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THE NEWCASTLE LITERARY AND PHILOSOPHICAL SOCIETY.

The hundredth anniversary of the Literary and Philosophical Society of Newcastle-on-Tyne was celebrated by a *conversazione* in the rooms of the institution on Tuesday. A large number of local notabilities were present, being received by Dr. Embleton. Dr. R. Spence Watson, and Mr. John Pattinson. The National Telephone Company had music laid on, and Dr. Watson read an interesting historical statement of the progress of the society.

Lord Armstrong lectured on "Electrical Phenomena." His Lordship said: The Literary and Philosophical Society was founded by a small number of literary and scientific men, of whom my father was one. For 30 years I have had the honour of being president, and as such it is fitting I should contribute in some way to the celebration I have, therefore, undertaken to exhibit to you this evening some electrical experiments which possess sufficient novelty to render them interesting to experts and, at the same time, entertaining to those who have but scant knowledge of electrical science.

The hydro-electric machine was my first electrical love; but soon after its introduction I became engaged in the hydraulic experiments which led to the establishment of Elswick, and from that time to very recent years the exigencies of business prevented my giving attention to electrical subjects. But I remained faithful to my first love and resolved to renew my addresses if ever circumstances permitted me to do so. This I did about a year ago, but in the meantime, I had grown old and unable to bear the necessary outdoor exposure, so I transferred my affections to a less exacting mistress that would be satisfied with indoor attentions. That second mistress was the Rhumkorff induction coil. My first endeavour was to combine induction coils in such a manner as to form a battery, just as we combine Leyden jars voltaic cells in battery. There were many impediments to doing this, and, although I have not wholly overcome them, I have succeeded, in making a very powerful apparatus upon this principle, which, however, is too cumbersome to be brought here this evening, and is not required for the experiments I intend to show you.

I have a large diagram illustrative of an induction coil. I am doubtful as to the expediency of explaining it, because to do so will be deemed a waste of time by experts, and a bore by those who are wholly ignorant of electricity, but where is an intermediate class to whom a popular explanation may be welcome, and for their sake I will endeavour to make the subject intelligible in as few words as possible.

His Lordship here described the induction coil, and then proceeded as follows: Now I daresay many of you will be tired of talk, and J more anxious to see than to hear. I will therefore first show you the spark from the induction coil on the table, which is a very powerful one, made by Apps. The short spark with which I commence consists entirely of flame, which Mr. Crookes has shown t to be due to the combustion of the nitrogen of the air in its union with the oxygen to form nitric acid; then, as I gradually increase a the separating distance, you will see a torrent of sparks passing u between the terminals. I go on increasing up to 18in., when sparks still continue to pass, though in reduced numbers. I will next

show you some other beautiful illuminating effects, and then proceed to things which, from their novelty, possess more scientific interest.

Probably many of you are aware that soon after I introduced my hydro-electric machine I designed and made a very large one for the Polytechnic Institution which then existed in London. It proved to be by far the most powerful instrument for the production of frictional electricity that had ever been seen. It was a very short time in my hands after its completion, and I made the best use of my time in trying experiments with it in the open air. Amongst other experiments I hit upon a very remarkable one. Taking two wine-glasses filled to the brim with chemically pure water, I connected the two glasses by a cotton thread coiled up in one glass, and having its shorter end dipped into the other glass. On turning on the current, the coiled thread was rapidly drawn out of the glass containing it, and the whole thread deposited in the other, leaving, for a few seconds, a rope of water suspended between the lips of the two glasses. This effect I attributed at that time to the existence of two water currents flowing in opposite directions, and representing opposite electric currents, of which the one flowed within the other and carried the cotton with it. It required the full power of the machine to produce this effect, but, unfortunately when it went to London, and was fitted up in the lecture-room, I could not get the full power on account of the difficulty of effecting as good insulation in a room as in the outside air. I therefore failed in getting this result, after announcing that I could do it, and I daresay I got the credit of romancing. It has ever since been my desire to establish my veracity in this matter, and with the powerful apparatus now at my command, I speedily succeeded in reproducing the experiment in a modified form. In fact, I have done it in different forms; but the one which I shall show you this evening is as striking as any; and can be performed with the single induction coil which I have upon the table. The conditions of the experiment are as follows: I take a glass bulb having a long neck on one side and a short nozzle on the other, the nozzle having an aperture of one-tenth of an inch diameter. Through this aperture a string composed of spongy cotton thread is passed. The string is barely sufficiently thick to fill the aperture, and is secured at the upper end by a knot or by attachment to a conducting wire, which enters the bulb through a cork at the top of the neck. The bulb is then plunged into a glass cistern, and both bulb and cistern are filled with carefully distilled water, and the cork is tightly inserted in the neck. The whole is placed in the field of the lantern as to be exhibited on the screen. And now, all being ready we send a positive current into the bulb, and make the cistern negative and if I am not again sold, as I was at the Polytechnic, you will see the cotton climb up into the bulb. You see it is so, and now I reverse the current and it comes rapidly down. Those who are near will see that there is a clear indication of water rushing out of the aperture all around the cotton. The water in passing the aperture becomes a little heated, and is rendered visible by a flicker, just as hot air becomes visible when it mingles with cold. But the bulb remains full, and if water comes out without lessening the quantity m the bulb, an equivalent quantity must be going in by the same aperture, and as the descending column visibly flows outside of the cotton the ascending current must flow inside the cotton, and must carry the cotton with it. The two currents become distinctly visible when the cotton is removed and though we cannot discern their relative position until they are clear of the aperture, the facts of the case seem to demonstrate that the negative current flows inside of the positive and determines the direction in which the cotton travels. This conclusion appears to me a very interesting one, and

may tend to elucidate the relationship between positive and negative currents. When the cork is omitted the level of the water in the bulb is free to rise or fall, but it remains stationary under compensating action of two currents. This, however, is not case when the cotton is in operation without the cork, because the cotton impedes the current which moves it and gives the ascendancy to the outside current, and thereby lowers the level of the water in the bulb. The contrary effect is, of course, produced by reversing: the electric current, and the water then rises in the bulb above the level of the water in the cistern.

In the course of experiments I was making on the dispersive effect of the electric spark upon dust, I observed that the disturbed dust always settled in circular lines. Although I afterwards found that this fact had been observed before, yet to me it was perfectly new, and, as it appeared to be a very interesting fact, I followed up the subject by an elaborate course of experiments which have yielded a rich harvest of results, revealing the hidden motions which attend the electric discharge.

I have already exhibited to the Royal Society photographs of many of the dust figures I have produced. Those photographs were of dust figures done on cardboard, and the photographs were afterwards transferred to glass and were shown at the Royal Society with the electric lantern. I will show you a few of these photographs this evening by way of introducing the subject after which you shall see a selection of figures, in actual process of formation, on the horizontal stage of a limelight lantern. In all these figures I shall use plates of glass with a layer of fine dust sifted over them, and shall operate upon the dust by a spark discharge acting in various ways. I use three kinds of dust calcined magnesia mixed with charcoal in the form of lampblack, tripoli powder, and hard carbon reduced to a fine powder. These three varieties act somewhat differently, and each kind has its application in the production of the best effects. The dust is sifted upon the plates in an evenly distributed layer, and the effects are shown by the manner in which the dust is displaced by the electrical disturbances.

You are all aware that when a gap is made in a conducting wire and a spark passes between the several points, all that can be seen is a streak of fire; but if I lay the severed wires upon the surface of a dust-plate we get the figure which I will now show you by a photographic plate inserted in the lantern. You see the dust is brushed away from the track of the spark, but the action takes place sideways and not in the direction of the spark. You also see that the discharge takes place not merely from point to point of the wires, but also from the sides of both the positive and negative wires, as indicated by beautifully regular streaks the dust - the stronger ones being positive and the weaker ones negative. You will also see that there are circular lines faintly visible outside of the central figure, but when a Leyden jar is used as a condenser to give density to the spark, these circular lines come out very strongly, but as I shall presently show you their actual formation, I need not show the photograph. But these circular lines are also produced by a vertical discharge through a hole in the glass, and as it IS not easy to do this on stage of the lantern without piercing the lens, you must be content to see the photograph, which shows the circular lines very distinctly. Another figure involving the same difficulty must also be shown by photograph. It exhibits dust-plate with six small glass pillars erected upon it to obstruct the motion of the dust. You see the lines are now diverted from the from the circular form and thrown into arches from pillar to pillar, while the spandrels are filled with inverted curves. You will also see that the ends of the arched lines cling to the glass pillars,

notwithstanding the outward drift of air, thereby indicating a strong attraction between the dust and the pillars. I will now dismiss the photographs and proceed to show you the formation of the figures upon the horizontal stage of the lantern, and this a thing which has not yet been exhibited in public. I will begin with an experiment in which the dust is thrown into circular lines by an electric discharge from a Leyden jar, passing between wires parallel with the surface of the dust, and sufficiently raised above the surface to avoid the sweeping action of the air blast, and I expect you will see the movement in great perfection on the screen. You observe that the dust is thrown into circular lines up to the very centre, and a close inspection also shows a very active reciprocal motion amongst the dust particles themselves, which seem to indicate a transmission of electricity by convection. I will now take another dust-plate, and raise the sparking points to such a height as will save the dust from any disturbance by the discharge. You shall see the dust-plate first, and notice that the spark has no effect upon the dust; but I will now place upon this dust plate a piece of sheet lead cut into the form of a cross, and supported on four needle points at a distance of one-tenth of an inch above the dust. You would naturally expect that this sheet lead, acting as a shield, would give to the underlying dust additional security against disturbance. But now, after passing a few sparks without effecting any disturbance of the exposed part of the dust, I lift the cross, and you see that the shielded part of the dust is thrown into beautiful symmetrical curves depicting the figure of the cross.

We may go a long way towards an explanation of these curious effects by saying that the particles of dust are polarised, and separated into wave lines by atmospheric vibrations; but this explanation fails to meet all the facts of the case, and for the present I must be content to show you the results without attempting to fully explain them.

I will now discard the Leyden jar and bring the wires down until they lie upon the dust-plate, and will take very gentle sparks direct from the coil. On doing so, you see the track of the spark and the off-shoots from the wires. You will also observe that the off-shoots from the positive wire bend round the spark track to get at the negative, while the negative off-shoots seem to make no effort to get round by the outside to the positive. I am therefore lead to believe that the negative current follows the inner course, and the positive the outer one, and this is in unison with the cotton experiment, which is presented every appearance of an internal and an external current, the inner being the negative current and the one which carried forward the cotton. And now you shall see a very beautiful figure, caused by splitting the positive current and bringing it to the sparking points in two lines, curved in a manner to show how the dust streaks behave towards each other. The field is not large enough to show the whole figure at once, but by moving the dust plate you shall see it all in parts. There is the figure, and you see a very marked distinction between the inside streaks and the outside ones, which is explained by the fact that the insides face and oppose one another. You see also various dark spaces which show absence of disturbing action, and there is a very peculiar dark band running parallel with the wires, which may be due to a motion from the surface of the plate. You would hardly expect to see such a revelation where nothing was to be seen before but a tiny spark. But we will now banish this spark to see a distance and operate upon the dust with the electric emanations from the wires alone, or from metallic terminals in contact with them. The positive and negative wire will then be mere branches from the main circuit, and the spark will take place on the main

line and not between the branch terminals. In the first place, I will draw down the point of the positive branch vertically as to touch the centre of a dust-plate. There is a lead ring serrated on the inner edge surrounding the dust-plate to which the negative branch may be attached, although it does not make any difference beyond exalting the effect, whether I attach or not. When I turn on the current you see that a circular figure is established on the plate showing radiations which represent the transverse view of what you have seen before. It is probable that self-induction is the operative principle in the production of these sparkless figure; but I observe that whenever electricians are at a loss for an explanation, they mystify their hearers by attributing the effect to self-induction, and I find it convenient to follow the practice in this instance. You will perceive a slight negative effect proceeding from the ring, but I now reverse the current and you then see a splendid display of streamers pouring inwards the circumference to the centre. A still more beautiful effect will be displayed in the next figure, in which the central part of the plate is occupied by a slender cross of sheet lead pointed at the tips. The influence of the points in the formation of this beautiful figure is very conspicuous. Another variety of figure equally beautiful is shown by placing on the dust - plate a strip of sheet lead, saw-shaped on both sides. In the last three experiments I have used tripoli dust, which is a very imperfect conductor, and has a slight adhesiveness to glass, which makes it show the pencillings more distinctly. But I will now use carbon dust which is a good conductor, and you will find quite a new effect is produced.

I shall use no spark on the dust-plate, and operate with branch wires from the circuit as before. In the first place, I shall bend down the negative branch perpendicularly, and cause it to touch the dust plate in the centre, and I shall apply the positive branch to the lead serrated ring which surrounds the dust-plate. You see up in massive circular waves from the circumference to the centre, followed by beautiful streamers from the surrounding points, and altogether presenting a most extraordinary figure, and one of great beauty. I will next put the four-pointed star already used in the centre, and proceed the same as in the preceding experiment. You see a figure widely different from the last, and not less beautiful. These dust figures may be multiplied in endless variety; but time will only permit of my showing you one more. I substituted for the four-pointed star a lengthened piece of lead, with parallel serrations on the two sides, and I take away the lead ring, together with the positive branch wire attached to it, and I place the negative wire in contact with the piece of lead now placed in the centre. As I have removed the positive wire, you will observe that the negative terminal acts without any opposite positive terminal, yet you will see that a figure is produced involving forms and motions which words can hardly describe, but, like all the others, distinguished by symmetry and beauty.

And now I have only one more remark to make. There will be some amongst you who will ask what use are such experiments as these? I answer that the more we pry into the mysteries of electricity the more we shall be able to apply it to the service of mankind; but, apart from that consideration, knowledge for knowledge sake is a worthy object of pursuit.