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OF THE ELECTROPHORUS, AND MR. BENNET'S EXPERIMENTS THEREWITH.

Fig. 73, represents an electrophorus. This instrument was invented by Mr. *Volta*, of Coma in Italy.* It consists of two plates of a circular form; the under plate is of brass covered over with a stratum of an electrical substance, generally of some negative electric, as wax, sulphur, &c. the upper plate is of brass, with a glass handle screwed on the center of its upper surface.

Resinous electrics generally succeed better for an electrophorus than those made only of glass, not only as they are less affected by the humidity of the air, but as they seem to have the power of retaining longer the electricity which is communicated to them.

To use this apparatus, first excite the under plate, by rubbing its coated side with a piece of clean dry flannel, or hare-skin; when this plate is well excited, it is to be laid on the table with the electric uppermost. Secondly, place the metal

* Mr. *Wilck*, in August 1762, contrived a resinous apparatus, to which he gave the name of a Perpetual Electrophorus. See *Scripta Academiæ Succ.* 1762.

plate upon the electric as in *fig.* 74 and 75. Thirdly, touch the metal plate with the finger, or any other conductor. Fourthly, separate the metal plate from the electric by the glass handle. This plate, when raised to some distance from the under one, will be found strongly electrified with the power which is contrary to that of the electric plate, and will give a spark to any conductor that is brought near it. By repeating this operation, *i. e.* by setting the metal plate on the electric, and then touching it with the finger, a great number of sparks may be successively obtained without a fresh excitation of the electric.

EXPERIMENT CCXIV. By examining the electrophorus with small pith balls, we find,

1. That as soon as the upper plate is placed on an electrophorus of wax, it acquires a weak positive electricity; and the contrary, if placed on an electrophorus of glass.

2. That when the upper plate is touched by the finger, it loses all its electricity.

3. When the upper plate is touched by the finger, and removed from the electrophorus, it acquires a strong negative electricity, if the electrophorus is of glass; and a positive electricity, if it is of wax.

The electrophorus may be considered as formed of several horizontal strata; so that when the upper one is excited, either by friction or communi-

cation, it is insulated by the inferior strata. Now all insulated electrics preserve their electricity a considerable time, and it is from that cause that the electricity of the electrophorus continues so long.

Insulated and excited glass induces the negative electricity on bodies brought within the sphere of its action, while negative electrics, in similar circumstances, produce the positive electricity. Therefore, the surface of the electrophorus ought to communicate immediately a positive electricity, if it is of wax; the negative, if it is made of glass: which is perfectly conformable to experiments. But when the upper plate is touched by the finger, the upper surface of the electrophorus ceases to be insulated, and gives the negative electricity to the upper plate, if it is of glass; and the contrary, if of wax; agreeable to the different experiments which are described in this Essay.

Electric bodies do not put the fluid in that degree of motion, which is necessary to produce the spark, or exhibit the phenomena of attraction and repulsion, while they are in contact with conducting substances; which is the reason why the upper plate exhibits no signs of electricity while it remains in contact with the under one, though they become sensible the instant it is removed from it.

" In the case of a glass electrophorus, as it is a case which admits of a somewhat easier illustration, the excited plate acts upon the electric matter naturally contained in the upper brass plate, so as to repel a part of its natural quantity from it in form of a spark, at that part where the finger is applied to it. If the brass plate in this state is lifted up by its handle, it will receive a spark from the finger. On being replaced, and the same operation taking place, the same result will be obtained; which may be continued for a great length of time, without diminishing the virtue of the excited electric, which in fact does not part with any of its own electricity, but only repels a part of what is in the upper plate, which is repeatedly restored to it from the earth by the person who makes the experiment."

EXPERIMENT CCXV. Place a piece of metal on an excited electrophorus, it may be of any shape; a pair of triangular compasses are very convenient for this purpose. Electrify the piece of metal with the power which is contrary to that of the electrophorus, and then remove it by means of some electric, and afterwards sift upon the electrophorus some finely powdered resin, which will form on its surface curious radiated figures. When the plate is negative, and the piece of metal positive, the powder forms itself

principally about those parts where the metal was placed; but, if the plate is positive, and the spark is negative, the part where the metal touched will be free from powder, and the other parts more covered.

EXPERIMENT CCXVI. *To recover the force of an electrophorus by itself.* Place the metallic cover on the resinous cake, touch it as usual; then take it up, and discharge it on the knob of a Leyden jar; repeat this operation several times, and then place the jar on the cake, and move it over its surface, holding the jar by the knob; this will augment the force of the electrophorus, and by reiterating the operation it will become very powerful.

EXPERIMENT CCXVII. Insulate a metal quart mug, and suspend a pair of small pith balls by silk, so that the whole of the electrometer may be within the mug; electrify the mug, and the electrometer will not be in the least affected. The similar atmospheres counteract each other; and, as no contrary power can take place in the electrometer, it will remain unelectrified. Touch the mug with some conducting substance, and it will immediately attract the balls.

EXPERIMENT CCXVIII. Suspend a small cylinder of gilt paper by tin-foil, and then touch the electrified and insulated mug with it; a spark will pass between them, and the electricity will be

diffused in each in proportion to their capacity. Now plunge the insulated cylinder to the bottom of the mug, and it will restore to it the electricity it had received, but does not give the least sign of electricity when taken out.

EXPERIMENT CCXIX. Connect a pair of pith balls with an insulated metal vessel, in which a metal chain is placed; raise the chain by means of a silk thread, and the divergence of the balls will diminish in proportion as the chain is raised and displayed; shewing, that the electricity is rarefied, and its density is diminished, in proportion as it spreads itself from the surface of the vessel on the extended chain; which is confirmed by the balls diverging again when the chain is let down into the vessel. This experiment affords an easy solution for many of the phenomena of atmospheric electricity; as, why the vapour of electrified water gives such small signs of electricity, and why the electricity of a cloud is increased by being compressed or condensed.

EXPERIMENT CCXX. Excite a slip of white flannel, or a silk ribbon, and take as many sparks from it as it will give; then double or roll it up, and the contracted flannel will be strongly electrical, give sparks, and throw out brushes of light.

NEW EXPERIMENTS WITH MR. LICHTENBURG'S LARGE ELECTROPHORUS, BY THE REV. MR. BENNET; AND EXTRACTED FROM HIS WORK, ENTITLED, "NEW EXPERIMENTS ON ELECTRICITY."

The following experiments are intended as improvements on Mr. *Lichtenburg*'s beautiful configuration; first made on a resinous electrophorus, by drawing over it the knob of a charged jar, and then rendered visible by sifting powdered resin over the plate; which falling very differently, according to the circumstances in which the experiment is made, exhibits the diffusion of electricity in a very pleasing manner; see *plate* 5, *fig.* 101, 102.

Mr. *Bennet*'s first electrophorus was a glass plate fifteen inches square, covered on one side with a thin resinous black coating, with tin-foil pasted on the other side; for, if the side opposite to the resinous one be not a conductor, the electrical fluid will not be easily diffused over it. Glass was used that the electricity might not be so liable to pass through the small holes and blistered places, which cannot well be avoided if the resinous substance be thinly spread upon wood or metal.

As powdered resin projected from a brush is negatively electrified, there appeared no doubt but that chalk and other powders, which by the same means are negatively electrified, would answer as well, or better; such powders were therefore tried, and found to succeed remarkably well.

EXPERIMENT CCXXI. The plate was suspended by a loop against a wall, that the grosser part of the powder might fall to the ground, and no more adhere to the plate than was attracted by the electricity diffused thereon. A small jar was charged very weakly by one revolution of the electrical machine, and after its knob had been drawn over the resinous plate, a cloud of chalk was projected by rubbing the lump upon a brush near the electrified surface of the plate; this produced a plain white line without any ramifications.

EXPERIMENT CCXXII. When the jar was charged by three revolutions of the machine, ramifications appeared upon the plate at a considerable distance from each other.

EXPERIMENT CCXXIII. Five or six revolutions caused the electrical fluid to spread upon the plate in ramifications very near each other. Close to each branch a small space was left uncovered with powder, forming a kind of shade to the figure. Beyond this shade the powder lay smooth, softening off externally.

EXPERIMENT CCXXIV. With a very strong charge the ramifications were close and broad, resembling white feathers with a very broad shade.

EXPERIMENT CCXXV. A circular brass plate with an insulating handle was placed upon the resinous plate, and a spark from the charged jar was communicated to the brass plate, which was then taken off by its insulating handle, and chalk projected, which produced a very regular circle of ramifications about four inches long, proceeding from the circumference of the space covered by the brass plate, and within the circle were a number of irregular figures somewhat like stars. A shock made to pass through the same plate generally produced more distinct ramifications, and sometimes without any stars within the circle; and if the brass plate was drawn along towards the edge of the electrophorus whilst touched with the knob of the jar, a very beautiful figure, see *plate* 5, *fig.* 101, was produced.

EXPERIMENT CCXXVI. A jar strongly and negatively charged was drawn over the plate, and afterwards a pointed wire, held in the hand only, was drawn over the same figure; then chalk was projected, which produced a beautiful ramified figure in the middle of the negative one.

EXPERIMENT CCXXVII. A conical tin funnel was placed with its base on the middle of the resinous plate, and a negative strong charge given

by connecting the discharging rod with the under side of the plate; then a positive charge was given in the same manner: the funnel was thrown off and chalk projected, which produced very beautiful ramifications both within and on the outside of the circle.

EXPERIMENT CCXXVIII. A knob of wood, about an inch in diameter was placed upon the wire of a jar which was charged highly positive, and the knob drawn over the plate so as to touch the surface; this produced a beautiful figure, the middle of which was smoothly covered with chalk, and the sides finely ramified with shades.

EXPERIMENT CCXXIX. A small candle was insulated, and its flame placed about an inch distant from the middle of the resinous plate; then the knob of a positively charged jar was suddenly brought to the flame, and both the flame and jar instantly taken away again. In this experiment, when the chalk was projected, a circular space about four inches in diameter was clean and free from powder; the rest of the plate was covered, except a great number of small circular or elliptical spots, which shews that the electrical fluid passed to the plate in detached balls, like some atmospheric meteors; or the plate absorbed from the air a contrary state of electricity, which produced this appearance.

EXPERIMENT CCXXX. If a positive figure be first drawn, and then a negative one across it, or *vice versa*, when the powder is projected, it is easy to distinguish which was first drawn, the second appearing to cover the first; and, when the positive figure is made last, the ramifications at the place of junction extend farther than the rest, and are left without powder; but, if both the strokes are positive or negative, the first will appear to cover the second.

EXPERIMENT CCXXXI. If powders of different colours are mixed, and projected over the figures, some of the colours will prevail on the middle and some on the outside, and especially if two figures whose electricity is contrary are made on the same plate; and most of all, when both the electrical states of the figures and powders are contrary: for example, if minium, whose electricity is strongly positive, and sulphur, very strongly negative, be powdered together, and then this mixed powder be put into the bellows, and blown upon the contrarily electrified figures, the powders separate, and the sulphur falls upon the positive figure, and the minium on the negative: this produces a very pleasing effect.