The principal piece of the machine is a plate of glass, PP, three feet or more in diameter. This plate is mounted upon a horizontal axis, and may be turned upon this axis by means of a crank. The wooden frame which supports the axis embraces the plate, and bears four cushions which press against the glass on its opposite faces, two above and two below the axis. The cushions are of leather stuffed with hair; by their friction they give rise to positive electricity in the plate when it is turned.

Two cylinders of brass, AA, are mounted on the table which supports the frame-work, and are insulated by glass pillars. These cylinders, called conductors, are united at their remote ends by a third cylinder of brass, as shown in the figure. At their ends nearest the plate they terminate in cylindrical pieces constructed so as to partially embrace the plate but not touch it. These pieces are called combs, from the fact that a great number of projecting teeth are placed on their sides next the plate. Finally, all of the ends of the cylinders in the machine are wrought into spherical forms, to prevent the dissipation of electricity as much as possible. The entire collection of metallic cylinders is called the *prime conductor*.

Use of the Electrical Machine.

371. When the plate is turned rapidly, the friction of the cushions or rubbers develops a great quantity of positive electricity on the glass, whilst the negative fluid goes to the rubbers and is conveyed through the frame to the earth, and thus disappears. The neutral fluid on the conductors is decomposed; the negative fluid flows through the teeth of the combs to the glass plate, tending to neutralize the positive fluid on the plate. The conductors thus losing the negative fluid, become charged with positive electricity.

What is the principal piece? How mounted? Describe the cushions. Describe the conductors and the method in which they are mounted. How are they electrified? What is the prime conductor? (**371.**) Explain the operation of the machine.

The electrical machine may be arranged to produce negative electricity as follows: The feet of the table are insulated by being placed upon glass supports, and the prime conductor is then connected with the earth by a metallic chain. This chain permits the positive electricity to flow out of the prime conductor, whilst the negative electricity, being unable to escape, accumulates upon the cushions, table, and frame of the instrument.

Measure of the Quantity of Electricity in the Machine.

372. The quantity of electricity in the prime conductor may be shown by an instrument called HENLEY'S electrometer.

This electrometer is represented on the left of the drawing of the machine, and consists of a vertical support of wood, bearing a quadrant divided into degrees. At the centre of the quadrant is attached a small arm of whalebone, turning around an axis and terminating in a pith ball.

When the machine is in operation, the ball rises along the quadrant, and by its divergence from the vertical indicates the quantity of electricity developed.

Precautions in using the Machine.

373. After the prime conductor is electrified, if we cease to turn the plate, and the air is dry, the pith ball will descend slowly, showing a gradual dispersion of the electricity. If the air is damp, the ball descends rapidly, showing a rapid loss of electricity. Electrical experiments seldom succeed in a damp day. In order that they should be successful, the instrument, as well as the surrounding atmosphere, ought to be perfectly dry.

Electricity will be developed more rapidly if the cushions are

How may it be arranged to collect negative electricity? (**372.**) How is the quantity of electricity on the prime conductor indicated? Describe the electrometer used. Its action. (**373.**) *What effect has dampness on the development of electricity? How is the electricity increased?*

covered with a paste composed of sulphur and tin, or an amalgam of zinc and mercury, or of tin and mercury.

Only a certain amount of electricity can be retained on the prime conductor, after which, if the plate is turned, the tension becomes so great that it escapes through the air or along the glass legs of the conductor, and all that is generated continues thenceforth to be dissipated. The electrometer indicates that the instrument is fully charged, by ceasing to rise, and remaining stationary as the plate is turned.

Finally, in order to attain the best possible results, the machine should not be placed too near the walls, or the furniture of a room, or any thing upon which it can act by induction. In particular all angular objects should be avoided. The prime conductor tends to abstract from surrounding objects their negative electricity, and to return to its neutral condition.

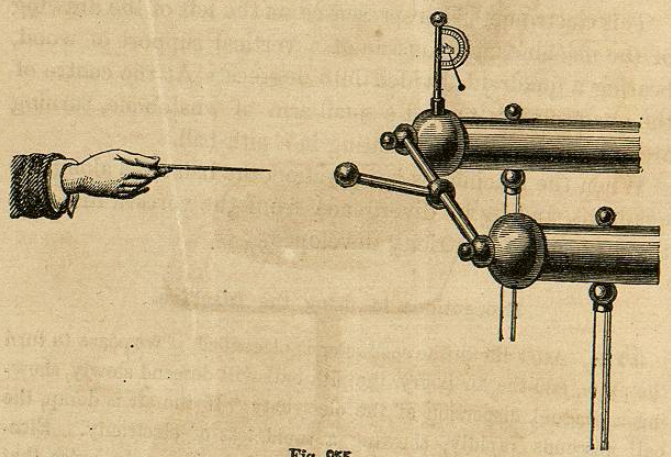

Fig. 255.

The effect of neighboring bodies may be illustrated by bringing a metallic point near a charged prime conductor, as shown in Fig. 255. When the point is at a considerable distance from the conductor, the electrometer begins to fall, showing a loss of electricity.

How do we know when the prime conductor is fully charged? What is the effect of neighboring conductors? How illustrated?

This may be explained by supposing negative electricity to flow from the point to the conductor, in accordance with what has been shown before.

It is sometimes said that the point draws off the electricity from the conductor, but this is not the case; the point abstracts none of the positive electricity, but gives to the conductor negative electricity, which unites with the positive fluid to neutralize it.

Electrophorus.

374. The ELECTROPHORUS is a machine due to VOLTA, by means of which we may obtain considerable quantities of electricity.

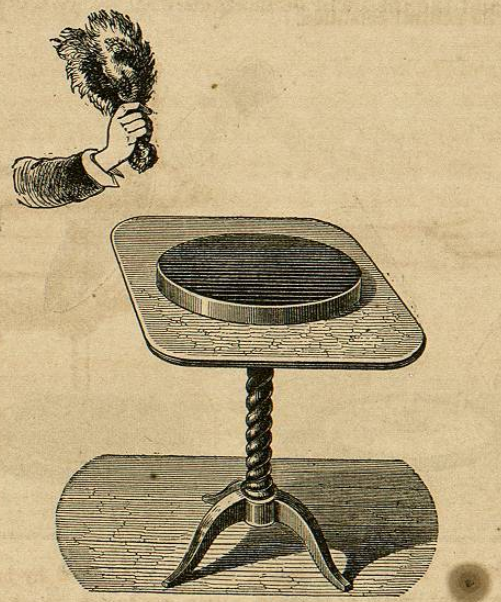

Fig. 256.

It consists of two pieces: one a plate of resin spread on

Effect of the point. (**374.**) What is an Electrophorus? Describe it. How is it used?

a table of wood, and the other a wooden plate, covered with tin foil, and provided with an insulating handle of glass. It is represented in Figs. 256, 257, and 258.

To use this instrument we commence by rubbing the resinous plate vigorously with a cat's skin, as shown in Fig. 256. This develops negative electricity in the resin. We then apply the disk, holding it by its handle. The plate of resin acts upon the disk by induction, drawing the positive fluid to the tin foil on its lower face, and repelling the negative fluid to the foil on the upper face. In this position, if the upper face be touched with the finger, as shown in Fig. 257, the negative fluid will be drawn off into the body, and the disk will be charged with positive electricity.

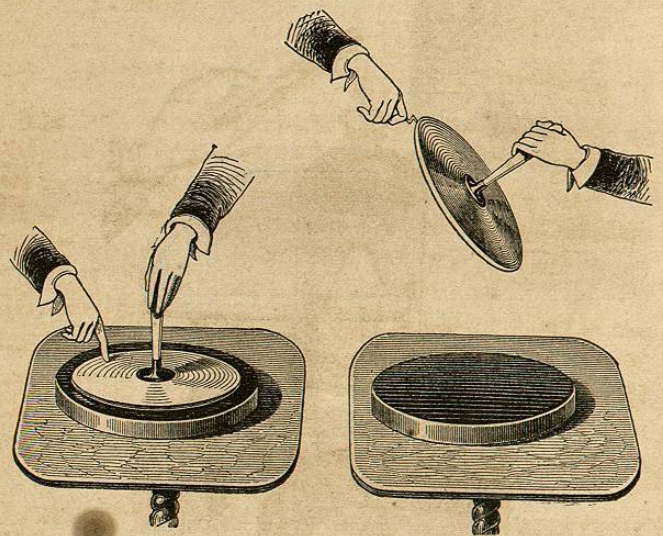

Fig. 257.

Fig. 258.

If the disk be raised from the resinous plate by its handle, and touched with the knuckle, as shown in Fig. 258, a spark

Explain its action.

will pass which is due to the negative electricity, passing from the body to the positively electrified plate.

If now we continue to repeat the manipulation, exhibited in Figs. 257 and 258, a succession of sparks may be obtained without the necessity of rubbing the resin again with the cat's skin. If the air is dry, the resin will continue in an electrified state for a very long time.

If the disk is raised from the resinous plate, without touching it with the finger, it at once comes to a neutral state, and no spark can be obtained.

Gold-leaf Electrometer.

375. The GOLD-LEAF ELECTROMETER is an instrument invented by BENNET, for determining whether a body is

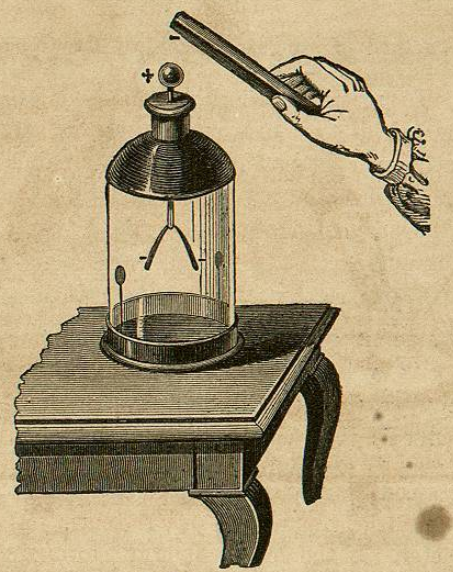

Fig. 259.

How may a succession of sparks be obtained? (**375.**) What is the Gold-leaf Electrometer?

electrified, and to show the kind of electricity with which it is charged.

It consists of a glass bottle, closed at the top by a cork, through which passes a large copper wire. This wire is terminated at its top by a copper ball, and has attached to its lower extremity two slips of gold-leaf. The instrument is represented in Fig. 259.

The cork and the whole top of the bottle are covered with a kind of varnish, made by dissolving sealing-wax in alcohol. This varnish is laid on with a brush, and serves to make the bottle a better non-conductor. This kind of varnish is often used in electrical experiments to render glass non-conducting. Glass in a dry state is a good non-conductor, but it is apt to condense moisture from the air so as to become a conductor. When covered with any resinous varnish, this trouble is removed.

Method of using the Gold-leaf Electrometer.

376. To ascertain whether a body is electrified, we bring the ball of the electrometer near it. If it is electrified, it acts upon the ball and its stem by induction, attracting the fluid of a contrary name into the ball, and repelling that of the same name into the gold leaves, which, being very light and electrified by the same kind of fluid, will diverge. This instrument is very sensitive, showing the slightest amount of electricity. To ascertain the kind of electricity in a body, proceed as before, until the gold leaves diverge, then touch the ball with the finger. The electrometer is then charged with a fluid of the opposite name to that in the body to be experimented upon. Now let a glass rod be rubbed with woolen cloth, so as to excite positive electricity, and then let it touch the ball of the electrometer. If the leaves diverge more, the electricity

Describe it. *Why is the top of the bottle varnished? Describe the varnish.* (**376.**) How do we ascertain when a body is electrified by this instrument? Describe the operation in detail.

in them before was positive, and that of the body in question was consequently negative. If, however, the leaves approach each other, the electricity in them before was negative, and consequently that in the body experimented upon was positive.

This is an exceedingly delicate test, and one of great practical value.

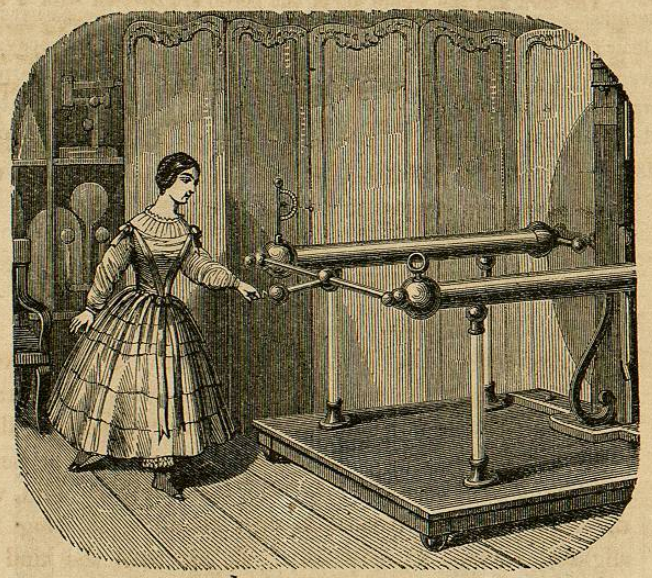

Fig 260.

III.—ELECTRICAL RECREATIONS.

Electrical Spark.—Electrical Shock.

377. An ELECTRICAL SPARK is a brilliant flash of light which passes when a conductor approaches a highly-electrified body.

Is this electrometer of much use? (**377.**) What is an Electrical Spark?

The method of drawing a spark from the prime conductor is shown in Fig. 260. The spark, when received by the human body, is accompanied by a sensation, called an *electrical shock*, which may be very painful and even dangerous.

The spark arises from the combination of the two contrary fluids. The positive fluid acting at a distance by induction, drives the positive fluid of the hand to the earth, and the body of the experimenter becomes negatively electrified. When the tensions of the positive electricity of the machine and the negative electricity of the body, overcome the resistance of the air, they rush together with a sharp crack and a bright light which constitutes the spark. When the electrical machine is powerful, the sparks take a zig-zag course, like lightning from a storm-cloud.

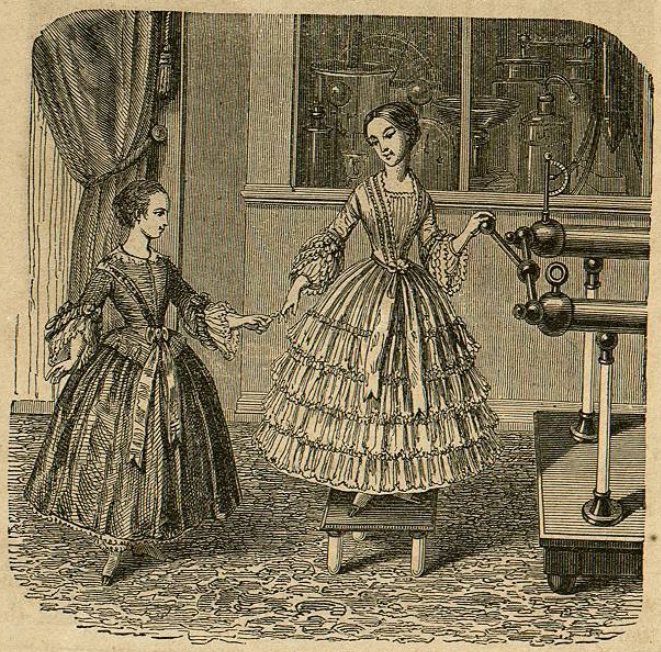

Fig. 261.

What is a shock? *What is the cause of the spark? Explain in detail.*

The Electrical Stool.

378. A spark may be drawn from the human body when properly electrified. For this purpose an ELECTRICAL STOOL, that is, a stool insulated by means of glass legs, is made use of, as shown in Fig. 261. A person standing on the stool, and taking hold of the prime conductor, becomes, when the plate is turned, positively electrified. If a second person now attempts to shake hands with the first, a shock will be experienced, and a spark will pass between them.

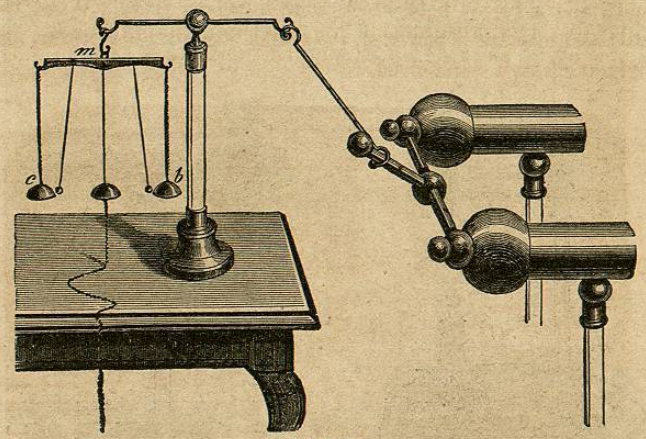

Fig. 262.

The Electrical Chime.

379. The ELECTRICAL CHIME is a collection of bells that are made to ring by means of electrical attractions and repulsions.

It consists, in the case shown in Fig. 262, of three bells suspended from a horizontal bar of wood, *m*. The outer bells, *b* and *c*, are suspended by metallic chains, and the

(**378.**) What is an Electrical Stool? Its use? (**379.**) What is an Electrical Chime? Describe it.

middle one by a silk cord; the middle bell, moreover, is connected with the earth by means of a metallic chain. Between the bells are two balls of metal, suspended from the bar, *m*, by a cord of silk. The entire apparatus is connected with the prime conductor of an electrical machine, as shown in Fig. 262.

When the machine is turned, the outer bells become positively electrified, and attract the balls, which impinge against them, become electrified, and are immediately repelled, striking against the middle bell, where they lose their charge, and are again attracted to the extreme bells, and again repelled. This alternate attraction and repulsion of the balls keep up the ringing as long as the plate is turned.

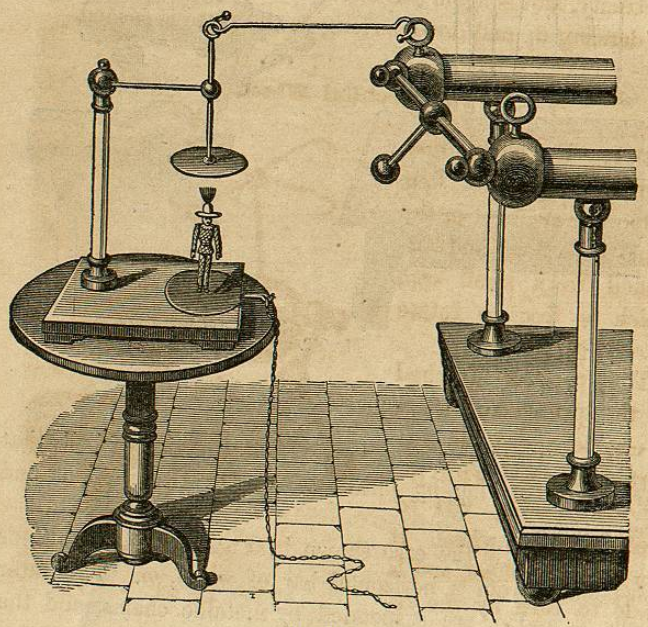

Fig. 263.

Explain the action of the electrical chime.

The Electrical Puppet.

380. The ELECTRICAL PUPPET consists of a little figure which is made to dance by means of electrical attraction and repulsion.

It consists of a light image made of elder pith, or some similar substance, placed between two metallic plates, one of which is in connection with the prime conductor of the machine, and the other with the earth by means of a chain, as shown in Fig. 263.

When the machine is turned, the upper plate is electrified, and attracts the image to it. The image is charged and immediately repelled to the lower plate, where it loses its electricity, and is again attracted to the upper plate, and so on, dancing up and down as long as the plate is turned.

The Electrical Wheel.

381. The ELECTRICAL WHEEL consists of four or more arms, bent in the same direction, and attached to a small cap, which is free to rotate about a pivot.

This pivot is attached to the prime conductor, or else to a metallic support, connected with the conductor. Fig. 264 represents such a wheel. It is a reaction wheel, and is made to turn by the es-

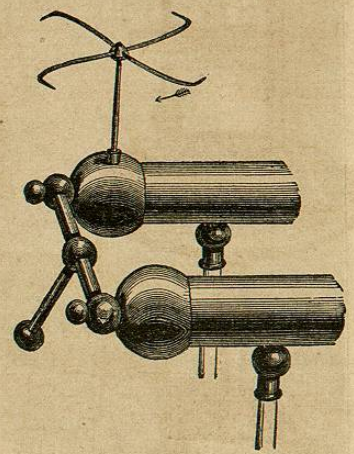

Fig. 264.

(380) What is the Electrical Puppet? Describe it. Explain its action. (381.) What is the Electrical Wheel? Describe it. Explain its action.

cape of electricity from the points. When the machine is turned, the prime conductor and the wheel become electrified; the tension of the electricity at the points becomes very great, and finally escapes with a force that causes the wheel to revolve in a direction indicated by the arrow-head, that is, in a direction contrary to that in which the points are bent. The wheel does not turn in a vacuum, which shows that electricity escapes from points in a vacuum without resistance.

The Electrical Egg.

382. The ELECTRICAL EGG is an egg-shaped light, produced by a flow of electricity through a vacuum.

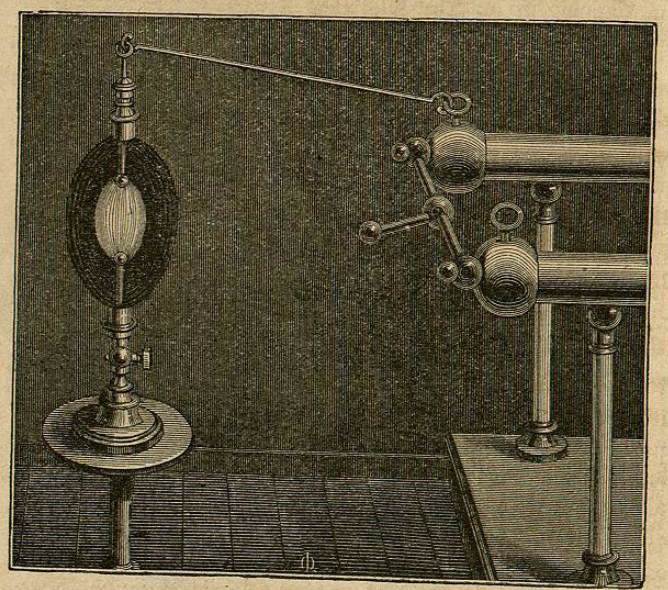

Fig. 265.

(**382.**) What is the Electrical Egg?

The method of exhibiting this light, and the apparatus employed, are shown in Fig. 265. The apparatus consists of a hollow globe or oval of glass, containing two small metallic spheres of metal at some distance apart. The upper one communicates with the prime conductor, and the lower one with the earth. The globe may be deprived of its internal air by means of the air-pump. Then, if the electrical machine be turned, a flow of electricity will take place from the machine to the earth through the two balls, and because the balls are in a vacuum there will be no obstruction to the flow. If the experiment is made in a darkened room, a beautiful violet-colored light will be seen between the two balls, of the shape shown in the figure.

The Electrical Square.

383. The ELECTRICAL SQUARE consists of a square plate of glass, upon one surface of which a thin strip of tin foil is fastened, running backwards and forwards across the plate, as shown by the black line in Fig. 266. One end of this strip of tin is made to connect with the prime conductor of the electrical machine, and the other end is made to communicate with the earth by a chain. The square is insulated by legs of glass.

When the machine is turned, a current of electricity flows through the strip of tin from the machine to the earth, and no spark is given out. If, however, the tin is broken at any point, there will be a succession of sparks at that point, which will be so close together as to produce a continuous light. If, now, the tin be broken by a penknife so that the points of rupture are arranged in a definite figure, as that of a flower, for instance, a continuous light will be seen at each of these points, and the figure will appear as if traced upon the glass with fire. Any kind of figure may be drawn,

Explain the method of exhibiting it. (**383.**) What is the Electrical Square? Describe it. Explain its action.