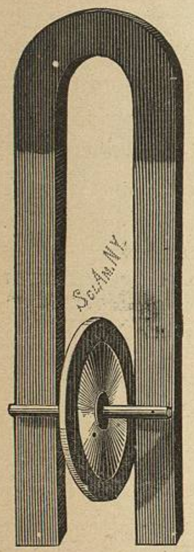
repulsion of similarly magnetized bodies. A number of strongly magnetized carpet needles are inserted in small corks, as shown in Fig. 344.

When floated, these needles arrange themselves in symmetrical groups, the forms of the groups varying with the number of needles.

Fig. 345.



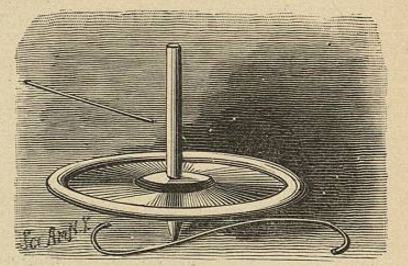
Magnet and Rolling Armature.

One pole on a bar magnet held over the center of a vessel containing the floating needles will disperse the needles, while the other pole will draw them together.

ROLLING ARMATURE AND MAGNETIC TOP.

The rolling armature applied to a long U-magnet exhibits the persistency with which an armature adheres to a magnet. The wheel on the cylindric armature acquires momentum in rolling down the arms of the magnet which carries it across the polar extremities and up the other side (Fig. 345).

Fig. 346.



Magnetic Top.

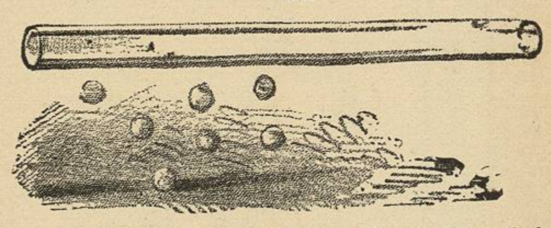
A very pretty modification of this toy has recently been devised. It consists of a top with a magnetic spindle and straight and curved iron wires (Fig. 346). The top is spun by the thumb and fingers in the usual way, and one of the wires is placed against the side of the point of the spindle. The friction of the spindle causes the wire to shoot back and forth with a very curious shuttle motion. The point of the top rolls first along one side of the wire and then along the other side.

CHAPTER XVII.

FRICTIONAL ELECTRICITY.

Many different views have been entertained regarding the nature of electricity, but notwithstanding the multiplicity of electrical inventions and discoveries and their numerous practical applications, the problem of the real nature of electricity remains unsolved. Recent experiments, however, have shown quite conclusively that electricity, like light, heat, and sound, is a phenomenon of wave motion. Laws governing its various manifestations have been discovered, so that, knowing the conditions of its production and use, results can be determined with certainty.

Fig. 347.



Attraction and Repulsion of Pith Balls by an Electrified Rod.

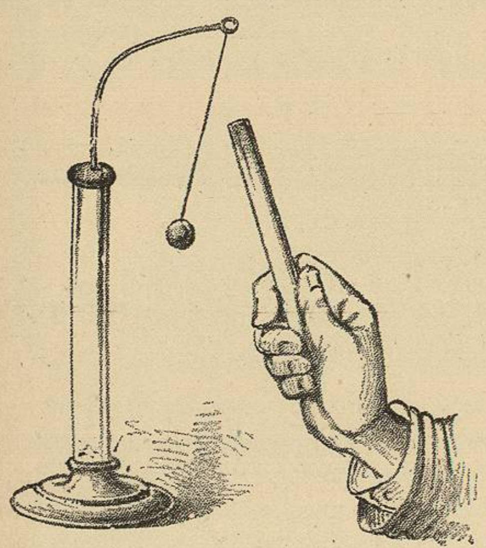
Electricity is evoked from bodies by friction, pressure, chemical action, and other causes. A glass rod or stick of sealing wax rubbed with dry silk or flannel becomes electrified, so that when it is held over bits of paper or small pith balls, as shown in Fig. 347, these will leap at once to the glass or sealing wax, and after a brief contact they will be repelled, to be again attracted and repelled, and so on.

It is a matter of indifference whether the rod be of glass or sealing wax; the result is the same. It is easy to determine by a very simple experiment that the electrification of the glass rod differs from that of the sealing wax. A pith ball is suspended by a silk thread from an insulating standard, and when an electrified glass rod is brought near the pith ball, the latter is immediately attracted, and after a brief contact is repelled.

The attraction of the pith ball by the electrified glass is due to the electrification of the ball in the opposite sense by induction from the glass rod.

Bodies oppositely electrified mutually attract each other. When the pith ball touches the glass rod, its former charge of electricity becomes neutralized, and it receives a charge by conduction which is like that of the glass rod. The two

Fig. 348.



Electric Pendulum.

bodies being now similarly electrified, the pith ball is repelled. Bodies having like charges of electricity mutually repel each other. Now, while the pith ball is charged with electricity received by conduction from the glass, if an electrified stick of sealing wax be brought near the pith ball, the latter will be at once attracted by the former, thus showing the electrification of the two bodies to be different.

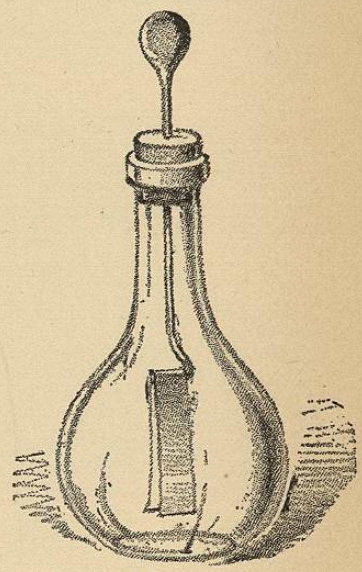
Two glass rods delicately suspended by silk threads, and electrified, will repel each other.

Two sticks of sealing wax treated in like manner will act

toward each other in the same way; but if one of the electrified glass rods be brought near one of the electrified sticks of sealing wax, there will be mutual attraction.

These two manifestations of electricity were originally called *vitreous* and *resinous* electricity, in consequence of being developed respectively upon glass and resin. Now, however, that which is evoked from glass is known as positive electricity, and that from resin as negative electricity, but these are merely convenient conventional names given to opposite phases of the same thing.

Fig. 349.



Electroscope.

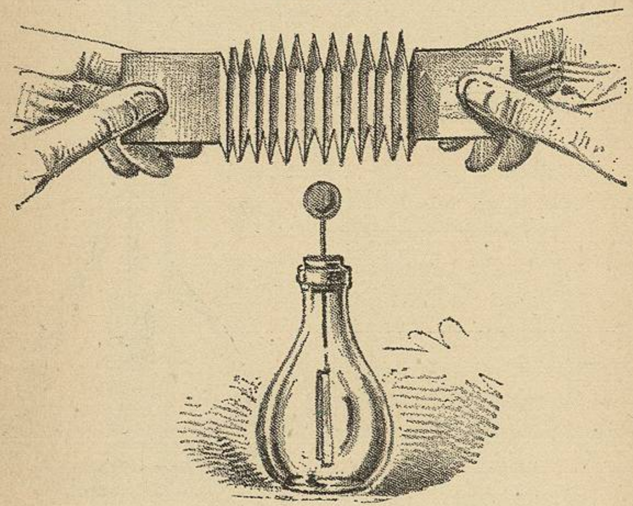
An electroscope is an instrument for determining the presence and kind of electricity.

The electroscope in its simplest form is shown in Fig. 349. It is far more sensitive than the electrical pendulum, and may be used in many instructive experiments.

It consists of a small flask or bottle, through the stopper of which is inserted a brass wire having at its upper end a metal ball and at its lower end a hook bent out horizontally to receive two strips of very thin metal leaf, either Dutch-metal leaf, silver or gold leaf, or aluminum leaf, the latter on account of its extreme lightness being preferable. The strips, which are three-eighths inch wide and two inches long, are fastened to the top of the wire hook by means of gum or even saliva alone.

To determine when a body is electrified, present it to the ball. If the leaves mutually repel each other and diverge, electricity is present. A slight touch of a glass rod, a rubber comb or ruler, or a wooden ruler, upon the clothing or carpet, or even upon a wooden surface, develops electricity in sufficient quantities to affect the electroscope. Very little friction is required to evoke a perceptible amount of electricity. One movement of the clothes brush upon the clothes or carpet affects the electroscope from a long distance. A feather duster brushed once over a varnished chair will cause the leaves of the electroscope to diverge at a distance of eight to ten feet, the effect in this case being produced by electrical induction, more fully described later on. An ordinary elastic rubber band drawn across the edge of the desk develops sufficient electricity to widely diverge

FIG. 350.



Experiment with Electroscope.

the leaves. The rubber band affords a curious example of the distribution of electricity on an extensible surface. If after electrification the rubber band is held over the electroscope, and alternately elongated and allowed to contract, the leaves of the electroscope will be seen to converge when the band is stretched, and to diverge when the band contracts.

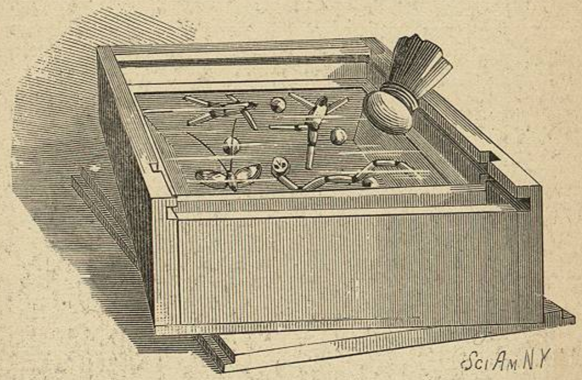
If a piece of paper, folded like a fan and well dried, is struck several times with a dry silk handkerchief or woolen cloth, and afterward alternately closed and opened over the

electroscope, as shown in Fig. 350, the reverse of what occurred in the case of the rubber band will happen. That is, when the paper is stretched out the leaves will diverge, and when it is closed up they will fall together, showing that in the latter case the electricity is masked.

There are many other interesting experiments that may be tried with the electroscope in connection with simple objects that may be found anywhere.

A toy exhibiting some of the phenomena of frictional electricity is shown in Fig. 351. It has received the name of Ano-Kato. It is a flaring box lined with tin foil, covered

FIG. 351.



Ano-Kato.

with a piece of ordinary window glass, and containing figures made of pith.

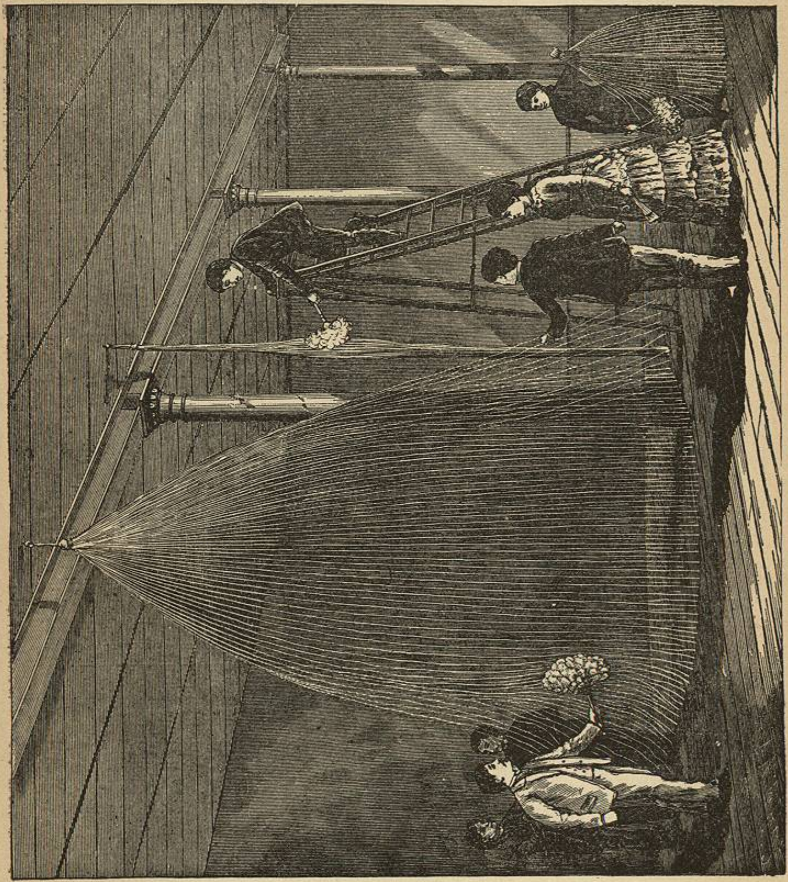
By rubbing the glass with a leather pad charged with bisulphide of tin, the electrical equilibrium is disturbed, and the figures are attracted and repelled, and made to go through all sorts of gymnastics.

An interesting example of the mutual repulsion of similarly electrified bodies is shown in Fig. 352.

For the experiment illustrated, the rubber strips were seventeen feet long.

A manufacturer in handling some of the rubber threads used in making suspenders and other elastic webs noticed that the threads at times repelled each other. The repulsion was naturally attributed to electrification, and the experiment illustrated was at once suggested. The elastic rubber strips used in the experiment were suspended from the ceiling in one of the apartments of the *Scientific American* office, and were electrified by simply brushing them over with a feather duster. The threads became more and more divergent as the electrification proceeded, until it finally became impossible to approach the threads without becoming entangled in them.

Fig. 352.

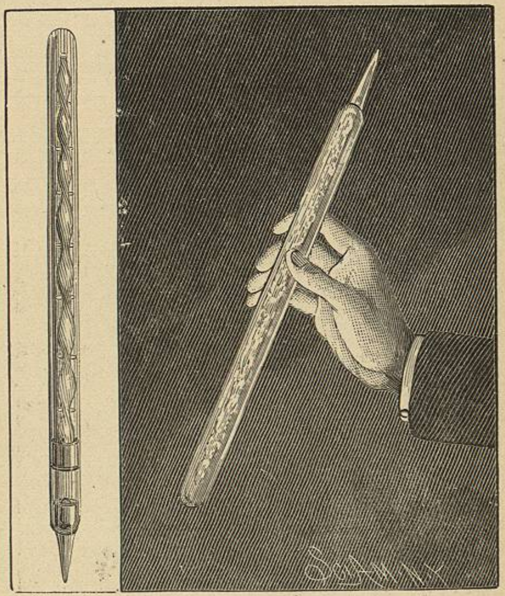


Mutual Repulsion of Electrified Threads.

Upon gathering all of the free ends of the threads together, the repulsion of the threads at their mid-length caused them to separate widely. When once electrified, in a dry day, the threads retain the charge for hours. They are discharged by connecting them with the ground through the body, and drawing them through the hand.

When the mercury in a barometer tube is agitated, the friction of the mercury on the glass generates electricity and produces effects which are visible in the dark.

Fig. 353.



Self-exciting Geissler Tube.

The self-exciting vacuum tube, shown in Fig. 353, operates in the same manner. The electrical effect is produced by the friction of mercury on the inner surfaces of the vacuous glass tube, as the tube is inverted or shaken. The tube is ingeniously contrived to prevent breakage by the falling of the mercury against the end of the tube, and at the same time to increase the effectiveness of the device by arranging two tubes concentrically, the inner tube being beaded, and provided with little knobs for breaking the fall of the mer-