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XXXI. *Account of some Electrical Experiments by M. DE NELIS, of Malines in the Netherlands: with an Extension of them.* By GEORGE JOHN SINGER, and ANDREW CROSSE, Esqrs. Communicated by Mr. SINGER.

DURING the last fifteen years, M. De Nelis has devoted considerable attention to the subject of electricity, which he states he was led to study in consequence of a thunder storm, which accidentally struck his house whilst his family were assembled round a table in the dining parlour.

The experiments he has made are very numerous, and present some facts of an interesting nature. The present account of them is selected in part from his recent communications to Mr. Tilloch, and partly from his correspondence with M. De la Metherie.

The first experiments were made with hollow cylinders of metal, open at top, and partly filled with water. In the centre of each cylinder a needle was insulated, by surrounding it with wax in such a manner as to keep it at an equal distance from the sides of the cylinder, whilst a thin slip of lead, or a piece of leaden wire attached to the lower end of the needle, was thus kept in the axis of the cylinder, and with its point resting on the bottom thereof.

In this disposition of the apparatus the metallic cylinder was connected with the outside of a large electrical battery, and the circuit was completed by means of the discharger, by connecting the internal coating of the battery with the upper end of the needle; the charge consequently passed through the small leaden wire, which was thus melted under water in the centre of a metallic vessel.

The effects produced by this experiment are, 1st, The needle and part of the water contained in the cylinder are projected from it with considerable force; and, 2dly, The cylinder itself is expanded more or less in proportion to its power of resistance. Very thin cylinders yield to the first explosion; but thicker ones require many repetitions of the experiment, and usually become undulated on the surface, whilst they expand gradually: at each explosion the expansion increases, and at length the cylinder is cracked or burst open.

M. De Nelis has employed cylinders of various metals, and of different thickness; some of wide and others of narrow bore. In general the effect is greatest with those of narrow bore when the thickness remains the same; but in comparative experiments with different metals and alloys, he did not find that their relative resistance corresponded with the tenacity assigned to them in the usual tables: The alloys appeared to resist more than the

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simple

simple metals; for a cylinder of pure silver was cracked at the fourth explosion, whilst a similar cylinder of sterling silver resisted eleven explosions without injury; and when any soldered metal was employed, the solder was found less susceptible of injury than the metal soldered. From these circumstances M. De Nelis is disposed to ascribe the effects produced, rather to the attraction of the electric fluid for the metals, than to the expansion which its rapid passage through imperfect conductors so invariably produces.

Anxious to ascertain the extent to which these effects might be carried, he employed a cylinder of iron, 18 lines diameter* and 27 lines high, having a hole drilled in its axis of one line and a half diameter and 18 lines deep; and it was torn open by 70 discharges of a battery of 100 feet of coating. The results of former experiments having rendered it probable that this large cylinder had yielded to a lower power than would have been requisite had the iron been perfect, another cylinder of the same size was made with great care, and 70 explosions produced no effect upon it. The interior of this cylinder was then filled with olive oil instead of water: in 30 explosions the bottom was perforated, though nine lines thick; the lateral expansion was very inconsiderable. M. De Nelis supposes that in these experiments the leaden wire is minutely divided, and combines with the oil or water and with the electric fluid to form a gaseous product, which exerts a powerful action on the metal cylinder by which it is surrounded. By this he appears not merely to express an expansive effect, but a peculiar attraction which he conceives to exist between the electric fluid and other bodies, and to which he applies the general term molecular attraction. This peculiar action he thinks decisively evinced by the last experiment; in which the bottom of the cylinder, a thickness of nine lines of excellent iron, was perforated, whilst the sides remained nearly without injury. By an extension of this experiment still more remarkable effects were produced: it was imagined that by increasing the thickness of the cylinder the lateral expansion would be entirely prevented, and the action of the charge be confined to its molecular attraction on the bottom of the cylinder. An iron cylinder of 28 lines diameter was drilled to within five lines of the bottom, and a cylinder of pure silver of the same size was procured; they were submitted in succession to the action of the battery. 200 explosions perforated the bottom of the iron cylinder, and produced an excavation of three lines diameter. With the silver cylinder 20 explosions occasioned an expansion at bottom, which con-

* One inch and a half English; the line being one-twelfth of an inch nearly.

tinued to increase to the 200dth explosion when it had produced a projection of 18 lines diameter and three lines high, but no perforation was apparent. This cylinder was sawed through, and the expansion which had taken place in the interior appeared to have been produced by the action of some power determined in every direction from a centre. M. De Nelis appears to consider these experiments as a demonstration of the different molecular attraction of the electric fluid for various metals: but I must confess that to me they seem to present no such evidence, nor do they appear to differ materially from the usual expansive effects of the charge. When electricity passes luminously through any fluid, it invariably produces a sudden and temporary expansion therein, and the expansion is greater in proportion to the quantity and momentum of the electricity, and to the nonconducting power of the fluid through which it passes: hence the spark is brighter and the expansion more considerable in oil, alcohol, or ether, than in water; more feeble in hot water than in cold, and still less evident in saline fluids and concentrated acids; but in every case the expansion is greatest when the bulk of the fluid in which it occurs is least, and when the spark by which it is produced passes through the greatest interval. The arrangement employed by M. De Nelis is well calculated to obtain these essentials; for the small leaden wire which he has substituted for the interrupted circuit of former electricians, admits the passage of a much more considerable charge than could be conveyed through the oil or water itself by the same power; whilst the fluid employed is so arranged as to occupy the least possible space compatible with the luminous passage of the charge through it.

In the experiments I have made on this subject I have been favoured with the assistance of my friend Andrew Crosse, Esq.; and it was by the aid of his powerful apparatus and active exertions that I was enabled to shorten the time of their performance materially. M. De Nelis generally employed a battery of 100 feet of coated surface, which he charged to about 60 of Henley's quadrant electrometer; this was most probably equal to 15 grains of Cuthbertson's discharging electrometer, at least it is so when the index of Henley's quadrant is terminated by a pith-ball; but a cork ball will only indicate about 40 with the same charge. 15 grains appeared therefore the most convenient power; and was employed in these experiments most frequently. The battery we made use of consists of 50 coated jars, exposing about 75 feet of coated surface; it was charged by two cylinder machines, one of them 52 inches circumference, and the other 40 inches only. The large machine I constructed in the year 1808: it is on the whole the best I have yet seen. The smaller

one was adapted to the purpose of these experiments for the occasion, and by a simple mechanical arrangement was made equal in charging power to the large one.

The joint action of these machines enabled us to charge the whole battery of 75 feet coating in two minutes; and this rate of charging was maintained through the whole of our experiments.

The metallic cylinders were all of the same size; namely, six lines diameter, and 24 lines high, with a bore of $2\frac{1}{2}$ lines diameter and 18 deep. We were provided with two of each of the following metals,—Bismuth, zinc, tin, lead, iron, copper, and brass. A steel wire or needle, about the 40th of an inch thick and three inches long, was then coated with wax in two places, to such a thickness as to admit of its sliding freely into the bore of either of the cylinders. The length of the needle was then prolonged by the addition of a piece of leaden wire $\frac{1}{10}$ th of an inch diameter and nine lines long to its lower extremity, in close contact with which it was secured by the same wax. Fig. 1, Plate III, represents this needle. W is the fine leaden wire, and CC the coatings of wax. All the precaution necessary in preparing such needles, is to place the wax round them with care, so as to keep the needle in the centre of the metallic cylinder when it is placed therein, during which process it is necessary to keep the leaden wire as straight as possible, that its end may rest on the bottom of the cylindrical cavity without approaching any where in contact with its sides. Several of these needles may be prepared before the commencement of the experiments, as it is necessary to employ a fresh one at every explosion. Fig. 2 represents one of the cylinders; its cavity (which is shown by dotted lines) is to be filled with water or oil, and a needle prepared as above, introduced carefully into it until the point of the leaden wire rests on the bottom of the cylinder. To prevent the oil or water from being thrown about, the cylinder should be placed in a wooden box, open on one side and lined with lead at bottom: the bottom being connected with the outside of the battery, a communication is made by a wire, between the upper part of the needle and the receiving ball of Cuthbertson's discharging electrometer, the electrometer being connected with the inside of the battery. This arrangement is shown in fig. 3.

In this disposition of the apparatus, a cylinder of bismuth filled with water was subjected to the action of the battery of 75 feet, charged to 15 grains. A single explosion shattered it to pieces, and dispersed the parts to a distance with considerable violence.

Another cylinder of bismuth the same size as the preceding
was

Fig. 1.



Fig. 2.

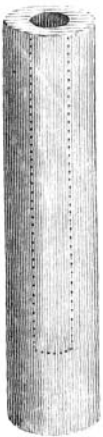


Fig. 3.

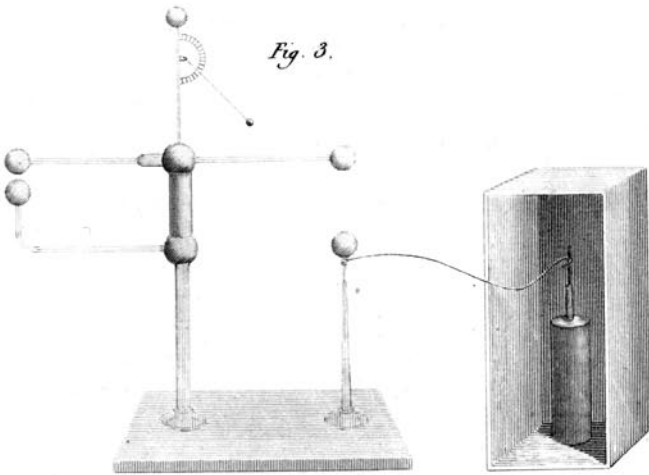


Fig. 4.

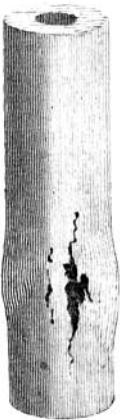


Fig. 5.



Fig. 6.

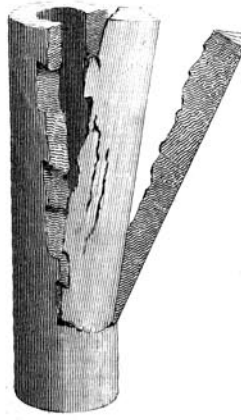


Fig. 7.

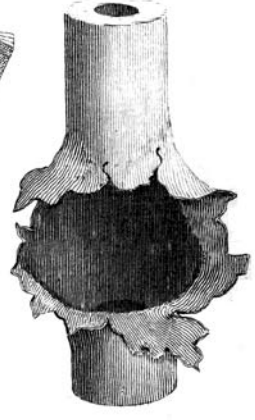


Fig. 8.

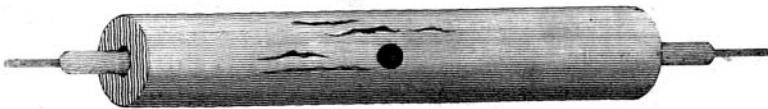


Fig. 9.



was exposed to a charge of eight grains only: it was dispersed with nearly the same violence in one explosion.

A cylinder of zinc of the same dimensions and under the same arrangement, with a charge of 15 grains was slightly cracked at the first explosion, and at the ninth explosion was opened by a wide rent, as shown in fig. 4.

A similar cylinder of zinc was filled with olive oil instead of water; one explosion broke a large piece out and threw it to a distance. This cylinder is represented in its present state by fig. 5.

A cylinder of tin of the same size filled with olive oil, was split open by one explosion of a charge of 15 grains; the rent being very similar to that of fig. 4.

A second cylinder of tin, the same size as the preceding, and under the same arrangement, gave a different result: it was expanded by the first explosion, and more so by the second and third; at the fourth it burst open: the rent was more considerable than in the last experiment.

A cylinder of iron of the same dimensions was arranged in the usual manner with olive oil, and a charge of 15 grains: the first explosion produced two cracks nearly the whole length of the cylinder; the second explosion detached a portion of the cylinder (nearly one-third) in the direction of its length, and threw it with violence to a distance.

The experiment was repeated with another cylinder of iron of the same size: the first explosion produced three cracks; the second explosion divided the cylinder in three parts in a very curious manner, as represented by fig. 6.

The thickness of these cylinders is greater than that of the strongest muskets; the expansive power of electricity acting in this way is therefore vastly superior to the most potent gunpowder.

A cylinder of copper became undulated on the surface at the first explosion; it expanded at the second, and continued to increase with every discharge until the twelfth, when it was burst open nearly in the same manner as fig. 4.

A second cylinder of copper exhibited nearly similar phenomena: it did not crack until the 14th explosion; but at the 15th it was torn with a wide rent.

A cylinder of brass, under similar circumstances, was undulated on the surface, and had a small perforation at the first explosion: these effects and the expansion of the cylinder continued to increase with each discharge until the sixth, when a wide rent was produced.

Another cylinder of brass, of the same description, exhibited

nearly similar phenomena, and was burst with analogous appearances at the fifth explosion : it had opened at the fourth.

A leaden cylinder of the same size was very much swelled by the first explosion, and perforated in three places : these effects increased greatly with the second ; and by the third it was burst open in a very curious manner, as is shown by fig. 7.

This experiment was repeated with another cylinder of lead, with precisely the same result, and in the same number of explosions.

A cylindrical tin vessel, four inches diameter and six inches in height, was suspended by strings a short distance from the ground in the open air, on the lawn in front of the electrical room : the can was filled with water, and a leaden wire of two inches long suspended within it, with its end touching the bottom of the can. A charge of the battery of 75 feet, to 15 grains, being passed through the leaden wire, it was melted ; about half the water was projected into the air to a considerable height, and the flat bottom of the can was bulged outwards, so as to assume a spherical surface.

M. De Nelis states that he made an experiment of this kind with a cylinder of two inches diameter ; and that the water was projected to the height of 40 feet.

He also exploded a wire in a leaden tube of an inch diameter, which was filled with water, and its ends stopped with corks ; the corks were expelled with violence, and the tube much expanded.

Fig. 8 represents a thick cylinder in which the lead wire, fig. 9, was introduced : the cylinder had a hole drilled in its centre like a flute, so that the oil might be permitted to escape when expanded ; but by three explosions of a battery of 75 feet the rents exhibited in the figure were produced.

These experiments certainly present very remarkable and permanent evidence of the expansive power of the electric charge ; and it is difficult to contemplate such extraordinary mechanical effects, without admitting that the power by which they are produced has at least the leading characteristics of a material substance.

Broomfield, near Taunton,
August 28, 1815.

G. J. SINGER.

✍ Some other experiments of M. De Nelis will form the subject of another communication.