SIMPLE EXPERIMENTS IN PHYSICS.

BY GEO. M. HOPKINS.

The value of observation was never more apparent than in the case of the discovery of the action of an electric current upon a magnetic needle by Christian Oersted in 1819. While passing through his laboratory on one occasion, with a compass in his hand, he noticed that the needle acted in a peculiar manner. By a few experiments he ascertained that the disturbance was caused by an electric current flowing through wires strung across his laboratory. To this circumstance we

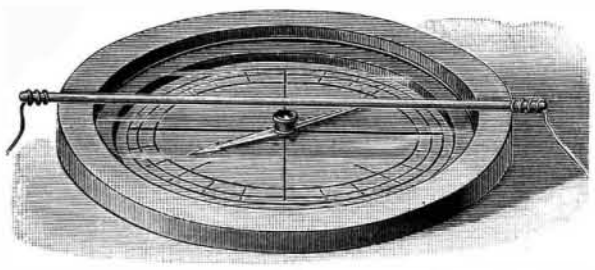


Fig. 1.—COMPASS FOR PROJECTING OERSTED'S EXPERIMENT.

owe the discovery of electro-magnetism. It is shown by experiment that the magnetic needle tends to arrange itself at right angles to a conductor carrying a current.

In Fig. 1 is illustrated a piece of apparatus for demonstrating this fact, either to a few individuals or to a large assemblage, by the aid of a lantern. It consists of a compass with a glass bottom having the scale marked on it. The needle turns on a pivot projecting from a little plate cemented to the center of the glass. When a conductor is laid across the compass, parallel with the needle, and a current is sent through the conductor, the needle is deflected in one direction or the other, depending upon the direction of the current.

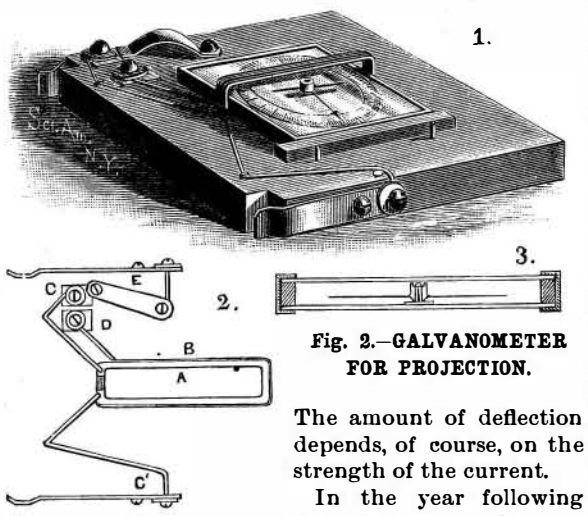


Fig. 2.—GALVANOMETER FOR PROJECTION.

The amount of deflection depends, of course, on the strength of the current.

In the year following the discovery of Oersted, Schweigger found that the power of the current over the needle was increased by causing the current to pass several times around the needle. Owing to this fact, the galvanometer was formerly known as the galvano-multiplier. A convenient and useful galvanometer for ordinary use, and for projection, is shown in Fig. 2; 1 showing the complete instrument in perspective, 2 being a diagram of the circuits, and 3 being a transverse section of the compass box. The foundation of this galvanometer is a fine photograph on glass of a complete scale of degrees of the size of an ordinary lantern slide. Upon the center of the photograph is cemented a small metallic disk, in which is secured a fine needle point, and upon the needle point is poised a jeweled compass needle taken from a pocket compass.

To diametrically opposite sides of the boss of the

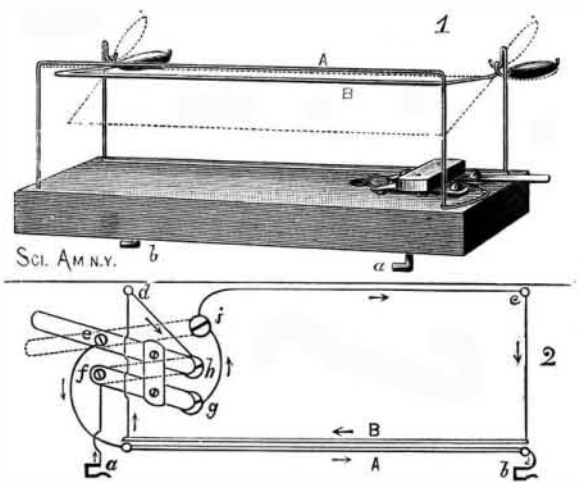


Fig. 3.—ATTRACTION AND REPULSION OF PARALLEL CONDUCTORS—AMPERE'S EXPERIMENT.

compass needle are soldered the heads of two entomological pins, which are perfectly adapted to this use, being long, thin, and finely pointed. These are arranged exactly at right angles with the needle. To one of these pins is cemented a thin paper arrow head, and upon the other pin is placed a small drop of solder to counterbalance the paper.

The compass thus formed is provided with a glass cover, separated from the scale by narrow strips of wood. The baseboard upon which the compass is mounted is provided with a round central aperture, a little larger than the circle of the scale. Across this aperture is secured an oblong rectangular coil, which will presently be described. The ends of the coil are let into recesses in the baseboard, so that when the compass is in its place the needle will occupy a central position in the coil. The compass, after adjustment, is fastened in place by six small brass screws, and along one edge of the compass is arranged a permanent bar magnet, which is held in its place by two pins. The bar magnet permits of bringing the pointers to zero, and renders the compass independent of the earth's magnetism, so that the galvanometer may be used in any position without regard to the magnetic meridian.

The coil consists of a narrow copper trough, A (see diagram), of U-shaped cross section, one-fourth inch wide and one-eighth inch deep, separated a short distance at one end of the coil, so that the current may be sent around the needle through the copper trough alone when desirable.

In the trough is wound a quantity of No. 40 silk-covered copper wire, forming the coil, B, one terminal of which is fastened to one end of the copper trough in such a way that the trough forms a continuation of the coil. The opposite or outer end of the fine wire coil is connected with the switch point, D. The corresponding end of the trough is connected with the switch point, C, and the remaining terminal of the trough is connected by a wire, C', with the contact spring at one edge of the baseboard. The contact spring at the opposite edge of the baseboard is connected with the pivot of the switch arm, E.

The contact springs are designed to make connections with the studs on the lantern, which in turn are connected with the conductors of the galvanometer circuit.

When the switch arm, E, is on the point, C, as shown in the diagram, the current passes through the trough only. Arranged in this way, the galvanometer is adapted to the measurement of heavy currents. When the switch arm is on the point, D, the current goes through both the fine wire coil and the trough. In this way the instrument is adapted to light currents. This galvanometer is adapted to the general run of experimental work. It makes a good image on the screen or ceiling when used in a lantern with a vertical attachment. The magnet interferes somewhat with its sensitiveness, and may be removed when very delicate action is desired.

In 1820 Ampere discovered that the action of a conductor in which a continuous current of electricity is maintained is like that of a magnetic needle. He replaced the needle by a delicately pivoted conductor, and demonstrated that all of the phenomena of the needle could be reproduced by the suspended conductor.

Another curious discovery, due to the same great physicist, is that of the mutual attraction and repulsion of parallel conductors. Apparatus for exhibiting this phenomenon is illustrated by Fig. 3. In this figure the perspective view shows the device adapted for projection, and the diagram shows the circuits.

Two parallel wires, A, B, are arranged one above the other, the wire, A, being fixed, the wire, B, being movable. The wire, A, is bent twice at right angles and its ends are inserted in the baseboard. The wire, B, is bent twice at right angles, and the arms thus formed are provided with eyes which are suspended on delicate pivots on the standards, *c*, *d*. These arms are prolonged beyond their pivots and provided with weights for counterbalancing the wire, the weights being so arranged as to cause the wire, B, to rest normally a short distance, say one-fourth or three-eighths inch, from the wire, A.

The connections with the battery or other electric generator are through the hooks, *a*, *b*. A current-reversing switch is provided, by which the current may be made to flow in the same direction or in opposite direction through the conductors, A, B. With the switch in the position shown, the current arriving at the hook, *a*, passes in the direction of the arrow to the switch arm, *f*, point, *g*, point, *i*, and standard, *c*, through the conductor, B, to the standard, *d*, thence to point, *h*, to the switch arm, *e*, thence through the conductor, A, to the hook, *b*. The current flowing in opposite directions through the conductors, A, B, causes the repulsion of the conductor, B.

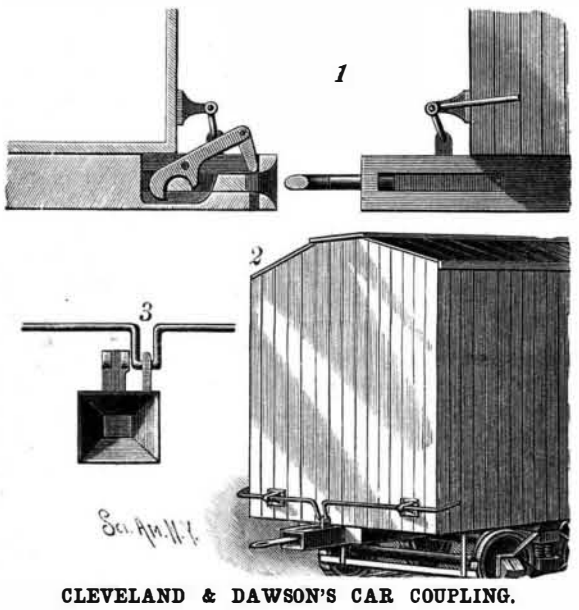
By shifting the switch arms, *e*, *f*, to the points, *i*, *h*, the current will flow through both conductors in the same direction, thereby causing them to mutually attract each other, the result being the movement of the conductor, B, toward conductor, A. This apparatus is designed especially for projection, the parallel wires only being visible on the screen.

Total Eclipse on New Year's Day.

A total eclipse of the sun will take place on January 1, 1889. The line of totality goes through a portion of California, Nevada, and Idaho. The Lick Observatory is directly in the path of the central line.

AN IMPROVED CAR COUPLING.

A car coupling designed to automatically couple cars as they come together is illustrated herewith, and has been patented by Messrs. George W. Dawson and Benjamin F. Cleveland, of Sac City, Iowa. The drawheads are duplicates of each other, and in each is a sliding block that is forced back by the entrance of the connecting link. This block is vertically recessed to form a rounded portion, which serves to raise and lower the outer end of a pivoted bar on which the coupling pin is pivoted, as shown to the left in Fig. 1, this pivoted bar working in a slot in the upper surface of the drawhead, and its lower edge being recessed to form projections which span the rounded portion of the sliding bar. To lift the coupling pin for uncoupling, the sliding block must be forced forward in the drawhead, which is effected by a rod held across the end of the car, and bent

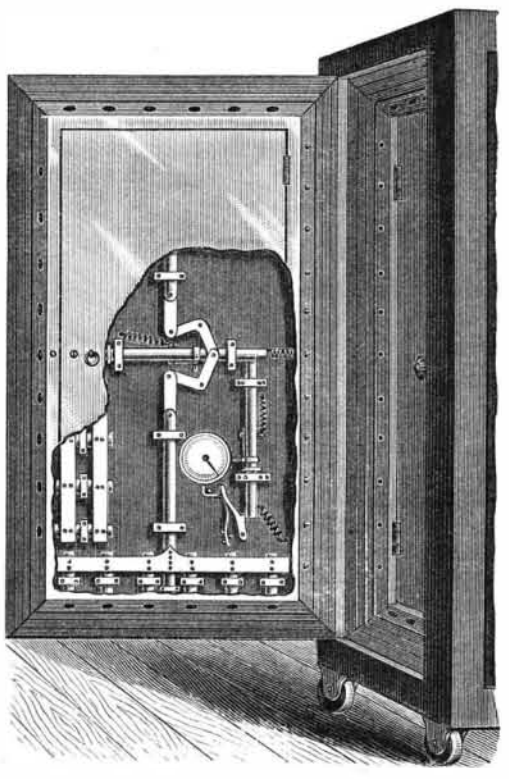


CLEVELAND & DAWSON'S CAR COUPLING.

to form a crank which connects with an arm attached to the sliding block, as shown in Figs. 2 and 3. When the sliding block is forced forward, it not only serves to lift the pivoted bar and coupling pin, but holds them in elevated position, ready to receive and engage the link of another car.

AN IMPROVED SAFE OR VAULT DOOR LOCK.

The accompanying illustration represents a safe or vault door which locks automatically when it is closed, and unlocks automatically at any predetermined time at which the clock which actuates the works may be set prior to closing the door. This has been patented by Mr. William M. Brown, Jr., of No. 1627 H Street, Sacramento, Cal. Our engraving shows an inside face view of the door partly broken away, with the bolt works in the position they have when the door is open and just prior to closing it. The door is made principally of steel and iron plates bolted together and rabbeted at the edges to fit into corresponding rabbets at the front of the body of the safe, and the lock or set works are so arranged as to give no clew to their arrangement on the safe door, being covered by an inner



BROWN'S SAFE OR VAULT DOOR LOCK.

door, which is opened to set the hands of the clock mechanism at the time the door is to open. The clock mechanism has a dial, preferably divided into hours from 1 to 24, and its hand is set to cause the spring barrel at any predetermined time to draw on a downwardly extending cord and lever, pulling a shoulder of