"The differences between them [the fossils exhibited and the Oriskany species of Rensselaeria] were slight, though well marked. Professor Hall described some of these differences, and Mr. Claypole acknowledged that a certain V-shaped groove was wanting in his specimens. Professor Hall thought that possibly the fossils should be referred to Amphigenia, which had many similarities to Rensselaeria."

The V-shaped groove in question is one of the generic marks of Amphigenia; and its absence, therefore, was urged by me as excluding the fossils from that genus, and inferentially as a strong argument in favor of placing them in Rensselaeria.

As the above-mentioned error places me (and I think Professor Hall also) in false positions, and involves a grave mistake in paleontology, I am induced to ask your insertion of this correction, which I have submitted to Professor Hall for his approval.

I ought to add that the suggestion of Amphigenia by Professor Hall was only the result of a momentary impression on the first sight of the fossil, and one which he immediately withdrew, on observing the absence of the V-shaped groove above alluded to.

E. W. CLAYPOLE.

Aurora.

The auroral display here to-night was unusually brilliant. I observed it first at 7.04 P.M. At this time a low but rather brilliant arch of light spanned the north-eastern horizon, the crest of the arch having an altitude of about 20°. During the next three minutes, the lights rapidly took on the 'streamer' form, gradually shooting upward to a little beyond the zenith, and at this time stretching from east, 10° south, around to west, 15° north, on the horizon. During about two minutes, the waving-curtain aspect was very pronounced in the north-east, after which only striated patches flamed out here and there, moving alternately west and east. These patches all converged toward the zenith, but left with one the impression of being pendulous and very near. The atmosphere appeared very clear, the moon full and bright, the twilight still strong; and there was light enough yet to enable one to read a newspaper, but with difficulty. The streamers, however, lay in sharp contrast against the blue sky, even where the twilight was strongest.

At 7.15 the lights began to die rapidly away, and at 7.50 none were to be seen; but at 8, and again at 8.13, there were distinct but small curtains to be seen in the north-west. At 8.20 there began a magnificent display. Three large curtains formed one above the other, the lowest about 20° above the horizon in the north-west. They drifted gently toward the zenith, swaying and folding just enough, it seemed, to suit the almost imperceptible breeze which was stirring. The lights could be easily seen within 7° of the moon; and yet it cast its shadow on the carpet in a room 13 by 14, where two kerosene-lamps were burning, one of them a no. 1, and the other a no. 2, burner. At 9.10 scarcely a trace of the aurora could be seen. A little later, a very faint diffuse light covered the northern sky to an altitude of about 25°. This soon became striped, and afterwards appeared to move bodily toward the zenith. At 10.20 the lower sky had become a deep blue; and just above it, at an altitude of 30°, a broad arch of bright but uniform light formed across the sky; and above this, extending past the zenith, were similar but much fainter bands. Five minutes later, the bright band unfolded a curtain which dropped in exquisite folds toward the horizon. This lasted less than two minutes, the whole belt of light becoming striated, but leaving a clear space next to the horizon; then followed about five minutes during which the illuminated portion of the sky seemed to be throbbing, and sending out waves of subdued light, which spread southward over the blue vault, dying away before the zenith was reached. This movement soon became more violent; and between 10.40 and 10.45 the lights had more the appearance of flames bursting rapidly from the sky, and spreading to the zenith, where they often turned abruptly toward each other, and met. This appearance continued growing gradually less marked until 12.15 A.M., when there was scarcely a trace of auroral display. At 12.40 a faint arch of diffuse light could be seen in the north, like that already described.

F. H. KING.

River Falls, Wis., Sept. 16, 1883.

THOMPSON'S PHILIPP REIS.

Philipp Reis: inventor of the telephone. A biographical sketch, with documentary testimony, translations of the original papers of the inventor, and contemporary publications. By SYLVANUS P. THOMPSON, B.A., D.Sc., professor of experimental physics in University college, Bristol. London, *E. & F. N. Spon*, 1883. 9+182 p., 3 pl. 16°.

THE rapid development of the literature of the telephone, and the wide-spread interest in matters relating to it, have rendered the most important details of its history familiar to the general reading public, as well as to the scientific world. The account of the life and labors of Philipp Reis, by Prof. S. P. Thompson, while repeating many of these well-known details, contains some interesting notices of the life and personal characteristics of the inventor, and of the various steps by which he brought his instruments to their final stage. Following the brief biographical sketch, are descriptions of the various forms of apparatus devised by Reis, with numerous illustrations; a statement of what the author terms the inventor's claim; copies of Reis's own publications respecting his invention, and of certain contemporary accounts of it and its operation; with the testimony of persons who witnessed his experiments. An appendix discusses the variable resistance of imperfect contacts, a comparison of Reis's receiver with later instruments, the doctrine of undulatory currents, with some additional notes and references relating to Reis's invention.

Had the efforts of the author been directed to the presentation of these things as matters of history merely, the book might be regarded as a valuable and interesting summary of facts relating to an important invention, and would demand but a brief notice here; but a cursory examination of it is sufficient to show that the author has failed to maintain that judicial attitude of mind which is indispensable to the just

and impartial record of historic verities. His book is throughout a labored special pleading, with the attempt to prove that Reis's invention not only anticipated, but actually embodied, the essential features of the present telephonic apparatus. Space will not permit the consideration of all the points which might be criticised, nor is it necessary. A few of the most important are sufficient to illustrate the spirit which pervades the work, and to show how the facts of history are perverted in the endeavor to maintain a false and illogical position.

It has been generally accepted as true, that Reis designed his transmitter to act as a contact-breaker, which should open and close the circuit once for each vibration produced by the sound to be transmitted. The support for this view is found not only in the repeated statements of Reis himself, but also in the construction of the apparatus. Reis says, in his own description of his transmitter (p. 56), "each sound-wave effects an opening and a closing of the current;" and again, in his letter to Mr. Ladd (p. 84), "If a person sing at the station A, in the tube (x) the vibrations of air will pass into the box and move the membrane above; thereby the platina foot (c) of the movable angle will be lifted up and will thus open the stream at every condensation of air in the box. The stream will be re-established at every rarefaction. For this manner the steel axis at station B will be magnetic once for every full vibration."

With these and other most distinct statements of Reis, as to the intention and action of his apparatus, before him, Professor Thompson, nevertheless, asserts that it was never designed to break the circuit. Thus, on p. 14 he says, "Theoretically, the last was no more perfect than the first, and they all embody the same fundamental idea: they only differ in the mechanical means of carrying out to a greater or less degree of perfection the one common principle of imitating the mechanism of the human ear, and applying that mechanism to affect or control a current of electricity by varying the degree of contact at a loose joint in the circuit." And again (p. 132), "Now this operation of varying the degree of pressure in order to vary the resistance of the interruptor or contact-regulator, was distinctly contemplated by Reis." Further, the author maintains that the combination of an adjusting-screw with a spring shows that Reis intended the platinum contact-piece to have a following motion, so as to make a contact with varying pressure. He says on p. 133, "By employing these following-springs, he introduced, in fact the element of *elasticity* into his interruptor; and clearly he introduced it for the very purpose of avoiding abrupt breaking of the contact." If we examine the illustrations of the different forms of the transmitting apparatus, we shall see that this device was employed for a very different purpose. In the earliest form, represented in fig. 1, the screw presses the spring *away* from the membrane, and, when the latter recedes in its vibration, the spring carrying the platinum point is prevented by the screw from following it, —an arrangement that tends to prevent, and was designed to prevent, a following contact, and insures a breaking of the circuit when the distance of the point is properly adjusted. The same is the case with the form of transmitter illustrated in fig. 2. In the form represented in fig. 3, the screw is present, and works against a spring; but the screw passes through a stout and firm piece of metal, and presses the spring which carries the contact-piece forward, that is, toward the membrane, thus giving it a rigid support. The spring serves merely to push back the con-

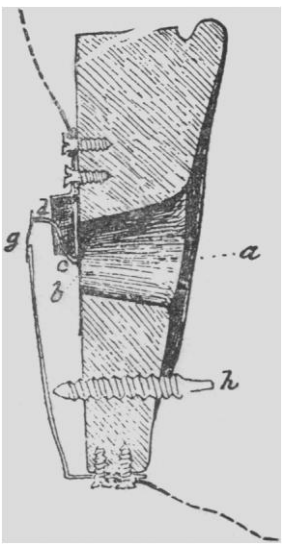

FIG. 1.

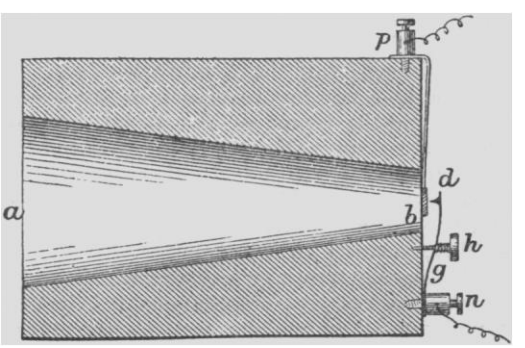

FIG. 2.

tact-piece when the screw is reversed, a very simple and common mechanical device for giving motion in opposition to the thrust of a screw. In the lever form, seen in figs. 4 and 5, the

screw is arranged in a similar manner, so as to regulate the distance of the contact-piece from the end of the lever most remote from the membrane. In all these instruments the screw acting upon the spring is expressly contrived to facilitate such an adjustment as will insure

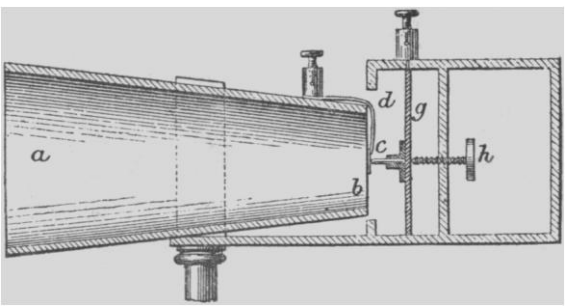

Fig. 3.

the breaking of contact under the impact of the sound-waves. Its function is related to the tension and elasticity of the membrane, to make a pressure so light in any case, that the vibrations should be able, without fail, to separate the contact-pieces.

To say, as Professor Thompson repeatedly does, that Reis employed his mechanism with the express intention of producing a variable current by the change of contact-resistance, and that he consciously and purposely utilized this principle, — at that time hardly recognized anywhere, and of which the practical application was not discovered till several years later, — is a gross misrepresentation, and an utter perversion of the facts. Reis did not know, and could not know, that the strength of a current could be controlled by the varying pressure of the conducting-surfaces between which it passes. Nowhere in his writings, — whether in his description of the instruments, or in the prospectus issued with them, or in his letter to Mr. Ladd, — nor in the article of Professor Böttger and the report of Von Legat, is there the remotest suggestion that the transmitter acted, or was intended to act, otherwise than by breaking the circuit. Nor is any thing of the kind to be found in any of the publications of the day, relating to this matter. With the knowledge which we now possess, of the varying resistance of pressure-contacts, it is indeed easy, by a slight modification, to cause the contact-pieces to vary the current by change of pressure, and thus reproduce the vibration-form with approximate accuracy. But to do this, it is necessary to prevent them from separating so as to break contact and interrupt the current. Such a modification, however slight it may be, totally changes the function of the contact-pieces, and amounts to a radical transformation of the apparatus. It is the very thing Reis studiously sought to prevent.

That Reis speaks of the form of acoustical vibrations, and their graphical representation by a curve, is no proof that he supposed his transmitter to act otherwise than by breaking the circuit. Yet Professor Thompson says (p. 165), "It is certain that Reis did not in any of his writings explicitly name an undulatory current: but it is equally certain that, whether he mentioned it or not, he both used one and intended to use one." Reis nowhere claims that his apparatus realized the normal vibration-form, even in the case of a simple tone; and there is no evidence in all his writings to show that he had ever considered the motions at the receiver to be the same as those of the original sound, except so far as there was a correspondence in period or rate of these motions with those at the transmitter. The idea of causing the motions in the receiver to have the same vibration-form as those in the transmitter originated with Bell, as did the method of securing this correspondence, which is indispensable to the reproduction of spoken words, by the use of an undulatory current. Says Sir William Thomson (*Tel. journ. and electr. rev.*, v. 293), "Mr. Graham Bell conceived the idea — the wholly novel and original idea — of giving continuity to the shocks, and of producing currents which would be in simple proportion to the motion of the air pro-

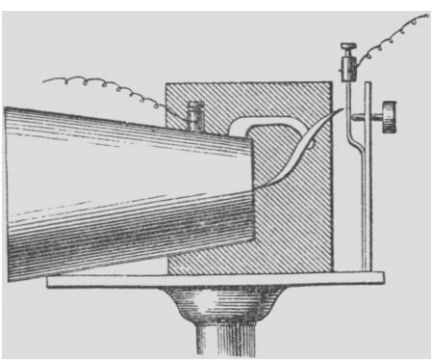

Fig. 4.

duced by the voice, and of reproducing that effect at the remote end of a telegraphic wire." The author of this book will scarcely have the hardihood to assert that his illustrious countryman, one of the greatest masters in electrical science, uttered these words in ignorance of a thing so well known as Reis's telephone.

As a further support to his position, the author lays great stress upon the statement that Reis's apparatus could and did transmit spoken words so as to be understood. As to the fact of speech having been transmitted occasionally, it is doubtless true that some words were recognized, but imperfectly, and with difficulty; and it is true, also, that when imperfectly meeting the conditions set upon it by the inventor, the apparatus, when applied to transmit spoken words, will, with skilful handling, sometimes 'deviate into sense' so far, that an occasional word or short phrase can be made out with effort, by attentive listening with the ear close to it. Professor Böttger, who took an enthusiastic interest in the matter, says that the operators could communicate words with each other, but adds, 'only such, however, as they had already heard frequently.' Of the other experimenters and witnesses whose testimony is given in the book, some were able to understand portions of what was said; others failed. Every one familiar with telephonic experiments knows how easy it is to recognize these familiar phrases by the mere intonation, and how different this is from understanding words not previously known. Is it any thing surprising, that the words of a familiar song should appear to be recognized when the air is heard? Granted that the spoken words were sometimes reproduced so as to be understood, it must also be admitted that the apparatus accomplished this so imperfectly as to be of no practical value. To make it practically efficient required a modification that was in itself a radical change and a distinct invention. That this was also Reis's opinion, will be seen from the extracts given in a subsequent paragraph.

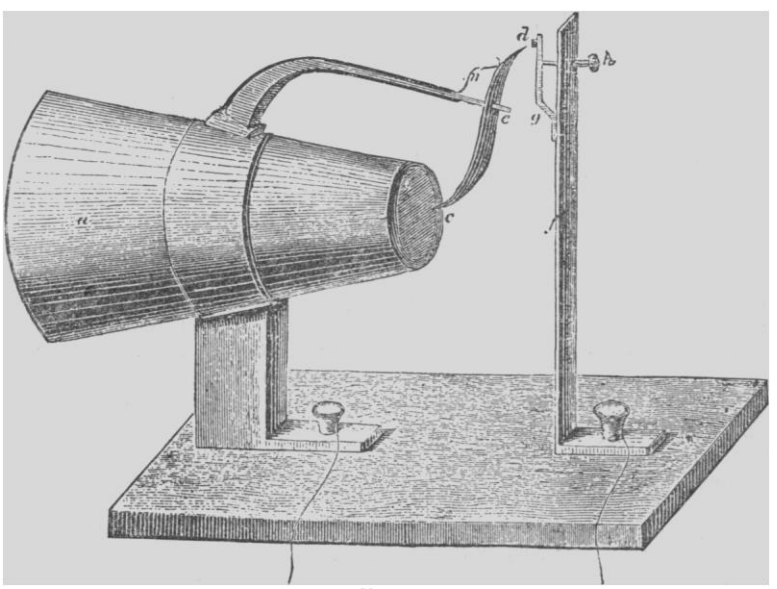

FIG. 5.

There is good evidence, in the later writings and advertisements of Reis, that he had come to the conclusion that the faithful reproduction of the complex motions which occur in articulate speech was impossible, and that he had silently abandoned the idea of reproducing speech. A further proof of this is found in the addition of the telegraphic signal-apparatus to the later forms of the instrument, to enable the experimenters to communicate with each other. Professor Thompson's argument that the Morse signal-apparatus, if intended for verbal communication, should have been reversed, meets the facts but half way; for the complete telephonic installation required a transmitter and a receiver at each end of the wire, so that the Morse signals could be sent in either direction with the same facility as the telephonic. Moreover, as if to prevent any possible question as to its use, Reis himself expressly says that the Morse apparatus is for the purpose of enabling the operators to communicate with each other; and, in the prospectus issued with the instruments, he describes a special alphabet, which he had devised to enable words to be spelled out. If these could be transmitted telephonically, why take this unnecessary trouble? This very provision is a most emphatic testimony that Reis, at this time, had become convinced that the apparatus as a transmitter of speech was a failure, and that, his original idea having proved impracticable, he had contented himself with sending musical tones.

In respect to this point, the letter of Reis, written by himself in English to Mr. Ladd, and given at p. 81, is most significant. He says, "Tunes and sounds of any kind are only brought to our conception by the condensations

and rarefactions of air or any other medium in which we may find ourselves." And again, on p. 82, "these were the principles wich (*sic*) guided me in my invention. They were sufficient to induce me to try the reproduction of tunes at any distance." And again, on the same page, "The apparatus consists of two separated parts; one for the singing-station A, and the other for the hearing-station B." Also in the same letter, p. 84, "If a person sing at the station A, in the tube (*x*) the vibrations will pass into the box and move the membrane above." Respecting the word 'tunes,' used by Reis, the author remarks, in a foot-note to p. 81, "This word, as the context and ending of the paragraph shows, should have been written *tones*. The letter, written in English by Reis himself, is wonderfully free from inaccuracies of composition; the slip here noted being a most pardonable one since the plural of the German *ton* is *tönen*, the very pronunciation of which would account for the confusion in the mind of one unaccustomed to write in English." The resemblance of *tönen* to *tunes* is not so remarkably close that it would be likely to mislead one whose knowledge of English is such as Reis shows himself in this letter to possess. The author does not attempt the explanation of the words 'singing' and 'sing' in the same letter. It is surprising that he should have allowed these words to pass unnoticed, for it was vital to his argument to prove that Reis mistook them for 'speaking' and 'speak.' The resemblance is about as close as in the other case, but in neither is the explanation likely to be admitted by the unprejudiced reader.

In taking himself back to the time of Reis's telephone, the author has failed to identify himself with the conditions of that time, and to leave behind him the subsequent acquisitions of science. He makes statements and claims which could only find their justification in a world very differently furnished with facts from this one. As an illustration of the mental disposition resulting from this, the following sentence from the author's preface may serve: "The testimony now adduced as to the aim of Philipp Reis's invention, and the measure of success which he himself attained, is such, in the author's opinion, and in the opinion, he trusts, of all right-thinking persons, to place beyond cavil the rightfulness of the claim which Reis himself put forward of being the inventor of the Telephone." But did any one ever dispute this claim during his life? and has the author forgotten that no possible basis for a rival claim existed until more than two years after Reis's death? — unless we except the suggestions of Bourseul, in 1854, which, while they certainly did anticipate the general idea of Reis's invention, were never carried to the stage of experiment, and were never set up in opposition to him, unless it has been done recently. The author can hardly have been ignorant of these suggestions; but, if not, he has carefully refrained from mentioning them. Reis never claimed that no new principle could ever be discovered which would enable the ends he sought to be attained in a different way, and more perfectly. His first article upon the subject ends with these words: "There may probably remain much more yet to be done for the utilization of the telephone in practice. For physics, however, it has already sufficient interest in that it has opened out a new field of labor." And Von Legat closes his report with this remark: "There remains no doubt, that, before expecting a practical utilization with serviceable results, that which has been spoken of will require still considerable improvement, and, in particular, mechanical science must complete the apparatus to be used."

The chief aim of the book is clearly this, — to endeavor, in direct opposition to the facts, to establish the untenable proposition that the Reis transmitter was designedly contrived by him to vary the contact-resistance by pressure, giving it a microphonic action, failure to accomplish which is fatal to its success in conveying spoken words. Professor Thompson has not always been of this opinion, and in another place he has given a correct account of the relation of Reis's invention to that of Bell. In his 'Elementary lessons in electricity and magnetism,' published in 1881, we find, on pp. 405 and 406, these words, — "The first attempt to transmit sounds electrically was made in 1852 [misprint for 1862] by Reis, who succeeded in conveying musical tones by an imperfect telephone. The transmitting part of Reis's telephone consisted of a battery and a contact-breaker, the latter being formed of a stretched membrane, capable of taking up sonorous vibrations, and having attached to it a thin strip of platinum, which, as it vibrated, beat to and fro against the tip of a platinum wire, so making and breaking contact. . . . Reis also transmitted speech with this instrument, but very imperfectly, for the tones of speech cannot be transmitted by abrupt interruptions of the current. . . . In 1876 Graham Bell invented the articulating telephone. In this instrument the speaker talks to an elastic disk of thin sheet-iron, which vibrates, and transmits its every movement electrically to a

similar disk in a similar telephone at a distant station, causing it to vibrate in an identical manner, and therefore to emit identical sounds.'' Here we have Reis spoken of as inventing '*an* imperfect telephone,' while Bell invented '*the* articulating telephone.' Reis's instrument was a 'contact-breaker,' and conveyed 'musical tones.' Reis's instrument transmitted speech 'very imperfectly,' and there is not the slightest suggestion of microphonic action in the transmitter. Yet two years later we have statements diametrically opposed to these.

The least that can be said of such varying and contradictory evidence is, that it totally destroys the credibility of the witness, and nullifies his claim to be accepted as a scientific authority, unless good reason is shown for the different opinion. The documents quoted in the book give no substantial reason for this change of ground, as they add very little of any importance to what was already generally known. The motive for the later opinions may be more intelligibly traced in the following items, which will be found in the *Telegraphic journal and electrical review*, vol. xii. p. 72, Jan., 1883, and p. 317, April 14, 1883, in the list of English patents: — "2578. Telephonic instruments. SYLVANUS P. THOMPSON. Dated May 31. 6d. This invention relates to telephonic instruments, and chiefly to improvements in receivers of a well-known form or type, invented by Phillip Reis.'' "3803. Improvements in telephonic apparatus. SYLVANUS P. THOMPSON. Dated August 9. 6d. Relates to telephonic transmitters based upon the principle discovered by Philipp Reis in 1861, namely that of employing current-regulators actuated, either directly or indirectly, by the sound-waves produced by the voice. By the term 'current-regulator,' the inventor means a device similar to that employed by Reis, wherein a loose contact between two parts of a circuit (in which are included a battery and a telephonic receiver) offers greater or less resistance to the flow of the electric current, the degree of intimacy of contact between the conducting-pieces being altered by the vibrations of the voice.''

For a contrast of colors, we may put side by side with these sentences the following, from the preface to the book now under consideration: "To set forth the history of this long-neglected inventor and of his instrument, and to establish upon its own merits, without special pleading, and without partiality, the nature of that much-misunderstood and much-abused invention, has been the aim of the writer. . . . He has nothing to gain by making Reis's invention appear either better or worse than it really was.''

Further comment upon the value of such testimony as is contained in this book is superfluous. What Reis accomplished, and what he failed to do, are now familiar matters of history. His well-earned fame can only suffer from such misstatement of facts, and the unjust exaggeration of his actual achievements.

OBLIGATIONS OF MATHEMATICS TO PHILOSOPHY, AND TO QUESTIONS OF COMMON LIFE.[1] — I.

SINCE our last meeting, we have been deprived of three of our most distinguished members. The loss by the death of Professor Henry John Stephen Smith is a very grievous one to those who knew and admired and loved him, to his university, and to mathematical science, which he cultivated with such ardor and success. I need hardly recall that the branch of mathematics to which he had specially devoted himself was that most interesting and difficult one, the theory of numbers. The immense range of this subject, connected with and ramifying into so many others, is nowhere so well seen as in the series of reports on the progress thereof, brought up, unfortunately, only to the year 1865, contributed by him to the reports of the association; but it will still better appear, when to these are united (as will be done in the collected works in course of publication by the Clarendon Press) his other mathematical writings, many of them containing his own further developments of theories referred to in the reports. There have been recently or are being published many such collected editions, — Abel, Cauchy, Clifford, Gauss, Green, Jacobi, Lagrange, Maxwell, Riemann, Steiner. Among these, the works of Henry Smith will occupy a worthy position.

More recently, Gen. Sir Edward Sabine, K.C.B., for twenty-one years general secretary of the association, and a trustee, president of the meeting at Belfast in the year 1852, and for many years treasurer, and afterwards president of the Royal society, has been taken from us at an age exceeding the ordinary age of man. Born October, 1788, he entered the Royal artillery in 1803, and commanded batteries at the siege of Fort Erie in 1814; made magnetic and other observations in Ross and Parry's north-polar exploration in 1818–19, and in a series of other voyages. He contributed to the association reports on magnetic forces in 1836, 1837, and 1838, and about forty papers to the *Philosophical transactions;* originated the system of magnetic observatories, and otherwise signally promoted the science of terrestrial magnetism.

There is yet a very great loss, — another late presi-

[1] Inaugural address by ARTHUR CAYLEY, M.A., D.C.L. LL.D., F.R.S., Sadlerian professor of pure mathematics in the University of Cambridge, president of the British association for the advancement of science, for the Southport meeting. From advance proofs kindly furnished by the editors of *Nature*.