ON PHYSICS, OR NATURAL PHILOSOPHY.
No. LIX.

(*Continued from page* 494.)

EFFECTS PRODUCED BY THE ACCUMULATION OF BOTH ELECTRICITIES.

Latent Electricity; Condenser.—Latent electricity is the state of neutralisation presented by the two electric fluids when, being brought together on the surfaces of two conducting bodies, they are separated by only a thin non-conducting layer. Through this neutralisation the electric charge may become very considerable, and greatly surpass what would take place in a single body. The apparatus by which electricity is thus accumulated is called a *condenser*. There are various sorts of condensers, all based upon the principle of electrisation by influence, and consisting of two conducting bodies separated by a non-conducting body.

The condenser of Œpinus is formed of two circular copper plates A and C, and a glass plate B which separates them, fig. 399. These plates being each furnished with an electric pendulum having a conducting rod, are isolated by glass feet, capable of sliding along a groove in the stand upon which they are placed. They are thus brought near to each other or separated to any distance that may be required. To collect the two electricities on the copper plates, put them in contact with the glass plate, as in fig. 398, then by means of

Fig. 398.

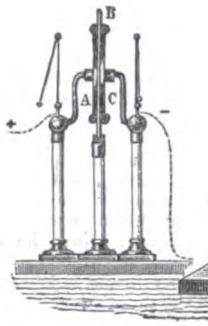
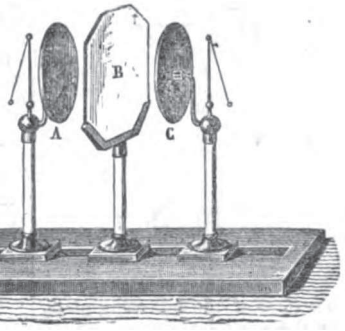


Fig. 399.



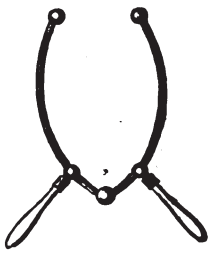
metallic chains make one of them, as *e. g.* A, communicate with an electrical machine and the other with the earth. The disc A is then electrised positively, like the machine, and if it were alone it would have the same quantity of electricity on an equal surface, allowing for the influence of the form; but the disc C completely changes the phenomenon, and it is that which causes the accumulation of the two electricities. In fact, the positive fluid of the disc A acting by influence through the glass on the plate C, attracts the negative fluid and repels the positive fluid into the earth. Now the negative fluid of the disc C reacts in its turn upon the positive fluid of the disc A and neutralises it, but only partially, on account of the interval between them. The electric tension on the disc A is no longer in equilibrium with the tension of the machine: the consequence of which is, that this latter communicates to the plate a fresh quantity of positive fluid, which acts as before upon the disc C, and so on up to a certain limit.

Slow and Instantaneous Discharge.—When the condenser is charged, that is to say, when the contrary electricities are accumulated on the two surfaces, the communication with the electrical machine and with the ground is broken by removing the two metallic chains. Only a part of the electricity of the plate A is then latent, while that of C is completely so. In fact the pendulum A diverges, while the pendulum C is vertical. But if we remove the plates from each other, fig. 399, both pendulums diverge, for the electricities are no longer latent.

The plates being in contact with the isolating plate, fig. 398, and the chains removed, we may discharge the condenser, that is to say, bring it back to the natural state in two ways, by a slow or an instantaneous discharge. To discharge it slowly, first touch the plate A—that is, the plate which contains an excess of electricity—with the finger, then all the positive fluid which is not made latent by the negative fluid of the disc C escapes to the earth, and as the disc C only renders latent a quantity of electricity less than its own, it is the plate C which after this first contact possesses the strongest charge; in fact, we see that the pendulum A falls back and the pendulum C diverges. If we now touch the disc C, its pendulum falls back while the pendulum A diverges, and so on if we continue touching the two discs alternately. The discharge takes place only very slowly, and if the air is dry, it is not completed until several hours have elapsed. If you first touched the plate C, which is less electrised, you would not remove any electricity from it, because all that it contains is rendered latent by the disc A.

When we wish to discharge the conductor instantaneously, we bring the two plates into communication by means of the *exciter*, an instrument consisting of two brass arcs with a ball of the same metal at the end of each, and connected together by a hinge upon which they turn. When the instrument is furnished with glass isolating handles, as in fig. 400, it is called the *glass-handled exciter*; if there are no handles, it is called the *simple exciter*. To make use of the exciter, apply one of the balls to one of the plates of the condenser, and bring the other near the second plate. A strong spark then appears, arising from the recombination of the contrary electricities accumulated on the two surfaces of the condenser. The recombination, however, is not complete, for we may in the same manner elicit a second and a third spark, and even more, though they become more and more feeble. Hence it is inferred, that when the two plates communicate together, the two electricities cannot be entirely recombined. On discharging the condenser with the exciter, we feel no sensation though we hold the exciter in the hand, and though it be the simple exciter. This

Fig. 400.

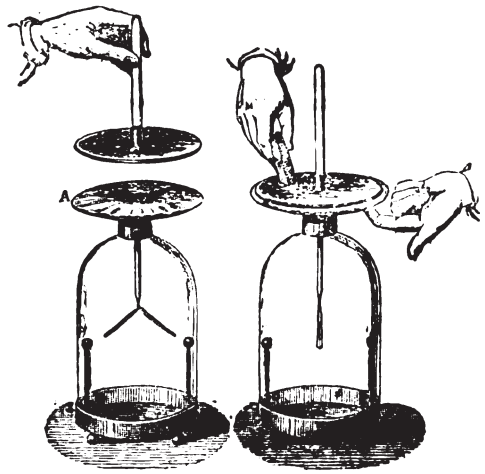


is owing to the fact, that the electric fluid always choosing the best of two conductors, the recombination of the two electricities is effected by the metallic arc, and not by the body of the experimenter. But if, while touching one of the

surfaces with one hand, you bring the other near the second surface, the recombination will take place through the arms and body, and a shock will be experienced, the violence of which will be proportional to the size of the surface of the condenser and the strength of the electric charge.

Volta's Condensing Electrometer.—This is nothing else than the gold-leaf electrometer already described, with the addition of two condensing discs. The copper rod which bears the pieces of gold leaf, instead of terminating above in a brass ball, ends in a brass disc, on which is placed a piece of glazed taffeta, fig. 401, rather larger than the disc, and serving to isolate it from a second disc of a similar sort, but furnished with a glass handle and placed above it. To render even small quantities of electricities perceptible by this electrometer, bring the body whose amount of electricity you wish to determine into communication with one of the plates, which is then called the *collecting plate*, and the other plate in communication with the earth, by touching it with the finger slightly wetted, fig. 402. The electricity of the body on which you are experi-

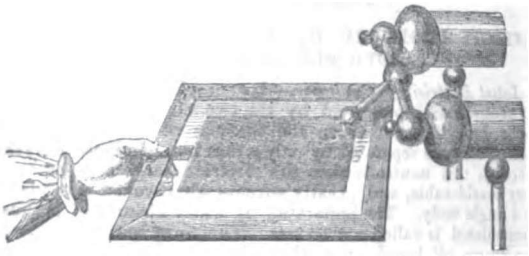
Fig. 401. Fig. 402.



menting then spreads over the surface of the collecting plate, and acts through the taffeta on the second plate and on the hand, so as to repel the electricity of the same kind to the earth and attract that of a contrary sort. The two fluids therefore collect on the two plates just as in the condenser of Œpinus, but without any divergence in the pieces of gold leaf, since the two electricities are rendered latent. The apparatus being thus charged, you may first withdraw your finger, and then the source of electricity, without as yet observing any divergence. But if you take up the upper plate, fig. 401, the electricity is no longer latent, and that of the second plate being distributed equally over the rod and over the pieces of gold leaf, these diverge very much. The divergence may be greatly increased by fitting to the foot of the apparatus two copper rods terminating in balls of the same metal, for these balls being electrised by the influence of the pieces of gold leaf, react upon them. The sensibility of the apparatus may be still further increased by removing the taffeta and separating the two plates by nothing more than a very thin layer of gum-lac varnish upon them. Lastly, instead of taking the upper plate for the collecter, as in our figure, it is better to take the lower plate, because it is always the plate which communicates with the source that is most charged. Like all electric apparatus, the condensing electrometer requires to be carefully dried and even warmed before experimenting.

The Fulminating Square is a condenser more simple than that of Œpinus, and better adapted to produce lively sparks and violent shocks. It consists of an ordinary square of glass with a wooden frame round it. On the two surfaces of the glass are stuck two leaves of tin-foil opposite each other, and leaving a border of about two inches between each and the frame all round. The leaves of tin-foil do not communicate with each other, but one of them communicates with the frame by means of a small piece of tin which bends over at A, fig. 403, in such

Fig. 403.



a manner that it touches the thumb of the person who holds the instrument in his hand. To charge the fulminating square, bring the isolated tin-foil—that is, the tin-foil which does not communicate with the wooden frame—near an electrical machine. As the other sheet of tin-foil is brought into communication with the earth by the hand, the two sheets act exactly like the plates of the condenser of Œpinus, and a great quantity of contrary electricities is collected on the two surfaces.

The fulminating square, like the condenser, is discharged with the simple exciter. For this purpose, hold the square in the hand, and apply one of the balls of the exciter to the extremity A of the little strip of tin belonging to the lower tin-foil. Then turning the exciter on its hinges, bring the other ball near the upper tin-foil, when a bright spark will appear accompanied by a report, owing to the recombination of the two electricities; but the experimenter will feel no shock, because the recombination takes place entirely through the metallic exciter. If, on the contrary, while holding the apparatus in the same manner, you first touch the isolated tin-foil, you will experience a violent shock, as the recombination will take place through the arms and body.

The Leyden Jar, so-called from the place where it was invented, is ascribable to Musschenbroeck, a Dutch philosopher (some say his pupil, Cuneus), who discovered it accidentally in 1746. Having fixed a metallic rod in the cork of a bottle full of water, he brought it near an electrical machine, intending to electrise the liquid. Now the hand which held the bottle performing the office of one of the plates of the condenser, while the water inside represented the other, positive fluid collected on the inner surface of the bottle, and negative fluid on the outer surface in contact with the hand. Consequently, having brought one hand near the metallic rod while the other grasped the bottle, Musschenbroeck received so violent a shock that, as he afterwards wrote to Reaumur, he would not have it again for the whole kingdom of France. However, this experiment being once known, attempts were made in all quarters to repeat it. The abbé Nollet, professor of natural philosophy at Paris, first replaced the water in the bottle by crumpled sheets of tin-foil, copper, silver, or gold. An English philosopher had already discovered that, by covering the exterior with tin-foil, the shocks might be rendered much more violent. The Leyden jar then took the form it still retains, but the theory of it was not understood till Franklin explained it by showing that, like the fulminating square, it is really a condenser.

As represented in fig. 404, at the moment of discharge, the

Fig. 404.