only as C. D.; all inquiries respecting him under the *alias* may be wholly unavailing, but the portrait transmitted from the police of the latter to that of the former city, removes the difficulty and puts the avenger of violated aw on the right track.

Still further: Judicial investigation into crime has been assisted by the microscope. It is stated as the result of the most careful and oft repeated examinations, that in every kind of animal the blood contains globules which constitute its colouring matter, differing in size from those of every other, and as a consequence that human blood can be distinguished accurately and certainly when examined through this instrument. By this mode a hiatus in evidence may be filled up, for the want of which a criminal might have escaped; or, on the other hand, circumstances apparently of great suspicion may be satisfactorily rebutted, and an unjustly accused individual may be saved.

I cannot refrain from recalling to you one among many instances of the discoveries of criminals effected through the aid of the microscope, in illustration of what I have said.

A box containing money had been stolen on one of the Railways in Prussia, and, after being emptied of its contents, was filled with sand and replaced on the car. The Police were at fault; the land round most of the stations in the north of Prussia is sandy, and the contents of the box seemed to afford them no clue to the place where the exchange had been made.

Professor Ehrenberg was applied to, and having procured samples of the sand along the line of the Railway, he, with the aid of the microscope, examined them, and also compared them with the sand in the box. The powerful instrument he used enabled him at once to discover the characteristic variations in the mineralogical composition and crystallization of the various specimens of disintegrated rock from the different localities. The station from whence the sand in the box had come was thus ascertained, and the conviction of the thief was the immediate consequence.

To the same professor is also due the application of the microscope for the detection of a singular literary forgery. A pretended palimpsest, purporting to be a history of some of the ancient Kings of Egypt, was submitted to him. It was clearly shown by the microscope that wherever the professedly ancient writing was crossed by that of more modern times, the ink of the old letters lay *upon* instead of *under* those of later date: precisely the reverse of what must have been the case had the palimpsest been genuine. The fraud was immediately and unanswerably exposed.

There are other topics which claim a passing attention. Among these: the proposition to establish a railway communication from Europe to India, intended for the transport of goods as well as of passengers, is of great interest, and suggests an inquiry as to the channels of former communication between Europe and the East.

According to Robertson, the Phenicians procured the products of India, brought overland, to Rhinocolura, in the Mediterranean, a port, according to the best maps I have had an opportunity of consulting, not far distant from the modern El-Arish, and conveying them by a short transport, thence to Tyre, made the latter city the great emporium of that most profitable commerce. The conquests of Alexander, and the founding of that city which still exists as an enduring monument of his far-sighted sagacity, drew commerce into a new channel, and transferred to Alexandria the trade of which the Phenicians had had the monopoly. Subsequently, a portion of this trade appears to have been carried on up the Euphrates and by land carriage to Palmyra, and thence to the Mediterranean, until the conquest of Palmyra by Aurelian destroyed this commerce. Some portion of the trade was also carried on through the Provinces which extend along the northern frontier of India, either by land carriage into the interior parts of Persia, or by means of rivers through Upper Asia to the Caspian, and thence to the Euxine sea.

It was through such channels of communication that Constantinople obtained its supply of East Indian products. The hostilities that sprang up between the Christians and the Mahommedans, almost, if not entirely, put an end to European intercourse with Alexandria, and with such parts of Syria as had been the marts of Indian commodities. At a later period Venice obtained a great control over this trade, which continued as long as Constantinople remained the capital of the Latin Empire. The restoration of the Imperial family to the throne, however, aided as it was by the Genoese, gave these in turn the advantages which the Venetians had monopolized, and the merchants of Venice were consequently driven to re-establish that commercial intercourse with Alexandria which had been so long interrupted. But the final overthrow of the Greek Empire by Mahomet II., in 1453, deprived the Genoese of their advantages and possessions both at Constantinople and in the Crimea, and again limited the introduction of the commodities of the East into Europe to purchases made in Egypt, or in certain ports in Syria, and this state of things continued until the Portuguese doubled the Cape of Good Hope, towards the close of the 15th century, and thus discovered a new route by ocean navigation to the East. This discovery, and the events consequent upon it, resulted in the almost total extinction of the commerce which Venice had so long enjoyed, and thenceforward the trade of Europe with India was carried on by sea, though other regions still obtained supplies of Eastern products by land carriage. Of late years the overland route to India by way of Alexandria has been again commonly used by travellers, but it has not been resorted to, at least to any considerable extent, for the conveyance of goods. Now, in addition to this route, two lines for railway communication have been suggested; one by the valley of the Euphrates, which is said to present no physical obstacles that may not readily be surmounted; the other commencing at Acre and passing by Basra, to continue along the southerly side of the Persian Gulph, and then crossing the spur of the Arabian Peninsula to Mascal, a port accessible by a short sea voyage from Bombay. This is represented as being much more direct than either of the other routes. Whether any of them will be found practicable, in a financial and commercial point of view, or in the existing state of things, and considering the character of the people through whose countries the transit is proposed, has yet to be ascertained and determined. Mahommedan antipathies to nations professing Christianity, at least to the Western powers of Europe, have doubtless greatly diminished, and when the "Infidel Soldan" disdains not to wear as a badge of honor, the emblem of the Christian Knight slaughtering the dragon, any enterprise which has no greater obstacles to contend against than religious prejudices, or the antipathies of an uncivilized against a civilized people, and which is backed by the prospect of bringing wealth in its train, need not be despaired of.

Another subject, however, more immediately interesting to us as inhabitants of the Western hemisphere, as well as subjects of the British Empire, claims attention. I allude to the projected Atlantic telegraph. Wonderful as is the application of voltaic electricity to land communication, its capability of adaptation to transmit submarine messages, which is no longer a mere matter of theory, is calculated still more to excite our admiration The nautical and engineering difficulties attending this mode of telegraphic communication have been proved to be surmountable, and the experience gained in establishing shorter lines has led to the determination to undertake this. It is gratifying to observe the unity of thought and action in reference to this great work that prevails on both sides of the Atlantic. A survey was made last summer in a steamer belonging to the United States, and soundings at intervals of about thirty miles were taken, from which it was ascertained that the greatest depth was rather less than $2\frac{2}{3}$ miles. Lieutenant Maury, the superintendent of the observatory at Washington, who deservedly occupies a high place among scientific men, in reporting on this survey, expresses no doubt of the ultimate success of the undertaking. "There is at the bottom of this sea between Cape Race in New-"foundland and Cape Clear in Ireland, a remarkable steppe, which "is already known as the telegraphic plateau," and extends for some 1300 miles in water so deep as to be beneath the effect of any tempest which may agitate the surface, for it has been ascertained "that the currents do not reach down to the bottom of the deep "sea, and that there are no abrading agents there, save alone the "gnawing tooth of time."

The principal difficulty anticipated was the size of the cable supposed to be necessary, not to resist the action of the sea, but to transmit messages at a speed sufficient to ensure commercial success. On this subject a paper was read in August last before the British Association for the advancement of Science, by Mr. E O. W. Whitehouse, in which he discussed the question whether the law of the squares was applicable or not to the transmission of signals in submarine circuits; and as the result of experiments on the limit to the rapidity and distinctness of utterance attainable—his experiments reaching over wires to the length of 1020 miles—he states his conviction that "nature knows no such application of that law," and that we may shortly expect to see a cable not much exceeding in weight a ton per mile, containing three, four, or five conductors, connecting Europe with America at an expense of less than one-fourth of such a one as would be necessary if the law of the squares were held to be good in its application to submarine currents, and if the deductions as to the necessary size of that wire, based upon that law, could be proved valid. Although his positions were combated, yet the result of his views as to the necessary size of the wire seems to have been adopted, for in an extract from Lt. Maury's report it is said: "It may now be considered as a settled "principle in submarine telegraphy, that the true character of a "cable for the deep sea is not that of an iron rope as large as a "man's arm, but a single copper wire, or a fascicle of wires coated "with gutta percha, pliant and supple, and not larger than a lady's "finger," or, at any rate, than an alderman's thumb!

I have seen it stated that the manufacture of this cable is already commenced, and you are all well aware of the support to the financial part of the undertaking, promised by the British Government. It is difficult to estimate the importance of its success to the North

American Provinces, whether as an element of commercial progress and improvement, or as a means of drawing more closely the ties which unite us to the Mother Country; and, while increasing the advantages we derive from that connection, enhancing the value of these colonies to the empire.

I have met with no account of any very recent proceedings towards the establishment of the interoceanic communication between the Atlantic and the Pacific. The last expedition organized to survey the Isthmus of Darien, was in 1854, when the Governments of England, France, the United States, and Granada, assisted in the object of the expedition. The result of that survey shewed that the harbours of Caledonia and Darien, were in every way adapted as the termini of the suggested Canal. It was further ascertained that a range of mountains varying from 900 to 1600 feet in height form the water-parting of the country, at a distance of only five miles from the Atlantic; the distance between the tidal waters on the opposite coast being under thirty miles; but such is the character of this mountain range, that no canal could be there constructed without tunnelling, though a railway might be constructed between ports, not more than thirty-six miles apart, the summit level to be crossed not exceeding nine hundred feet above the sea. Other lines, having the same object, have been suggested and discussed, but the present unsettled political condition of the territories through or near to which any such communication could be established, seems to postpone indefinitely any practical attempt to realize the design.

In passing from this subject it will not be altogether inappropriate to refer to a matter which has been recently discussed, and on which new light has been thrown by Captain Becher, R.N. I allude to the question where Columbus made his first landing on this side the Atlantic. Navarette names Turks Island as the one which the natives called Guanabani, and on which the discoverer conferred the name of San Salvador. Washington Irving or the other hand decides in favour of Cat Island, situated fully 300 miles distant from Turks Island, and which, on every map that I have seen, is marked as the San Salvador of Columbus. Meenoz, who was the Spanish Cosmographer-in-chief for the department of the Indies, in a history of America, of which he lived to publish only the first volume, points out Watling's Island about fifty miles easterly of Cat Island, as the first landfall, and this view Captain Becher supports and confirms.

Turning to matters of closer local interest I should make a more extended reference to the Geological Map of Canada, prepared by Sir William Logan, but for the circumstance that during the past year it was produced before this Institute, when Sir William favored the members present with some instructive and highly gratifying observations upon it and upon the geological structure of the Province. We then expressed what I am sure we continue to feel, our full appreciation of the valuable services he has rendered in conducting the Survey still in progress, as well as our pleasure to find that his high merit has been recognized and fitly acknowledged, as well by our Sovereign and the French Emperor, as by some of those Societies in England whose members are peculiarly well qualified to judge of the skill and value of his operations.

There is one more subject of at least equal interest, and of no less importance than any on which I have touched, to which I entreat your brief attention. I allude to education, which may be viewed both in reference to the objects of the Canadian Institute, and also in its more extended relation to the advancement and well-being of the Province. As to the former, the observations recently made by Professor Daubeny, so thoroughly, and in such appropriate language, convey what I wish to say, that I gladly avail myself of them. "It begins, indeed, to be generally felt, that amongst the "faculties of mind, upon the development of which in youth, success "in after-life mainly depends: there are some which are best im-"proved through the cultivation of the physical sciences, and that "the rudiments of those sciences are most easily acquired at an "early period of life. That power of minute observation, those "habits of method and arrangement, that aptitude for patient and "laborious enquiry, that tact and sagacity in deducing inferences "from evidence short of demonstration, which the natural sciences "more particularly promote, are the fruits of early education, and "acquired with difficulty at a later period. It is during childhood "also, that the memory is most fresh and retentive, and that the "nomenclature of the sciences, which from its crabbedness and tech-"nicality often repels us at a more advanced age, is acquired almost "without an effort."

It is gratifying to us to know that, so far as is compatible with a system of Common School teaching, elementary instruction in the physical sciences is receiving proper attention; and we may point with pride and pleasure to the conspicuous attainments and ability of many of those who, as Professors in the various branches of literature and science are employed in University education in this Province. We need not go beyond our own ranks to find several who are justly esteemed as authorities in the departments to which their attention is devoted. But in the schools in which preparation is made for a course of University study, it appears to me there is room for improvement in this particular, and I am sure you will concur with me in expressing a hope, that whatever may be found wanting in this important practical department of education may be speedily supplied.

The other branch of the question is of still more serious consequence. We yet, happily, have the opportunity of endeavouring to anticipate and to prevent evils which older communities are striving to mitigate and to cure. The increase of offences committed by the young, forces itself on the attention of Statesmen as well as of Philanthropists. Lord Stanley, not very long ago remarked, in reference to it: "The only means for diminishing crime consists in the detec- " tion and training of criminal children to habits of honest industry:" a sad but pregnant admission, not only of the absence of right education, but of a training in the paths of vice and crime. Our young country has not yet sunk to that stage of demoralization; we may yet, I trust, look with hope and confidence to the prevention of guilt, by training children before they have become initiated in vicious pursuits; and this is the object attainable, as appears to me, through our Common School system. If it requires any change—any new powers to make it thoroughly efficient in that respect, such change should not be delayed, such powers should not, and I believe, could not be long withheld! No man who seriously reflects on the subject will pay grudgingly the amount he may be taxed to render our Schools accessible to those whose parents or guardians are unable or even unwilling to pay for their education. Every farthing thus expended, will save pounds of the cost attending the detection and punishment of crime. But many will think the taxation neither wise nor just if they see free schools with a comparatively slender attendance, while the streets are filled with idle and vagrant children, ignorant, uneducated, if not already vicious, in danger of falling before the first temptation. It is the office of the Legislature to consider and determine what amount of interference with the rights of parents who neglect this duty to their children should be sanctioned—to what extent and in what manner a needful compulsion should be brought to bear both upon parents and children. It may not be a problem of easy solution, but, I think, it is one that must be solved. In alluding to this subject here, I trust I have not overstepped the limits, within which, in this place, I ought to confine my remarks, but it is of such paramount importance that scarcely any effort to attract attention to it can be condemned as either ill-timed or misplaced.

But it is time that I bring these desultory observations to a close. More than thirty-six years have passed since I first knew Western Canada. An eye-witness of most of the leading events that have happened in her history during that period, an actor in some of them—I cannot compare what is, with what was, without feelings of mixed wonder and rejoicing. The wilderness has given place to fields of standing corn; towns have sprung up where the first blows of the settler's axe had not yet awakened the echoes of the forest; the locomotive dashes on with fiery speed where the early pioneer explored his dubious way by the Indian path; the vessel launched on the waters of Lake Michigan finds her moorings in the River Mersey! I might compare the Province as it was then, to the bark canoe floating on the waters of a river—as it is now, to a gallant ship entering upon the billows of the broad ocean. At first:

"Through pleasant banks the quiet stream
Went winding pleasantly;
By fragrant fir groves now it past,
And now thro' alder shores;
Through green and fertile meadows now,
It silently ran by!
The flag flower blossomed on its side,
The willow tresses waved,
The flowing current furrowed round
The water-lily's floating leaf,
The fly of green and gauzy wing
Fell sporting down its course.
And grateful to the voyager
The freshness that it breathed,
And soothing to his ear
It's murmur round the prow!"

* * * * *

"But many a silent spring meanwhile,
And many a rivulet and rill,
Had swollen the growing stream.
And when the southern sun began
To wind the downward way of Heaven,
It ran, a river deep and wide,
A broader and a broader stream.

* * * * *

" The sun goes down, the Crescent moon
Is brightening in the firmament,
And what is yonder roar?
That sinking now, and swelling now,
Still louder, louder grows.
* * * * *
" The moon is bright above,
And the great Ocean opens on their way."

May we not well hope that, under the protection of Divine Providence, the future progress of the Province will be even more prosperous than its past has been. Her children enjoy advantages unsurpassed in the history of any country; a soil whose abundant fertility readily yields to the husbandman the most valuable agricultural products; a climate which, notwithstanding its extremes, brings all those products to full maturity; a system of education, adapted in its elementary portion to the wants of the poorest of the community, and rising to the highest requirements of intellectual culture and scientific attainments; a body of law, devised by the wisdom of past ages, and improved by the experience of successive generations; a constitution, which confers the privilege and imposes the obligation of working out the problem of self-government under the guardianship of the Mighty Empire of which we form part; and above all these: for their guiding star, Christianity, which confers, and be it reverently acknowledged, alone confers the power to satisfy the profoundest longings of the human heart, and to lead all who follow its guidance, to the promised haven of eternal peace.

NOTE ON THE COMPOSITION OF PARALLEL ROTATIONS.

BY J. B. CHERRIMAN, M. A., CANTAB:
PROFESSOR OF NATURAL PHILOSOPHY, UNIVERSITY COLLEGE, TORONTO.

Poinsot, in his famous *Memoire sur la Rotation des Corps*, has pointed out the fundamental connection between the forms to which a system of Forces acting on a rigid body can be reduced, and those by which the motion of a free rigid body at any instant can be exhibited. It is the object of the present note to trace this analogy in a particular case, which has not, so far as I am aware, yet been noticed.

Any system of Forces acting on a rigid body can be reduced to a single Resultant Force, acting at some assigned point as origin, and to a single resultant couple; the former of these remaining invariable, both in magnitude and direction, whatever origin be assumed while the latter varies in both respects for different origins, remaining constant, however, for origins situated along the direction of the Resultant Force.

Adopting the usual notation by taking as the type of the Forces the rectangular components X, Y, Z of the force acting at the point (x, y, z), we have as resultants at the origin of co-ordinates the single Force whose rectangular components are $\Sigma(X)$, $\Sigma(Y)$, $\Sigma(Z)$; and the single couple whose momental components round the same axes are

$$L = \Sigma(Zy - Yz),\ M = \Sigma(Xz - Zx),\ N = \Sigma(Yx - Xy).$$

If we now seek the resultants corresponding to an origin whose co-ordinates are (x', y', z'), we find the same Resultant Force, and a new resultant couple (L', M', N'), where

$$\begin{aligned} L' &= L + \Sigma(Y).z' - \Sigma(Z).y' \\ M' &= M + \Sigma(Z).x' - \Sigma(X).z' \\ N' &= N + \Sigma(X).y' - \Sigma(Y).x' \end{aligned}$$

From these equations we have

$$L'.\Sigma(X) + M'.\Sigma(Y) + N'.\Sigma(Z) = L.\Sigma(X) + M.\Sigma(Y) + N.\Sigma(Z)$$

Hence if the resultant couple be resolved into two whose axes are respectively perpendicular and parallel to the direction of the Resultant Force, the latter remains invariable in magnitude whatever origin be adopted; and hence also the resultant couple will be the least possible when the origin is so assumed that the former vanishes, or, in other words, when the axis of the couple is in the direction of the Force.

If we seek an origin which shall make the resultant couple vanish, or which shall cause the system of Forces to be reduced to a single resultant Force, we must have for the determination of this origin (x', y', z'),

$$L' = o,\quad M' = o,\quad N' = o,$$

or

$$\left.\begin{aligned} o &= L + \Sigma(Y)z' - \Sigma(Z)y' \\ o &= M + \Sigma(Z)x' - \Sigma(X)z' \\ o &= N + \Sigma(X)y' - \Sigma(Y)x' \end{aligned}\right\}\ \ldots\ldots\ldots(1)$$

These equations are inconsistent unless a certain condition hold, which is,

$$o = L.\Sigma(X) + M.\Sigma(Y) + N.\Sigma(Z)\ \ldots\ldots\ldots(2)$$

When this condition is satisfied, (provided $\Sigma(X)$, $\Sigma(Y)$, $\Sigma(Z)$, do not all vanish,) the equations (1) are equivalent to only two independent equations, and represent a straight line, every point of which is an origin such as required.

In the particular case where the system consists of Forces in parallel directions, taking F as the type of *one of these at the* point (x, y, z), and l, m, n for the direction-cosines of their common direction, we have

$$\Sigma(X) = l\,\Sigma(F);\quad \Sigma(Y) = m\,\Sigma(F);\quad \Sigma(Z) = n\,\Sigma(F);$$
$$L = n\,\Sigma(Fy) - m\,\Sigma(Fz)$$
$$M = l\,\Sigma(Fz) - n\,\Sigma(Fx)$$
$$N = m\,\Sigma(Fx) - l\,\Sigma(Fy)$$

The condition (2) is in this case satisfied, and (provided $\Sigma(F)$ do not vanish) the equations (1) assume the form

$$\frac{x' - \dfrac{\Sigma(Fx)}{\Sigma(F)}}{l} = \frac{y' - \dfrac{\Sigma(Fy)}{\Sigma(F)}}{m} = \frac{z' - \dfrac{\Sigma(Fz)}{\Sigma(F)}}{n}$$

Hence the line of action of the single Resultant passes through the point whose co-ordinates are $\dfrac{\Sigma(Fx)}{\Sigma(F)}$, $\dfrac{\Sigma(Fy)}{\Sigma(F)}$, $\dfrac{\Sigma(Fz)}{\Sigma(F)}$; these are independent of l, m, n, and this point therefore remains the same so long as the forces and their points of application are unaltered, whatever be their direction; for this reason, it is called the *Centre of Parallel Forces.*

In like manner, the motion at any instant of a free rigid body can be reduced to a single rotation about an axis passing through some assigned point as origin, and to a single motion of translation proper to this origin and common to all the points of the body; the former of these remaining invariable both in magnitude and direction, whatever origin be assumed, while the latter varies in both respects for different origins, remaining constant, however, for origins situated along the axis of Rotation.

Adopting the usual notation by taking ω_x, ω_y, ω_z, for the components of the rotation round three rectangular axes, and u, v, w *for* the components of the velocity of translation along the same axes, we have for the velocities u', v', w', along these axes, of a point (x', y', z')

$$u' = u + \omega_y z' - \omega_z y'$$
$$v' = v + \omega_z x' - \omega_x z'$$
$$w' = w + \omega_x y' - \omega_y x'$$

and these give the motion of translation when the point (x', y', z') is assumed for origin From these equations we have

$$u' \omega_x + v' \omega_y + w' \omega_z = u \omega_x + v \omega_y + w \omega_z.$$

Hence, if the velocity of translation be resolved into two, respectively perpendicular to and along the axis of rotation, the latter remains invariable in magnitude whatever origin be adopted; and hence also the velocity of translation will be the least possible when the origin is so assumed that the former vanishes, or, in other words, when the velocity of translation is in the direction of the axis of Rotation.

If we seek an origin which shall make the motion of translation vanish, or which shall make the whole motion reducible to a single rotation, we must have for the determination of this origin (x', y', z'),

$$u' = 0, v' = 0, w' = 0,$$

or

$$\left.\begin{aligned} 0 &= u + \omega_y z' - \omega_z y' \\ 0 &= v + \omega_z x' - \omega_x z' \\ 0 &= w + \omega_x y' - \omega_y x' \end{aligned}\right\} \text{.........(1)}$$

These equations are inconsistent unless a certain condition hold, which is

$$0 = u \omega_x + v \omega_y + w \omega_z \text{ ....(2)}$$

When this condition is satisfied (provided ω_x, ω_y, ω_z do not all vanish), the equations (1) are equivalent to only two independent equations and represent a straight line, every point of which is an origin such as required.

In the particular case where the motion consists of rotations round parallel axes, taking ω as the type of one of these about an axis through the point (x, y, z), and l, m, n for the direction-cosines of the common direction of their axes, we have

$$\omega_x = l\,\Sigma(\omega);\ \omega_y = m\,\Sigma(\omega);\ \omega_z = n\,\Sigma(\omega).$$

Also the linear velocity along the axis of x generated in the origin of co-ordinates by one of these rotations ω being $n \omega y - m \omega z$, we have

$$\begin{aligned} u &= n\,\Sigma(\omega y) - m\,\Sigma(\omega z) \\ v &= l\,\Sigma(\omega z) - n\,\Sigma(\omega x) \\ w &= m\,\Sigma(\omega x) - l\,\Sigma(\omega y) \end{aligned}$$

The condition (2) is in this case satisfied, and (provided $\Sigma(\omega)$ do not vani ,/ the equations (1) assume the form

$$\frac{x' - \dfrac{\Sigma(\omega x)}{\Sigma(\omega)}}{l} = \frac{y' - \dfrac{\Sigma(\omega y)}{\Sigma(\omega)}}{m} = \frac{z' - \dfrac{\Sigma(\omega z)}{\Sigma(\omega)}}{n}$$

Hence the axis of the single resultant rotation passes through the point whose co-ordinates are $\frac{\Sigma(\omega x)}{\Sigma(\omega)}$, $\frac{\Sigma(\omega y)}{\Sigma(\omega)}$, $\frac{\Sigma(\omega z)}{\Sigma(\omega)}$; these are independent of l, m, n, and this point therefore remains the same so long as the magnitudes of the rotations, and the points through which their axes are drawn are unaltered, whatever be the common direction of these axes; by analogy this point might be called the *Centre of Parallel Rotations*.

ON A SMALL CAPILLARY WAVE NOT HITHERTO DESCRIBED.

BY JOHN LANGTON, M. A.,

VICE-CHANCELLOR OF THE UNIVERSITY OF TORONTO.

Read before the Canadian Institute, 17th January, 1857.

It is well known that the shape and velocity of waves, and the different circumstances under which they are propagated, have attracted considerable attention amongst men of science, not only from the importance of the subject as connected with the theory of tides, but also from its practical bearing in relation to the resistance of fluids, and the best form for vessels which are destined to move in them. An elaborate report upon waves was prepared by J. Scott Russell, for the British Association, in 1844, the experiments detailed in which have been the origin of some of the greatest improvements of the present day in ship-building, and have inseparably connected the wave line with the name of Russell. Although this report is principally devoted to the solitary wave of translation, which gave rise to the investigation, it treats at less length of other varieties, and may, I believe, be said to embody all that is known upon the subject from observation. There is nothing, however, amongst the waves there enumerated in any way resembling that which I propose bringing under the notice of the Institute to-night, nor have I elsewhere seen any account of its having been previously observed. Amongst all the different kinds of waves, varying as they do in dimensions from the great tidal wave, which, with an elevation of only a few feet, rests upon a base of hundreds of miles in extent, to the ripple which is raised by a summer's breeze, the wave which I am about to introduce to you is, perhaps, the smallest. It is, indeed, so minute that it might easily have escaped notice, for under ordinary circumstances it cannot much exceed $\frac{1}{20}$ of an inch in height, and hardly reaches an inch in amplitude. Such an exceedingly minute object may seem scarcely of sufficient interest to form the subject of a paper to be read before the Institute; and being apparently only a disturbance of the capillary film on the surface, which is subject to very different laws and forces from those which govern the motions of the whole mass of a fluid, it is doubtless of much inferior importance to the waves which Russell experimented upon. But as no fact is so trifling that it may not assist in establishing correct views of the operations of nature, and as the Institute has invited communications from its members, giving an account of original observations upon all phenomena, I venture to call attention to some curious particulars which I have noticed respecting this capillary wave, which differs from all others previously described in being a solitary one.

The wave in question may be observed in three different situations. Wherever a large body of water, with a strong current, meets comparatively still and deep water below, it may always be seen, as a sharply defined line, like a hair upon the surface, winding about amongst the numerous eddies which are formed in such situations, ever varying in its outline, and carried along apparently with the general course of the stream, whilst upon the whole it maintains nearly the same position. It is also generally to be found where there exists any impediment to a current, as a dead tree projecting out into a river, or a boom thrown across the stream. In this case the wave may be observed at a distance of from one to three feet above the obstacle, the distance varying with the force of the current. The third case is the reverse of the former one, where a body, propelled through still water, pushes this small wave before it. It occurs much more rarely under these circumstances, and may more easily elude observation, and since my attention has been attracted to it I have often failed to produce it; but it was in this form that I first got any insight into its nature.

Paddling in a canoe in a sheltered bay, with just sufficient air stirring overhead, without raising a ripple on the water, to cause the canoe, when abandoned to itself, to drift broadside on at the rate of perhaps half a mile an hour, I perceived the wave in advance of the canoe, at a distance of about three feet. If the wind died away, the wave was maintained at a greater distance, and upon one occasion I could distinctly trace it so far as from between eight and nine feet from the canoe, beyond which it became fragmentary, and disappeared. If the speed increased suddenly, the wave disappeared, and the slightest ripple on the surface obliterated it at once. But if the wind freshened very gradually, the wave approached nearer and nearer, becoming more strongly defined and more elevated above the surface, and it could still be seen under the lee of the canoe, and at a distance of eight or nine inches from it, after the breeze had increased so as to make a strong ripple on the water outside. If the speed grew still greater, it became first obscured, and finally destroyed, by waves of an entirely different character,—viz., the ripple caused by the canoe itself,—which it is remarkable did not make their appearance in contact with the canoe, but first broke out on the farther side of the capillary wave.

But my attention was principally attracted to the effect which was produced upon the little particles floating near the surface. The opportunity was a good one for observation, for, being in the vicinity of a marsh, the water was very impure, and a bright sunshine enabled me to see the motes at a considerable distance. Light bodies resting on the water without being wetted, as a feather or thistle down, seemed hardly at all affected, except by a slight motion as the wave passed under them; and larger particles, which reached to a depth of perhaps an eighth of an inch, passed it without any disturbance. But smaller ones, floating close to the surface, were violently agitated as the wave reached them, and though they passed a little beyond it, their apparent motion towards the canoe was retarded and finally stopped, at distances from the wave depending upon their respective sizes, the larger ones penetrating the farthest The interval between the wave and the canoe became thus soon filled with small objects, very regularly sorted according to their sizes, the larger, however, being proportionally much closer together than the smaller ones. If the wind now freshened the wave approached nearer to the canoe, and all the particles were driven in with it, but the smaller ones were much more affected than the larger. If the wind again slackened the wave receded, leaving the particles where they were, and fresh ones were collected in the vacant space, so that, after a few alterations of speed, the regular assortment according to size was soon interfered with, and a miscellaneous scum was pushed on before the canoe, comprising floating matter of all sizes, up to an eighth of an inch or more in depth; for it must be observed, that although objects of that size passed under the wave without disturbance, and penetrated a long way beyond it without check, their motion was at last arrested before reaching the canoe.

From these facts I was induced to conclude that a body propelled through the water at a low velocity, and with an even regular motion, pushes before it a wedge-shaped film of water, the under surface of which is not a straight line, but a curve of rapidly increasing curvature; that, at very low velocities, this film remains unbroken to a distance of several feet; and that, with increased speed, the distance to which it extends is diminished, whilst its greatest depth remains nearly uniform. There are two things, however, which this supposition will not account for. It will not account for the wave itself: for the film which I have imagined does not appear to extend so far, and under no circumstances did any of the particles, even the smallest, become stationary, till they had passed the wave by about two inches, that interval being always perfectly free from the scum collected. The other circumstance which is left unexplained is, why the feathers and thistle down resting on the water were not also arrested when they came to the film. I do not attempt to account for the difficulty, I only record the facts as I observed them.

I endeavoured to arrive at some conclusion as to the form and size of the wave, but without much success. Its exceeding minuteness, the inconvenient position of the observer in the canoe at a considerable distance from it, and that distance constantly changing with the varying force of the wind, made any accurate measurements almost impossible. I therefore had recourse to the second form, in which I have mentioned that it occurs, where, from the similarity of the circumstances, one would expect to meet with the same facts, and which in many respects afforded greater facilities for observation.

When the water was high in the river in which I made my observations, a great deal of foam came down from the falls above, and at every projecting tree there was a dense collection of froth, with a clear space intervening between it and the wave. Upon clearing away this froth I could observe its gradual re-formation. It was very curious to watch a small patch of foam sailing down with the current. When it approached very close, and in passing the wave, its velocity seemed momentarily increased, but it was then suddenly arrested, whilst there would shoot out from underneath it bits of sawdust, and other matter that had become entangled in it, which would arrange themselves according to their draught of water in the vacant space between the wave and the log, the foam itself remaining at a distance of about two inches from the wave. Every moment brought down fresh accessions, which gradually pushed on before them that which had already arrived, till the whole space soon became covered as before; but there was always left between the wave and the froth the narrow strip of clear water already mentioned.

Even here it was not easy to ascertain accurately the shape of the wave, in consequence of its constantly shifting with the undulations and irregularities of the current, but I came to the conclusion that it could rarely be more than $\frac{1}{20}$ of an inch high, and I satisfied myself, from the distortion of objects seen by reflection, that the wave was convex towards the direction of the stream, and concave towards the log, the sensible convexity not extending so much as half an inch beyond the sharply defined cusp, and the concavity not very much more. It became questionable even whether it could be said strictly to be elevated above the surface at all, not only because, if the farther side were convex, it was difficult to conceive how it could regain the level without a corresponding concavity, of which I saw no sign, but also from the consideration of the third form in which the wave may be met with, and which I shall mention presently. I was rather led to conclude that the concave side was depressed below the general level, and that the rise towards the log was very gradual.

I had subsequently an unusually good opportunity of seeing the wave in a very extreme case, where a boom had been stretched across a current running at least six miles an hour. Here it approached sometimes within two inches of the dense mass of rubbish collected on the boom, but always with a perfectly clear space intervening, though much narrower than before. The wave itself was apparently fully a quarter of an inch high, and clearly concave towards the boom and convex beyond; but the question of whether it was the result of an elevation or of a depression of the general surface could not be decided, because the whole mass of water was heaped up against the boom, and the farther slope of the wave was broken into a succession of ripples, very much exceeding the primary wave both in height and amplitude, and differing from it in not being cusped, though otherwise imitating its general shape.

There is one point in which the wave, formed above an impediment in a stream, differs from that seen in advance of a body propelled through still water. At a very low velocity I stated that I had seen it at as great a distance as eight or nine feet from the canoe; but in the gentlest stream I do not think I ever saw it as far as four feet from the object which causes it. The reason appears to me to be, that it is easier to maintain the wave already formed than to form it. I do not believe that it would ever be originally produced at such a distance from a moving body; but, being already formed at a higher velocity, its existence may be prolonged under circumstances which of themselves would not have given rise to it.

The third situation in which the wave occurs, as an undulating line amongst the eddies, does not at first sight appear to bear much analogy to those previously mentioned, and I had for many years noticed it without any clue to its origin; but by the light obtained from observations made in the other cases, it was easy to perceive that it was identical in all the three. When there was foam on the river, it was all collected on one side of the little ridge, with a clear strip intervening, and the same checking of the motion of floating particles took place. Although there was no solid body obstructing a stream in this case, there was still water opposing itself to a current, or at least a stream flowing in one direction impeding an eddy setting upon it sideways. On approaching such a wave with a canoe, one may at once perceive how differently the two sides are affected. If you come down upon it broadside on with the stream, the approach of the canoe has no effect upon it, although you advance quickly enough to make a strong ripple, and you can even pass over it and it re-appears undisturbed on the other side. But if you approach in the other direction, you cannot get near it at all. If you advance upon it cautiously, you drive it on before you, and if you press it too hard, ripples begin to shew themselves on its further face, and it breaks up and disappears. In such situations, by careful handling, I have driven a wave so far as to detach a portion of it from the rest, and have carried it on before me for ten or fifteen yards, whilst, after a while, a new wave was formed in the original situation. This may further illustrate the remark which I before made, that it is much easier to maintain one of these waves in existence than to form one, for I never succeeded in producing one in calm water with the irregular motion which accompanies the most careful use of the paddle.

In some cases, where the water boils up from below, you find an irregular circular patch surrounded by one of these waves, and approaching from the outside you may drive it before you till the two sides meet, or by coming upon it end on, you may divide it into two. In this latter case, if it be not very large originally, both the patches will go on rapidly contracting, till they finally run up to a point with a little conical jet; and if the wave be well marked and your motion pretty swift, at the moment of disappearance there is a drop of water projected into the air. In such instances, when the circle has become very small, although the motion is too rapid for any precise observation, it is evident to the eye that the included space is elevated above the mean level, which confirms the remark I made when speaking of the shape of the wave.

I believe I have now mentioned all the facts which I have ascertained respecting this apparently insignificant, but in my view very interesting little object, excepting the very different manner in which it is affected by different disturbing causes. As I stated before, if you approach in one direction you may take a canoe over it, and it emerges on the other side unimpaired; the irregular currents of an eddy have no effect upon it, except to give it an undulating movement, and I have seen it maintaining its place amongst the standing waves of a rapid when they have been several inches high. I have even raised considerable swells by rocking a canoe close to it, and it rides over them without disturbance, but the slightest ripple caused by the wind makes it disappear in a moment; and if spirits of turpentine be dropped on the water a little above it, the whole wave is instantly obliterated, to a distance apparently far beyond that to which the oily film extends.

I regret that I can produce no exact numerical data. I made most of these observations some years ago, in the last days of the fall, and whilst I was making preparations for obtaining more precise results the winter overtook me, and before the opening of the water in the spring other avocations interfered with my plans. The points which it appears desirable to ascertain numerically are, the distances of the wave corresponding to different velocities, and the depths to which the film extends at different intervals, also examined at different velocities. The question also arises, what change, if any, is caused by the depth to which the object generating the wave extends. Whether it be a pier rising from deep water, or a two-inch plank floating on the surface, I think there will be found little or no difference; but one would expect that there must be some limit to the draught of water of an obstacle which would raise a wave, corresponding probably to the greatest depth of the film. I confess that I should like to see the experiment repeated with substances merely resting on the water, without being wetted, for the observations which I made appear to be inexplicable, and I unaccountably omitted to verify them under other circumstances.

As I may probably have no opportunity of continuing my observations myself, I mention these desiderata in case any other member of the Institute should fall in with my little friend and take any interest in the investigation of his history.

REVIEW.

Tales of Mystery, and Poems. By Edgar Allan Poe. London: Vizetelly, 1857.

The writings of Edgar Allan Poe have already been appreciated in various forms, and they possess such an individuality of character, and a power of fascination even in their least attractive aspects, that we may be assured they will again and yet again be subjected to re-issue, criticism, censure, and laudation: as intellectual products, ephemeral in their aspect, and yet such as this age at least will not willingly let die. We have purposely selected for our present notice, the volume named at the head of this article, though it is merely a popular selection of a few of Poe's prose writings, issued in a cheap form along with his poems. At another time we may have larger space at our command, and shall then pass under review the more comprehensive literary memorial of this eccentric and wayward child of genius, recently issued from the American press. The publication we refer to is entitled: "The Works of the late Edgar Allan Poe, with a memoir by Rufus Wilmot Griswold; and notices of his genius, by N. P. Willis, and J. R. Lowell." In this latter work four substantial volumes are devoted to the Essays, Poems, and fugitive pieces, and to notices of the biography and genius of Poe,—a writer of whom, if America may not be proud, it is only because the strange moral obliquity of the man, has steeled the hearts of his countrymen against that pride, akin to love, with which they would otherwise have learned to regard the author and the poet. In some striking respects we feel tempted to designate Edgar Allan Poe the Charles Lamb of America—so marked is that strange whimsical individuality of his, that quaint gravity and affectation of seriousness in dealing with a jest, and that sober and deliberate purpose of laughing in his sleeve at the literary lies he successfully palmed upon the most credulous of publics. And yet, assuredly, no two men were every more dissimilar. When, some eleven years after Charles Lamb had been laid beneath the green turf of Edmonton Churchyard, a few survivors of his old circle of friends,—and among the rest his loving biographer, Sir T. N. Talfourd,—met to lay the remains of Mary Lamb along side those of her brother, his biographer thus records the revived memories which the scene awakened: "so dry is the soil of the quiet Churchyard that the excavated earth left perfect walls of stiff clay, and permitted us just to catch a glimpse of the still untarnished edges of the coffin in which all the mortal part of *one of the most delightful* *persons who ever lived* was contained, and on which the remains of her he had loved with love passing the love of woman, were henceforth to rest." How strange the contrast of one whom even we who know him only by his writings cannot help loving, with this author who, like him, expresses such unmistakeable individuality and self-originating characteristics on every page, but only to make us admire with shuddering; as one might gaze on the cold glittering pinnacles of polar ice-cliffs. The poet Lowell has been called in to aid in setting forth the true attributes of his genius, but he had already stamped his just estimate of him in the pungent terseness of a stanza of his "Fable of Critics:"

> "Here comes Poe with his Raven, like Barnaby Rudge,
> Three-fifths of him genius, and two-fifths sheer fudge;
> He has written some things far the best of their kind,
> But some how the heart seems squeezed out by the mind!"

Genius Poe unquestionably had; with eccentricities too, enough to furnish any ordinary half dozen of the irritable race of poets, critics, and editors. But the selfishness of morbid sneering cynicism never took a colder and more repellant aspect; and we look back upon him with a strange sadness as on one of the gifted contributors to the permanent stock of our sources of literary pleasure, whom yet it is all impossible to love. In the prose of Poe, with its odd matter-of-fact anatomising of mystery, there is a singular artificiality of art that seems too much to betray the wires and pulleys of the puppet-master; but few as are his poems, it is difficult to believe the heart so well simulated, if no genial pulsation of human affection and sympathy actually throbbed beneath that cynic heart of his. To these, therefore, the rare and brief out-gushings, as it might seem, of the genuine feeling of "man of woman born," we shall devote such brief space as the demands on our pages admit, in this notice of Edgar Allan Poe; remembering that for him, instead of the hero-worship, which fondly exaggerates the virtues of a favorite author, while "to his faults a little blind," it has been till now his fate to be coarsely anatomised by those who have proved only too willing to expose his frailties, if not to deepen the shadows of his dark life-picture. For this there can beno excuse, for whatever his frailties as a man, no charge can be brought against him of having pandered his genius, or wielded his pen in the cause of vice.

The following brief but touching lyric, is dedicated—we may presume,—to th› memory of the same "rare and radiant maiden whom the angels name Lenore," who constitutes the heroine of his more famous "Raven" lyric. But sweet and gracefully touching as are some of the ideas, and musical as are the lines, the "Raven" of Poe's morbid genius flutters ever towards the close, and he winds up this, as well as nearly every other pæan, with thoughts born of his own brooding misanthrophy which could well be spared.

LENORE.

Ah, broken is the golden bowl! the spirit flown for ever!
Let the bell toll!—a saintly soul floats on the Stygian river;
And Guy de Vere, hast *thou* no tear?—weep now or never more!
See! on yon drear and rigid bier, low lies thy love, Lenore!
Come! let the burial rite be read—the funeral song be sung!—
An anthem for the queenliest dead that ever died so young—
A dirge for her the doubly dead in that she died so young.

"Wretches! ye loved her for her wealth, and hated for her pride,
And when she fell in feeble health, ye blessed her—that she died!
How *shall* the ritual, then, be read?—the requiem how be sung
By you—by yours, the evil eye—by yours, the slanderous tongue
That did to death the innocence that died, and died so young?

Peccavimus! but rave not thus! and let a Sabbath song
Go up to God so solemnly the dead may feel no wrong!
The sweet Lenore hath "gone before," with Hope that flew beside,
Leaving thee wild for the dear child that should have been thy bride—
For her, the fair and *debonnair*, that now so lowly lies,
The life upon her yellow hair, but not within her eyes—
The life still there upon her hair—the death upon her eyes.

"Avaunt! to-night my heart is light. No dirge will I upraise,
But waft the angel on her flight with a pæan of old days!
Let *no* bell toll! lest her sweet soul, amid its hallowed mirth,
Should catch the note, as 't doth float up from the damned earth,
To friends above, from fiends below, the indignant ghost is riven—
From hell unto a high estate far up within the heaven—
From grief and groan, to a golden throne, beside the King of Heaven."

The same strangely morbid bent of thought which mars the beauty of the stanzas here is perhaps even more apparent in his piece called "The Bells," suggested we can scarcely doubt by Moore's "Evening Bells," ringing, unconsciously perhaps, in memory's ear. But the American Poet's theme is, in its starting point at least, a thoroughly native one: the mirthful, heart-enlivening music of the sleigh-bells, which give a music to our long winter that repays in part the coyness of the spring's forest-songsters, and cheeringly contrasts with the melancholy pathos of our summer nightingale, the Whip-poor-will. We say nothing of certain ranal choristers, not unknown as Canadian nightingales! The Sleigh Bell; the Wedding Bell; the Fire Bell; and the Funeral Knell; each in succession has a stanza devoted to it. It is not uncharacteristic, nor without its significance, that the "Sabbath Bell" finds no place in the otherwise comprehensive series. The second and the last of these lyrical peals will suffice to exhibit the poet once more in his real aspect of strange antithesis:

Hear the mellow wedding bells,
Golden bells!
What a world of happiness their harmony fortells!
Through the balmy air of night
How they ring out their delight!
From the molten-golden notes,
And all in tune,
What a liquid ditty floats
To the turtle-dove that listens, while she gloats
On the moon!
Oh, from out the sounding cells,
What a gush of euphony voluminously swells!
How it swells;
How it dwells
On the Future! how it tells
Of the rapture that impels
To the swinging and the ringing
Of the bells, bells, bells,
Of the bells, bells, bells, bells,
Bells, bells, bells--
To the rhyming and the chiming of the bells!

* * * * *

Hear the tolling of the bells!
Iron bells!
What a world of solemn thought their monody compels!
In the silence of the night,
How we shiver with affright
At the melancholy menace of their tone!
For every sound that floats
From the rust within their throats
Is a groan.
And the people— Ah, the people—
They that dwell up in the steeple,
All alone,
And who tolling, tolling, tolling,
In that muffled monotone,
Feel a glory in so rolling
On the human heart a stone—
They are neither man nor woman—
They are neither brute nor human—

They are Ghouls;
And their king it is who tolls;
And he rolls, rolls, rolls,
Rolls
A pæan from the bells!
And his merry bosom swells
With the pæan of the bells!
And he dances, and he yells;
Keeping time, time, time,
In a sort of Runic rhyme,
To the pæan of the bells—
Of the bells:
Keeping time, time, time,
In a sort of Runic rhyme,
To the throbbing of the bells—
Of the bells, bells, bells—
To the sobbing of the bells;
Keeping time, time, time,
As he knells, knells, knells,
In a happy Runic rhyme,
To the rolling of the bells—
Of the bells, bells, bells,—
To the tolling of the bells—
Of the bells, bells, bells, bells—
Bells, bells, bells—
To the moaning and the groaning of the bells.

Reiteration is carried here to the utmost length short of wearisome satiety; yet the curious collocation of words must be felt to embody the full ideal of the pealing bells; and this would be much more apparent could we spare room for the whole piece. The varied power of expression is shown by ringing all the changes of words which each successive bell requires. The merry tinkle of the sleigh-bells; the mellow voluminous chime of the wedding bells; the brazen clang of the alarum bells; and the muffled, throbbing knell of the funeral bells; each and all of these seem reproduced in imaginary peal, which echoes through the fancy as the eye silently passes over the curious patch-work of rhyme and rythm strung together in artistic semblance of the music they describe.

One example more we must find room for, of a quaint conceit, more than once successfully accomplished by this singular poet, and perhaps most curious as illustrating the same odd fancy for grappling with self-imposed difficulties, which furnishes the strange plots of so many of his tales of mystery. The subject and occasion of the poem is common,—if not common-place—enough; being one of the thousand-and-one verse missives of the Festival of Saint

Valentine. Some of the rhymes, here as elsewhere, read strangely to unfamiliar ears, e. g. *Læda* and *reader*. But such are not without precedent on the American Parnassus. Whittier constantly rhymes such words as *law* and *war*, as in the following couplet:

"Still shall the glory and the pomp of war
Along their train the shouting millions draw."

No one, however, can have read Poe's "Raven" without recognising his complete mastery of the varied cadences of alliteration, resonance, and the ample musical compass of English rhymes; though in the following bagatelle he had other accomplishments in view:

For her this rhyme is penned, whose luminous eyes,
Brightly expressive as the twins of Læda,
Shall find her own sweet name, that nestling lies
Upon the page, enwrapped from every reader.
Search narrowly the lines!—they hold a treasure
Divine—a talisman—an amulet
That must be worn at *heart*. Search well the measure—
The words—the syllables! Do not forget
The trivialest point, or you may lose your labour!
And yet there is in this no Gordian knot
Which one might not undo without a sabre,
If one could merely comprehend the plot.
Enwritten upon the leaf where now are peering
Eyes scyntillating soul, there lie *perdus*
Three eloquent words oft uttered in the hearing
Of poets, by poets—as the name is a poet's too.
Its letters, although naturally lying
Like the knight Pinto—Mendez Ferdinando—
Still form a synonym for Truth.—Cease trying!
You will not read the riddle, though you do the best you *can* do.

This the reader perchance pronounces no great poetic feat; but he has not yet solved the poet's riddle. In the days of old George Wither, poets were wont to invent for themselves new shackles, and to write rhomboidal dirges, triangular odes, and lozenge-shaped lyrics or canzonets. The acrostic is an old fashion not yet altogether obsolete; and the ordinary restraints of the sonnet, Spenserian stanza, or the ottava rima, still furnish pleasant "poetic pains," as in elder centuries. But the hardest of such poetic labours are trifles compared with that which Poe has here achieved; as will be seen if the reader undertakes its solution according to the following directions. Read the first letter of the first line in connection with the second letter of the second line, the third of the third line, and so on to the end, and the name of the fair object of the poet's pains will be revealed; a name which though far from common is not unfamiliar to Canadian ears, nor without its memorial amongst ourselves. After all, however, it is on his "Raven" that Poe's fame as a poet will rest, and its strange odd mingling of morbid and beautiful fancies with the luscious surfeitings of rhyme, will long attract and repel the reluctantly admiring reader with its curiously fascinating charms.

D. W.

SCIENTIFIC AND LITERARY NOTES.

ENGINEERING AND ARCHITECTURE.

INTERESTING EXPERIMENT IN STEAM NAVIGATION.

A trial trip of a steam vessel of an interesting character took place on the river Thames, recently. The Hoyer, a paddle steamer, of nearly 190 tons, and drawing only two feet of water has been constructed to navigate the shallow waters on the west coast of Denmark, between the islands and the mainland. A reference to the map of Denmark will show the peculiar geographical position of this part of the coast. From the river Eider to the Horns reef, a distance of 80 miles, it is bounded by a number of islands, varying in size, and situated from three to ten miles from the shore. They are rich in cattle and grain. and inhabited by a hardy and industrious race, who, from their peculiar position, enjoy but little communication with the mainland; the space between being composed of a long, low flat (partly dry at low water,) and numerous small and intricate channels, difficult and tedious to navigate. The communication hitherto could be made only in small boats, and during bad weather the inhabitants have been unable, for weeks together, to communicate with the coast. The Hoyer (so named after one of the towns) has been constructed to remedy this disadvantage, and in conjunction with the Royal Danish Railway, to place the inhabitants of these hitherto isolated places in daily communication, not only with the coast, but with the whole North of Europe. From her light draught of water, she will pass easily over the flats at tide time, while her size and strength will enable her to navigate the channels, conveying passengers, cattle, and goods with speed and safety. The following are her dimensions:—Length, 120 feet; breath, 18¼ feet; depth, 7½ feet; gross tonnage, 190; horse power, 40; with accommodation for 80 passengers and 100 tons of cargo. On her trial trip, with the wind against her, and with so little hold of the water, she averaged 12 miles an hour, with scarcely any perceptible effort or vibration, and fully realised the expectations of her constructors.

She has been built for the Husum and Hoyer Steam Packet Company, composed of Danish and English proprietors, to ply between those places and the islands, in connection *with the Royal Danish Railway, which connects the North Sea with* the Baltic. This railway, the result of the skill and enterprise of Sir S. M. Peto and his friends, is now in full operation, and has not only opened a short and expeditious route to the Baltic, but has placed at the disposal of our markets an almost inexhaustible supply of cattle and grain. To the port of Tonning, on the Eider, the North Sea terminus of this railway, a place but little known a few years since, two large steamers, belonging to the North of Europe Steam Navigation Company, ply weekly from London and Hull; whilst on the opposite side, at Flensburg, on the Baltic, a fleet of smaller steamers, belonging to the same company, maintain the communication with Copenhagen, Husum, Aarhuus, Stettin, Dantzic, Konisberg, and St. Petersburg.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

(Concluded.)

CHELTENHAM, 6th August, 1856.

"UNEQUAL SENSIBILITY OF THE FORAMEN CENTRALE TO LIGHT OF DIFFERENT COLOURS," BY MR. J. C. MAXWELL.

When observing the spectrum formed by looking at a long vertical slit through a simple prism, I noticed an elongated dark spot running up and down in the blue, and following the motion of the eye as it moved *up and down* the spectrum, but refusing to pass out of the blue into the other colours. It was plain that the spot belonged both to the eye and to the blue part of the spectrum. The result to which I have come is, that the appearance is due to the yellow spot on the retina, commonly called the *Foramen Centrale* of Soemmering. The most convenient method of observing the spot is by presenting to the eye, in not too rapid succession, blue and yellow glasses, or, still better, allowing blue and yellow papers to revolve slowly before the eye. In this way the spot is seen to fade away in time, and to be renewed every time the yellow comes in to relieve the effect of the blue. By using a Nicol's prism along with this apparatus the brushes of Haidinger are well seen in connexion with the spot, and the fact of the brushes being the spot analyzed by polarized light becomes evident. If we look steadily at an object behind a series of bright bars which move in front of it, we shall see a curious bending of the bars as they come up to the place of the yellow spot. The part which comes over the spot seems to start in advance of the rest of the bar, and this would seem to indicate a greater rapidity of sensation at the yellow spot than in the surrounding retina. But I find the experiment difficult, and I hope for better results from more accurate observers.

"ON AN INSTRUMENT TO ILLUSTRATE POINSÔT'S THEORY OF ROTATION," BY MR. J. C. MAXWELL.

In studying the rotation of a solid body according to Poinsôt's method, we have to consider the successive positions of the instantaneous axis of rotation with reference both to directions fixed in space and axes assumed in the moving body. The paths traced out by the pole of this axis on the *invariable plane* and on the *central ellipsoid* form interesting subjects of mathematical investigation. But, when we attempt to follow with our eye the motion of a rotating body, we find it difficult to determine through what point of the *body* the instantaneous axis passes at any time,—and to determine its path must be still more difficult. I have endeavoured to render visible the path of the instantaneous axis, and to vary the circumstances of motion, by means of a top of the same kind as that used by Mr. Elliott to illustrate precession. The body of the instrument is a hollow cone of wood, rising from a ring, seven inches in diameter and one inch thick. An iron axis eight inches long, screws into the vertex of the cone. The lower extremity has a point of hard steel, which rests in an agate cup, and forms the support of the instrument. An iron nut, three ounces in weight, is made to screw on the axis, and to be fixed at any point; and in the wooden ring are screwed four bolts, of three ounces, working horizontally, and four bolts, of one ounce, working vertically. On the upper part of the axis is placed a disc of card, on which are drawn four concentric rings. Each ring is divided into four quadrants, which are coloured red, yellow, green and blue. The spaces between the rings are white. When the top is in motion, it is easy to see in which quadrant the instantaneous axis is at any moment, and the distance between it and the axis of the instrument; and we observe:—1st. That the instantaneous axis travels in a closed curve, and returns to its original position in the body. 2nd. That by working the vertical bolts, we can make the axis of the instrument the centre of this closed curve. It will then be one of the principal axes of inertia. 3rd, That by working the nut on the axis, we can make the order of colours either red, yellow, green, blue, or the reverse. When the order of colours is in the *same* direction as the rotation, it indicates that the axis of the instrument is that of *greatest* moment of inertia. 4th. That if we screw the two pairs of opposite horizontal bolts to different distances from the axis, the path of the instantaneous pole will no longer be equi-distant from the axis, but will describe an ellipse, whose longer axis is in the direction of the *mean axis* of the instrument. 5th. That, if we now make one of the two horizontal axes less and the other greater than the vertical axis, the instantaneous pole will separate from the axis of the instrument, and the axis will incline more and more till the spinning can no longer go on, on account of the obliquity. It is easy to see that, by attending to the laws of motion, we may produce any of the above effects at pleasure, and illustrate many different propositions by means of the same instrument.

"ON THE BALAKLAVA TEMPEST, AND THE MODE OF INTERPRETING BAROMETRICAL FLUCTUATION," BY MR. T. DOBSON.

In the month of November, 1854, the passage of a storm over the British islands caused a considerable depression of the barometric column, beginning on the 11th of November and ending on the 19th. During four consecutive days of this period of diminished atmospheric pressure, there occurred in the coal mines of Britain, five fatal explosions, at the following places:—on Nov. 13, at Old Park Colliery, Dudley, Worcestershire; Nov. 14, Cramlington Colliery, Northumberland; Nov. 15, Bennet's Colliery, Bolton, Lancashire, and Birchey Coppice Colliery, Dudley; Nov. 16, Rosehall Colliery, Coatbridge, N. B. These facts alone render this storm worthy of special attention, independently of the notoriety which it has acquired from its disastrous effects on the allied fleets and armies in the Crimea. The meteorological circumstances which characterized the Balaklava tempest have been determined with unusual care and skill, from a very great number of observations at stations spread over the whole surface of Europe, by M. Liais, of the Imperial

Observatory at Paris. In all probability, many years will elapse before a great storm on land is subjected to an examination so rigorous and complete as that undertaken by M. Liais in the present instance. This storm may, therefore, be adopted as the most satisfactory test that we are likely to have for some time to come of the correctness of the principles of interpretation which I have already applied to barometric fluctuations, in my report on the relation between explosions in coal mines and revolving storms,—principles which flow directly from the nature of cyclones. The cyclonic interpretation in this case would be—First, that the curves indicate the passage of a cyclonic, of which the centre passed to the Southward of England. This is inferred from the gradual increase of the barometric depression from the Orkneys in the north to Teignmouth in the south, and depends on the fact that the height of the mercurial column decreases continuously from the circumference to the centre of the cyclone. This inference is confirmed by the observation that the wind blew from the eastward at all the stations. Second, that the cyclone was progressing to the eastward. This is derived from observing that, at each station, the wind began at S. E. while the mercury was falling, veered to E. when the mercury was lowest, and then to N. E. as the mercury rose. The charts of M. Liais fully establish the truth of the inferences derived above from the contemporaneous barometric curves in Britain. They prove that the Balaklava tempest was a cyclone, moving to the eastward, along a central track which passed to the southward of Britain. It is known that during their transit from the Gulf of Mexico to the western coasts of Europe, across the comparatively uniform surface of the ocean, cyclones preserve an approximately circular form. The excellent charts of M. Liais, at the same time that they exhibit the progress of the storm day by day, from the shores of Britain across the continent of Europe, to the Caucasian mountains and the borders of the Caspian Sea, show also the remarkable modifications produced in the normal condition of the cyclone by mountains and other irregularities of the surface of the land. Thus, for example, a portion of the cyclone is delayed nearly twenty-four hours in passing the Alps. The consequence of this and similar obstructions is, that what was nearly a circular atmospheric wave while crossing the ocean, takes the form of a much elongated and somewhat distorted ellipse on land, enveloping an elliptical central area of maximum barometric depression, which extends, on one chart, from Dantzic in the Baltic to Varna in the Black Sea. Around this central space the wind still blows continuously in the direction peculiar to the cyclones of the northern hemisphere. In the case, therefore, of the Balaklava tempest, whose nature has been determined with much greater exactness than that of any other tempest on land, we have unequivocal testimony that the principles of cyclonology may be safely applied to interpret the fluctuations of the barometer in Great Britain.

ON ATMOSPHERIC CURRENTS AT LIVERPOOL.

This was supplementary to Mr. Osler's previous reports, and related to the diurnal laws of the wind when referred to sixteen points of the compass, giving the mean results of above 70,000 observations. It appeared that at Liverpool the various winds have their maximum and minimum velocity at definite and generally different hours. Thus the E.N.E. wind has its maximum about 5 p.m., the E. at 9 p.m., the E.S.E. at midnight, the S.E. at 6 a.m., S.S.E. at 10 a.m., S. at noon, and the corresponding minimums at twelve hours distance from these respectively. The N.N.E. and S.S.W. have each two maximums and minimums in the twenty-four hours. Generally the maximum velocity is about double the minimum.

AN IMPROVED STEREOSCOPE, BY M. A. CLAUDET.

This is designed to remedy the illusion of curvature shown by plane surfaces when examined by the refracting or semilenticular stereoscope. This illusion M. Claudet thinks arises from the fact that straight lines, viewed through a prism or semilens, parallel to the base thereof, are bent with a concavity towards the edge of the prism or lens; and both the pictures in the stereoscope being bent in the same manner, their coalescence produces a surface concave to the spectator. To avoid this defect, only the central part of each lens is employed, and the axes of the eyes are to be pointed in nearly parallel directions. In illustration of this theory, M. Claudet mentioned a beautiful optical experiment. If holding a prism in each hand, their refracting edges being vertical and turned towards each other, the window of a room be looked at, at first, two windows are seen with their vertical lines bent in opposite directions: by inclining gradually the optic axes of the eyes, the two images can be made to coincide, and, in the single resulting window, the latent curvature of the vertical lines ceases and is replaced by a curvature from back to front, producing the illusion of a window concave to the spectator.

THE POLYHEDRON OF FORCES, BY MR. J. T. GRAVES.

"If any number of forces act upon a point and be represented in magistude by the areas of the faces of a polyhedron, their directions being normal to these faces, they will keep the point at rest."

This is an extension of the well known principle of the "Polygon of Forces." It can also be applied to the composition of Couples, and Linear and Rotatory velocities after the manner of Poinsot.

THE LAW OF THE SQUARES—IS IT APPLICABLE OR NOT TO THE TRANSMISSION OF SIGNALS IN SUBMARINE CIRCUITS?"—BY MR. O. W. WHITEHOUSE.

Before proceeding to the consideration of this subject, the author wished to explain, with reference to his paper read on a previous day, that it was for the purpose of determining the force of either intermitting or alternating currents, whose duration was not sufficient to admit of the needle assuming a position of rest, that he proposed the use of the magneto-electrometer—an instrument rendering available the force of magnetic attraction instead of the deflection of the needle—as a means of measuring the amount of current circulating. This force was, he said, until we approach the point of magnetic saturation of the iron, strictly proportioned to the energy of the current under examination. The number of grains thus lifted on the arm of the lever, the author proposes to call the practical "value" of the current for telegraphic purposes. The most striking features of this instrument are—1st. The facility of determining the value of currents which do not admit of being tried by the galvanometer;—2nd. The very great range which this instrument has (viz., from unity up to half a million,) as well as the definiteness and accuracy of the results, even the extremes of the register being strictly comparable with each other;—3rd. Unlike the degrees upon the galvanometer, these grains of force are units of real "value" and of practical utility, as was shown by a telegraphic instrument in circuit being worked perfectly by a current of four grains. Referring to the proceedings of this Section last year, at Glasgow, the author quoted Prof. W. Thomson's paper on this subject, where he stated "that a part of the theory communicated by himself to the Royal Society last May, and published in the proceedings, shews that a wire of six times the length of the Varna and Balaklava wire, if of the same lateral dimensions, would give thirty-six times the retardation, and thirty-six times the slowness of action. If the distinctness of utterance and rapidity of action practicable with the Varna and Balaklava wire, are only such as not to be inconvenient, it would be necessary to have a wire of six times the diameter or better, thirty-six wires of the same dimensions, or a larger number of small wires twisted together, under a gutta-percha covering, to give tolerably convenient action by a submarine cable of six times the length." The author then stated, that circumstances had enabled him to make very recently a long series of experiments upon this point, the results of which he proposed to lay before the Section; adding, that an opportunity still existed for repeating these experiments upon a portion of cable to which he could obtain access, and that he was ready to show them before a committee of this Section in London, if the important nature of the subject should seem to render such a course desirable. Although the subject of submarine telegraphy had many points of the highest importance requiring investigation, and to the consideration of which he had been devoting himself recently, Mr. Whitehouse proposed to confine his remarks on this occasion to the one point indicated in the title, inasmuch as the decision of that one, either favourably or otherwise, would have, on the one hand, the effect of putting a very narrow limit to our progress in telegraphy, or, on the other, of leaving it the most ample scope. He drew a distinction between the mere transmission of a current across the Atlantic (the possibility of which he supposed everybody must admit) and the effectual working of a telegraph at a speed sufficient for "commercial success;" and we gathered from his remarks that there were those ready to embark in the undertaking as soon as the possibility of "commercial success" was demonstrated. The author then gave a description of the apparatus employed in his researches, of the manner in which the experiments were conducted, and, lastly, of the results obtained. The wires upon which the experiments were made were copper, of No. 16 gauge, very perfectly insulated with gutta-percha—spun into two cables, containing three wires of equal length (83 miles,) covered with iron wires and coiled in a large tank in full contact with moist earth, but not submerged. The two cables were subsequently jointed together, making a length of 166 miles of cable, containing three wires. In addition to this, in some of the latest experiments, he had also the advantage of another length of cable, giving, with the above, an aggregate of 1,020 miles. The instruments, one of which was exhibited, seemed to be of great delicacy, capable of the utmost nicety of adjustment, and particularly free from sources of error. The records were all made automatically, by electro-chemical decomposition, on chemically prepared paper. The observations of different distances recorded themselves upon the same slip of paper,—thus, 0.83 and 249 miles were imprinted upon one paper, 0.83, 498 miles upon another slip, and 0.249, 498 upon another, and 0.535, 1,020 upon another. Thus, by the juxtaposition of the several simultaneous records on each slip, as well as by the comparison of one slip with another, the author has been enabled to show most convincingly that the law of the squares is not the law which governs the transmission of signals in submarine circuits. Mr. Whitehouse showed next, by reference to published experiments of Faraday's and Wheatstone's (*Philosophical Magazine*, July, 1855,) that the effect of the iron covering with which the cable was surrounded was, electrically speaking, identical with that which would have resulted from submerging the wire, and that the results of the experiments could not on that point be deemed otherwise than reliable. The author next addressed himself to the objections raised against conclusions drawn from experiments in "Multiple" cables. Faraday had experimented, he said, upon wires laid in close juxtaposition, and with reliable results; but an appeal was made to direct experiment, and the amount of induction from wire to wire was weighed, and proved to be as one to ten thousand, and it was found impossible to vary the amount of retardation by any variation in the arrangement of the wires. Testimony, also, on this point was not wanting. The Director of the Black Sea Telegraph, Lieut. Col. Biddulph, was in England, and present at many of the experiments. He confirmed our author's view, adding, "that there was quite as much induction and embarrassment of instruments in this cable as he had met with in the Black Sea line." The author considers it, therefore, proved "that experiments upon such a cable, fairly and cautiously conducted, may be regarded as real practical tests, and the results obtained as a fair sample of what will ultimately be found to hold good practically in lines laid out *in extenso*. At the head of each column in the annexed table is stated the number of observations upon which the result given was computed,—every observation being rejected on which there could fall a suspicion of carelessness, inaccuracy, or uncertainty as to the precise conditions; and, on the other hand, every one which was retained being carefully measured to the hundredth part of a second. This table is subject to correction, for variation in the state of the battery employed, just as the barometrical observations are subject to correction for temperature. Of this variation as a source of error I am quite aware, but I am not yet in possession of facts enough to supply me with the exact amount of correction required. I prefer, therefore, to let the results stand without correction.

AMOUNT OF RETARDATION OBSERVED AT VARIOUS DISTANCES. VOLTAIC CURRENT TIME STATED IN PARTS OF A SECOND.

Mean of 550 obsrvns.	Mean of 110 obsrvns.	Mean of 1840 obsrvns.	Mean of 1960 obsrvns.	Mean of 120 simultaneous observations.	
83 miles ·08	166 miles ·14	249 miles. ·36	498 miles. ·79	535 miles. ·74	1020 miles. 1·42.

—Now it needs no long examination of this table to find that we have the retardation following an increasing ratio,—that increase being very little beyond the simple arithmetical ratio. I am quite prepared to admit the possibility of an amount of error having crept into these figures, in spite of my precautions; indeed, I have on that account been anxious to multiply observations in order to obtain most trustworthy results. But I cannot admit the possibility of error having accumulated to such an extent as to entirely overlay and conceal the operation of the law of the squares, if in reality that law had any bearing on the results. Taking 83 miles as our unit of distance, we have a series of 1, 2, 3, 6, and 12. Taking 166 miles as our unit, we have then a series of 1, 3, and 6. Taking 249 miles, we have still a series of 1, 2, and 4, in very long distances. Yet even under these circumstances, and with these facilities, I cannot find a trace of the operation of that law." The author then examined the evidence of the law of the squares, as shown by the value of a current taken in submarine or subterranean wires at different distances from the generator thereof, which he showed were strongly corroborative of the previous results. He next examined the question of the size of the conducting wire; and he had the opportunity of testing the application of the law, as enunciated by Prof. Thomson last year. The results, far from confirming the law, are strikingly opposed to it The fact of trebling the size of the conductor augmented the amount of retardation to nearly double that observed in the single wire. The author, however, looked for the *experimentum crucis* in the limit to the rapidity and distinctness of utterance attainable in the relative distances of 500 and 1,020 miles. 350 and 270 were the actual number of distinct signals recorded in equal times through these two lengths respectively. These figures have no relation to the squares of the distance. "Now, it the law of the squares be held to be good in its application to submarine circuits, and if the deductions as to the necessary size of the wire, based upon that law, can be proved to be valid also, we are driven to the inevitable conclusion that submarine cables of certain length to be successful must be constructed in accordance with these principles. And what does this involve? In the case of the Transatlantic line, whose estimated length will be no less than 2,500 miles, it would necessitate the use, for a single conductor only, of a cable so large and ponderous, as that probably no ship except Mr. Scott Russell's leviathan could carry it,—so unwieldy in the manufacture, that its perfect insulation would be a matter almost of practical impossibility,—and so expensive, from the amount of materials employed, and the very laborious and critical nature of the processes required in making and laying it out, that the thing would be abandoned as being practically and commercially impossible. If, on the other hand, the law of the squares be proved to be inapplicable to the transmission of signals by submarine wires, whether with reference to the amount of retardation observable in them, the rapidity of utterance to be attained, or the size of conductor required for the purpose, then we may shortly expect to see a cable not much exceeding one ton per mile, containing three, four or five conductors, stretched from shore to shore, and uniting us to our Transatlantic brethren, at an expense of less than one-fourth that of the large one above mentioned, able to carry four or five times the number of messages, and therefore yielding about twenty times as much return in proportion to the outlay. And what, I may be asked, is the general conclusion to be drawn as the result of this investigation of the law of the squares applied to submarine circuits? In all honesty, I am bound to answer, that I believe nature knows no such application of that law; and I can only regard it as a fiction of the schools, a forced and violent adaptation of a principle in Physics, good and true under other circumstances, but misapplied here."

In reply to this, Prof. W. Thomson writes to the *Atheneum*, that he believes Mr. Whitehouse's results are reconcileable with his theory, because he is confident that the theory is true, though *he is not confident that he sees the true way of* reconcilement; and, in the mean time, he believes that a more "matter of fact" proof must be afforded of the possibility of attaining sufficient capacity of communication through a cable 1,000 miles long, than Mr. Whitehouse's experiments supply. Mr. Whitehouse, in answer, says, that this "matter of fact" proof has been given—in short—"we have recently telegraphed at a commercially satisfactory speed through an unbroken subterranean circuit of 2,000 miles." Prof. Thomson, (*Atheneum*, Nov. 1,) now enters into an elaborate discussion, in which he appears to concede the question so far as the practical working of the telegraph is concerned with the "law of squares:" he shews that in results calculated from the theory, the deviations, from the law of squares, occur to as great an extent as in Mr. Whitehouse's actual experiments; these deviations, depending on the precise nature "of the electrical operations performed at one end of the wire, and of the test of electrical effect afforded by the receiving instrument at the other hand."

ON THE MANUFACTURE OF IRON AND STEEL WITHOUT FUEL, BY MR. W. BESSAMER.

Mr. Bessamer asserted that crude iron contains about 10 per cent. of carbon; that carbon cannot exist at white heat in the presence of oxygen, without uniting therewith and producing combustion, that such combustion would proceed with a rapidity dependent on the amount of surface of carbon exposed; lastly, that the temperature which the metal would acquire would be also dependent on the rapidity with which the oxygen and carbon were made to combine, and consequently that it was only necessary to bring the oxygen and carbon together in such a manner that a vast surface should be exposed to their mutual action in order to produce a temperature hitherto unattainable in our largest furnaces. With a view of testing practically this theory, he had constructed a cylindrical vessel of three feet in eight, somewhat like an ordinary cupola furnace, the interior of which was lined with fire-bricks; and about two inches from the bottom of it inserted five tuyere pipes, the nozzles of which were framed of well burnt fire-clay, the orifice of each tuyere pipe being about three-eighths of an inch in diameter. These were so put into the brick lining (from the outer side) as to admit of their removal and renewal in a few minutes when they were worn out. At one side of the vessel, about half way up from the bottom, there was a hole made for running in the crude metal, and on the opposite side there was a tap-hole stopped with loam, by means of which the iron was run out at the end of the process. The vessel should be placed so near to the discharge-hole of the blast furnace as to allow the iron to flow along a gutter into it. A small blast cylinder would be required, capable of compressing air to about 8 lb. or 10 lb to the square inch. A communication having been made between it and the tuyeres before named, the converting vessel would be in a condition to commence work. It would, however, on the occasion of its being first used after re-lining with fire-bricks, be necessary to make a fire in the interior with a few baskets of coke, so as to dry the brickwork and heat up the vessel for the first operation, after which the fire would have to be all carefully raked out at the tapping-hole, which would again be made good with loam. The vessel would then be in readiness to commence work, and might be so continued without any use of fuel, until the brick lining in the course of time became worn away and a new lining was required. The tuyeres are situated nearly close to the bottom of the vessel; the fluid metal will therefore rise some eighteen inches or two feet above them. It is necessary, in order to prevent the metal from entering the tuyere-holes, to turn on the blast before allowing the fluid crude iron to run into the vessel from the blast furnace. This having been done, and the fluid iron run in, a rapid boiling up of the metal will be heard going on within the vessel, the metal being tossed violently about, and dashed from side to side, shaking the vessel by the force with which it moves from the throat of the converting vessel. Flame will then immediately issue, accompanied by a few bright sparks. This state of things will continue for about 15 or 20 minutes, during which time the oxygen in the atmospheric air combines with the carbon contained in the iron, producing carbonic acid gas, and at the same time evolving a powerful heat. Now, as this heat is generated in the interior of, and is diffused in innumerable fiery bubbles through the whole fluid mass, the metal absorbs the greater part of it, and its temperature becomes immensely increased;

and by the expiration of the 15 or 20 minutes before named, that part of the carbon which appears mechanically mixed and diffused through the crude iron has been entirely consumed. The temperature, however, is so high that the chemically-combined carbon now begins to separate from the metal, as is at once indicated by an immense increase in the volume of flame rushing out of the throat of the vessel. The metal in the vessel now rises several inches above its natural level, and a light frothy slag makes its appearance, and is thrown out in large foam-like masses. This violent eruption of cinder generally lasts five or six minutes, when all further appearance of it ceases—a steady and powerful flame replacing the shower of sparks and cinder which always accompanies the boil. The rapid union of carbon and oxygen which thus takes place adds still further to the temperature of the metal, while the diminished quantity of carbon present allows a portion of the oxygen to combine with the iron, which undergoes combustion, and is converted into an oxide. At the excessive temperature that the metal has now acquired, the oxide, as soon as formed, undergoes fusion, and forms a powerful solvent of those earthy bases that are associated with the iron. The violent ebullition which is going on mixes most intimately with scoriæ and metal, every part of which is thus brought into contact with the fluid, which will thus wash and cleanse the metal most thoroughly from the silica and other earthy bases which are combined with the crude iron, while the sulphur and other volatile matters which cling so tenaciously to iron at ordinary temperatures are drawn off, the sulphur combining with the oxygen, and forming sulphurous acid gas. The loss in weight of crude iron during its conversion into an ingot of malleable iron, was found, on a mean of fo. xperiments, to be 12½ per cent, to which will have to be added the loss of metal in the finishing rolls. This will make the entire loss probably not less than 18 per cent., instead of about 28 per cent., which is the loss on the present system. A large portion of this metal is, however, recoverable, by treating with carbonaceous gases the rich oxides thrown out of the furnace during the boil. These slags are found to contain innumerable small grains of metallic iron, which are mechanically held in suspension in the slags, and may be easily recovered, by opening the tap hole of the converting vessel, and allowing the fluid malleable iron to flow into the iron ingot moulds placed there to receive it. The masses of iron thus formed will be perfectly free from any admixture of cinder, oxide, or other extraneous matters, and will be far more pure and in a sounder state of manufacture than a pile formed of ordinary puddle bars. And thus it will be seen that by a single process, requiring no manipulation or particular skill, and with only one workman, from three to five tons of crude iron passes into the condition of several piles of malleable iron in from thirty to thirty-five minutes, with the expenditure of about one-third part the blast now used in a fiery furnace with an equal charge of iron, and with the consumption of no other fuel than is contained in the crude iron. To persons conversant with the manufacture of iron (said Mr. Bessamer), it will be at once apparent that the ingots of malleable metal which I have described will have no hard or steely parts, such as are found in puddled iron, requiring a great amount of rolling to blend them with the general mass; nor will such ingots require an excess of rolling to expel cinder from the interior of the mass, since none can exist in the ingot, which is pure and perfectly homogeneous throughout, and hence requires only as much rolling as is necessary for the developement of fibre; it therefore follows that, instead of forming a merchant bar or rail by the union of a number of separate pieces welded together, it will be far more simple and less expensive to make several bars or rails from a single ingot. Doubtless this would have been done long ago, had not the whole process been limited by the size of the ball which the puddler could make. I wish to call the attention of the Meeting to some of the peculiarities which distinguish cast steel from all other forms of iron—namely, the perfect homogeneous character of the metal, the entire absence of sand-cracks or flaws, and its great cohesive force and elasticity, as compared with the blister steel from which it is made—qualities which it derives solely from its fusion and formation into ingots, all of which properties malleable iron acquires in a like manner by its fusion and formation into ingots in the new process; nor must it be forgotten that no amount of rolling will give to blister steel (although formed of rolled bars) the same homogeneous character that cast steel acquires by a mere extension of the ingot to some ten or twelve times its original length. One of the most important facts connected with the new system of manufacturing malleable iron is, that all the iron so produced will be of that quality known as charcoal iron; not that any charcoal is used in its manufacture, but because the whole of the processes following the smelting of it are conducted entirely without contact with, or the use of any mineral fuel; the iron resulting therefrom will in consequence be perfectly free from those injurious properties which that description of fuel never fails to impart to iron that is brought under its influence. At the same time this system of manufacturing malleable iron offers extraordinary facility for making large shafts, cranks, and other heavy masses. It will be obvious that any weight of metal that can be founded in ordinary cast iron by the means at present at our disposal may also be founded in molten malleable iron, to be wrought into the forms and shapes required, provided that we increase the size and power of our machinery to the extent necessary to deal with such large masses of metal. A few minutes' reflection will show the great anomaly presented by the scale on which the consecutive processes of iron making are at present carried on. The little furnaces originally used for smelting ore have been from time to time increased in size until they have assumed colossal proportions, and are made to operate on two or three hundred tons of materials at a time, giving out ten tons of fluid metal at a single run. The manufacturer has thus gone on increasing the size of his smelting furnaces, and adapting to their use the blast apparatus of the requisite proportions, and has by this means lessened the cost of production in every way. His large furnaces require a great deal less labor to produce a given weight of iron than would have been required to produce it with a dozen furnaces; and in like manner he diminishes his cost of fuel, blast and repairs, while he insures a uniformity in the result that never could have been arrived at by the use of a multiplicity of small furnaces. While the manufacturer has shown himself fully alive to these advantages, he has still been under the necessity of leaving the succeeding operations to be carried out on a scale wholly at variance with the principles he has found so advantageous in the smelting department. It is true that hitherto no better method was known than the puddling process, in which from 400 lb. to 500 lb weight of iron is all that can be operated upon at a time; and even this small quantity is divided into homœopathic doses of some 70 lb. or 80 lb., each of which is moulded and fashioned by human labor, and carefully watched and tended in the furnace, and removed therefrom one at a time, to be carefully manipulated and squeezed into form. When we consider the vast extent of the manufacture, and the gigantic scale on which the early stages of the process is conducted, it is astonishing that no effort should have been made to raise the after-processes somewhat nearer to a level commensurate with the preceding ones, and thus rescue the trade from the trammels which have so long surrounded it. Before concluding these remarks, I beg to call your attention to an important fact connected with the new process, which affords peculiar facilities for the manufacture of cast steel. At that stage of the process, immediately following the boil, the whole of the crude iron has passed into the condition of cast steel of ordinary quality. By the continuation of the process the steel so produced gradually loses its small remaining portion of carbon, and passes successively from hard to soft steel, and from soft steel to steely iron, and eventually to very soft iron; hence, at a certain period of the process any quality of metal may be obtained. There is one in particular, which, by way of distinction, I call semi-steel, being in hardness about midway between ordinary cast steel and soft malleable iron. This metal possesses the advantage of much greater tensile strength than soft iron. It is also more elastic, and does not readily take a permanent set, while it is much harder and is not worn or indented so easily as soft iron. At the same time it is not so brittle or hard to work as ordinary cast steel. These qualities render it eminently well adapted to purposes where lightness and strength are specially required, or, where there is much wear, as in the case of railway cars, which from their softness of texture soon become destroyed. The cost of semi-steel will be a fraction less than iron, because the loss of metal that takes place by oxidation in the converting vessel is about two and a half per cent. less than it is with iron; but as it is a little more difficult to roll, its cost per ton may be fairly considered to be the same as iron. But as its tensible strength is some thirty or forty per cent. greater than bar iron, it follows that for most purposes a much less weight of metal may be used; so that taken in that way the semi-steel will form a much cheaper metal than any we are at present acquainted with. The facts which I have brought before the Meeting are not mere laboratory experiments, but the result of working on a scale nearly twice as great as is pursued in our largest ironworks—the experimental apparatus doing 7 cwt. in thirty minutes while the ordinary puddling furnace makes only 4½ cwt. in two hours, which is made into six separate balls, while the ingots or blooms are smooth, even prisms, ten inches square by thirty inches in length, weighing about equal to ten ordinary puddle balls.

RESEARCHES IN THE CRIMEAN BOSPHORUS, AND ON THE SITE OF THE ANCIENT GREEK CITY OF PANTICAPŒUM (KERTCH), BY DR. D. MACPHERSON.

The present town of Kertch is built close to the site where 500 years B. C. the Milesians founded a colony. About fifty years before Christ, this colony became subject to Rome, or rather a Satrap of the Roman Empire, from the circumstance of the Bosphorian kings, who were also rulers of Pontus, having been subdued by this people in Asia. In the year 375 of our era, the colony was utterly annihilated by the Huns. Barbarous hordes succeeded one upon another thereafter until A. D. 1280, when the Genoese became possessors of the soil, and held it until expelled by the Turks in 1473; they being in their turn expelled in 1771 by the Russians. The characteristic features around Kertch are the immense tumuli, or artificial mounds that abound in this locality, more especially within the second vallum. These sepulchres of the ancient world are found in many places. We have them in the form of barrows in England, and cairns in Scotland. Calculated as they are for almost endless duration, they present the simplest and sublimest monument that could have been raised over the dead. The size and grandeur of the tumuli found in this locality excite astonishing ideas of the wealth and power of the people by whom they were erected, for the labour must have been prodigious and the expenditure enormous. The highest specimens of Hellenic art have been discovered in these tumuli—such as sculpture, metal, alabaster and Etruscan vases, glass vessels, remarkable for their lightness, carved ivory, coins, peculiarly pleasing on account of their sharpness and finish, and trinkets, executed with a skill that would vie with that of our best workmen. All originals were forwarded to the Hermitage, at St. Petersburgh, duplicates being preserved in the Museum at Kertch, and these might have been with ease secured to England on the investment of the place by the Allies; but with the exception of some bas-reliefs, which, in connexion with other two officers, I transmitted to the British Museum, the whole of these rare treasures were barbarously made away with. The local tradition is, that these tumuli were raised over the remains, and to perpetuate the memory, of the kings or rulers who held sway over the colonists, and that the earth was heaped upon them annually on the anniversary of the decease of the prince, and for a period of years corresponding to the rank or respect in which its tenant was held, or had reigned; and to this day successive layers of earth, which were laid on in each succeeding year, can be traced in their coating of sea-shell or charcoal having been first put down. I have counted as many as 30 layers in a scarp made in one of those mounds, about two-thirds from its base. They are to be seen of all sizes, varying from 10 to 300 feet in circumference, and in height from 5 to 150 feet, and are usually composed of surface soil and rubble masonry. Herodotus' reference to these sepulchres is the earliest account which history has recorded of this mode of burial; and I would particularly draw your attention to his description of the mode adopted by the Scythians to perpetuate the memory of their deceased princes, for you will hereafter see that one of my excavations corresponded exactly with the description given by him. "The tombs of the Scythian kings," he states, "are seen in the land Gherri, at the extreme point to which the Borysthenes is navigable. Here, in the event of a king's decease, after embalming the body, they convey it to some neighbouring Scythian nation. The people receive the royal corpse, and convey it to another province of his dominions, and when they have paraded it through all the provinces, they dig a deep square fosse, and place the body in the grave on a bed of grass. In the vacant space around the body in the fosse they now lay one of the king's concubines, whom they strangle for the purpose, his cup-bearer, his cook, his groom, his page, his messenger, fifty of his slaves, some horses, and samples of all his things. Having so done, all fall to work, throwing up an immense mound, striving and vying with each other who shall do the most. The Greeks, who always respected the religion of the countries they had subjugated, and who, in process of time, imbibed, to a certain extent, their customs and observances, appear to have adopted this Scythian mode of burial. Instead, however, of placing their magistrates or rulers in a "deep square fosse" dug in the earth, they built tombs, and over these raised the conical hill. But I examined several without meeting with any success. All, or nearly all, of these tumuli have been already explored. Not far from Mons Mithridates I came upon a portion of an aqueduct which probably conveyed water to the Acropolis. It was formed of concave tiles; one of these, with a Greek name thereon, I have brought with me. On one occasion I arrived at the place where five stone tombs were found adjoining, neither of which contained any relic, but in a spot contiguous a large ornamented earthenware jug and five glass cups, one within the other, were discovered. It was not unusual thus to find the remains in one spot and the ornaments in another. On removing the earth off the sides of a rock, the apex of which was only perceptible on the summit, I struck upon a recess, three sides of a square chiselled out of a rock 16 feet in length and 8 in depth. Following this, I reached a stone seat; hewn out on each side of this seat small recesses had been made, apparently for the purpose of receiving lamps. After descending 12 feet I came to human remains, and for five days the workmen turned nothing out of this pit but human bones. How far these would have descended I know not, for I ceased my explorations here, feeling satisfied, from the appearance of the bones, that they must have been placed there at the same period—the result, most probably, of some great engagement, for many of the skulls and long bones presented fractures and injuries. The marks on the rock would indicate that sacrificial meetings, possibly commemorative of the event, were held here. Replacing these remains, I preceded to a point indicated as the tombs of the diminutive or pigmy race, but discovered nothing that would indicate a peculiar class of people. Beneath an extensive sloping artificial tumulus, running at right angles with the the ridge extending northwards from Mons Mithridates, I came upon a mass of rubble masonry, beyond which was a door leading to an arched chamber, built under the side of the mound. This led me to a larger chamber, which was also arched. The walls of the larger chamber were marked off in squares, with here and there flowers, birds, and grotesque figures. Over the entrance into this chamber were painted two figures of griffins rampant, two horsemen, a person in authority and his attendant—the latter carrying in his hand a long spear—being rudely sketched on one of the inner walls. There were no remains of any sort in this tomb or temple. A recess in the walls on two sides resembled doors blocked up. On removing the masonry to the right the skeleton of a horse was found. To the left a human skeleton lay across the door. Tunnelling on each side, the work was carried on beneath the descents of former explorations from above. On the right-hand side the tunnel extended ten yards, but nothing of interest was met with. On the left, descending as the tunnel was formed, arriving occasionally at objects possessing much interest, I came upon a layer of natural slate rock, the sides and roof of the tunnel being composed of artificial soil, charcoal, animal remains, and, as usual, heaps of broken pottery. Thirty feet from the entrance, the rock suddenly disappeared to the front and left, the mark of the chisel being perceptible on the divided portion. Tunnelling in the rock, we again reached 12 feet from the spot where it had disappeared, loose sand occupying the intervening space, into which the exploring rod, six feet long, dropped without any effort. I worked down into this shaft 12 feet. But the left side of the shaft, which was composed of the same loose sand as far as the steel rod could reach, was continually falling in. Moreover, the labour carried on by candlelight of raising the earth in baskets, and conveying it in wheelbarrows to the outside through the building was becoming very arduous, and I was compelled to abandon the work. At this period no relics or remains of any sort were discovered, and the steel rod sunk into the loose sand as if it had been so much flour. I felt satisfied that this shaft led to rich treasures below, but regard for the safety of my workmen prevented my proceeding deeper. The tunnel was carried on a few feet further, and the earth allowed to drop into the shaft. I now sought out other ground, and selected a place removed about 100 yards from that I had just left. Descending some ten feet, I struck upon a tomb cut out of the solid rock. Not far from this my attention was attracted to an excavation in the rock, somewhat similar to, but on a much smaller scale, than that large descent which I had just abandoned. Clearing the surface, I found that the rock was hewn out 8 feet in width and 12 in length, the intervening space being filled with sand, similar in all respects to the other into which the steel rod sunk with ease. Fifteen feet of this sand being removed, I came upon the skeleton of a horse. A few feet further on, an upright flag, four feet high, and the breadth of the shaft, was placed over the entrance of a tomb cut out of the calcareous clay. The opening faced the east by an arched door, 24 inches wide and 32 high. The tomb was of a semi-circular form, arched, 10 feet by 12 in diameter, and 6 feet high in the centre. Above the doorway a lintel-stone was placed, on which the slab which closed it rested. The cavity was cut out of the natural calcareous clay, which was firm and consistent, the form and shape of the instrument by which it had been removed being very distinct. The candle burnt brightly on entering. The floor was covered with beautiful pebbles and shells, such as are now found on the shores of the Sea of Azov. A niche was cut out of the walls on three sides, in which lay the dust of what once was human. It was a sight replete with interest to survey this chamber—to examine each article as it had been originally placed more than 2,000 years ago—to contemplate its use, and to behold the effect of 20 centuries upon us proud mortals. There lay the dust of the human frame, possessing still the form of man. The bones had also crumbled into dust; the space once occupied by the head did not exceed the size of the palm of the hand, but in the undisturbed dust, the position of the features could still be traced. The mode in which the garments enveloped the body, and the knots and fastenings by which these were bound, being also distinct. On each niche a body had been placed, and the coffins, crumbled into powder, had fallen in. At the head were glass bottles—one of these contained a little wine. A cup and a lacrymatory of the same material and a lamp were placed in a small niche above. A coin and a few enamelled beads were in the left hand, and in the right a number of walnuts—the wine and nuts being doubtless placed there to cheer and support the soul in its passage to Paradise. Some fibulæ and common ornaments, valuable only on account of their antiquity, were also found. Continuing my researches in the same locality, I came upon other similar shafts, at the end of which were the bones of a horse, and then the large flagstone closed the mouth of tombs similar to the last. I now resolved to made another attempt to explore the great shaft: the only mode of effecting this being to remove entirely that portion of the hill above it, I brought all my labourers to the spot, although the few days that remained of our sojourn in Kertch would hardly enable me, I feared, to complete the work. Placing my men in two gangs, each were made to work half an-hour without ceasing. On the third day we struck on two large amphoræ, containing each the skeleton of a child between four and six years of age. Underneath these were the tombs of two adults, and then came the skeleton of a horse. There was now every indication that a great feast or sacrifice had been held, for a few feet further on we came upon immense heaps of broken amphoræ, fragments of wine jars, the inside of which were still encrusted with wine lees, broken drinking cups, flat tiles which may have served the purpose of plates, beef and mutton bones, fragments of cooking pots still black from the smoke, and quantities of charcoal. Descending still further, we came upon what appeared to have been a workshop—portions of crucibles in which copper had been smelted, corroded iron, lumps of vitreous glass, broken glass vessels, moulds, and other things being found. Five feet deeper we exposed the excavation in the rock, and a shaft exactly similar to, but on much larger scale than the descent into the arched tombs. As the hill was removed, platforms were scarped on the sides, on which the earth was thrown up, a man being placed on each platform; and as I descended into the shaft, similar platforms of wood were slung from above. On the twelfth day we reached a depth of 16 feet in the shaft, the portion of the hill removed being 38 feet in length, 20 in depth, and 12 in breadth. The mouth of the shaft hewn out of the rock, 3 feet in thickness, was 18 feet long by 12 broad. It then took on a bell shape, the diameter of which was 22 feet, cut out in dark consistent clay, a depth of nearly 7 feet. Beyond this the size of the shaft became a square seven feet, cut out of successive layers of sandstone and calcareous clay. When we had attained a depth of 30 feet in the shaft, the labour of raising the earth became very great; but by means of a block and shears, which Capt. Commerell, of Her Majesty's ship Snake, very kindly fixed over the descent, the work was much facilitated, the earth being slung up in baskets, and the men ascending and descending in the same manner. A few feet beyond the bones of the horse, and exactly in the centre of the shaft, the skeleton of an adult female appeared enveloped in sea-weed. Under the neck was a lacrymatory, and on the middle finger of the right hand a key-ring. Three feet further we met a layer of human skeletons, laid head to feet, the bones being here in excellent preservation,—as, indeed, we found them to be in all places where the calcareous clay came into immediate contact with them. There were 10 adult male skeletons on this spot, and separated by a foot of clay between each. Five similar layers were found, being 50 in all. I may state that toads in large numbers were found alive in this part of the pit. We had now reached a depth of 42 feet in the shaft, the bones of another horse were turned out, and then we came on loose sand to a depth of 5 feet. Six more skeletons were here again exposed. The sides of the shaft were regular and smooth, the mark of the chisel on the rock being as fresh as when first formed. Six feet more of the loose sand being now taken away, hard bottom could be felt by the steel rod, and there lay two skeletons, male and female, enveloped in sea-weed; and in a large amphora at the corner, which was unfortunately found crushed, were the bones of a child. Some beautiful specimens of pottery, an electrine urn, much broken, lacrymatories, beads and a few coins, were all that I got to repay my labours on this spot. I examined well on every side, and in the rock below, for a trap-door or concealed passage, and an abrupt perpendicular division in the natural strata or layers of calcareous clay appeared to indicate the existence of such, but I found none. Everything during the descent had promised so very favorably, that I fully expected to have found a large chamber leading on from the termination of the shaft; but if such does exist, the discovery of the passage to it utterly baffled all my researches. When the coins I discovered are cleaned, I shall probably be able to fix a date to this wonderful place. The deep fosse, the mode in which the skeletons were found at the bottom, the 6 discovered immediately above these, 50 about the centre, and the bones of the horses, are exactly in harmony with the description of Herodotus of the mode in which the Scythian kings were buried. The substance which I have called sea-weed, from its bearing stronger resemblance to that production than anything else I can compare with it, may possibly be the "grass" described by Herodotus as used to envelope the body. If such be the case, the description is in all respects exact. There was now no time to enter upon fresh explorations.

THE ARCTIC CURRENT AROUND GREENLAND, BY CAPT. IRLINGER, R. D. N.

Many hydrographers assert that a current from the ocean around Spitzbergen continues its course along the east coast of Greenland, and thence in a nearly straight line towards the banks of Newfoundland. In this opinion I do not agree. Considerable quantities of ice are annually brought with the current from the ocean around Spitzbergen to the south and south-west along the east coast of Greenland, around Cape Farewell, and into Davis Strait. These enormous masses of ice are frequently drifted so close to the southern part of the coast of Greenland that navigation through it is impossible. To demonstrate the existence of this ice-drift, I may mention the following extract from the log-book of the schooner Activ, Capt. J. Andersen. This vessel belongs to the colony of Julianehaab, and is used as a transport in this district:—7th of April, 1851, the Activ left Julianehaab, bound to the different establishments on the coast between Julianehaab and Cape Farewell. The same day the captain was forced by the ice to take refuge in a harbour. Frequent snow-storms and frost. On account of icebergs and great masses of floe ice inclosing the coast, it was impossible to proceed on the voyage before the 23rd, when the ice was found to be more open; but after a few hours' sailing the ice again obliged the captain to put into a harbour. Closed in by the ice until the 27th. The ice was now open, and the voyage proceeded until the *1st of May*, when the ice compelled him to go into a harbour. In this month violent storms, snow and frost. From the most elevated points ashore very often no extent of sea visible; now and then the ice open, but not sufficiently so for proceeding on the voyage. At last, on *the 6th of June*, in the morning, the voyage was continued; but the same evening the ice inclosed the coast, and the schooner was brought into "Blisshullet," a port in the neighboured of Cape Farewell. The following day the voyage was pursued through the openings between the ice; and on the 18th of June the schooner arrived again at Julianehaab. Whilst the masses of ice, as above mentioned, inclosed the coast between Juliannehaab and Cape Farewell, the brig Lucinde crossed the meridian of Cape Farewell on the 26th of April, in lat. 58° 3' N. (101 nautical miles from shore), and no ice was seen from the brig before the 2nd of May, in lat. 58° 26' N., and 50° 9' W. of Greenwich. Further, Capt. Knudten, commanding the Neptune, bound from Copenhagen to Julianehaab, was obliged, on account of falling in with much ice, to put into the harbour of Frederikshaab on the 8th of May, 1852, and was not able to continue his voyage to Julianehaab before the middle of June, because a continuous drift-ice (icebergs as well as very extensive fields) was rapidly carried along the coast to the *northward*. Capt. Knudten mentions, that during the whole time he was closed in at Frederikshaab he did not a single day discover any clear water even from the elevated points ashore, from which he could see about 28 nautical miles seaward. Whilst the Neptune was inclosed by the ice at Frederikshaab, the brig Balder, on the home passage from Greenland to Copenhagen, crossed the meridian of Cape Farewell on the 9th of June in lat. 58° 9' N. (100 miles from shore) in clear water, and no ice in sight. From the above it is evident that the current from the ocean around Spitzbergen, running along the east coast of Greenland past Cape Farewell, continues its course along the western coast of Greenland to the north, and transports in this manner the masses of ice from the ocean around Spitzbergen into Davis Strait. If the current existed, which the before-named writers state to run in a direct line from East Greenland to the banks of Newfoundland, then the ice would likewise be carried with that current from East Greenland; if it were a submarine current, the deeply-immersed icebergs would be transported by it; if it were only a surface-current, the immense extent of field-ice would indicate its course, and vessels would consequently cross these ice-drifts at whatever distance they passed to the southward of Cape Farewell. *But* *this is not the case:* experience has taught that vessels coming from the eastward, steering their course about 2° (120 nautical miles) to the southward of Cape Farewell, seldom or never fall in with ice before they have rounded Cape Farewell and got into Davis Strait, *which is a certain proof that there does not exist even a branch of the Arctic current which runs directly from East Greenland towards the banks of Newfoundland.*

EXPLORATIONS THROUGH THE VALLEY OF THE ATRATO TO THE PACIFIC IN SEARCH OF A ROUTE FOR A SHIP CANAL BY MR. F. M. KELLEY, OF NEW YORK.

Several surveying expeditions have been sent by Mr. Kelley into this region, and much valuable information has resulted. But the chief result is a conviction of the feasibility of a ship-canal through the isthmus. The most recent of Mr. Kelley's explorers, Mr. Kennish, proposes to enter the Atrato by the Cano Coquito. The greatest depth on the bar is about 4 ft. at low water; the soundings gradually deepen and become 30 ft. within 2 miles, when the depth increases to 47 ft., and is nowhere less up to the Truando. The width varies from a quarter of a mile to 2 miles, and the removal of the bar would allow of the transit of the largest steamers. The confluence of the Truando is about 63 miles from the Gulf, and that river forms the channel of the proposed line for 36 miles. The line then follows the valley of the Nerqua through rock-cutting, and passes the summit by a tunnel of 3¼ miles. It reaches the Pacific through the valley of a small stream, and debouches at Kelley's Inlet. In the valley of the Atrato, 300 miles long and 75 broad, and lying between the Antiochian mountains on the east and the Cordillera of the Andes on the west, rain falls almost daily; which accounts for the immense supply of water in that region. On the Pacific side of the Cordillera there is scarcely any rain for eight months of the year. The greater portion of the rain falling in the Atrato valley is caught above the confluence of the Truando. Fifteen large tributaries and numerous smaller streams fall into the Atrato and contribute to the immense lagoons, which form natural reservoirs and a superabundant store of water throughout the year. There are various cogent reasons for selecting the confluence of the Truando as the best point from whence the passage from the Atrato to the Pacific may be effected. In the first place there is no point of junction with the Atrato by western tributaries so near the level of high water on the Pacific as that of the Truando. It happens to be 9 ft. above the Pacific at high water, and it is therefore of sufficient elevation to prevent the Pacific at high water from flowing through the proposed cut into the Atrato; while it is not so high as to cause the current from the Atrato to the Pacific at *low* water to pass through the cut too rapidly. In fact, the elevation of the Truando confluence just preserves a preponderating balance on the side of the Atrato. The Atrato, at the junction of the Salaqui, is only 1 ft. above the level of the Pacific at high water; but the dividing ridge is 1,063 ft. high and 30 miles wide, according to a survey of that route by Mr. Kennish and Mr. Nelson. Should any of the rivers at the mouth of the Atrato be selected, without reference to the height and width of the dividing ridge, it may be observed that the maximum tidal wave in the Pacific being 25 ft. and that on the Atlantic only 2 ft., the Pacific at high tide would flow into the Atlantic with a current equal to a head of 11½ ft.; and at low water in the Pacific the Atlantic would flow into it with a similar current. In the inlet of the Gulf of Micuel, recently called Darien Harbour, the action of the tide is so strong, that H. B. M. steamship Virago, commanded by Capt. Prevost, dragged both anchors ahead, and was only brought up by paying out nearly all her cable. The heights of the tides and levels of the two oceans have been well established by the recent observations of Col. Totten in Navy Bay on the Atlantic and in a deep bend of the Bay of Panama on the Pacific. On the Atlantic a consecutive series of thirty-two observations were taken in the months of August and September during the season of calms. On the Pacific two sets of observations were made. The first, during May and June, when fifty-four consecutive tides were observed in a season of calms: and the second in November and December, when fifty-two consecutive tides were observed in a season of light winds. The results do not exactly correspond, and are given in the following table:—

	Pacific.		Atlantic.
	May and June.	Nov. and Dec.	Aug. and Sept.
Greatest rise of tide	17·72	21.30	1·60
Least	7·94	9·70	0·63
Average	12·08	14·10	1·16
Mean tide of Pacific above mean tide of Atlantic..	0·759	0·140	
High spring tide of Pacific above high spring tide of Atlantic	9.40	10·12	
Low spring tide of Pacific *below* low spring tide of Atlantic	6·55	9·40	
Mean high tide of Pacific above mean high tide of Atlantic	6·25	6·73	
Mean low tide of Pacific *below* mean low tide of Atlantic	4·73	5·26	
Average rise of spring tides	14·08	17·30	
Average rise of neap tides	9·60	12·40	

These observations make the mean level of the Pacific from 0·14 to 0·75 higher than the mean level of the Atlantic; but this is probably owing only to local circumstances, and it may be assumed that there is no difference in the mean levels of the two oceans. The conclusions arrived at by the successive independent surveys carried out at the expense of Mr. Kelley may be summed up as follows:—First, That the oceans can be united through the Atrato and Truando by a canal without a lock or any other impediment. Second, That while the distance between the oceans by this route is only 131 miles, half that distance is provided by nature with a passage for the largest ships. Third, The remaining distance requires the removal of bars, excavations, and cuttings, presenting no unusual difficulties. Fourth, Harbours, requiring but little improvement to render them excellent, exist at the termini.

ON ISOTHERMAL LINES, BY PROFESSOR HENNESSY.

The author discusses the distribution of those lines in islands. Considering an island having its shores bathed by a warm oceanic current, the isothermals, if the direct solar radiation were abstracted, would be closed curves surrounding the centre of the island and related to the coast-line, their shapes being variously modified by ranges of mountains, inequalities in the surface, and prevalent winds. By now introducing the effect of solar radiation it follows from the mathematica theory of heat, that the entire quantity of heat received by a unit of surface of the island will depend on two principal terms: one, a function of the distance of the point from the coast, and capable of being expressed in some cases as a function of the difference of latitude of that point and the nearest point on the coast, and, secondly, of a term depending on the latitude and on an elliptic function of the second order, having for its modulus the line of the obliquity of the equator. The effect of solar radiation will therefore be to transport the centres of all the closed isothermals towards the pole of the hemisphere in which the island lies; and some of these lines may thus ultimately terminate at the coast with their convex sides turned towards the equator, while others may still continue as closed curves in the interior of the island. The observations collected by Dr. Lloyd in his "Meteorology of Ireland" confirm this theory.

Dr. Lloyd remarked that the influence of the Gulf Stream in elevating the temperature of the coast-stations in Ireland was one of the first results that presented itself in the discussion of the observations referred to, but the inland stations were not numerous enough to form the basis of deduction as to the law of the actual distribution of temperature. He had therefore formed the isothermals from the coast observations, and had compared the inland temperature calculated from these with the observed. This comparison had shown that the effect of the Gulf Stream was even greater than had been anticipated, the temperature over the sea exceeding that over the land by nearly 4° Fah., being more than the utmost due to geographical position alone. Hence it was plain that the actual isothermals must be closed curves, but the case of Ireland, bathed as it was by the waters of a heated sea, cannot be taken as a type of the general phenomena of island temperature. According to Dufresney, the temperature of the sea was generally higher than that of the air above it, but the difference was very small except in the regions of heated currents flowing from a warmer zone.

ON THE ECLIPSE OF THE SUN IN HERODOTUS.

The Rev. Dr. Hincks has introduced a discussion on the eclipse that Herodotus describes as terminating a battle between the Medes and Lydians. This was supposed by Bayer in 1728, to have been the eclipse of May 18th, 603 B.C., but this view was opposed by Baily in 1811, who argued for the eclipse of Sept. 30, 610 B.C. Baily was, however, confuted by Mr. Hind, who has shown that the shadow would fall nearly 10° to the north of Baily's computation, and who falls back on the eclipse of May 28th, 585 B.C. Dr. Hincks conceived this to be an error, and was in favor of the original eclipse of Bayer, viz,—on May 18th, 603 B.C., and intimated a desire to learn what the actual track of this eclipse was according to the most modern tables of the moon.

Dr. Whewell on this remarked that this very eclipse and the whole ground over which Dr. Hincks had travelled had already been fully investigated by the Astronomer Royal in the R. S. Transactions for 1850. M. Bosanquet writes to the *Athenæum* (Aug. 23rd) that "not only the track of the eclipse of 603 B.C. but of every eclipse bearing upon the question between the years 630 and 580 B.C. has been examined by the Astronomer Royal, and the result of his investigations published in the *Phil. Trans.* for 1852, which had been entirely overlooked by Dr. Hincks:" also, that Mr. Hind in 1852 had shewn the eclipse of 585 B.C. to be the only one satisfying all the conditions: that, however, a short time back, the error discovered in Planche's tables had led to a re-calculation of the path for 585 B.C. and the alteration necessary was found to be very slight, so as not to invalidate the conclusion that this must be the eclipse of Herodotus. In reply Dr. Hincks writes to the *Athenæum* (Oct. 25) that Dr. Whewell and Mr. Bosanquet are both mistaken: that the paper by the Astronomer Royal in the *Phil. Trans.* for 1853 contains no calculation for the eclipse of 603 B.C. but only for that of 585 B.C. which latter is inconsistent with known historical facts: the former (603) has never been calculated since Mr. Baily's paper in 1811; and it is known that the tables used by Mr. Baily are defective. Dr. Hincks believes that the error in the moon's longitude introduced by adopting this eclipse will be found consistent with those pointed out by Mr. Adams to exist in Damoiseau's tables, and, after throwing back on Dr. Whewell the imputation of ignorance, again impresses on astronomers the necessity of re-calculating the track for 603 B.C. There the matter rests for the present.

THE MOON'S ROTATION.

Mr. Jelinger Symons, one of "Her Majesty's Inspectors of Schools," communicated to *The Times* not long ago a grand discovery he had made, viz.—that astronomers were all wrong in supposing the moon to have a rotation round its axis. Undeterred by the universal reclamation that assailed him, he brought the subject forward at the British Association, following a paper read by Dr. Whewell on the subject with one of his own, entitled "On Phenomena recently discovered in the Moon." The "recently discovered phenomena" consisted only of his previous assertion, with the addition, that the proper mode of describing the moon's motion was to say that she rotated "round a line, not exactly passing through the earth but near it." He illustrated his position by a machine, which however, was seen, by those capable of analysing its motions, to contradict its author. Unfortunately for himself, this gentleman travelled out of his subject into another department in an incidental sentence, when he stated, as a proof how necessary it was to correct the statements in which philosophers sometimes indulged, that it was now asserted that there were not large assemblages of water upon the moon, whereas Newton has not only traced out her seas, but had actually calculated the heights of the lunar tides—Mr. Symons thus interpreting "lunar tides" to mean tides on the moon instead of tides on the earth caused by the attraction of the moon.

Innumerable illustrations have been given of this motion of the moon for the purpose of rendering this purely geometrical conception familiar to minds not versed in geometry, but we do not remember to have met with the following—viz: that a spectator on the moon has just the same reason to attribute a motion round its axis to his moon, as an earthsman has to his earth: for he will find his meridian passing successively through every quarter of the heavens and completing a revolution once a month, just as a spectator on the earth finds his meridian passing through every quarter of the heavens once in a siderial day; the result being in each case the same, namely, an apparent motion of the heavens from east to west completing a revolution, in the case of the earth, in one day, in that of the moon, in one lunation; and, necessarily, the interpretation of such apparent motion being also the same.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

(Concluded.)

ACOUSTICS AS APPLIED TO PUBLIC BUILDINGS, BY PROFESSOR HENRY, OF THE SMITHSONIAN INSTITUTION.

At the meeting of the American Association, in 1854, I gave a verbal account of a plan of a lecture room adopted for the Smithsonian Institution, with some remarks on acoustics as applied to apartments intended for public speaking. At that time the room was not finished, and experience had not proved the truth of the principles on which the plan had been designed. Since then the room has been employed for two winters for courses of lectures to large audiences, and I believe it is the universal opinion of those who have been present that the arrangement for seeing and hearing, considering the size of the apartment, is entirely unexceptionable. It has certainly fully answered all the expectations which were formed in regard to it previous to its construction.

The President of the United States directed Capt. Meigs to confer with Prof. Bache and myself in regard to the acoustics of the new rooms in the ante-room of the Capitol. Previous to this we first studied the peculiarities of the present hall of the House of Representatives. This is allowed to be one of the worst possible apartments for public speaking; and to determine the cause of the confusion of sounds which exists during debate, is of considerable importance in suggesting improvements in the arrangement of the new rooms. We afterwards examined the principal churches and halls in Philadelphia, New York and Boston, and the peculiarities of these, as far as the investigation extended, may be referred to a few well established principles of sound which have been applied to the construction of this lecture room. To apply them generally, however, in the construction of public halls requires a series of preliminary experiments.

In every small apartment it is an easy matter to be heard distinctly at every point but in a large room, unless from the first in the original plan of the building provision be made on acoustic principles for a suitable form, it will be difficult, and indeed in most cases impossible, to produce the desired result. The same remark may be applied to lighting, heating and vantilation, and to all the special purposes to which a particular building is to be applied. I beg, therefore, to make some preliminary remarks on the architecture of buildings bearing on this point, which, though they may not meet with universal accéptance, will, I trust, commend themselves to the common sense of the public in general.

In the erection of a building, the uses to which it is to be applied should be clearly understood, and provision definitely made for every desired object.

Modern architecture is not a fine art par excellence, like painting or sculpture, the object of the latter is to produce a moral emotion, or awaken the feelings of the sublime or the beautiful, and we egregiously err when we apply their productions to a merely utilitarian purpose. To make a fire screen of Rubens' Madonna, or a candelabrum of the statue of the Apollo Belvidere, would be to debase these exquisite productions of genius, and to do violence to the feelings of the cultivated lover of art. Modern buildings are made for other purposes than artistic effect, and in them the æsthetical must be subordinate to the useful; then the two may coexist, and an intellectual pleasure be derived from a sense of adaptation and fitness, combined with a perception of harmony of parts and the beauty of detail.

The buildings of a country should be an ethnological expression of the wants, habits, art and sentiment of the time in which they are erected. Those of Egypt, Greece and Rome were intended at least in part, without the art of printing, to transmit to posterity an idea oi the character of the periods in which they were erected. It was by such monuments that these nations sought to impress an idea of their religious and political sentiment on future ages.

The Greek architect was untrammelled by any condition of utility. Architecture was with him, in reality, a fine art. The temple was formed to gratify the popular deity. The minutest parts were exquisitely finished, since nothing but perfection on all sides, and in the smallest particular, can gratify an all seeing and critical eye. It was intended for external worship, and not internal use. It was without windows, and entirely open to the sky, or if closed with a roof the light was merely admitted through a large door. There were no arrangements for heating or ventilation. The uses, therefore, to which, in modern times, buildings of this kind can be applied, are exceedingly few; and though they were objects of great beauty and fully realised the intention of the architect when originally constructed, yet they cannot be copied in our days without violating the principles which should govern in architectural adaptation.

Every vestige of ancient architecture which now remains on the face of the earth should be preserved with religious care; but to servilely copy those, and to attempt to apply them to the uses of our day, is as preposterous as to attempt to harmonize the refinement of civilization of the present age with the superstition of the times of the Pharaohs. It is only when a building expresses the dominant sentiment of an age, when a perfect adaptation to its use is joined to harmony of proportions and an outward expression of its character, that it is entitled to our admiration. It has been aptly said that it is one thing to adopt a particular style of architecture, but a very different one to adapt it to the purpose intended.

Architecture should not only change with the character of the people, and in some cases with the climate, but also with the material to be employed in construction. The introduction of iron and of glass requires an entirely different style from that which sprung from the caves of Egypt, the masses of marble from which the lintels of the Grecian temples are formed, or the introduction of brick by the Romans.

The great tenacity, and power of resistance to crushing, of iron as a building material, should point out for it a far more slender and apparently lighter arrangement of parts. An entire building of iron, fashioned in imitation of stone, might be erected at small expense of invention on the part of the architect, but would do little credit to his truthfulness or originality. The same may be said of our modern pasteboard edifices, in which, with their battlements, towers, pinnacles, "fretted roofs and long drawn aisles," cheap and transient magnificence is produced by painted wood or decorated plaster. I must not, however, indulge in remarks of this kind, but must curb my feelings in regard to this subject, since I speak from peculiar experience.

But to return to the subject of acoustics as applied to apartments intended for public speaking. While sound, in connection with its analogies with light, and in its abstract principles, has been investigated within the last fifty years with a rich harvest of results, few attempts have been successfully made to apply these principles to practical purposes. Though we may have a clear idea of the abstract operation of a law of nature, yet when the conditions are varied and the actions multiplied, the results frequently transcend our powers of logic, and we are obliged to appeal to experiment and observation, not only to assist in deducing consequences, but also to verify those which have been arrived at by logical deduction. Furthermore, though we may know the manner in which a cause acts to produce a given effect, yet in all cases we are obliged to ascertain the measure of effect under given conditions.

The science of acoustics as applied to buildings, perhaps more than any other, requires this union of scientific principles with experimental deductions. While on the one hand the simple deductions from the established principles of acoustics would be unsafe from a want of knowledge of the constants which enter into our formula, on the other hand empirical data alone are in this case entirely at fault, and of this any person may be convinced who will examine the several works written on acoustics by those who are deemed practical men.

Sound is a motion of matter capable of affecting the ear with a sensation peculiar to that organ. It is not in all cases simply a motion of the air, for there are many sounds in which the air is not concerned. For example, the impulses which are conveyed along a rod of wood from a tuning fork to the teeth. When a sound is produced by a single impulse, or an approximation to a single impulse, it is called a noise—when a series of impulses, a continued sound, &c.; if the impulses are equal in duration among themselves, a musical sound. This has been illustrated by a quill striking against the teeth of a wheel. A single impulse from one tooth is a noise, from a series of teeth in succession a continued sound, and if all the teeth are at equal distances, and the velocity of the wheel is uniform, then a musical note is the result. Each of these sounds is produced by the human voice, though they apparently run into each other. Usually, however, in speaking, a series of irregular sounds of short duration are omitted—each syllable of a word constitutes a separate sound of appreciable duration, and each compound word and sentence an assemblage of such sounds. It is astonishing that in listening to a discourse the ear can receive so many impressions in the course of a second, and that the mind can take cognizance of and conquer them.

That a certain force of impulse, and a certain time for its continuance are necessary to produce an audible impression on the ear is evident; but it may be doubted whether the impression of a sound on this organ is retained appreciably longer than the continuance of the impulse itself. Certainly not longer than the 1-10th of a second. If this were the case, it is difficult to conceive why articulate discourse which so pre-eminently distinguishes man from the lower animals, should not fill the ear with a monotonous hum; but whether the ear continues to vibrate, or whether the impression remains a certain time on the *sensorium*, it is certain that no sound is ever entirely instantaneous, or the result of a single impression, particularly in inclosed spaces. Every impulse must give rise to a forward, and afterwards to a backward motion of the atom. The impulse is not only communicated to the ear but to all bodies around, which, in turn, themselves become centres of reflected impulses.

Sound, from a single explosion in air equally elastic on all sides, tends to expand equally in every direction; but when the impulse is given to the air in a single direction, through an expansion taken place on all sides, it is much more intense in the line of the impulse. For example, the impulse of a single explosion, like that of the detonation of a bubble of oxygen, is propagated equally in all directions; while the discharge of a cannon, while heard on every side, is much louder in the direction of the axis; so, also, a person speaking is heard much more distinctly in front than at an equal distance behind. Many experiments have been made on this point, and I may mention those repeated in the open space in front of the Smithsonian Institution. In a cir 'e one hundred feet in diameter, the speaker in the centre and the hearers in succession at different points of the circumference, the voice was heard distinctly directly in front, gradually less so on either side, until in the rear it was scarcely audible. The rates of distance for distinct hearing directly in front, on the sides, and in the rear, were about as 100, 75 and 30.

Those numbers may serve to determine the form in which an audience should be arranged in an open field, in order that those on the periphery of the space may all have a like favorable opportunity of hearing, though it should not be recommended as the interior form of an apartment, in which a reflecting wall would be behind the speaker.

The impulse producing sound requires time for its propagation, and thus depends upon the intensity of repulsion among the atoms; and, secondly, on the specific purity of the matter itself. If the medium were entirely rigid, sound would be propagated instantaneously. The weaker the repulsion between the atoms, the greater will be the time required to transmit the motion from one to the other; and the heavier the atoms the greater will be the time required for the action of a given force to produce in them a given amount of the motion. Sound, also, in meeting an obstacle, is reflected in accordance with the law of light, making the angle of incidence equal to the angle of reflection. The tendency, however, to a divergency in a single beam of sound, appears to be much greater than that in the case of light. The law, however, appears to be definitely observed in the case of all beams that are reflected in a direction near the perpendicular. It is on the law of the propagation and reflection of sound, that the philosophy of echo depends Knowing the velocity of sound, it is an easy matter to calculate the interval of time which elapses between the original impulse and the return of the echo. Sound moves at the rate of 1,125 feet in a second at the temperature of 60 degrees. If, therefore, we stand at half this distance before a wall, the echo will return to us in one second. It is, however, a fact known from universal experience, that no echo is perceptible from a near wall, though one in all cases must be sent back to the ear; the reason of this is that the ear cannot distinguish the difference between the similar sounds, as, for example, that from the original impulse and its reflection, if they follow each other at less than a given interval, which can only be determined by actual experiment; and as this is an important element in the construction of buildings, the attempt was made to determine it, with some considerable degree of accuracy. For this purpose the observer was placed immediately in front of the wall of the west end of the Smithsonian building, at the distance of 100 feet; the hands were then clapped together; a distant echo was perceived, the elapsed time of the passage of the impulse from hand to ear, and that from the hand to the wall and back to the ear was sufficiently great to produce two entirely distinct impressions. The observer then gradually approached the building until no echo or perceptible prolongation of the sound was observed. By accurately measuring this distance, and doubling it, we find the interval of space within which two sounds may follow each other without appearing separately. But if two rays of sound reach the ear, without having passed through distances differing from each other greater than this, they produce the effect of separate sounds. This distance we have called the limit of perceptibility in terms of space. If we divide this distance into the velocity of sound, we ascertain the limit of perceptibility in time.

In the experiment just made with the wall, a source of error was discovered, in the fact that a portion of the sound returned was reflected from the cornice under the eaves, and as this was at a greater distance than the part of the wall immediately perpendicular to the observer, the moment of the cessation of the echo was less distinct. In subsequent experiments with a louder noise the reflection was observed from a perpendicular surface of about twelve feet square, and from this more definite results were obtained. The limit of the distance in this case was about thirty-five feet, varying slightly, perhaps, with the intensity of the sound and the acuteness of different ears. This will give about one-sixteenth of a second as the limit of time at which the ear can separately distinguish two similar sounds. From this experiment we learn that the reflected sound may tend to strengthen the impression or to confine it, according as the difference of time between the two impressions is greater or less than the limit of perceptibility. An application of the same principle gives us the explanation of some phenomena of sound which have been considered mysterious. Thus, in the reflection of an impulse from the edge of a forest of trees, each leaf properly situated within a range of thirty feet of the front plane of reflection, will conspire to produce a distinct echo, and these would form the principal part of the reflecting surfaces of a dense forest, for the remainder would be screened, and being a greater distance every ray which might come from them would serve to produce merely a low continuation of the sound.

On the same principle we may at once assert that the pannelling of a room, or even the introduction of reflecting surfaces at different distances, will not prevent the echo, provided they are parallel to each other, and situated relatively to each other within the limit of perceptibility.

Important advantage may be taken of the principle of the reflection of sound by the proper arrangement of the reflecting surfaces behind the speaker. We frequently see in churches, as if to diminish the effect of the voice of the preacher, a mass of drapery placed directly in the rear of the pulpit. However important this may be in an æsthetical point of view, it is certainly at variance with correct acoustic arrangements—the great object of which should be to husband every articulation of the voice, and to transmit it unmingled with their impulses, and with as little loss as possible to the ears of the audience.

Another effect of the transmission and reflection of sound, is that which is called reverberation, which consists of a prolonged musical sound, and is much more frequently the cause of indistinctness of perception of the articulations of the speaker than the single echo.

Reverberation is produced by repeated reflection of a sound from the walls of the apartment. If, for example, a single detonation takes place in the middle of a long hall, with naked and perpendicular walls, an impulse will pass in each direction, will be reflected from the walls, cross each other again at the point of origin, be again reflected, and so on until the original impulse is entirely absorbed by the solid materials which confine it. The impression will be retained upon the ear during the interval of the transmission past it of two successive waves, and thus a continued sound will be kept up, particularly if the walls of any part of the room are within thirty-five feet of the ear. If a series of impulses, such as those produced by the rapid snaps of the teeth of a wheel against a quill, be made in unison with the echoes, a continued musical sound will be the result. Suppose the wheel to be turned with such velocity as to cause a snap at the very instant the return echo passes the point at which the apparatus is placed, the second sound will combine with the first, and thus a loud and sustained vibration will be produced. It will be evident from this that every room has a key note, and that if an instrument be sounded on this, it will resound with great force. It must be apparent also that the continuance of a single sound and the tendency to confusion in distinct articulation will depend on several conditions—first, on the size of the apartment; second, on the strength of the sound, or the intensity of the impulse; third, on the position of the reflecting surface; and, fourth, on the nature of the material of the reflecting surfaces.

In regard to the first of these, the larger the room, the longer time will be required for the impulse to reach the wall along the axis; and if we suppose that at each collision a portion of the original force is absorbed, it will require double the time to totally extinguish it in a room of double the size, because the velocity of sound being the same, the number of collisions in a given time will be inversely as the distance through which the sound has to travel.

Again, that it must depend upon the loudness of the sound, or the insecurity of the impulse must be evident, when we consider that the cessation of the reflections is due to the absorption of the walls, or irregular reflection, and that consequently the greater the amount of original disturbance the longer will be the time required for its complete extinction. This principle was abundantly shown by our observations on different rooms.

Thirdly, the continuance of the resonance will depend upon the position of the reflecting surfaces. If these are not parallel to each other, but oblique, so as to reflect the sound, not to the opposite but to the adjacent wall, without passing through the longer axis of the room, it will evidently be sooner absorbed. Any obstacle also which may tend to break up the wave and interfere with the reflection through the axis of the room, will serve to lessen the resonance of the apartment. Hence, though pannelling the ceiling and introducing a variety of oblique surfaces may not prevent an isolated echo, provided the distance be sufficiently great and the sound sufficiently loud, yet that they do have an important effect in stopping the resonance is evident from theory and experiment. In a room fifty feet square, in which the resonance of a single intense sound continued six seconds, when cases and other objects were placed around the wall, its continuance was reduced to two seconds.

Fourthly, the duration of the resonance will depend on the nature of the material of the wall. A reflection always takes place at the surface of a new medium, and the amount of this will depend on the elastic force or power to resist compression and the density of the new medium. For example, a wall of nitrogen, if such could be found, would transmit nearly the whole of a wave of sound in air, and reflect but a very small portion. A partition of tissue paper would produce nearly the same effect. A polished wall of steel, however, of sufficient thickness to prevent yielding would reflect, for practical purposes, all the impulses through the air which might fall upon it. The rebound of the wave is caused, not by the oscillation of the wall, but the elasticity and mobility of the air. A single ray of sound striking against a yielding board would probably increase the loudness of the reverberation, but not its continuance. On this point a series of experiments were made by the use of the tuning fork. In this instrument the motion of the foot and of the two prongs give a sonorous vibration to the air, which, if received upon another tuning fork of precisely the same size and form, would reproduce the same vibrations.

It is a fact well established by observation, that when two bodies are in perfect unison, and separated from each other by a space filled with air, the vibrations of the one will be transmitted to the other. From this consideration it is probable that very nearly the same effect ought to be produced in transmitting immediately the vibration of a tuning fork to a reflecting body as to duration and intensity, as in the case of transmission through air. This conclusion is strengthened by floating a flat piece of wood in a vessel of water standing upon a sounding board; placing a tuning fork on this, the vibrations will be transmitted to the board through the water, and sounds will be produced of the same character as those emitted when the tuning fork is placed directly on the board. A tuning fork was suspended from a fine cambric thread, vibrated in air, and, from the mean of a number of experiments, was found to continue in motion 252 seconds. In this experiment, had the tuning fork been in a perfect vacuum, suspended without the use of a string, and further, had there been no etherial medium, the agitation of which would give rise to light, heat, electricity, or some other form of etherial motion, the fork would continue its vibration forever.

The fork was next placed upon a large thin pine board—the top of a table. A loud sound, in this case, was produced, which continued less than ten seconds. The whole table, as a system, was thrown into motion, and the sound produced was as loud on the under side as on the upper side. Had the tuning fork been placed upon a partition of this material, a loud sound would have been heard in the adjoining room; this was proved by sounding the tuning fork against a door leading into a closed closet. The sound within was apparently as loud as that without.

The rapid decay of sound in this case was produced by the great amount of the motive power of the fork being communicated to a large mass of wood. The increased sound was due to the increased surface. In other words, the shortness of duration was compensated for by the greater intensity of effect produced.

The tuning fork was next placed upon a circular slab of marble: about three feet in diameter and three-fourths of an inch thick; the sound emitted was feeble, and the undulations continued 115 seconds, as deduced from the mean of six experiments.

In all these experiments, except the one in vacuum, the time of the cessation of the tuning fork was determined by bringing the mouth of a resounding cavity near the end of the fork; this cavity, having previously been adjusted to unison with the vibrations of the fork, gave an audible sound when none could be heard by the unaided ear.

The tuning fork was next placed upon a cube of India rubber, and this upon the marble slab. The sound emitted in this case was scarcely that in the case of the tuning fork suspended from the cambric thread; and from this anology of the previous experiments we might at first thought suppose the time of duration would be great—but this was not the case; the vibrations continued only forty seconds.

The question may here be asked what became of the impulses lost by the tuning fork? They were neither transmitted to the India rubber, nor given off to the air in the form of a sound, but were probably expended in producing a change in the matter of the India rubber, or were converted into heat, or both. Though the inquiry did not fall strictly within the line of this series of investigations, yet it was of so interesting a character, in a physical point of view, to determine whether heat was actually produced, that the following experiment was made:—

A cylindrical piece of India rubber, about 1¼ inches diameter, was placed in a tubulated bottle with two openings, one near the bottom and the other at the top; a stuffing box was attached to the upper, through which a metallic stem, with a circular foot to press upon the India rubber, was made to pass, air tight. The lower tubular was closed with a cork, in the perforation of which a fine glass tube was cemented; a small quantity of red ink was placed in the hole to serve as an index. The whole arrangement thus formed a kind of thermometer, which would indicate a certain amount of change of temperature in the inclos[ed a]ir. On the top of the stem the tuning fork was screwed, and consequently its vibrations were transmitted to the rubber within the bottles. The glass was surrounded with several coatings of flannel to prevent the influence of the external temperature. The tuning fork was then sounded, and the vibrations were kept up for some time. No reliable indications of an increase of temperature were observed. A more delicate method of making the experiment next suggested itself. The tube containing the drop of red ink, with its cork, was removed, and the point of a compound wire formed of copper and iron was thrust into the substance of the rubber, whilst the other ends of the wire were connected with a delicate galvanometer. The needle was suffered to come to rest. The tuning fork was then vibrated, and its impulses transmitted to the rubber. A very perceptible increase of temperature was the result. The needle moved through an arc from one to two and a half degrees. The experiment was varied, and many times repeated; the motions of the needle were always in the same direction, viz: in that which was produced when the point of the compound wire was heated by momentary contact with the fingers. The amount of heat generated in this way is, however, small, and, indeed in all cases in which it is generated by mechanical means, the amount evolved appears very small in comparison with the labor expended in producing it. Jule has shown that the mechanical energy generated in a pound weight, by falling through a space of 750 feet, elevates the temperature of a pound of water one degree.

It is evident that an object like India rubber actually destroys a portion of the sound, and hence in cases in which entire non-conduction is required, this substance can probably be employed with perfect success.

The tuning fork was next pressed upon a solid brick wall. The duration of vibration, from a number of trials, was eighty-eight seconds. Against a wall of lath and plaster the sound was louder, and continued only eighteen seconds.

From these experiments we may infer that if a room were lined with a wainscot of thin boards, and a space left between the wall and the wood, the loudness of the echo of a single noise would be increased, while the duration of the echo would be diminished. If, however, the thin board were glued or cemented in solid connection to the wall, or embedded in the mortar, then the effect would be a feeble echo, and a long continued resonance similar to that from the slab of mable. This was proved by first determining the length of continuance of the vibrations of a tuning fork on a thin board, which was cemented to a flat piece of marble.

A series of experiments were next commenced with reference to the actual reflection of sound. For this purpose a parabolic mirror was employed, and the sound from a watch received on the mouth of a hearing trumpet, furnished with a tube for each ear. The focus was near the apex of the parabola, and when the watch was suspended at this point, it was six inches within the plane of the outer circle of the mirror. In this case the sound was confined at its origin and prevented from expanding. No conjugate focus was produced, but, on the contrary, the rays of light, when a candle was introduced, constantly diverged. The ticking of the watch could not be heard at all when the ear was applied to the outside of the mirror, while directly in front it was distinctly heard at the distance of thirty feet, and, with the assistance of the ear trumpet, at more than double that distance. When the watch was removed from the focus the sound ceased to be audible. This method of experimenting admits of considerable precision, and enables us to directly verify, by means of sound transmitted through air, the results anticipated in the previous experiments. A piece of tissue paper placed within the mirror, and surrounding the watch without touching it, slightly diminished the reflection. A simple curtain of flannel produced a somewhat greater effect, though the reflecting power of the metallic parabola was not entirely masked by the thicknesses of flannel, and I presume very little change would have been perceived had the reflector been lined with flannel glued to the surface of the metal. The sound was also audible at the distance of ten feet, when a large felt hat, without stiffening, was interposed between the watch and the mirror. Care was taken in these experiments so to surround the watch that no ray of sound could pass directly from it to the reflecting surface.

With a cylindrical mirror with parabolic base very little increased reflection was perceived. The converging beams were merely in this case in a simple plane perpendicular to the mirror, and passing through the ear, while, to the focal point of the spherical mirror, a solid cone of rays was sent.

The reflection from the cylindrical mirror forms what is called a "caustic" in optics, while that from a spherical mirror gives a true focus, or, in other words, collects the sound from all parts of the surface and conveys them to one point of space. These facts furnish a ready explanation of the confusion experienced in the Hall of Representatives, which is surmounted by a dome, the under surface of which acts as an immense concave mirror, reflecting to a focus every sound which ascends to it, leaving other points of space deficient in sonorous impulses.

Water and other liquids, which offer great resistance to compression, are good reflectors of sound. This may be shown by the following experiment:—When water is gradually poured into an upright cylindrical vessel, over the mouth of which a tuning fork is vibrated until it comes within a certain distance of the mouth, it will reflect an echo in unison with the vibrations of the fork, and produce a loud resonance. This result explains the fact, which had been observed with some surprise, that the duration of the resonance of a newly plastered room was not perceptibly less than that of one which had been thoroughly dried.

There is another principle of acoustics which has a bearing on this subject. I allude to the refraction of sound. It is well known that when a ray of sound passes from one medium to another, change in velocity takes place, and consequently a change in the direction or refraction must be produced. The amount of this can readily be calculated where the relative velocities are known. In rooms heated by furnaces, and in which streams of heated air passed up between the audience and speaker, a confusion has been supposed to be produced, and distinct hearing interfered with by this course. Since the velocity of sound in air at 32 degrees of Fahrenheit has been found to be 1,090 feet in a second, and since the velocity increases 1.14 feet for every degree of Fahrenheit, if we know the temperature of the room and that of the heated current, the amount of angular refraction can be ascertained. But since the ear does not readily judge of the difference of direction of two sounds emanating from the same source, and since two rays do not confuse the impression which they produce upon the ear, though they arrive by very different routes, provided they are within the limit of perceptibility, we may therefore conclude that the indistinctness produced by refraction is comparatively little. Professor Bache and myself could perceive no difference in distinctness in hearing from rays of sound passing over a chandelier of the largest size, in which a large number of gas jets were in full combustion. The fact of disturbance from this cause, however, if any exist, may best be determined by the experiment with a parabolic mirror and the hearing trumpet before described.

These researches may be much extended; they open a field of investigation equally interesting to the lover of abstract science and to the practical builder, and I hope on behalf of the committee, to give some further facts with regard to this subject at another meeting.

I will now briefly describe the lecture room which has been constructed in accordance with the facts and principles stated above, so far, at least, as they could be applied.

There was another object kept in view in the construction of this room besides the accurate hearing; the distinct seeing. It was desirable that every person should have an opportunity of seeing the experiments which might be performed as well as hearing distinctly the explanation of them.

By a fortunate coincidence of principles, it happens that the arrangements for ensuring unobstructed sight do not interfere with those necessary for distinct hearing.

The law of Congress authorizing the establishment of the Smithsonian Institution directed that a lecture room should be provided, and accordingly in the first plan one-half of the first story of the main building was devoted to this purpose. It was found, however, impossible to construct a room on acoustic principles in this part of the building which was necessarily occupied by two rows of columns. The only suitable place which could be found was therefore on the second floor. The main building is 200 feet long and 50 feet wide; but by placing the lecture room in the middle of the story a greater width was obtained by means of the projecting towers.

The main gallery is in the form of a horse shoe, and occupies three sides of the room. The speaker's platform is placed between two oblique walls. The corners of the room which are cut off by these walls afford recesses for the stairs into the galleries. The opposite corners are also partitioned off so as to afford recesses for the same purpose.

The ceiling is twenty-five feet high, and therefore within the reach of perceptibility. It is perfectly smooth and unbroken, with the exception of an oval opening near the platform, through which light is admitted.

The seats are arranged in a curved form, and were intended to rise in accordance with the panoptic curve originally proposed by Professor Bache, which enables every individual to see over the head of the person immediately in front of him. The original form of the room, however, did not allow of this intention being fully realised, and therefore the rise is rather less than the curve would indicate. The general appearance of the room is somewhat fan-shaped, and the speaker is placed as it were in the mouth of an immense trumpet. The sound directly from his voice, and that from reflection immediately behind him, is thrown forward upon the audience, and as the difference of the distance travelled by the two rays is much within the limit of perceptibility, no confusion is produced by direct and reflected sound. No echo is given off from the ceiling, for this is also within the limit of perceptibility, while it assists the hearing in the gallery by the reflection to that place of the oblique rays.

Again, on account of the oblique walls behind the speaker, and the multitude of surfaces, including the gallery pillars, stair screens, &c., as well as the audience, directly in front, all reverberation is stopped.

The walls behind the speaker are composed of lath and plaster, and therefore have a tendency to give a more intense though less prolonged sound than if of solid masonry. They are also intended for exhibiting drawings to the best advantage.

The architecture of this room is due to Captain Alexander, of the Corps of Topographical Engineers. He fully appreciated all the principles of sound which I have given, and varied his plans until all required conditions, as far as possible, were fulfilled.

CANADIAN INSTITUTE.

Session—1856-57.

FIRST ORDINARY MEETING—*Saturday, 6th December*, 1856.

E. A. Meredith, Esq., LL.B., Vice President, in the Chair

The following Gentlemen, provisionally elected by the Council during the recess, were Balloted for and declared duly elected Members :

A. T. Augusta, Esq., Yonge St., Toronto.
Robt. Armour, Esq., Bowmanville, C. W.
Isaac Buchanan, Esq., Hamilton, C. W.
James Brown, Esq., Toronto, C. W.
J. Beatty, Junr., Esq., M. D., Cobourg, C. W.
G. G. Bird, Esq., M. D., Bowmanville, C. W.
Rev. R. G. Cox, Wellington, P. E. District, C.W.
Ed. Fitzgerald, Esq., Toronto, C. W.
A. J. Fergusson, Esq., M.P.P., Guelph, C. W.
Rev. Robt. Irvine, D.D., Hamilton, C. W.
Edgar J. Jarvis. Esq., Toronto, C. W.
Rev. Professor Kendall, Trinity College, Toronto, C. W.
Rev. J. Laing, Scarborough, C. W.
H. H. Meredith, Esq., Port Hope, C. W.
Dan. McLellan, Esq., Hamilton. C. W.
John McBride, Esq., Toronto, C. W.
Revd. D. Pierce, Kingston, C. W.
J. P. Russell, Esq., M.D., Quebec, C. E.
J. W. Tate, Esq., Belleville. C. W
W. G. Tomkins, Esq., C. E., Hamilton, C. W,
Major F. Wells, 1st Royal Regiment of Foot.
Rev. W. S. Darling, Toronto, C. W.
Hon. L. T. Drummond, M. P. P. Montreal, C. E.

William Hewson, Esq., Whitby, C. W.
R. Sandars, Esq., Trinity College, Toronto, C. W.
Dr. Charles Sewell, Toronto, C. W.
J. F. Smith, Toronto, (Junior Member).

The donations to the Library and Museum received since the last ordinary meeting, were laid upon the table. The Secretary was instructed to include a record of them in the Annual Report, and to communicate the thanks of the Institute to the Donors for their valuable contributions.

Professor Cherriman gave the requisite notice of motion of an amendment to Regulation 4. Sec. II., touching the amount payable to constitute Life Membership; and Dr. Wilson to Regulation 1. Sec. VII., for the addition of a third Vice-President to the office bearers in accordance with the terms of the Charter.

The following Papers were read:

1. By Capt. William Kennedy:

"On the proposed expedition to the Arctic Regions in further search of the records or remains of Sir John Franklin."

2. By the Rev. W. A. Adamson, D.C.L.:

"On the decrease, restoration, and preservation of the Salmon in Canada."

SECOND ORDINARY MEETING—13*th December*, 1856.

James Bovell, M. D., Vice-President, in the Chair.

The following Gentlemen were elected Members:

Thomas M. Clark, Esq., Toronto.
Hon. James Patton, M.A., Barrie, C. W.
Beverly Robinson Morris, Esq., M. D., Toronto.
W. Loring Cillery, Esq., Toronto.
William Shirrefs, Esq., Toronto.
A. S. Kirkpatrick, Esq., Toronto.
Christopher Paterson, Esq., Barrister, Toronto.

The following Donations were then announced, and the thanks of the Institute voted to the Donors:

From the Secretary of the School of Mines, Paris:

Annales des Mines, 5e Serie, Tome VI. 5e Livraison de 1854—55.
Do. do. VII. 1re, 2e, 3e Livraison de 1855.

From the Regents of the University *ex-officio* Trustees of the State Library, in behalf of the State of New York.

Documents relating to the Colonial History of the State of New York. Vols. III., IV. and VII.

Annual Report of the Trustees of the New York State Library, 22nd January, 1856.

Science and Religion—Sermon delivered in Albany during the Session of the American Association for the advancement of Science: by the Rev. Bishop Hopkins, D.D.

Religious Bearing of Man's Creation. Discourse delivered in Albany during the Session of the American Association for the advancement of Science: by Edward Hitchcock, D.D., LL.D.

From D. Appleton & Co., New York—

Milledulcia ; A Thousand Pleasant Things selected from "Notes and Queries."

From Harper & Brothers, Publishers, New York—

New Granada—Twenty Months in the Andes, by Isaac F. Holton, M. A., with maps and illustrations.

Beaumarchais and his Times—French Society in the Eighteenth Century, by Louis de Leménie, translated by Henry S. Edwards.

Lake Ngami—Wanderings in South Western Africa, by Charles J. Andersson.

From A. H. Armour, Esq.,—

Almanach de Gotha, 1856.

Montreal in 1856, a Sketch prepared for the Opening of the Grand Trunk Railway of Canada ; Pamphlet.

From Rev. J. M. Phillippo, per Prof. Croft—

Transactions of the Society of Arts, Jamaica, for year 1854-5.

The following Communications were read:

1. By Professor Chapman:
   "A description of some Trilobites found at Whitby; *illustrated by specimens.*"
2. By James Gilbert:
   "On the Arizara Copper Mine, accompanied with specimens of Ore from the California Mines."

The requisite nominations of office-bearers for the ensuing year were made, and the Vice-President announced that on the following Saturday, the Annual General Meeting would take place at Seven P. M., to receive the report of the Council, elect the officers and members of Council for the ensuing year, and for other business.

ANNUAL GENERAL MEETING—*Saturday, 20th December,* 1856.

E. A. MEREDITH, LL.B., Vice-President, in the Chair,

The following Gentlemen were elected Members :

HUGH THOMSON, Esq., Toronto,
JAMES W. DUNSFORD, Esq., Verulam, C. W.
CHARLES F. GILDERSLEEVE, Esq., Toronto.
WILLIAM BALDWIN SULLIVAN, Esq., Toronto.
JOHN HEAD, Toronto. *(Junior Member.)*

The following Communications were read:

1. By Professor Croft, D. C. L.,:
   "Notes on the Oxalate of Manganese."
2. By Joseph Robinson, Esq.,:
   "On a Process for Preserving Timber from Decay."
3. By James Bovell, M. D.,:
   "On Cell Developement."
4. By R. T. Pennefather, Esq.,:
   "Notes of a Journey made by Governor Simcoe, from Niagara to Detroit, in 1793."

Prof. Cherriman, in accordance with previous notice, moved:

That Rule 4, Sec. II., shall be amended by erasing the sum of £7 10s. and substituting therefor £10, as the sum payable by Members for Life—Carried.

Dr. Wilson, in accordance with previous notice, moved:

That in Rule 7, of Section II., the words "and third" be added after "second" so as to admit of the election of a third Vice-President in accordance with the provisions of the Charter.—Carried.

The Report of the Council for the year 1855-56, was then read as follows:

ANNUAL REPORT OF THE COUNCIL, 1856.

The Council of the Canadian Institute have the honor to submit the following Report of the proceedings of the Institute during the past year.

The Council have the highest satisfaction in announcing that upwards of one hundred and fifty names have been added to the list of Members since the date of the last Annual Report, and that the accessions thus made to the numerical strength of the Institute indicate not only local, but widely spread interest and co-operation.

The total number of Members of the Institute now amount to five hundred, of whom it may be interesting to note that there are: 370 residents of Toronto, 162 of other parts of Upper Canada, 33 of Lower Canada, and 10 Foreign Members: thus establishing the Institute as provincial rather than local in its character.

The Council have continued to make such additions to the Library by purchase as the funds at their command would seem to justify; and they trust that those additions, comprising nearly one hundred volumes of completed Works—independent of periodical literature—will commend their efforts in this particular to the approval of the Institute.

The Council have great pleasure in submitting the list of Donations made to the Library during the past year, indicative not only of extended interest in this important branch of our efforts, but illustrating continued and very remarkable liberality on the part of Donors to whom the Institute had before been largely indebted. Although anxious to avoid invidious references where so many are entitled to the acknowledgments of the Institute, the Council are warranted in particularly noting the generous contributions of the Honorable J. M. Brodhead of Washington, a valuable donation, including 25 volumes; of Mr. Bohn of London, England, including 58 volumes; and of Dr. Chewett of Toronto, including 57 volumes; to each of whom the Institute is especially indebted for large and very valuable additions to its collection, of a class of works peculiarly suited to the objects which the Institute is chiefly designed to promote. By the various additions thus made to the Library, its value for the purposes of reference has been considerably increased, and it now embraces a collection of upwards of seventeen hundred volumes, the great majority of which are of a scientific or practical character.

In the last annual Report for the year 1855-6, the Council expressed their regret that no addition to the Museum had been made during the year then closing. It is therefore with greater satisfaction that the Council have now to acknowledge the receipt of contributions:—the list of which, embracing various specimens in Geology and Natural History, and a small collection of fifty-five silver coins, including those of Edward II., III., and VI., and Queen Elizabeth, will be enumerated in the classified catalogue,—not only because of the value attaching to these donations, but as justifying the hope that the collection may be early augmented to a standard of usefulness.

The practical value of such collections depends so largely on facility for reference, that members of the Council have engaged in the preparation of classified catalogues of the Library and Museum—and such measures have been taken as warrant the assurance that these will be completed for use during the present session.

The Council have further to announce that, in fulfilment of the conditions annexed to the acquisition of the valuable library of the Athenæum, referred to in last Report, arrangements have been effected under which the public may visit and consult the Library of the Institute daily between the hours of three and five o'clock; and that a book has been opened wherein Members are invited to enter the title of any work which they recommend to the Council for purchase.

By these measures it is hoped that the Library, already of very considerable value, may become of more direct and continuous utility to our members and the public at large, whil the interest thus excited may direct attention, not only to its possessions, ... to its deficiencies, and thus may result in increasing and more general efforts in aid of its extension, as well as in the augmentation of the Institute's collections of specimens of Natural History, Minerals, and other objects of scientific interest and value, so as ultimately to render both the Library and Museum creditable to the Institute and beneficial to the Province at large.

In submitting the list of communications read at the meetings of the Institute during the session, 1855-56, the Council are gratified in being able to note that, whilst the number of papers read last year was largely in excess of that reported for the preceding session, the proportion emanating from the general body of Members of the Institute, as distinguished from Members of the Council, has also been considerably augmented : an evidence of growing co-operation which the Council regard as most important and satisfactory ; and giving promise, as they trust, of still further and more effective manifestation of activity during future Sessions.

Prof. Croft. D. C. L.—"On the Hydrates of Hydro Sulphuric Acid. 1st December, 1855.

Prof. Wilson, LL. D.—"On displacement and extinction among the Primeval Races of Man." 1st December, 1855.

Prof. Chapman.—"On a method of representing Crystaline Forms." 8th December, 1855.

Prof. Bovell, M. D.—"On some points in the Natural History of the Leech." 15th December, 1855.

J. G. Hodgins, Esq.—"On a specimen of the *Proteus of the Lakes.*" 15th December, 1855.

Capt. Noble, R. A., F. R. S.—"On the value of the Factor in the Hygrometric Formula." 12th January, 1856.

Professor Cherriman, M. A.—"On a method of reducing the general equation of the second degree in Plane Co-ordinate Geometry." 12th January, 1856.

Professor Chapman.—"Report of the *Committee* appointed to examine the specimen of the Proteus exhibited before the Institute." 12th January, 1856.

Prof. Croft, D. C. L.—"On some new salts of Cadmium and on the Iodides of Barium and Strontium." 12th January, 1856.

Rev. Prof. Young, M. A.—"On Professor Ferrier's Theory of Knowing and Being." 19th January, 1856.

Major Lachlan.—"Communication relative to a simultaneous system of Meteorological observations throughout the Province, including a letter on the subject from Prof. Henry, Secretary of the Smithsonian Institute." 19th January, 1856.

G. W. Allan, Esq.—"The President's Address." 26th January, 1856.

J. G. Hodgins, Esq.,—"On the steps which have been taken by the Educational Department to establish a System of Meteorological Stations throughout Upper Canada." 26th January, 1856.

W. D. Campbell, Esq.—A method of determining the errors below 32° Fahr. of mercurial Thermometers which have been compared and corrected above the freezing point." 26th January, 1856.

Prof. Wilson, LL.D.—"Traces of the Ancient Miners of Lake Superior." 26th January, 1856.

J. Brown, Esq.—"On the Aborigines of Australia." 2nd February, 1856.

Prof. Kingston, M. A.—"Meteorological Report for 1855." 2nd February, 1856.

Rev. Prof. Young, M. A.—"Brief Notes on certain statements of Sir Wm. Hamilton, regarding the validity of our Primary Beliefs." 9th February, 1856.

Prof. Wilson, LL.D.—"Remarks on a singular conformation of the land, produced by the confluence of the St. Louis and Nemagi Rivers into Lake Superior." 9th February, 1856.

Prof. Chapman.—"Report on Minerals lately received from the Toronto Athenæum." 9th February, 1856.

G. W. Allan, Esq., President.—"On the Migratory Birds of Canada." 16th February, 1856.

J. Brown, Esq.—"On the Manners and Customs of the Aborigines of Australia." 2nd part. 16th February, 1856.

Thos. Reynolds, M. D.—"On a collection of Copper implements found in the neighbourhood of Brockville." 16th February, 1856.

S. Fleming, Esq., C. E.—"The Geological Survey of Canada." 23rd February, 1856.

Prof. Chapman.—"On the Classification of Trilobites." 23rd February, 1856.

Rev. A. C. Geikie.—"An enquiry into the Causes of Deterioration in the population of New England." 23rd February, 1856.

P. MacGregor, Esq.—"On the Climate of Canada." 1st March, 1856.

Prof. Wilson, LL.D.—"On the Pictured Rocks of Lake Superior." 1st March, 1856.

Prof. Croft, D. C. L.—"On the specific gravity and analysis of Copper Instruments found in the neighbourhood of Brockville." 1st March, 1856.

Prof. Hind, M. A.—"On the Blue Clay of Toronto." 8th March, 1856.

Jos. Robinson, Esq.—"On Fish Jointing on the permanent way of Railroads." 8th March, 1856.

Prof. Croft, D. C. L.—"On the construction of a safety Camphene Lamp." 8th March, 1856.

Rev. Prof. Young, M. A.—"A new proof of the Parallelogram of Forces." 15th March, 1856.

T. C. Keefer, Esq., C. E.—"On Civil Engineering." 15th March, 1856.

Colonel Baron de Rottenburgh.—"Some observations on the supposed Self-Luminosity of the Planet Neptune." 29th March, 1856.

A. Brunel, Esq., C. E.—"Economy of Fuel for Steam Machinery." 29th March, 1856.

Paul Kane, Esq.—"On the habits and customs of the Walla-Wallas, one of the North American Indian Tribes;" from the Author's Journals. 5th April, 1856.

Prof. Chapman.—"Brief Notices by Lieut. Maury, of Washington, on some comparative phenomena of the North and South Atlantic Oceans." 5th April, 1856.

Prof. Chapman.—"Some Fossil specimens from the Crimea exhibited and described." 5th April, 1856.

E. A. Meredith, LL.B.—"Influence of the recent Gold Discoveries on Prices." 19th April, 1856.

Prof. Bovell, M. D.—"On the Varieties of the Human Race." 26th April, 1856.

P. MacGregor, Esq.—"On the physiological character of the climate of North America." 26th April, 1856.

In view of the successful character of the Canadian section of the Exhibition of the Industry of all Nations at Paris, in 1856, and especially of that portion of it entrusted to Sir Wm. Logan: and of the honors which had been conferred upon him by Her Majesty, by the Emperor of the French, and by the learned Societies of England and France, the Institute determined to accord such a welcome on his return to Canada, and such congratulations on his well-earned and richly merited dignities, as would be fitting from this Society to him as its first President, and expressive of the esteem in which he is held by its Members.

The necessary preliminary measures having been taken, Sir William Logan was invited to be present at a meeting of the Institute held on the 5th April, 1856—when an address of congratulation was presented to him by the President, G. W. Allan, Esq. This address, together with the reply of Sir Wm. Logan, have already been recorded, and published in the Transactions of the Institute; and, together with a portrait of him by which its rooms are now adorned, remain as enduring mementos of the appreciation of the Society of the services which he has rendered to Science, and the honor and benefits he has conferred on Canada by his successful researches as a practical Geologist.

Attached hereto will be found the Report of the Editing Committee nominated by the Council to conduct the Canadian Journal—submitting a statement of their proceedings during the past year, and their views in reference to the important duty entrusted to them.

To that document the Council desire to direct the special attention of the Institute—and in doing so to congratulate its members on the steady and increasing success of the publication, which they feel justified in regarding as the most essential and promising element of the future prosperity and usefulness of the Institute.

The scheme for a New Series of the Journal submitted in the last Annual Report, and subsequently authorized by the Institute, has been carried into effect with, as the Council venture to believe, very satisfactory results.

The public criticism of the work has been favorable, its form has been approved as convenient, and its circulation has increased, while the expense of its publication is considerably reduced. Much of this is undoubtedly due to the high character which attached to the earlier series of the Journal, the experience gained by its issue, and the excellent basis thus formed for the more mature work; yet much is also to be attributed to the services and indefatigable zeal of the General Editor, Dr. Wilson, under whose direction the work has been issued, along with the valuable and effective co-operation of his coadjutors, of whose joint labors the Members have already enjoyed abundant opportunities of judging for themselves.

The practice adopted by the Council in reference to the former series of the Journal, of placing it in the hands of the trade for general sale, having been found to be attended with much trouble, without any adequate advantages to repay the care of looking after booksellers' accounts, and the returns of agents for copies on sale, the Council have adopted the practice—usually acted upon by Scientific Societies at Home, with their Transactions,—of printing the Journal exclusively for distribution among the Members of the Institute, and such Institutions and Societies as they may transmit it to in gift, or exchange for their publications. As the annual payment of four dollars from Members resident in Toronto, and of three dollars from country Members, is not more than the Journal of the Institute may be considered fully worth,—in addition to the other advantages which resident Members enjoy,—this arrangement has in no degree checked the increasing circulation of the Journal, while it has materially contributed to the large addition of new Members above referred to. The only exception which the Council have deemed it advisable to make to this rule is, that Members are permitted to purchase additional copies, and Provincial Literary and Scientific Societies to subscribe for the Journal by an annual payment in advance, at the same rate as the subscription required from non-resident Members.

The experience of the Council during the past year has fully confirmed them in the wisdom of this course, and they accordingly recommend that it be adhered to, and that the new series of the Journal be continued and permanently adopted in its present form; and they have much satisfaction in announcing that Dr. Wilson has consented to continue his services as Editor in Chief during the ensuing year. With a view to meet the rapidly increasing numbers of the Institute, the Council instructed the Editing Committee to increase the new edition of the Journal from seven hundred and fifty—the number of the former series—to one thousand copies; of these about six hundred and fifty have been distributed, and the remainder are in reserve to meet the demands consequent on the future extension of the Institute, and the exchanges which its rapidly extending relations with foreign Societies may require.

EDITING COMMITTEE'S REPORT.

The Committee appointed to edit the new series of the Canadian Journal, beg leave to submit to the Council the following Report of their proceedings during the past year.

In accordance with the instructions of the Council, as set forth in the scheme prepared and published in the Annual Report for 1855, the duties of the Editing Committee were classified and divided among its members.

The organization of this Committee having only taken place at the close of last year, and their duties being further complicated by the transfer of the printing of the Journal to a different firm from that formerly employed, some delay necessarily took place in the first number; and difficulties were occasioned to the Editing Committee on more than one subsequent occasion by impediments entirely beyond their control, such as the want of the requisite fonts of type, especially for some of the scientific papers of a special character. But these and other obstacles to the regular publication of the Journal are now, it is hoped, no longer likely to interfere with its issue at the appointed periods.

From the Treasurer's accounts it appears that the entire cost of printing the Journal for the year 1856, including illustrations, postages, &c., for an edition increased to one thousand copies, amounts to £257 0s. 9½d.* and in reference to this your Committee would only draw attention to the fact that nearly the whole of the matter being original, printed from the authors' manuscripts, and subject to their revision and corrections, it is mainly owing to the exertions of those Editors of the various sections who have gratuitously superintended the correction of the press, that this source of former outlay no longer occurs; but that, on the contrary, a considerable increase in this department of necessary expenditure has been avoided.

In the six numbers for 1856, constituting the first volume of the New Series of the Canadian Journal, twenty-nine original papers have been printed, twenty-four of which have been selected from the communications made to the meetings of the Institute during last session. Of the twenty-three Reviews accompanying these, twenty have been contributed by members of the Editing Committee; and they have much pleasure in acknowledging the valuable services rendered to them, and to the Institute, by the contributions of the Rev. Professor Young, and Professor Buckland to this department. In carrying out the fourth head of the scheme adopted for the new series of the Journal, which required "all matter derived from published sources, to be printed in small type, and to form a distinct division or appendix," your Committee have appended to each number a section entitled Scientific and Literary Notes; but it will be found that only a small portion of this is borrowed from published sources. It has already, on more than one occasion, embodied the first notice of original discoveries or observations, and has regularly included translations and careful abstracts on one or more branches of Science, from Home and Foreign Journals; so that your Committee venture to hope this section of the Journal will be regarded by many of its readers as not the least valuable of its contents.

The Editing Committee earnestly invite contributions from the members at large. The departments of Natural History, Geology and Mineralogy, Natural Philosophy, and Engineering, might be greatly enriched by short notices derived from personal observation, throughout the various districts of this widely extended Province; and to all the sections of the Journal it must be in the power of many members to furnish additions of general interest and value. For those which embrace subjects connected with the Ancient Races and the early historical monuments of this Continent, communications are specially desired. Probably no season passes over without the disclosure of some remains of the Aboriginal possessors of the land, accompanied with evidences of ancient arts, customs, or sepulchral rites; and it is a matter of great moment, and calculated to confer a permanent value on the Journal as a book of reference, that such should be accurately noted and recorded as they occur. The same observations apply to the Fauna and Flora of the Continent, which are unquestionably disappearing from many localities, now encroached upon by the clearings of new settlers: and

* The difference between this statement of the actual cost of the Journal, in the Report of the Editing Committee, and that embodied in the Treasurer's Report, arises from the latter charging the Journal, as in former years, with one-half of the Assistant Secretary's salary

concerning the former habitats of which, notices put on record now, will hereafter possess an ever increasing value. Further, the Editing Committee would urge on all the members of the Canadian Institute the duty of aiding to secure the communication of materials requisite to make this periodical alike creditable to the Society and useful to the Province.

In thus summing up their first year's labors, and inviting future co-operation, it is with sincere regret that the Committee have to record the loss to the Institute, as well as to themselves, of two esteemed coadjutors, whose services have contributed to the interest of the Journal during the past year. The recall of Captain Noble, R.A., by whom the admirable Meteorological Reports have hitherto been furnished for Quebec, will, it is feared, bring that valuable series of returns to a close; while in the resignation by the Rev. G. C. Irving, of the Chair held by him in Trinity College, Toronto, and his subsequent departure for Europe, the Editing Committee, and the members of the Institute at large, have lost a fellow-laborer, whose absence will long be felt to create a blank in their meetings.

DAN. WILSON, Convenor.

Toronto, November 1, 1856.

TREASURER'S REPORT, 1856.

Statement of Canadian Institute General Account for 1856.

Cash Balance from last year	£273	17	8			
" received from Members	346	17	10			
" " for sale of Journal	36	13	0			
" " Government Grant	250	0	0			
" " Athenæum	150	0	0			
				£1,057	8	6
Arrears due the Institute by Members for 1852	4	2	6			
" " " 1853	4	15	0			
" " " 1854	8	7	6			
" " " 1855	27	3	9			
" " " 1856	68	5	0			
				112	13	9
Cash due the Institute for sales of the Journal, Old Series	47	5	0			
Cash due the Institute for sales of the Journal, New Series	42	6	3			
				89	11	3
				£1,259	13	6
Cash paid on account to publication of the Old Series of the Journal	150	1	3			
" " " New Series	182	15	10			
" " " Library	123	19	7			
" " General Account	239	5	4			
" transferred to Building Fund	150	0	0			
Balance due by Institute to the General Account	10	12	3			
" " " Library	5	1	6			
" " " Journal	111	13	10			
				973	9	7
Estimated balance in favor of the Institute				£286	3	11

Statement of Building Fund Account.

Balance from 1855	1000	0	0			
Cash received by subscriptions in 1856	211	10	0			
Cash transferred from the General Account	150	0	0			
				1361	10	0
Disbursements as per Vouchers				92	4	3
Total Cash Balance				£1269	5	9
Cash due on Subscription List				534	15	0
Interest due on Cash Invested				94	13	3
Estimated Balance in favor of the Building Fund				£1898	14	0

The Treasurer in account with the Canadian Institute.

DR.						
Balance of Building Fund from 1855	1000	0	0			
Cash received by Subscription to Building Fund	211	10	0			
" Balance of General Account from 1855	273	17	8			
" received from Members	351	12	10			
" " Government Grant	250	0	0			
" " Athenæum	150	0	0			
" " Sales of Journal	31	18	0			
				£2,268	18	6
CR.						
Cash paid on account of the publication of Old						
" Series of the Journal	150	1	3			
" " " New Series	182	15	10			
" " Library	123	19	7			
" " General Account	239	5	4			
" " New Building	92	4	3			
				788	6	3
" Invested				1389	6	8
" Balance in Bank of Upper Canada				91	5	7
				£2,268	18	6

D. CRAWFORD,
Treasurer.

When the Council assumed office, they, with the Members of the Institute generally, indulged the hope that during the past summer some progress might have been made in the erection of the new building; when, however, they came to consider in detail the provision which must necessarily be made, the expenditure which it involved, and the entire insufficiency of the funds at command to secure such progress as would justify active measures during the season, they were reluctantly compelled to abandon any attempt to proceed with the structure during the present year. The calls upon the public from other quarters had been so pressing and continuous, that the Council feared the prosecution of their appeal for aid under the circumstances would have been productive of injury to the scheme. They preferred therefore rather to await a more promising opportunity for calling in subscriptions, than to urge their claims at a period which such efforts as they made abundantly manifested to be so unpromising; and they were further induced to this decision, by the reflection that whilst the funds already in their possession would continue to fructify, they might confidently rely upon additions to them by future Parliamentary Grants, as well as by the increased liberality of individual subscribers when less intruded upon by rival appeals. Having then secured such amount as will suffice for the objects in view, they anticipate the time as not far distant when the Institute may engage in the work free from the risk of debt, and without the apprehension of the depressing and perhaps disastrous influence which such could scarcely fail to have on the Institute.

The Council trust that these views will meet with the entire concurrence of the Members of the Institute, and that the motives by which they were governed in adopting, after the most anxious and mature deliberation, the course of procedure here referred to, may stimulate the members and friends of the Institute to such active co-operation and liberality in their contributions as will justify the construction of the building during the ensuing summer, and enable the successors of the present Council, in presenting their next Report, to congratulate the Members on its speedy completion, if not to present it to them, assembled in their own Hall.

F. W. CUMBERLAND,
Secretary.

Toronto, 6th December, 1856.

AUDITOR'S REPORT, 1856.

We, the undersigned, beg to report to the Council of the Canadian Institute, that we have examined the Cash Book and compared the Vouchers with the items of expenditure recorded, which agree. There appears to be a Balance in the Treasurer's hands of ninety-one pounds five shillings and sevenpence currency, and invested by the Treasurer, upon securities exhibited to us, one thousand three hundred and eighty-nine pounds six shillings and eightpence.

J. STEVENSON,
HERBERT MORTIMER, } *Auditors.*

Toronto, 9th December, 1856

The Report was unanimously adopted.

The Chairman having appointed Mr. Sheriff Jarvis and Mr. S. Fleming as scrutineers, the ballot for Election of Officers for the ensuing year was proceeded with, and

The following Gentlemen were declared duly elected;

President, the Hon. Chief Justice Draper, C. B.	
1st Vice President,	Professor E. J. Chapman.
2nd do	Col. Baron de Rottenburg.
3rd do	John Langton, M.A.
Treasurer,	D. Crawford.
Corresponding Secretary,	Thos. Henning.
Recording do	J. George Hodgins, M.A.
Librarian,	Prof. Croft, D.C.L.
Curator,	Prof. Hind, M.A.
Council,	Prof. Wilson, LL.D.
" Prof.	Cherriman, M.A.
"	E. A. Meredith, LL.B.
"	S. B. Harman, Esq.,
"	Rev. Professor Young, M.A.
"	James Bovell, M.D.

The following Donations to the Museum were announced, and the thanks of the Institute voted to the Donors:

From Mr. Bethune, Walpole:—

A Pair of Insects. (Phasma.)

From Mr. W. Couper, Toronto:

55 specimens, of 42 Species of Insects, viz:

				Exotic Coleoptera:
9	Specimens,	4	Species,	Cincindelidæ,
15	"	9	"	Carabidæ,
1	"	1	"	Scarites,
1	"	1	"	Silpha,
1	"	1	"	Hister,
1	"	1	"	Blaps Mortisaga,
2	"	1	"	" "
4	"	4	"	Curculionidæ,
1	"	1	"	Lixus,
1	"	1	"	Bostrichus,
1	"	1	"	Clerus,
2	"	2	"	Cerambycidæ,
1	"	1	"	Donacia,
1	"	1	"	Hispa,
10	"	9	"	Chrysomelidæ,
2	"	2	"	Cassidæ,
2	"	2	"	Coccinellidæ.
55		42		

Also,

1 " Blatta and 1 Hymenopterous Insect—exotic.

THIRD ORDINARY MEETING.—*10th January*, 1857.

The Hon. Chief Justice DRAPER, C.B., President, in the Chair.

The following Gentlemen were elected Members:

ROBERT SNELLING, Esq., Toronto.
Rev. SALTERN GIVENS, Yorkville.
ALEX. MANNING, Esq., Toronto.
JAMES GRAND, Esq., Toronto.
WILLIAM PROUDFOOT, Esq., Hamilton.
SAML. H. STRONG, Esq., Toronto.
GEO. F. DUGGAN, Toronto, (Junior Member.)

The following Donations to the Library and Museum were announced, and the thanks of the Institute voted to the Donors:

From the Author:

Sketch of the Montreal Celebration of the Grand Trunk Railway of Canada, by W. Baldwin Sullivan, Esq.

From the Hon. J. M. Brodhead, per A. H. Armour, Esq.,:

"United States Japan Exhibition, vol. III."

"Patent Office Reports, 1855."

From the Author, per A. H. Armour, Esq.,:

"An Overland Journey round the World in the years 1841, and 1842," by Sir George Simpson.

From Phillips, Sampson & Co.:

"Prescott's Robertson's History of Charles V.," three volumes.

"Religious Truths, illustrated from Science," by E. Hitchcock, D.D., LL.D.

From John Head, Esq.:

"A large Stone Gouge."

The President's ANNUAL ADDRESS was delivered by the Hon. Chief Justice Draper, C.B.

The following Paper was then read:

1. By the Rev. Professor Hincks:

"On Cell Developement."

This communication, containing some strictures on a paper on the same subject read by Professor Bovell at the previous meeting, and Professor Bovell not being present, it was ordered to be transmitted to him for the purpose of affording him an opportunity of further discussing the subject.

FOURTH ORDINARY MEETING.—*17th January*, 1857.

The Hon. Chief Justice DRAPER, C.B., President, in the Chair.

The following Gentlemen were elected Members:

ROBERT P. CROOKS, Esq., Toronto.
T. C WALLBRIDGE, Esq., Belleville.
JAMES JOS. WOODHOUSE, Esq.,
WILLIAM ANDERSON, Esq., Toronto.
EDWARD HURD, Esq., Toronto.
AUGUSTUS HEWARD, Esq., Montreal.
EDWARD D. ASHE, Esq., R. N., F.R.A.S., Quebec.
JOHN CRICKMORE, Esq., Toronto.
WILLIAM HAMILTON, Esq., Toronto.

The following Papers were then read:

1. By Col. Baron de Rottenburg:

"Observations on the General Telescopic aspect of the Five Primary Planets, including the Planet Mercury."

2. By JOHN LANGTON, Esq., M, A.:

"On a Small Wave hitherto undescribed."

3. By Prof. D. WILSON, LL.D.:

"On the Mediæval Pageant of the Dance of Death."

Professor Wilson called the attention of the Institute to the great loss sustained by the scientific world in the late painful death of the distinguished Geologist, Hugh Miller. He bore a gratifying testimony to the character and personal worth of the deceased Geologist, and to his earnest and self-sacrificing devotion to the science with which his name will ever be honorably associated, and in the too ardent pursuit of which his life has been made a sacrifice.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—DECEMBER, 1856.

Latitude—43 deg. 39.4 min. North. Longitude—79 deg. 21 min. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp of the Air.				Mean Temp. + or − of the Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN	6 A.M	2 P.M	10PM	ME'N		6 A.M	2 P.M	10 P.M	M'N	6 A.M	2 P.M	10 P.M	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M	2 P.M	10PM	Re-sul't.	ME'N		
					°	°	°	°	°																			
1	29.842	29.748	29.714	29.7652	27.8	33.7	26.6	28.57	− 2.22	.134	.151	.113	.130	.88	.79	.79	.81	N E	E b N	N	N 23 E	7.6	6.0	6.0	5.25	6.57	...	1.0
2	.683	.560	.300	.5112	28.9	27.1	26.2	26.72	− 3.77	.125	.114	.138	.122	.78	.76	.96	.83	NW b N	N b E	E N E	N 52 E	12.0	11.6	23.6	14.48	17.60	...	5.8
3	28.740	28.857	29.078	28.9098	35.6	29.5	27.7	30.43	+ 0.35	.187	.102	.132	.139	.90	.62	.86	.79	E b N	W b S	W	S 79 W	32.8	25.0	17.5	16.56	21.01	Inap	0.2
4	29.450	29.607	.732	29.6158	21.0	29.4	28.0	26.55	− 3.23	.112	.133	.114	.113	.96	.81	.74	.78	W b N	W b N	W S W	N 76 W	11.1	17.3	8.8	10.25	10.91	...	Inap
5	.791	.783	.842	.8178	26.0	29.7	20.8	24.93	− 4.43	.124	.122	.084	.104	.87	.73	.72	.75	W	W b S	SW b W	S 66 W	9.5	10.5	7.4	9.33	9.66	...	...
6	.822	.803	.800	.8142	21.0	28.5	21.5	23.45	− 5.62	.099	.109	.101	.100	.85	.69	.84	.78	W S W	W S W	W S W	S 71 W	16.4	20.2	11.5	14.27	14.28	...	...
7	.825	.765	—	—	22.8	27.6	—	—	—	.117	.131	—	—	.92	.86	—	—	W b S	W S W	W S W	S 77 W	12.3	8.8	6.8	6.95	8.11	...	0.3
8	.814	.849	.949	.8842	17.6	23.8	20.5	20.40	− 8.07	.088	.101	.105	.096	.86	.76	.91	.83	N	N W	W b N	N 48 W	6.2	2.0	6.8	3.77	4.18	...	0.1
9	30.076	30.138	30.164	30.1285	20.5	28.2	28.2	25.73	− 2.42	.098	.125	.121	.115	.86	.80	.77	.81	N N W	E S E	S S E	S 56 E	3.8	0.5	9.5	3.21	4.42	...	...
10	30.072	29.920	29.713	29.8820	28.7	33.7	35.0	31.47	+ 3.57	.146	.133	.142	.135	.92	.69	.70	.76	S E b E	E	E b S	S 82 E	4.2	7.8	7.5	6.78	7.41	0.330	...
11	29.382	.087	.219	.2292	34.5	41.2	38.1	37.80	+10.15	.195	.232	.205	.206	.98	.90	.90	.91	E	S b W	SW b W	S 33 W	12.5	15.5	20.5	11.13	18.57	0.855	...
12	.439	.513	.643	.5180	34.1	34.9	29.2	33.38	+ 6.03	.139	.146	.139	.145	.71	.72	.86	.76	SW b W	SW b W	W S W	S 55 W	13.0	9.4	5.5	10.46	10.62	...	Inap
13	.842	.828	.583	.7315	32.1	35.2	34.7	34.05	+ 6.90	.164	.167	.146	.155	.91	.82	.73	.80	SW b W	S W	E b N	S 56 E	9.5	3.0	13.5	4.44	9.91	...	2.6
14	28.973	28.512	—	—	33.2	35.2	—	—	—	.189	.167	—	—	1.00	.82	—	—	E	SW b S	W b S	S 70 W	17.4	27.0	37.0	19.76	28.06	0.465	0.4
15	29.375	29.648	.745	.6155	19.7	19.5	20.0	19.35	− 7.42	.078	.077	.086	.083	.71	.71	.77	.76	W b S	NW b N	W b S	N 75 W	26.8	12.4	7.0	8.87	9.67	...	0.1
16	.741	.682	.770	.7400	19.0	21.9	14.9	18.00	− 8.57	.095	.086	.066	.080	.90	.70	.73	.76	SW b W	W b S	N W b N	N 81 W	4.5	16.2	16.0	7.64	10.20	...	0.3
17	.972	30.054	30.204	30.0972	7.2	5.3	-1.1	3.45	−22.92	.057	.050	.035	.048	.87	.83	.76	.84	N b W	N N W	N b W	N 15 W	7.7	13.6	8.3	8.17	8.27	...	Inap
18	30.414	30.436	30.383	30.4187	-8.8	-1.6	2.7	-2.08	−23.25	.022	.038	.052	.040	.67	.88	.95	.86	N	N E b N	N N E	N 52 E	4.6	5.1	9.2	7.41	9.77	...	1.0
19	30.205	29.906	29.553	29.8553	15.4	23.3	29.8	24.00	− 2.07	.087	.093	.148	.112	.93	.72	.89	.82	E	E b S	E S E	S 67 E	18.8	13.0	12.0	13.82	14.72	...	0.2
20	29.285	.251	.598	.3918	37.7	35.2	18.0	29.85	+ 3.97	.206	.199	.077	.153	.91	.97	.75	.85	S	W b S	W S W	S 59 W	13.0	15.4	31.0	19.02	19.96	0.080	Inap
21	.758	.771	—	—	13.7	23.3	—	—	—	.065	.085	—	—	.76	.66	—	—	SW b W	SW b S	W N W	S 48 W	18.2	8.5	3.8	10.19	11.87	0.060	Inap
22	.519	.391	.562	.4922	19.4	21.7	16.0	18.45	− 7.22	.092	.119	.081	.095	.84	.98	.85	.89	S S E	S S E	N W b N	N 75 E	12.0	12.5	6.0	1.07	8.18	...	3.0
23	.701	.773	.810	.7785	5.0	12.2	6.8	8.37	−17.20	.043	.070	.056	.057	.73	.86	.87	.83	N W	N W b N	N W	N 33 W	4.8	14.4	12.0	9.21	9.38	...	...
24	.715	.529	.444	.5518	6.9	17.4	14.4	13.12	−12.37	.058	.073	.079	.070	.89	.73	.89	.83	NW b W	N W b W	W N W	N 62 W	10.0	16.8	18.0	16.19	16.34	...	...
25	.433	.477	—	—	17.2	21.9	—	—	—	.085	.107	—	—	.85	.88	—	—	W b N	W b N	SW b W	S 79 W	12.2	30.0	15.0	15.13	15.78	Inap	0.1
26	.593	.635	.755	.6775	23.5	28.7	24.8	25.60	+ 0.30	.110	.143	.121	.122	.84	.90	.88	.87	SW b W	W	N b E	N 85 W	11.6	20.6	14.4	10.49	14.47	Inap	Inap
27	.849	.825	.745	.8010	14.9	23.2	18.7	19.03	− 6.25	.079	.105	.096	.094	.88	.81	.91	.87	N W	N b E	N E b N	N 7 E	10.6	5.5	5.0	8.37	9.42	...	0.5
28	.522	.427	—	—	22.3	26.6	—	—	—	.121	.134	—	—	.98	.91	—	—	N E b E	N E b E	W S W	S 62 W	10.5	5.6	12.5	2.27	10.49	Inap	0.1
29	.521	.614	.690	.6218	28.4	26.6	24.4	26.33	+ 1.13	.136	.123	.113	.123	.87	.83	.84	.84	W S W	SW b W	W b S	S 62 W	12.0	11.0	7.0	8.55	8.70	...	Inap
30	.723	.707	.742	.7300	23.9	25.7	22.8	24.13	− 1.03	.124	.106	.109	.113	.95	.75	.86	.85	W	W S W	N W b W	S 78 W	3.4	2.0	3.4	2.96	3.13	...	0.6
31	.839	.891	.915	.8858	20.5	25.1	25.7	23.92	− 1.27	.111	.121	.119	.117	.96	.87	.85	.89	W S W	N W	N b E	N	2.0	5.0	7.5	5.22	6.70	...	Inap
M	29.7080	29.6937	29.7174	29.7113	21.56	25.35	22.09	22.88	− 4.21	.112	.117	.107	.110	.86	.79	.83	.82					11.94	12.01	11.32		11.56	1.790	16.3

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR DECEMBER.

Highest Barometer . . . . . . 30.480 at 10.30 a. m. on 18th } Monthly range=
Lowest Barometer . . . . 28.459 at 11.40 a. m. on 14th } 2.021 inches.

Self-register-ing Ther.
- Maximum temperature . . . . 42°2 on p. m. of 11th } Monthly range=
- Minimum temperature . . . . —9°1 on a. m. of 18th } 51°3
- Mean maximum temperature . . 28°74 } Mean daily range = 13°19
- Mean minimum temperature . . 15°55 }
- Greatest daily range . . . . 25°5 from a. m. of 20th to a. m. of 21st.
- Least daily range . . . . 3°3 from a. m. of 15th to a. m. of 16th.

Warmest day . . 11th ... Mean Temperature . . . 37°80 } Difference=39°88.
Coldest day . . . . 18th ... Mean Temperature . . . 2°08 }

Maximum. { Solar, ... 52°0 on p. m. of 4th } Monthly range=
Radiation. { Terrestrial . . . . . . —18°5 on a. m. of 18th } 70°5

Aurora observed on 1 night, viz.: 23rd; possible to see Aurora on 11 nights; impossible to see Aurora on 20 nights.

Snowing on 20 days; depth, 16.3 inches; duration of fall, 62.0 hours.

Raining on 6 days; depth, 1.790 inches; duration of fall, 21.3 hours.

Mean of cloudiness=0.76; most cloudy hour observed, 6 a. m., mean=0.82: least cloudy hour observed, 10 p. m.; mean=0.67.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
2003.57	2160.36	1661.69	5094.20

Resultant direction of the wind, S 87° W; Resultant Velocity, 4.62 miles per hour.

Mean velocity of the wind 11.56 miles per hour.
Maximum velocity . . . 41.4 miles per hour, from 11 p. m. to midnight on 14th

Most windy day . . . . 14th—Mean velocity, 28.06 miles per hour.
Least windy day . . . . . . 30th—Mean velocity, 3.13 do

Most windy hour Midnight to 1 a. m—Mean velocity, 12.81 do } Difference
Least windy hour 7 to 8 a. m.—Mean velocity, 9.92 do } 2.89 miles.

No Thunder or Lightning recorded this month.
7th. Large and perfect Halo round the Moon at 9 p. m
8th. Toronto Bay frozen over. Skaters and Pedestrians crossing.
" Halo round the Moon from 7 p. m.
9th. Halo and Corona round the Moon from 10 to 11 p. m.
10th. Very perfect Halo round the Moon from 9 p. m.
14th. The most windy day yet recorded at the Observatory.
18th. The coldest day in December yet recorded.
23rd. Faint Aurora at midnight,

The Barometric range for this month (2.021 inches) is the greatest yet recorded at the Observatory. A very remarkable range within 12 hours (1.014 inches) occurred from midnight of the 13th to noon of the 14th.

The Rain and Snow were both in excess of the average; the former by 0.251 inches, and the latter by 1.9 inches.

Wind. This was the most windy December since the commencement of the series, giving a mean velocity of 3.83 miles above the average of 9 years.

The resultant direction and velocity for December from 1848 to 1856, was N 75° W 2.88 miles per hour.

COMPARATIVE TABLE FOR DECEMBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Velocity
1840	24.3°	— 1.7°	41.0°	— 4.4°	45.4°	3	Inap	18	not recorded.	° —	—	—
1841	28.7	+ 2.7	45.5	+ 2.4	43.1	7	6.600	5		—	—	1.33 lbs.
1842	24.7	— 1.3	40.3	+ 3.8	36.5	3	0.880	17		—	—	0.61 "
1843	30.0	+ 4.0	41.1	+ 2.7	38.4	6	1.040	8	8.1	—	—	0.53 "
1844	28.2	+ 2.2	48.9	— 0.8	49.7	6	Impft	6	4.2	—	—	0.40 "
1845	21.1	— 4.9	37.6	— 2.7	40.3	2	Inap	12	4.7	—	—	0.70 "
1846	27.5	+ 1.5	49.2	+ 3.7	45.5	5	1.215	9	6.0	—	—	0.57 "
1847	30.1	+ 4.1	50.0	+ 6.6	43.4	7	1.185	8	6.8	—	—	0.35 "
1848	29.1	+ 3.1	49.1	+ 0.6	48.5	7	2.750	7	16.5	S 83 W	1.04	5.44 mls.
1849	26.5	+ 0.5	41.3	— 5.2	46.5	5	0.840	12	9.6	N 22 W	2.56	6.23 "
1850	21.7	— 4.3	48.3	— 9.7	58.0	2	0.190	18	29.5	N 44 W	2.93	7.40 "
1851	21.5	— 4.5	43.8	—10.5	54.3	6	1.075	15	10.7	[illegible] 82 W	4.00	7.37 "
1852	31.9	+ 5.9	51.0	+13.9	37.1	7	3.995	10	20.1	S 69 W	1.02	6.54 "
1853	25.3	— 0.7	42.2	— 5.2	47.4	4	0.625	13	22.3	N 38 W	2.41	4.98 "
1854	21.9	— 4.1	41.8	— 5.9	47.	5	0.590	12	17.2	N 47 W	4.18	8.66 "
1855	27.0	+ 1.0	45.9	— 2.1	48.0	6	1.845	10	29.5	S 88 W	5.33	11.38 "
1856	22.9	— 3.1	41.2	— 9.1	50.3	6	1.790	20	16.3	S 87 W	4.62	11.56 "
Mean	26.02	...	44.60	—1.29	45.89	5.1	1.539	11.7	14.4	—	—	7.73

MONTHLY METEOROLOGICAL REGISTER AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—JANUARY, 1857.

Latitude—43 deg. 39.4 min. North. Longitude—79 deg. 21 min. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Mean Temp. + or — of the Average	Tens. of Vapour.				Humidity of Air.			
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M.	2 P.M.	10 P.M.	ME'N		6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.	M'N
1	29.964	29.961	29.971	29.9627	° 24.4	° 26.6	° 22.8	° 24.37	° — 0.85	.122	.134	.120	.124	.91	.91	.94	.92
2	.842	.673	.461	.6350	22.6	30.3	31.0	28.92	+ 3.72	119	139	165	145	94	82	95	89
3	.235	.239	.542	.3555	30.5	30.5	26.7	28.77	+ 3.62	167	141	111	138	98	82	76	87
4	.708	.783	—	—	22.8	23.7	—	—	—	107	122	—	—	85	94	—	—
5	.893	.859	.967	.9135	14.7	16.4	4.7	10.33	—14.80	085	075	052	066	95	78	87	85
6	30.059	30.055	30.034	30.0495	—7.4	5.4	6.3	1.42	—23.72	024	049	054	043	67	81	85	80
7	29.918	29.861	30.047	29.9122	4.8	9.0	—8.4	1.00	—24.13	055	047	025	042	92	65	78	81
8	30.147	30.109	30.002	30.0705	-11.1	4.7	6 3	0.42	—24.72	025	046	056	044	86	79	90	87
9	29.769	29.596	29.487	29.5933	12.2	19.0	19.8	17.08	— 8.05	076	090	099	088	94	84	90	88
10	.311	.207	.323	.2805	18.1	22.0	22.0	20.38	— 4.67	097	114	108	105	94	94	88	92
11	.550	.713	—	—	7.0	7.9	—	—	—	060	054	—	—	92	81	—	—
12	.871	.777	.695	.7783	8.8	15.4	15.8	13.37	—11.72	063	077	088	077	90	84	93	90
13	.604	.48"	.529	.5357	13.6	22.1	20.5	18.40	— 6.68	080	103	108	096	93	84	95	90
14	.484	.475	.619	.5393	18.9	19.4	10.0	15.42	— 9.68	101	093	056	082	97	85	77	86
15	.808	.967	30.080	.9608	—3.0	6.4	4.3	2.32	—22.78	038	052	052	046	90	81	90	86
16	30.028	.741	29.541	.7453	5.7	16.4	18.7	13.53	—11.47	053	091	096	081	85	93	91	92
17	29.547	.805	30.079	.8358	17.6	3.2	-12.8	1.60	—23.42	096	038	027	048	95	70	100	83
18	30.130	30.101	—	—	-17.8	—2.3	—	—	—	018	036	—	—	90	84	—	—
19	29.833	29.616	29.549	6645	—3.0	15. 1	15.4	9.78	—15.10	038	086	088	072	91	93	95	93
20	.587	.429	.309	.4310	13.1	16.2	19.1	16.43	— 8.42	073	080	096	084	86	84	90	86
21	.268	.425	.624	.4633	22.0	16.2	5.7	13.72	—11.07	111	086	053	078	91	90	85	86
22	.712	.717	.756	.7337	-12.8	-12.2	14.6	14.38	—39.22	026	027	023	025	96	96	96	98
23	.746	.847	.856	.8218	-16.2	—6.2	-7.7	-9.18	—33.85	020	020	032	028	91	71	94	87
24	.734	.566	.740	.6898	6.1	9.3	1.4	5.07	—19.50	055	062	051	054	87	87	100	91
25	.887	30.054	—	—	—4.4	10.9	—	—	—	038	059	—	—	97	77	—	—
26	30.151	29.864	.604	.8437	2.8	16.5	28.8	16 82	— 7.67	052	089	152	101	93	92	96	94
27	29.566	.898	30.125	.8850	33.5	20.9	16.5	25.27	+ 0.92	191	135	070	131	100	81	82	89
28	30 158	30.035	29.961	30.0463	6.8	24.3	19.0	16.48	— 7.82	058	111	097	089	90	83	91	88
29	29.888	29.873	.935	29.9043	13.3	25.9	20 6	19.27	— 4.93	082	112	099	094	96	79	86	86
30	.999	.953	.793	.9055	16.2	19.2	22.3	18.83	— 5.27	080	102	118	099	84	94	95	91
21	.454	.237	.187	.2908	27.0	32.1	27.2	28.88	+ 4.90	140	172	144	150	94	95	96	94
M	29.7621	29 7138	29.7343	29.7362	10.34	16.04	12.64	12.75	—12.05	.079	.088	0083	.083	.91	.84	.90	.89

Day.	Direction of Wind.			Resul't. Direction.	Direction of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.		6 A.M.	2 P.M.	10 P.M.	Result.	ME'N		
1	N E b N	E N E	N N E	° N 37 E	9.8	6.7	8.5	8.06	8.31	...	...
2	N E b N	E	S E	S 57 E	10.0	7.0	8.0	9.23	10.86	Inap	3.5
3	S S W	S W b W	N W b W	N 80 W	17.5	10.6	12.8	11.41	14.08	...	0.3
4	W b N	N W b W	W b N	N 74 W	11.3	15.2	5.0	10.12	10.37	...	Inap
5	N W b N	N N W	N W b N	N 19 W	5.4	8.8	5.0	7.65	7 79	...	...
6	N N W	W N W	W	N 56 W	4.3	7.7	2.0	5.20	5.39	...	...
7	N N W	N b W	N N W	N 63 W	2.7	21.6	19.2	12.85	13.64	...	0.2
8	W b N	W S W	W b S	S 75 W	6.0	5.8	3.0	5.51	7.15	...	...
9	W S W	S W b W	S W	S 58 W	9.0	16.1	15.2	13.80	13.86	...	...
10	W S W	W S W	N b W	N 13 W	3.9	3.0	6.5	7.43	8.17	...	5.5
11	N b W	N W b N	W N W	N 41 W	24.8	21.0	1.5	12.77	13.66	...	...
12	W b S	S W b W	S W b W	S 62 W	5.8	16.0	13.5	10.45	10.52	...	...
13	W b S	S W b W	W S W	S 71 W	3.2	10.4	3.2	6.65	6.78	...	0 2
14	W N W	N b W	N W b N	N 16 W	0.2	10.8	13.0	9.32	9.38	...	0.9
15	N N W	W b N	W	N 54 W	5.7	9.3	3.5	5.35	6.30	...	...
16	W S W	S W	S W b W	S 58 W	8.2	15.9	15.0	14.42	15.08	...	0.3
17	W	N W	N b W	N 36 W	18.0	28.8	4.6	13.38	14.78	...	0.1
18	N	N	N	N 4 W	11.0	11.6	10.9	9.47	9.59	...	...
19	N	N W b W	N b W	N 38 W	15.0	14.2	7.3	9.32	10.37	...	0.2
20	W b N	S S W	S W	S 38 W	6.9	15.2	15.0	14.18	14.69	...	1.0
21	W S W	W	N b W	N 83 W	10.2	20.2	7.2	13.66	15.87	...	Inap
22	N N W	N N W	N N W	N 22 W	6.8	19.6	2.0	9.93	10.22	...	...
23	N b E	W b N	N b W	N 69 W	14.5	0.2	0.2	4.28	6.71	...	...
24	S W	S W	W S W	S 52 W	16.4	22.4	2.2	12.81	13.80	...	0.2
25	W	W b N	W b S	N 87 W	7.2	20.0	3.0	9.31	9.63	...	0.2
26	W	S E b S	Calm	S 21 E	0.4	7.5	0.0	3.20	3.70	Inap	Inap
27	S W	S W b W	N W b W	N 53 W	1.0	18.8	4.8	9.18	9.56	...	...
28	N b E	E b S	N N E	N 27 E	7.0	5.8	5.4	4.49	5.52	...	...
29	N N W	S S W	N b W	N 52 W	2.5	7.0	5.2	1.36	3.12	...	...
30	N b W	E	E b N	N 80 E	6.0	11.2	21.5	15.28	16.01	...	5.0
21	E	E S E	S W b W	S 10 W	24.0	6.4	24.0	6.42	14.75	Inap	4.2
M	....	....	....	....	8.87	12.74	8.01	......	10.31	Inap	21.8

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JANUARY.

Highest Barometer........................ 30.168 at 8 a. m., on 8th } Monthly range=
Lowest Barometer .... 29.181 at 4 p. m., on 31st } 0.987

Self-regist'ing Thermom.
- Maximum Temperature...............37.°2 on a. m., of 27th } Monthly range=
- Minimum Temperature............—20.°1 on p. m. of 22nd } 57.°3
- Mean maximum Temperature .... 19°46 } Mean daily range=
- Mean minimum Temperature .... 0°85 } 18.61
- Greatest daily range ....35°0 from a. m. of 26th to a. m. of 27th.
- Least daily range.................. 5.9 from p. m. of 11th to a. m. of 12th.

Warmest day......... 2nd ... Mean temperature......... 28°92 } Difference = 43°30.
Coldest day........... 22nd ... Mean temperature...... —14.38 }

Maximum. { Solar ....44°0 on a. m. 27th } Monthly range=
Radiation. { Terrestrial............................ —30°5 on a. m. 23rd } 74°5

No auroral light observed.
Possible to see Aurora on 12 nights; impossible on 19 nights.

Snowing on 16 days.—depth 21.8 inches; duration of fall 87.8 hours.
Raining on 3 days,—depth inapp. inches; duration of fall 6.5 hours.

Mean of cloudiness = 0.69.
Most cloudy hour observed, 8 a. m., mean = 0.74; least cloudy hour observed, 2 p. m., mean, =0.63.

Sums of the components of the Atmospheric Current, expressed in miles,

North.	South.	East.	West.
2860.21	1610.39	897.11	4367.69

Resultant direction N. 70° W.; Resultant Velocity 4.96.
Mean velocity.......................... 10.31 miles per hour.
Maximum velocity .... 32.0 miles from 10 to 11 a. m. on the 17th.
Most windy day........................ 30th ...Mean velocity 16.01 miles per hour.
Least windy day .... 29th...Mean velocity 3.12 ditto.
Most windy hour ... 11 a. m. to noon......Mean velocity 13.63 ditto. } Difference
Least windy hour ... 10 to 11th p. m.......Mean velocity 8.11 ditto. } 5.52 miles.

5th—Corona round the moon at 8 and 9 p. m.
6th—Halo round the Moon, 7 p. m.
12th—Halo round the Moon, at midnight.
22nd—The coldest day recorded in January, only once equalled, viz, on 6th February, 1855.

This has been the coldest month yet recorded at Toronto, the temperature having been 10°.47 below the average of January for the last 18 years, and 1°7 lower than that of February, 1843, the coldest month that had been previously known.

The quantity of snow was 7.85 inches above the average of the last 15 years.

The Resultant Direction of the wind in January, from 1848 to 1857 inclusive was N 72° W, and the resultant velocity 2.78 miles.

COMPARATIVE TABLE FOR JANUARY.

YEAR.	Temperature.					Rain.		Snow.		Wind.		
	M'n.	Diff. from Aver.	Max. ob'd.	Min. ob'd.	Range.	No. of days.	Inch's.	No. of days.	Inch's.	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	° 17.0	° —6.2	° 40.6	° —13.8	° 54.4	4	1.395	11	Not re corded	...	...	....
1841	25.6	+2.4	41.7	— 4.1	45.8	2	2.150	14		...	...	0.36 lbs.
1842	27.9	+4.7	45.8	+ 1.3	44.5	5	2.170	9		...	...	0.78
1843	28.7	+5.5	54.4	+ 1.5	52.9	6	4.295	12	14.2	...	...	0.69
1844	20.2	—3.0	44 6	— 7.7	52.3	7	3.005	11	24.9	...	...	0.70
1845	26.5	+3.3	43.0	— 3.4	46.4	5	imper	9	22 7	...	...	0.70
1846	26.7	+3.5	41.2	+ 0.3	40.9	5	2.335	10	6.0	...	...	0.55
1847	23.3	+0.1	42.6	— 2.2	44.8	7	2.135	5	7.5	...	...	1.09
1848	28.7	+5.5	51.5	—12.0	63.5	7	2.245	8	7.1	N 82° W	2.03	5.82 miles
1849	18.5	—4.7	40.1	—15.2	55.3	4	1.175	10	9.2	N 63° W	3.76	6.71
1850	29.7	+6.5	46.3	+10.6	35.7	5	1.250	8	5.2	N 37° W	0.69	5.80
1851	25.5	+2.3	43.2	—12.8	56.0	4	1.275	10	7.8	S 77° W	3.26	7.69
1852	18.4	—4.8	37.3	— 7.0	44.3	0	0.000	19	30.9	N 68° W	3.14	7.67
1853	23.0	—0.2	40.9	— 6.6	47.5	1	0.290	6	7.5	N 27° W	2.52	6.34
1854	23.6	+0.4	45.2	— 4.3	49.5	7	1.270	11	7.5	N 78° W	2.31	6.86
1855	25.9	+2.7	48.2	— 4.7	52.9	5	0.525	13	23.3	N 80° W	1.86	7.67
1856	16.0	—7.2	33.1	—12.1	45.2	0	0.000	14	13.6	N 75° W	5.24	10.69
1857	12.8	-10.4	34.6	—20.1	54.7	3	inapp	16	21.8	N 70° W	4.96	10.31
M	23.22	...	43.02	—6.24	49.26	4.3	1.501	10.9	13.95			7.56 miles

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—DECEMBER, 1856.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL. D.

Latitude—45 deg. 32 min. North. Longitude—73 deg, 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32° Fahr.			Temp. of the Air.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Velocity in miles per hour.			Mean direction of Wind.	Rain in Inches.	Snow in Inches.	Weather, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.				6 A.M.	2 P.M.	10 P.M.
1	29.998	29.953	29.935	7.1	20.4	15 8	.060	.078	.105	.90	.60	.94	W	W by S	W S W	7.63	5.90	3.55	W 2 S	...	...	Cir. Cum. Str. 4	Cir. Str. 9.	Cir. Str. 10.
2	.745	.817	.774	18.5	31.9	19.1	.100	.135	.097	.8	.69	.77	W by S	W by S	E N E	0.12	0.12	0.06	W 2 S	...	...	Cir. Str. 8.	Str. 9.	Do. 10.
3	.246	28.992	28.970	8.5	11.0	15.1	.065	.077	.100	.91	83	.91	E N E	NE by E	NE by E	1.08	2.05	13 41	E 33 N	...	3.70	Do. 2.	Snow.	Snow.
4	29.978	29.841	29.791	10.5	11.9	11.8	.077	.080	.075	.85	.83	.82	W N W	W by N	W N W	9.75	22.84	29.11	W 23 N	...	...	Do. 8.	Cir. Str. 8.	Cir. Str. 10.
5	.916	.612	.842	10.0	18.1	10.0	.074	.099	.074	.82	.81	.82	W	W by N	W by N	16.19	10.[illegible]	0.21	W 11 N	...	...	Do. 10.	Ly Cum. 2.	Clear.
6	.886	.840	.823	8.9	24.2	19.1	.060	.135	.110	.83	.84	.88	W by S	W N W	W N W	10.10	2.15	2.80	W 11 N	...	0.14	Clear.	Clear.	Snow.
7	.934	.856	.928	7.2	14.5	9.0	.060	.083	.067	.88	.79	.90	W N W	W by S	W	7.77	10 47	3.61	W 3 N	...	..	Str. 4.	Do.	Cir. Str. 8, L. H.
8	.941	.949	30.031	1.9	15.0	11.5	.044	.073	.080	.85	.68	.83	W	W by S	W by S	0.57	0.17	3.37	W 11 S	...	..	[illegible] Str. 2.	Cum. Str. 2.	Do. 8.
9	30.154	30.218	.340	6.1	15.0	10.1	.058	.074	.079	.91	.70	.88	W by S	W N W	W S W	2.85	1.67	3.86	W 11 N	...	...	Cir. [illegible] 4.	Cir. Str. 6.	Clear.
10	.380	.249	.282	0.6	17.7	5.6	.043	.088	.051	.88	.79	.79	S S W	E S E	E N E	2.40	0.00	3.42	E 20 N	...	...	Clear.	Fog.	Do.
11	29.679	29.701	29.384	8.5	32.5	38.3	.065	.197	173	.91	.94	.70	E N E	S by E	S	5.41	7.62	11.82	S 20 E	0.300	...	Hoarfrost.	Sleet & Rain.	Cir. Str. 10.
12	.346	.432	.601	7.0	38.4	30.9	.218	.227	.171	.90	.89	.89	W S W	W S W	W S W	13.44	22.82	10.00	W 23 S	...	...	Cir. Str. 8.	Cir. Str. 8.	Do. 4.
13	.894	.957	30.135	18.0	24.5	12.5	.153	.134	.088	.88	.86	.87	N W b W	N N W	N E	5.52	2.15	2.40	N 23 W	...	..	Do. 8.	Do. 9.	Clear Zod. Lght.
14	29.593	29.000	28.720	23.1	23.6	20.3	.089	.135	.114	.89	.90	.87	E N E	E by N	S S E	7.64	15.44	13.12	E 33 N	...	5.80	Snow.	Snow.	Cir. Str. 10.
15	.313	.416	29.916	11.0	6 0	0.6	.043	.050	.043	.83	.80	.82	W by N	W N W	N W	26.90	26.80	16.40	W 13 N	...	...	Cir. Str. 6.	Clear.	Clear.
16	.945	.974	.965	-8.5	[illegible].0	0.0	.026	.050	.046	.80	.89	.90	N N W	NE by E	NE by E	0.91	1.78	4.86	W 23 N	...	Inp	Cir. Str. 10.	Cir. Str. 10.	Snow.
17	30.081	30.012	30.392	-9.5	-7.6	-14.9	.024	.028	.021	.81	.80	.86	N E by E	NE by E	N W b W	15.40	3.21	16.97	E 33 N	...	...	Clear.	Clear.	Clear.
18	.611	.577	.748	-24.2	-10.0	-14.7	.009	.028	.023	.66	.89	.89	N W by W	W by S	W by S	6.50	5.50	4.04	W 3 S	...	...	Do.	Do.	Clear Zod. Lght.
19	.733	.518	.338	-21.4	-6 6	-5.0	.015	.034	.031	.79	.76	.82	E N E	NE by E	N E b E	0.12	2.11	7.52	E 33 N	...	...	Cir. Str. 6.	Cir. Str. 10.	Snow.
20	29.736	29.457	29.453	20.2	34.5	35.5	.107	.203	.203	.82	.91	.92	S	S	W S W	11.30	3.42	9.97	S 1 W	0.167	3.60	Snow.	Sleet & Rain.	Cr. Sr. 10, F. Au. B
21	.546	.848	30.021	26.4	19.2	5.5	.141	.103	.058	.88	.82	.90	W by N	W N W	SE by S	9.11	26.62	2.10	W 23 N	...	...	Clear.	Clear.	Clear Zod. Lght.
22	29.967	29.841	29.886	-4.5	6 9	7.5	.033	.039	.062	.84	.83	.90	E S E	NE by E	NE by E	1.41	7.73	14 93	E 33 N	...	...	Do.	Do.	Cir. Str. [illegible]0.
23	.933	.873	.891	9.0	15.8	8.9	.067	.087	.066	.90	.78	.92	N E by E	[illegible] E	N N E	14.07	12.90	3.41	N 44 E	...	...	Do.	Cir. Cm. Str. 2.	Clear Zod. Lght.
24	.906	.433	.381	-1.0	17.0	5.1	.038	.096	.051	.83	.83	.84	W N W	W by N	W N W	7.62	8.11	16.83	W 33 N	...	2.00	Cir. Str. 10.	Snow.	Snow.
25	.336	.375	.522	3.4	8.4	-5.0	.049	.058	.030	.85	.80	.81	W	W by N	W by N	16 23	12.55	12.86	W 10 N	...	...	Clear.	Cir. Str. 10.	Clear.
26	.668	.714	.701	-5.3	8.0	7.1	.031	.058	.061	.80	.68	.79	W by S	W by N	W by N	12.07	4.21	13.75	W 10 N	...	...	Cir. Str. 4.	Clear.	Do.
27	.841	.787	.936	0.0	17.5	12.5	.065	.089	.071	.84	.83	.84	W by S	S E by E	W by S	14.43	9.41	16.24	W 10 S	...	...	Do. 10.	Cir. Str. 6	Cir. Str. 10.
28	.846	.825	.762	0.0	15.0	4.2	.060	072	.051	.85	.72	.85	W by S	W by S	N W	0.82	0.16	4.20	W 10 S	...	Inp	Do.	Snow.	Clr. F. Au. Bor.
29	.686	.674	.743	0.0	24.7	21.2	.081	.124	.112	.89	.87	.90	S E by E	SE by E	W by S	23.22	0.82	4.11	E 33 S	...	0.40	Snow.	Cir. Str. 10.	Do.
30	.570	.704	.905	0.0	30.5	23.4	.063	.164	.125	.89	.88	.90	W S W	W S W	S E	4.26	0.27	0.03	W 23 S	...	...	Cir. Str. 6.	Do. 6.	Cr. Sr. 10, Dis. Lt.
31	30.033	30.059	30.103	0.0	23.4	19.6	.145	.118	.104	.91	.86	.88	E N E	N E	N N E	3.42	4.63	2.75	N 43 E	...	Inp	Do. 10.	Light Snow.	Do. 10.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—JANUARY, 1857.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapor.			Humidity of Air.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.
1	30.142	29.963	30.199	18.9	26.2	21.3	091	.135	.089	.80	.83	.73
2	.177	30.095	.003	18.2	24.2	18.5	.088	.091	.088	.72	.63	.72
3	29.913	29.527	29.585	18.1	25.0	21.0	.088	.125	.086	.73	.80	.64
4	.734	.863	.921	18.6	20 3	11.2	.110	.101	.077	.85	.77	.85
5	.921	.923	29.064	— 3.5	2.6	— 7.1	.033	.046	.028	.83	.84	.82
6	30.052	.913	29.991	—13.9	— 3.0	— 6.5	.023	.036	.029	.98	.85	.86
7	29 961	.840	.942	—15.1	— 1.7	— 9.7	.0 9	.038	.029	.83	.81	.86
8	30.052	30 053	30.108	—14.0	— 3.5	—13.0	.016	.032	.021	.63	.70	.74
9	29.800	29.607	29.601	—13.5	5.0	10.6	.023	.053	.064	81	.80	.86
10	.538	.506	.591	10.4	25.0	11.6	.064	.127	.075	84	.83	.91
11	.712	.683	.732	2.7	6.8	— 4.8	.047	.059	.036	.84	.92	.84
12	.907	.844	.927	— 4.2	8.5	11.0	.033	.058	.075	.84	.81	.91
13	.718	.684	.663	11.5	21.4	18 5	.075	.115	.101	.94	.94	.91
14	.666	.794	.851	14.0	17.4	7.0	.083	096	.051	.86	.84	.78
15	.906	.934	30.163	— 2.0	1.5	— 6.4	.046	.044	.034	.84	.83	.89
16	30.140	.926	29.756	— 8.9	15.9	11.2	.032	.081	.075	.88	.84	.90
17	29.52"	810	30.171	15.5	— 1.2	—18.5	.081	.038	.016	86	.83	.80
18	30.431	30.400	.195	—31.8	— 5.6	—17.5	.010	.027	017	.81	.71	.81
19	29.984	29.591	29.534	—15.2	10.3	8.5	.019	.071	.065	.83	.90	.93
20	.722	.736	.741	— 5.1	6.5	5.3	.031	059	.059	82	.79	.81
21	.556	.634	.651	3 0	29.7	16.1	.049	.155	.084	.82	.90	.84
22	.677	.577	.817	— 3.5	— 9.0	—23.5	036	.024	.012	.82	.78	.75
23	.829	.898	.918	—29.6	—21.1	—25.3	.008	.014	.011	.68	.65	.73
24	.976	.982	.944	—29.6	— 3 3	— 9.4	.008	.029	.024	.70	.68	.69
25	30.054	30.144	30.326	—21.2	8.3	— 5.4	.013	.064	.031	.77	.90	.82
26	.450	.214	.029	—17.6	8.0	12.6	.019	.059	.078	.89	.87	.90
27	29.850	29.874	.163	12.6	27.9	20.1	.078	.147	.103	91	.94	.89
28	30.430	30.314	.244	9.4	27.9	18.0	.053	.147	.094	.90	.89	.85
29	.052	29.989	.031	8.1	25.9	16.1	065	.132	084	.89	.87	.84
30	.341	30.305	.308	1.0	11.0	— 6.0	.044	.059	.029	.86	.70	.82
31	.131	29.624	29.597	— 7.1	11.4	9.0	.028	.069	.067	.83	.80	.89

Day.	Direction of Wind.			Velocity in miles per hour.			Mean direction of Wind.	Rain in Inches.	Snow in Inches.	WEATHER, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.				6 A.M.	2 P.M.	10 P.M.
1	N E by E	E N E	N E b E	2.05	2.21	3.80	...	...	...	Cir. Str. 10.	Cir. Str. 10.	C. C. Str. 6.
2	S E by E	E N E	E b S	0.60	1.02	7.12	...	...	...	C. C. Str. 6.	Do. 8.	C. Str. 10.
3	S by E	N E b E	N E	11.95	7.03	14.26	...	...	4.10	Snow.	Snow.	Do. 10. L. H.
4	W N W	W N W	N W	11.86	9.62	15.30	...	...	Inp	Cir. Str. 10.	C. Str. 2.	Do 2.
5	W N W	W by N	W b N	22.60	11.63	10.27	...	..	...	Clear.	Clear.	Clear.
6	W N W	W N W	W b N	19.06	13.52	14.01	...	...	..	Do.	Do.	Cir. 2.
7	W by N	W	W N W	17.85	13.47	25.68	...	...	Inp	Cir. Str. 4.	C. C. Str. 4.	C. C. 6. L. H.
8	W S W	W S W	W	26 71	3.83	9.06	...	...	...	Clear.	Clear.	Clear.
9	S W	N W b W	W S W	10 96	2.15	3.70	..	...	Inp	Cir Str. 10.	Cir. Str. 10.	Cir. Str. 10.
10	W by S	S S E	N E b E	1 61	0.11	6.77	...	...	Inp	Do.	Do.	Snow.
11	N E	N W	W b N	24 25	6 00	12.40	...	...	...	Do. 10.	Do. 6.	C. C. Str 4.
12	W	W	W b S	6.53	19.07	12.42	...	...	...	Str. 8.	Clear.	Cir. Str. 10.
13	W S W	S W	S W	11.30	9.60	2.15	...	...	Inp	Cir. Str. 10.	Snow.	Do 10.
14	N W b W	N E	N E	7.81	4.91	3.05	...	...	..	Do. 10.	C. C. Str. 6.	Do. 10.
15	N	W by N	W S W	5.12	8.37	5.41	...	..	...	Do. 9.	Clear.	Clr. Zod. Lgt.
16	W	S W b W	S S W	9.10	4.83	0.15	...	...	...	Do. 10.	Cir. Str. 10.	Snow.
17	W b S	N b E	N b E	8.75	18.07	12.92	...	...	0.70	Snow.	Clear.	Clr. Zod. Lgt.
18	N W	S W b W	N E	3.50	1.15	0.03	...	...	...	Clear.	Do.	C. Str. 10.
19	N E b N	N E b E	W N W	18.16	15.05	13.63	...	...	1.60	C. Str. 6.	Snow.	Snow.
20	W N W	N W	N E	14.92	3.87	1.80	...		...	Clear.	C. Str. 10.	Cir Str 10.
21	N N E	W	W	6.90	8.35	4.66	...	.	0.70	C. Str. 10.	Do. 10.	Clr. Zod. Lgt.
22	W N W	W N W	W N W	13.63	12.43	23.22	...	...	...	Cir. 4.	Light Cum.	Clr. do. do.
23	W N W	W N W	W S W	26.29	13 03	10.55	...	..	...	Hazy.	Do. 2.	Clr. do. do.
24	W S W	S E by S	N E b N	1.75	4.60	1.85	...	...	...	C. Str. 7.	C. Str. 10.	C. Str. 6.
25	E b N	W S W	S S E	1.40	2.17	0.62	. .	...	...	Clear.	Do. 10.	Clr. Zod. Lgt.
26	S	S E b S	S S E	7.06	2.30	11.22	...	...	.	Do.	Do.	C. Str. 10.
27	S W	W	W S W	12.42	0.00	0.52	...	Inp	4 80	Snow.	Do. 10.	Clr. Zod. Lgt.
28	E b N	E N E	E N E	2.82	0.20	3.32	...	...	...	Clear.	Do. 2.	Do. do. do
29	E S E	S W b W	W b N	6.32	1.08	3.12	...	...	...	C. Str. 10.	Do. 10.	Do. do. do.
30	N E by E	N E b E	E N E	5.53	3 77	3.80	...	...	...	Clear.	Clear.	Do. do. do.
31	N E b E	N E b E	N E b E	20.21	20.10	18.10	...	...	7.20	C. St. 10.	Snow.	Cir. Str. 10.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR DECEMBER.

Barometer	Highest the 18th day	30.748
	Lowest the 14th day	28.720
	Monthly Mean	29.836
	Monthly Range	2.028
Thermometer	Highest the 12th day	35°2
	Lowest the 18th day	—24°.2
	Monthly Mean	10°43
	Monthly Range	59°4

Mean of Humidity .... .850

Greatest Intensity of the Sun's Rays .... 84°9

Lowest Point of Terrestrial Radiation .... —25°.1

Rain fell on 2 days, amounting to 0.467 inches; it was raining 17 hours and 55 minutes.

Snow fell on 9 days, amounting to 18.64 inches; it was snowing 51 hours 20 minutes.

Most prevalent wind, N E by E—1257 miles. Least prevalent wind, S W by W—7 miles.

Most windy day, the 4th day; mean miles per hour, 25.00.

Least windy day, the 2nd day; mean miles per hour, 0.36.

Most windy hour, from 3 to 4, A. M., 4th day; velocity 38.40 miles.

There were 78 hours and 40 minutes calm during the month.

There were 5 cloudless days in the month.

The total amount of miles traversed by the wind was 6628.20, which being resolved into the Four Cardinal Points, gives N 464.70 miles. S 458.50 miles, W 4387 miles, and E 1318 miles.

Aurora Borealis visible on 3 nights.

Zodiacal Light visible.

The electric state of the atmosphere has indicated very high tension. Electrometers constantly affected.

Ozone was in moderate quantity.

Distant flash of Lightning in the S. E. at 8.15 P. M. 30th day.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR JANUARY.

Barometer	Highest, the 18th day	30.431
	Lowest, the 11th	29.506
	Monthly Mean	29.915
	Monthly Range	0.925
Thermometer	Highest, the 28th day	27°.9
	Lowest, the 18th day	—31.8
	Monthly Mean	4°.03
	Monthly Range	59°.70

Greatest intensity of the Sun's Rays .... 78°.4

Lowest point of Terrestial Radiation .... —32.4

Mean of Humidity .... .840

Rain fell on 1 day. Inapp.

Snow fell on 11 days, amounting to 19.10 inches; it was snowing 64 hours 50 minutes.

The Aurora Borealis not visible.

Zodiacal Light very bright.

Lunar Haloes visible on 2 nights.

The electrical state of the Atmosphere has indicated high and constant Tension.

Ozone was in small quantity.