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The Thirty-eighth Ordinary General Meeting was held on Wednesday, the 10th November, 1875, Mr. LATIMER CLARK, President, in the Chair.

The President rose and said—

GENTLEMEN,—In meeting together for the first time after the recess, I have much pleasure in stating that the business of the Society has been well attended to by the Council, and the preparation of the Catalogue of the Ronalds Library has been duly carried on, and is now in an advanced state. The work, however, is of such magnitude that I fancy it will be a long time before we can announce its completion ; in the meantime it is going on, and about one-third of the catalogue has been written out and is in type.

The Paper for this evening is “On the respective merits and durability of Gutta-percha and India-rubber Joints,” by Mr. Henry C. Mance, of the Persian Telegraph Department, a member of the Society, and well known to most of us, and I hope when that Paper comes before you it will be discussed in a way that the importance of the subject deserves. But, before we commence, it is my duty to take some notice of the loss of one of our most distinguished members ; I allude to the death of Sir Charles Wheatstone. A greater name than that we can seldom expect to have in our Society. Sir Charles Wheatstone was distinguished, not only amongst the members of this Society, but throughout the world, as one of the most eminent men of science of this or any past

era, and I do not think we can duly appreciate the greatness of his name unless we regard it from a proper distance. You cannot discover the tallest tree in the forest while you are standing under its shadow. If you wish correctly to estimate the magnitude of a building, it is necessary to place yourself at a distance from it; it is only then you can fully realise its real proportions as compared with its fellows. So it is with the name of Sir Charles Wheatstone: I feel that, in order to appreciate how great a man he has been, we must look forward many years—I mean by that a very great many years—if we can take our stand in imagination, a thousand years hence the name of Wheatstone will still be well known and highly honoured. So far as we can judge from the history of the human race, and of the past, I am of opinion that, as long as history lasts, the name of Wheatstone will be associated with that of Watts and Stephenson as men who, in the era of Queen Victoria, were prominent in the introduction of those magnificent enterprises by which the whole world has been practically reduced to one-twentieth part of its former size. Our successors will hear in their day of the giants of the Victorian era; they will hear the name of Watts in connection with the steam-engine, and of Stephenson in connection with the locomotive and railways; and they will also hear of Wheatstone in connection with the electric telegraph. We who are closer to him, and know more of the history of the invention, are well aware that others are entitled to share with him in the fullest degree the honour of the introduction of the electric telegraph; but history is written very much by scientific men, and Sir Charles Wheatstone was himself an eminently scientific man, and mingled so much with scientific men, that those who will be the recorders of the history of the future will, to a great extent, associate his name alone with the practical introduction of the electric telegraph. I do not speak of the justice or injustice of the matter, but from the position he held here and on the continent it is certain, after we have passed away, that his name will be more prominently associated with the introduction of the electric telegraph than any other. Therefore, I say we lose in him an honoured name, and one of the most distinguished members our Society can ever expect to possess.

I think it will not be a loss of time if we, as an electrical society, consider for a few moments the great services which Sir Charles Wheatstone has rendered to the science of electricity; and, if it will not be detaining you too long, I will review briefly a few of the valuable improvements which he introduced in telegraphic and electrical science.

Our late lamented and distinguished member was born, as most of you know, at Gloucester, in the year 1802. His parents not being persons of affluence, he had to earn an honest living at the commencement of his life. I believe he was connected with the sale of musical instruments. He, however, soon rose above that. His talents became known, and in 1834 he was appointed Professor of Natural Philosophy at King's College, and a worthy choice they made, whoever chose him. He early distinguished himself in science, for in that same year, 1834, he made that marvellous experimental determination of the velocity of electricity which would have been of itself enough to render his name immortal amongst the roll of men of science. It must have been a happy inspiration which struck him—but, knowing the man, it ought not to surprise us—it was a magnificent idea of his, that method of using a revolving mirror to illustrate the velocity of electricity, and subsequently that of light itself—a velocity so great that by no other mundane means could we demonstrate its existence at all; but Wheatstone, in 1834, conceived the happy idea of causing a mirror to revolve at a velocity of 800 times per second, and by that means to demonstrate whether a current of electricity did or did not take an appreciable time to pass round a circuit of wire. In his lecture-room at King's College he suspended a length of about four miles of wire round the room, and he sent through those four miles of wire a discharge from a Leyden jar, and caused the discharge to form sparks and make itself manifest at three places—first at the instrument where it left the jar, second at two miles distance of wire, and lastly again when it re-entered the jar, and these three breaks were so arranged that they were all in a direct line opposite to him. He looked at these three points where the sparks passed in a mirror revolving at an immense velocity. It was nothing more than the works of a watch, on which he fixed his

tiny mirror, and at the time when the current was passing in the right direction he saw the reflection of the three discharges from the Leyden jar. Now, if these discharges were all absolutely simultaneous, the mirror would show all the three in the straight line in which they were arranged; but if not simultaneous, the middle one being a little later, the mirror would have turned through a minute portion of space, and its reflection would not be in a straight line, but reflected at a point a little distance from the others, and the three sparks would not be in a straight line but in a slightly curved line. This magnificent experiment Sir Charles Wheatstone carried out successfully in his own lecture-room, to his very great delight, as we may readily imagine. He saw that these sparks were not in a straight line, and that the current had taken some time to traverse the three points of the wire and reach the end of the circuit. From this it was deduced that the velocity of electricity is 288,000 miles per second, which does not vary very materially from the velocity of light, and Wheatstone announced this as the result of his wonderful experiment, and it at once spread his name through the world of science, as the author of one of the most magnificent discoveries ever recorded. Since then that system has been used for determining the velocity of light, and the revolving mirror is now one of the most powerful means of determining high velocities and minute portions of time. In determining the velocity of electricity we know, as Faraday pointed out, that there is no such thing as a constant velocity of electricity; in fact, no one knows what the ultimate velocity of electricity is; we know however what takes place in such an experiment as this; there is the same phenomenon in a submarine cable—that is, before the spark could cross the middle space at two miles from the battery, it had first to charge the two miles which existed between the battery and the conducting knobs to a tension sufficient to strike across that distance, and the time it took in charging that two miles of wire would depend upon the conductivity of the wire, and also on the amount of its electrostatic capacity. Faraday showed that if you put Leyden jars in circuit, or if you have a submarine circuit instead of the walls of a room, the velocity, instead of being 288,000 miles per second, might only

be 144,000 or less, the function of velocity evidently depending upon the conductivity and the amount of electrostatic capacity of the wire; therefore, though Wheatstone supposed that he had discovered the determinate velocity of electricity—we know that it is in some cases more and in some less—that it is in fact entirely dependent upon the two functions I have stated. Still, the experiment was one of so brilliant a character that alone it was enough to immortalise his name.

In 1835 he made another discovery, and ascertained that when metals were *volatilised* by the electric spark—that is, when a current was passed between two terminals of different metals—the spectrum when viewed through the prism showed certain determinate lines of light, and he showed also that these lines of light varied in different metals, and he went so far as to say that it was possible to determine what kind of metals the terminals were composed of by looking through the prism and observing the position of the lines of light which were shown on the spectrum.

He in fact distinctly foreshadowed the method of spectrum analysis which has since made us acquainted with the nature and composition of the fixed stars.

In the same year (1835) Wheatstone was engaged at King's College in giving lectures on electricity and other subjects of natural philosophy. Amongst others, he gave a lecture to his class on Baron Schelling's telegraph, which was, to a great extent, the same telegraph which was afterwards so largely introduced in England. In doing so, he pointed out that there must be a great future before such a force as we possessed, and he thoroughly demonstrated to the world that there was the possibility of such an invention as the electric telegraph, and that the means were then known by which it could be introduced. This was his first association with the electric telegraph.

In the following year we come to a period of great importance in Wheatstone's life. It appears that Sir William—then Mr.—Cooke, on the 6th of March, 1836, saw some experiments which were made at Heidelberg with Professor Muncke's telegraph, and he was so struck with the important nature of these experiment that he abandoned the occupation he was then following—that of a

surgeon,—and came to England with the determination to pursue the question of the electric telegraph to its fullest end. He accordingly arrived in England on the 22nd of April, 1836; but it was not till January, 1837, that he had so far advanced the question he was dealing with as to be able to exhibit it publicly in London. He was not himself a man of great scientific knowledge. He was, as I have said, a surgeon, and, feeling his want of scientific knowledge, he twice consulted Professor Faraday and Dr. Roget, as the best persons he could go to, with the view of carrying out his pet idea of bringing the electric telegraph into practical use on the railways, especially in tunnels, where there was great necessity for it. By the advice of Dr. Roget, on the 27th of February, 1837, Mr. Cooke visited Wheatstone at his house in Conduit Street, who afterwards introduced him to his lecture-room at King's College. He then proposed to Wheatstone that they should enter into a partnership to carry out the electric telegraph, and, strange to say, Wheatstone was at first disinclined to enter into an arrangement of the kind. We all know how very frequently a small circumstance may determine the future course of a man's life. He may be late at dinner, he may pass on the right hand side of a street instead of the left, he may be civil or inattentive to a man, and a trivial circumstance may produce an entire change in his future career. Wheatstone, in my opinion, will owe much of that celebrity which I think he will obtain in future years to his connection with the electric telegraph, and I believe had he not associated himself with Sir William Cooke he might have remained only a distinguished professor who had demonstrated and explained the possibility of electric telegraphy. But fortunately he took the other course, and did enter into partnership with Cooke. Reluctant at first, he might have contented himself with saying, "I have made a great name in science, whereas you are not a scientific man, and my intention is to continue my experiments and give the world the benefit of them." Cooke, however, took another view of the matter. "I want," said he, "to make money by the telegraph, and I want your assistance; let us work together and treat the thing from a commercial point of view instead of a merely scientific one." It was proposed that a patent should be

taken out, and in those days a patent cost several hundred pounds; and Wheatstone consented to become partner in the concern. I look upon that as the turning-point in the greatness of Wheatstone; for I suppose, had he not taken that resolution, he would have remained simply as one scientific man amongst a great many others of the present era; but having joined Cooke, and having with him successfully introduced the electric telegraph, he has gained for himself a higher pinnacle of scientific eminence than would have been possible by any other career. It was in May, 1836, that Cooke and Wheatstone resolved to unite together in this great scientific enterprise, their deed of partnership being dated the 19th of November, 1837. On the 25th of July, 1836, the trial of the telegraph was made from Euston Square to Caniden Town. That may be regarded as the first piece of practical electric telegraph which has existed, and was the origin of the great telegraph system which has since spread all over the world. Wheatstone was able to foresee, at this early period, what we all now so well know, the value of Ohm's laws. He was the first to appreciate and employ Ohm's formulæ long before others recognised their importance or their truth. I may add that in the same year, 1836, Wheatstone was elected worthily a Fellow of the Royal Society.

In 1837 Cooke and Wheatstone took out a patent for the five-needle telegraph, which is essentially the child of Sir Charles Wheatstone. This consisted of a keyboard of peculiar arrangement, two opposite electro-magnets deflecting a needle. The instrument, however, never came into practical use, but, like all he did, it was eminently ingenious. The opposed electro-magnets were, however, a very important introduction in telegraphy. They also patented—I do not know which of the two introduced it—but I believe it was Sir Charles Wheatstone who invented—the system of sounding distant alarms by removing a detent of clockwork by the aid of a local battery, contact being made in mercury by a needle dipping in cups. All these important introductions were patented in 1837. They proceeded further with their inventions, and in 1839 the telegraph line was laid from Paddington to Drayton, and extended to Slough in 1841, and rendered such service in leading

to the arrest of the Quaker murderer, Tawell, that it at once brought the electric telegraph into popular favour.

In 1848 Sir Charles Wheatstone suggested a very important step in the march of the electric telegraph. Before the Select Committee of the House of Commons on Railways he gave his opinion in evidence that it was quite practicable to construct a submarine telegraph from England to France, from Dover to Calais, or from Dover to Boulogne. As far as I know, he was the first to say he believed in the practicability of submarine telegraphy. That is now thirty-five years ago, and few at the time could have expected to witness what has happened since then. At this time (1840) Sir Charles introduced another invention, namely, the chronoscope, for measuring small intervals of time by means of electricity, more especially the velocity of projectiles, and I need not say what an important part that is now playing in the science of warfare. In the same year, also, he took out a patent for a form of alphabetical telegraph, showing letters by an escapement and rotating commutator, a step-by-step motion. In the same year Cooke and Wheatstone erected the telegraph line on the Blackwall Railway, the first practical line, after the line to Slough, on the Great Western Railway.

In 1841 they patented a type-printing electric machine, which was then a great novelty. It was a machine with a step-by-step motion, similar in principle to the one previously introduced in 1840, showing letters on the dial, but it also carried round the type on a number of light springs. This machine was worked by two wires, and, when the type was brought round, a hammer, acted on by a second current, fell upon it, and printed it on the paper. That was the first type-printer, a machine of which we have since seen such great developments. He also used a rotating magnetic machine, in which five coils revolve between six permanent magnets, with a commutator to give permanent currents, and he introduced an improvement of similar character in the electro-magnetic engine. He likewise introduced the well-known rheostat or resistance coil, which is in such constant use at this day, his first machine being a perfect resistance coil of a most elegant character. He also invented a chronoscopic method of recording time by a surface carrying



paper ruled to represent equal intervals of time, revolving uniformly by clockwork, and an electro-magnetic armature carrying a pencil. By this means the exact moment of the passage of a star or other phenomenon could be recorded, and this instrument is now fast coming into use in all the large observatories of the world.

I may here mention an incident in connection with the Blackwall telegraph which is interesting, and, I believe, true; I will mention it as stated to me by Mr. Greener, one of our members, twenty years ago. In 1841, probably in September or March, a very high tide occurred, which caused the inundation of the Blackwall Railway, and it rose to such a height that it injured the piping through which the wires were carried, and reduced the number of working wires from seven or eight—they were then using a wire to each station—to one or two. Mr. Cooke, who was the practical engineer of the telegraph, was in great trouble, fearing that some accident might ensue by the failure of his telegraph, and by their being unable to communicate with the intermediate stations from the Blackwall end of the line. I have been assured, not only by Mr. Greener, but also by another telegraphic clerk on the Railway, that they had previously arranged a code of signals on one wire by deflecting the needles alternately, once, twice, or thrice, to the right or left, as we do now with the single-needle telegraph, and had managed to carry on communications respecting their dinners and other private matters. Mr. Cooke, on being informed that it was still possible to telegraph, gladly availed himself of the new means of communication by one wire, and from that moment our well-known single and double needle instrument was practically invented. If these statements be accurate, the first idea of the double-needle telegraph did not originate either with Wheatstone or Cooke, but was suggested by Mr. Greener and his partner, who was at the time engaged with him on the Blackwall telegraph.

In 1841 a difference arose between Wheatstone and Cooke as to who was the real inventor of the telegraph, and I think we must all now admit that neither of them was solely. They however agreed to submit the question to arbitration—Isambard Brunel acting on the part of Mr. Cooke and Professor Daniell on that of Mr. Wheat-

stone. I will just read to you an extract from their award, and it is a very short one. They say: "Whilst Mr. Cooke is entitled to stand alone as the gentleman to whom this country is indebted for having practically introduced and carried out the Electric Telegraph as a useful undertaking, promising to be a work of national importance, and Professor Wheatstone is acknowledged as the scientific man whose profound and successful researches had already prepared the public to receive it as a project capable of practical application, it is to the united labours of two gentlemen so well qualified for mutual assistance that we must attribute the rapid progress which this important invention has made during the five years since they have been associated.—M. I. BRUNEL, J. F. DANIELL."

I am not aware that anything important in the history of Wheatstone occurred in 1842; but in 1843 he read a paper before the Royal Society, which was called "An Account of several new Processes for determining the Constants of a Voltaic Circuit;" and that paper I have always thought one of the most valuable and instructive papers that I am acquainted with. There is no member of this Society at the present day, however high his station or great his knowledge, who can read that paper through again without interest, and those who do not know it ought to make themselves acquainted with it. Considering the early date at which it was written, a more able paper on electricity I have never read. In the first place, he introduced to the notice of the world the principle of the Wheatstone bridge, now so familiar to all. We are aware it was not his invention, nor did he ever claim it. It was discovered and invented in 1833 by Mr. S. W. Christie, who published a description of it in the *Philosophical Transactions*; but the form in which he put it was not that of the parallelogram with which we are all so familiar; one side of the parallelogram was doubled back across the other, which gave it a confused appearance, and perhaps from this cause it did not attract notice; but Wheatstone, by embodying it in his paper in 1843, at once brought it into favour, and from that hour to this the instrument has been in the hands of every electrician. Wheatstone always used Daniell's battery in his experiments and lectures, and explained its advantages in this paper. In the same communication he describes the system

of units of electrical resistance. His unit was one foot of copper weighing 100 grains. He showed how this might be applied to the measurement of *distances* as well as electrical resistances, and practically he was the father of the system of measurement of telegraphic resistance; the paper as a whole, abounding as it does in simple but practical formulæ, for the calculation of resistances and of electric currents, is one of which it is difficult to speak too highly, considering the early date at which it was written. In 1843 he invented a machine by which, by making contact with the mercury in the bulb of a thermometer, he was able to register the observations of meteorological instruments at great distances, and to record the meteorological or physical changes going on. Such an instrument is one of considerable importance, and has been practically in use ever since.

In May of the same year Cooke and Wheatstone introduced a system of giving audible signals by striking a bell, using the derived current with a sensitive signal apparatus. This had been done by others, but theirs was a decided improvement of the telegraph, and brought into notice the system we now know as the sound telegraph. Also in the same year Wheatstone discussed the laws of derived circuits, and it is needless to say how valuable these are to us as electricians. He used shunts, and patented the method of applying stops to the needle and giving signals by successive right-and-left movements, although this had apparently been done two years previously on the telegraph of the Blackwall Railway. He also introduced in the same year a method of covering electrical conducting wires with leaden tubes, which to some extent foreshadowed the custom of the present day.

At this period of time Cooke had so far worked out the business part of the undertaking that on the 2nd September, 1845, the Electric Telegraph Company was registered, and commenced its operations in 1846. Wheatstone, by his arrangement with his partner, received 33,000*l.*, a substantial reward for the eminent services he had rendered to telegraphy.

From 1845 to the year 1858, so far as I remember and know, Wheatstone appears to have dropped entirely out of the telegraph connection, and I often wondered why a man who had made

so great a name did not again come to the front and bring his great electrical knowledge and inventive faculties into use; he did not do so, but, having received his well-deserved reward, he appears to have retired entirely from the field. After the lapse of some thirteen years, however, he introduced his system of automatic printing, that beautiful apparatus for transmitting messages at great speed by the punching of holes in paper. The idea was originally due to Bain, who in 1846 described and tried to introduce the system even in that early period of telegraphs; but it did not come into use, and, though many similar attempts were made by myself and others, all failed from our not having the requisite mechanical skill to make it practically successful. Wheatstone, however, aided by that admirable mechanic Mr. Stroh, brought out the beautiful instrument with which we are now so familiar and which is in hourly use, and he alone deserves the merit and credit of having made automatic telegraphy a perfect success.

In the same year, or perhaps a little later, he introduced that beautiful little instrument with which we are equally familiar, viz. the alphabetical dial telegraph, worked by the hand, and now in universal use; and in connection with that I need not point out where one of the secrets of Wheatstone's great success lay. He perceived distinctly what others did not, that, having to deal with extremely delicate forces and feeble currents of electricity, it was hopeless to attempt to employ heavy machinery, but that it was necessary to use the smallest and lightest appliances. In making his first experiments he used needles six or eight inches long, weighing half an ounce; subsequently the working parts were reduced to a small size, combined with exquisite workmanship, and weighing only a few grains. He made all his apparatus of a very light and highly delicate character; and it is the lightness and delicacy of the alphabetical and many other of his instruments which constitutes one great secret of their perfection and success. Wheatstone made, subsequently to 1858-9, some other very important inventions. Amongst these was a method of driving magneto-electric clocks by a series of revolving magnets worked by pulsating currents. He likewise

introduced an improvement in over-house telegraphs, and was the originator of the plan of suspending wires most in use in the present day. Latterly he experimented on a very delicate system of electrical communication, that is, with a drop of mercury in a capillary tube with a column of acid on each side; and he proved the fact that the most delicate current passing through a capillary tube of acid will cause a globule of mercury to move to the right or left, according as the current is directed through it.

I have now completed, so far as I know, the list of the principal discoveries of Sir Charles Wheatstone in electrical science. It now only remains to point out what great results have followed from the introduction of this system. I am informed that at the time of the transfer of the electric telegraphs to the General Post Office, in January 1870, the number of automatic instruments sending messages on punched paper was only six. There are now 140 in constant use. At the time of the transfer there were 644 needle instruments in use throughout all England. At the present day the number is increased to 3,941. At the same period there were 39 dial alphabet instruments in operation. There are now 4,178. I am further informed that at the present time by day there are 14,030 miles of wire worked automatically; by night 19,000 miles are hourly and momentarily in use on that system. I have received the further information that the railway mileage was, in 1870, 45,000 miles of wire, of which 35,000 were worked on the needle system of Wheatstone. We see what results have followed, and how far at this day it is appreciated and in use, when we learn that the present Post Office mileage amounts to no less than 108,000 miles at work in the telegraph service of this country.

I think I have mentioned most of the important contributions of Sir Charles Wheatstone to electrical science, but, if there are any which I have omitted, I hope some member will describe them. I may add that he was to the day of his death incessantly working upon new ideas, and I have no doubt there exist many unpublished experiments in which he was engaged, and the knowledge of which he has left behind him; I have only to express the hope that those who have access to his papers will kindly at some day give them, if not to this Society, to the

world at large, believing as I do that they will be of considerable interest and importance.

Dr. C. W. SIEMENS (past President) said : Mr. President and gentlemen, I have a proposition to make which I am sure you will all second and approve, that is, to ask our President to allow the address which he has just given us to be printed—not only in our Proceedings, but separately, and circulated to the members. I have listened, and I have no doubt all present have listened, with great interest and pleasure to his address regarding the works of our most highly respected and esteemed member, the late Sir Charles Wheatstone. He has done it, I consider, in a very masterly manner. I have read other notices regarding the works of Sir Charles Wheatstone, amongst others the address of M. Tresca before the French Academy, and I have taken part in a memorial addressed by the Royal Institution in his honour, but I have not hitherto found his works recorded in such a temperate, just, and complete manner as has been done this evening by Mr. Clark. We should honour the dead, but we should also be just with regard to them, and, whilst we avoid fulsome praise, we should take care to give them fairly and fully that amount of credit which is due to them. In the case of Sir Charles Wheatstone that amount of credit is a very large amount indeed. Sir Charles Wheatstone laboured during a period of between thirty and forty years incessantly in the field of science, and his fertile mind has produced results such as few have been allowed to attain ; therefore he can well afford to have his works justly dealt with, and they need not be increased or diminished by one iota. There are one or two points mentioned by the President which I think could hardly be claimed for Sir Charles Wheatstone. I would mention the one regarding the effect of electricity in the capillary tubes. Sir Charles Wheatstone followed up the experiments on that subject with his usual energy, but I believe the idea was first suggested at Frankfort by Professor Lippmann. I think our President will be too glad to correct any excess of credit ; it would not be a credit to Wheatstone, but rather detract from his real merits, if anything that was not fairly due to him was attributed to him. I think however, on the whole, we have heard an address regarding the

works of Sir Charles Wheatstone which deserves to live amongst us as a lasting record of the works of one of the greatest men this century will have to boast of. I beg to propose that our President be requested to allow his Address to be printed and circulated amongst the members.

PROFESSOR ABEL : I beg to second the motion which has been made by Dr. Siemens. In doing so, I feel I represent here a gentleman who would have been more worthy, in every respect, to second it, namely, Mr. Sabine, the son-in-law of Sir Charles Wheatstone, who, owing to unavoidable circumstances, is not present this evening. But I believe I may claim—though my claim is a very modest one—to say a few words with reference to the great labours which Sir Charles Wheatstone has carried out, and the great success of his works. I feel happy in the recollection of the fact that nearly a quarter of a century ago I was associated with him in a humble way in one small branch of the many subjects which he took up with such enthusiasm, and I may be allowed to say there can be no man existing in the Society of Telegraph Engineers who ever was associated with Wheatstone who will not feel proud of that association, however humble it might have been. It was my fortune more than twenty years ago to work with Wheatstone in the application of high tension electricity to the explosion of mines, and I consider the enthusiastic way in which he entered into this subject led to the rapid development of that very important application of electricity which we have had on many occasions opportunities of noticing, and from which I believe this country will reap many advantages in the future. It was Wheatstone who proposed the application of magneto-electric currents to the explosion of mines, and he was the first to bring forward a powerful magneto-electric machine, which was first experimented upon by Mr. Henley for this purpose. He brought under the notice of the Government the successful labours of Du Moncel, Savari, von Ebner, and others in this direction, and I consider if he had only done this service he had done an important work. He did more, he constructed the first practical and thoroughly efficient magneto-electric machine for the explosion of mines, and it was at his

instigation that I devoted time to devise the actual means of doing this by his machine. With him, to undertake a work was to set about it with remarkable enthusiasm, to which was added an astonishing amount of ingenuity, and we cannot fail to notice how very rapidly he brought his scientific ideas into practical use. I consider we have had brought before us a most lucid and in every way a most valuable summary of the life of Sir Charles Wheatstone as presented by his works, and therefore I beg most heartily to second the motion of Dr. Siemens.

The proposition having been carried by acclamation,

The PRESIDENT: I have to say how deeply I feel the loss we have sustained in the death of our respected member. I think it would be proper, in a case of this kind, that we should pass a vote of sympathy on the part of this Society to the relatives of Sir Charles Wheatstone. I need scarcely tell you, what you would almost surmise, namely, that we had warmly hoped to have been honoured by nominating him as our next President, and it had been decided to communicate with him for that purpose when his lamented death intervened. In fact, the wish had been already communicated to his friends. I therefore propose that we offer a vote of deep condolence to the relatives of Sir Charles Wheatstone on the part of this Society.

MAJOR MALCOLM: I am quite sure that not a single hand will be raised in controversion of the proposition which has just been made by the President. I think we all cannot but feel that this Society has experienced a most serious loss in the death of Sir Charles Wheatstone, and I think, feeling it ourselves, we must feel with his relatives for the great loss which they themselves have experienced. It was not alone to telegraphic and electrical science that Sir Charles Wheatstone devoted himself, but, as we know, he applied himself to the whole range of science. I have the greatest, I can hardly call it pleasure, in seconding the President's proposition, and I trust you will allow me to put it to the meeting.

The proposition was then put and unanimously agreed to.

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