SOME EXPERIMENTS WITH AN ELECTRO-MAGNET.

BY GEO. M. HOPKINS.

Many very interesting and instructive experiments may be tried by means of an electro-magnet having a length of five or six inches, and capable of sustaining a hundred pounds or so. The experimenter should make his own magnet. If he is the possessor of tools and a lathe, and understands working iron, let him bend his U-shaped bar, square off its ends, turn two wooden spools suited to the bar, fill them with wire, and proceed with his experiments. But if he is not quite so fortunate, it is possible the hints here given may be of some service. It often happens that a blacksmith is not available, or a bar of the right size is not at hand. To avoid difficulties of this kind, the core of the magnet is made of twenty thicknesses of ordinary one inch hoop iron, about 1-20 inch thick, thus making a rectangular U-shaped core one inch square. The parallel arms of the magnet may be five inches long, and the distance between the arms four inches.

The pieces of hoop iron are readily bent and fitted one over the other in succession, the inner one being

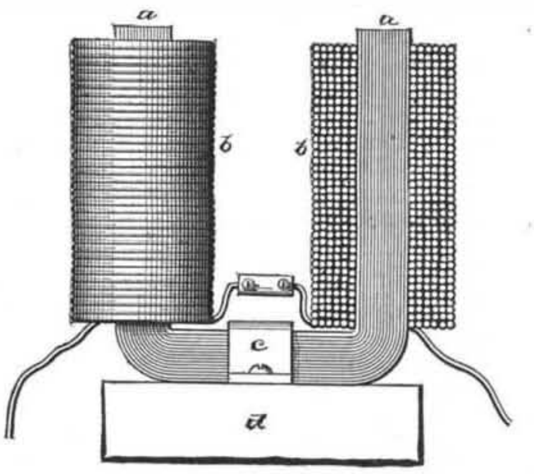


Fig. 1.—ELECTRO-MAGNET PARTLY IN SECTION.

fitted to and supported by a rectangular wooden block. When the core has reached the required thickness, the layers of which it is formed are fastened together by means of iron rivets passing through holes traversing the entire series of iron strips near the ends of the core. If it is inconvenient to secure the layers in this way, they may be wrapped from the extremities down to the angles with very strong carpet thread or shoe thread and afterward coated with shellac varnish, which holds on the thread and assists in cementing the whole together.

The extremities, *a a*, of the core must be filed off squarely, and the yoke is to be clamped to the base, *d*, by the clip, *c*, which may be made of hoop iron or of wood.

To the arms, *a a*, are fitted the coils, *b b*, which are formed by the aid of the device shown in Fig. 2. This device consists of two wedge-shaped wooden bars, A B, which together form a bar a little larger than the core of the magnet, and two mortised heads, C D, fitted to the bar with a space of 4¾ inches between them. The head, D, is provided with a screw for clamping the wedge bars, A B, and with an aperture, *a*, for the inner end of the wire. The heads are lined with thick paper, and the bar between the heads is covered with a single thickness, E, of heavy paper.

The winding is begun by passing the end of the wire (No. 16 copper cotton-covered magnet wire) through the aperture, *a*, allowing it to project about three inches, then winding the wire evenly over the bar from one end toward the other until the head, C, is reached. Before the second layer of wire is wound, the first one is brushed over with thin glue. The second layer is then wound, starting from the head, C, and winding in the same direction toward the head, D, and when the second layer is complete it is brushed over with the glue, after which the third layer is wound and glued, and so on, laying the wire on like thread on a spool until six or eight layers have been applied.

To prevent the destruction of the coil by the loosening of the ends of the wire, a loop of tape should be placed on the beginning of the first convolution and laid over the first layer of wire, so that it may be clamped by the second layer, and in a similar manner some stout threads should be placed between the outer layer and the adjacent layer, so that they may be tied over the last convolution of the last layer. After the glue has become thoroughly dry and hard, the heads, C D, are removed from the bars, A B, and the tapering bars are knocked out of the coil in opposite directions, their wedge shape facilitating this removal. Two coils precisely alike are required. When they are placed on the core, the inner end of one coil is

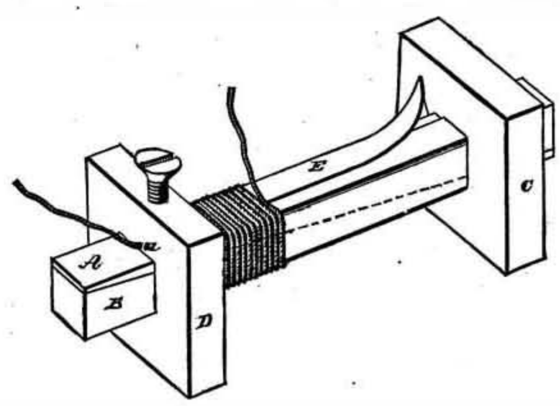


Fig. 2.—FORM FOR COILS.

connected with the outer end of the other, and the remaining ends are connected with a battery.

To give the coils a finished appearance, they may be coated with shellac varnish, colored with a pigment of suitable color, vermilion for example.

Probably the best battery for use in connection with this magnet is one of the plunging bichromate form. The simple plunge battery described on page 116, vol. lvii., SCIENTIFIC AMERICAN, will answer admirably.

To the poles of the magnet should be fitted two short

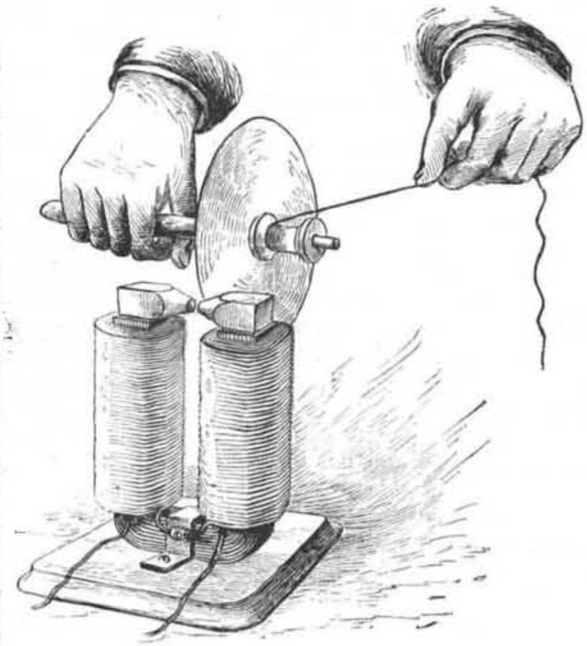


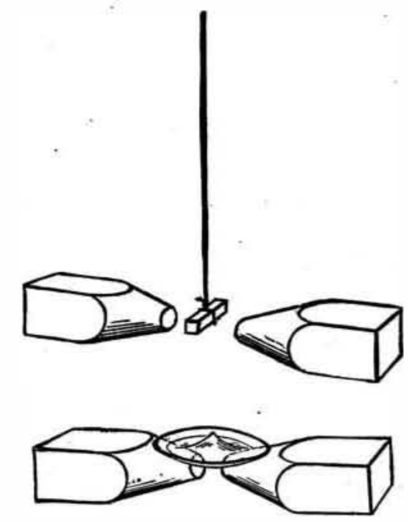
Fig. 3.—FOUCAULT'S EXPERIMENT.

iron bars, having conical ends. These bars will need no special fastening, as the attraction of the magnet will hold them in place.

It is perhaps hardly necessary to enter into the details of many experiments with this magnet, as they are described in the text books. A few well noticed, the reader is referred to electrical and physical works for others.

In Fig. 3 is shown a simple way of reproducing Foucault's experiment. A centrally apertured copper disk, 6 inches in diameter, is attached by means of small nails to the end of a common spool, and the spool is mounted so as to turn on a screw inserted in a handle. The short iron bars are arranged on the poles of the magnet, as shown in the engraving, with the conical ends about one-fourth inch apart. A strong current is sent through the magnet, and the copper disk is whirled rapidly by quickly unwinding a string from the spool, after the manner of top spinning. The edge of the disk is then inserted between the conical pole pieces, but without touching them. The rotation of the disk is almost instantly stopped. A sheet of copper moved back and forth between the pole pieces offers a sensible resistance.

Most experiments in diamagnetism may be per-



Figs. 4 and 5.—DIAMAGNETISM.

formed with this magnet. Short bars of various metals may be suspended, by means of a silk fiber, between the poles. Iron, nickel, cobalt, manganese, etc., will arrange themselves in line with the poles, while bismuth, antimony, and several other metals will arrange themselves across the line of the poles. The former are known as paramagnetic bodies, the latter as diamagnetic.

Liquids placed in a watch glass, as shown in Fig. 5, exhibit paramagnetic or diamagnetic properties; by piling up at the center of the glass, as shown in the engraving, if paramagnetic, or by piling up on opposite sides of the center, if diamagnetic.

The coils of this magnet being removable may be used in magnetizing steel bars, and for other purposes requiring the coils only.

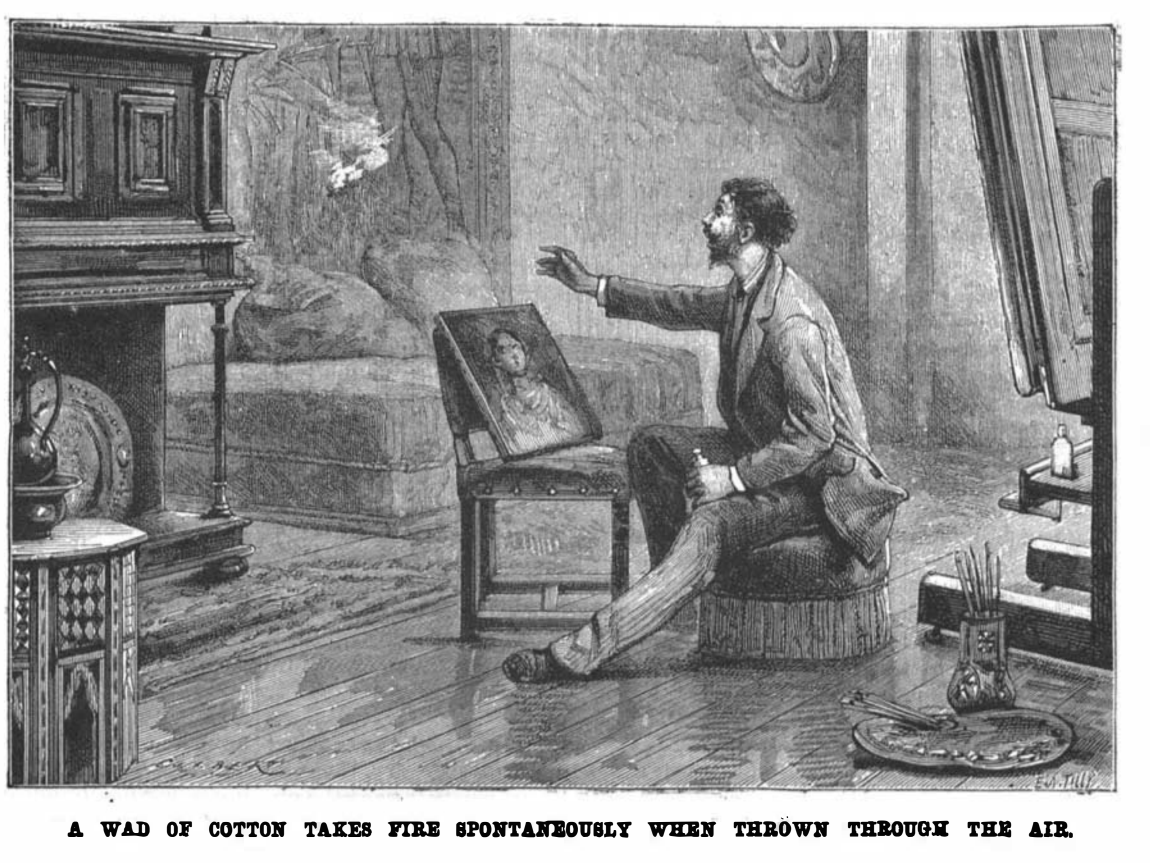
There are about three pounds of wire in each coil of the magnet.

SPONTANEOUS COMBUSTION.

In November of last year a force of men was sent aboard of the City of Newcastle to extinguish a fire in a cargo of cotton which had been generated by spontaneous combustion. An unsuccessful attempt to extinguish the fire had been made at Queenstown, the first port at which the vessel stopped.

Baled cotton and also cotton and fibers and rags that are saturated with oil are quite subject to spontaneous combustion. In five years 46 ships bound for Liverpool alone, and loaded with cotton, were burned either at sea or just before or after their departure. This figure is much too low, judging from the remarks of a rich English banker who is familiar with affairs in all parts of the world. Of the long list of vessels laden with cotton or grain, nine had just been burned in whole or part, and he added that it was necessary that steps should be taken to prevent the fermentation of cotton, which appeared to be more combustible at that period than usual.

The remarkable tendency which is observable in tissues and cotton when moistened with oil, to become heated when oxidation sets in, deserves particular attention, and especially so from the sad results that may follow negligence, caused too often by ignorance of the



A WAD OF COTTON TAKES FIRE SPONTANEOUSLY WHEN THROWN THROUGH THE AIR.