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

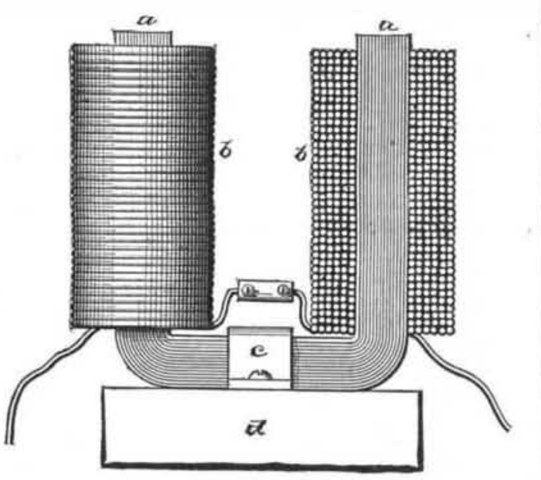


Fig. 1.—ELECTRO-MAGNET PARTLY IN SECTION.

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

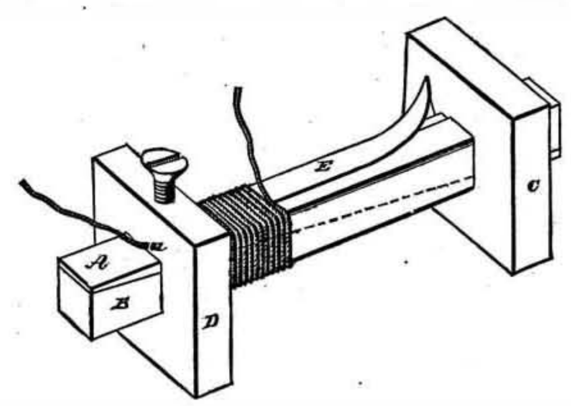


Fig. 2.—FORM FOR COILS.

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

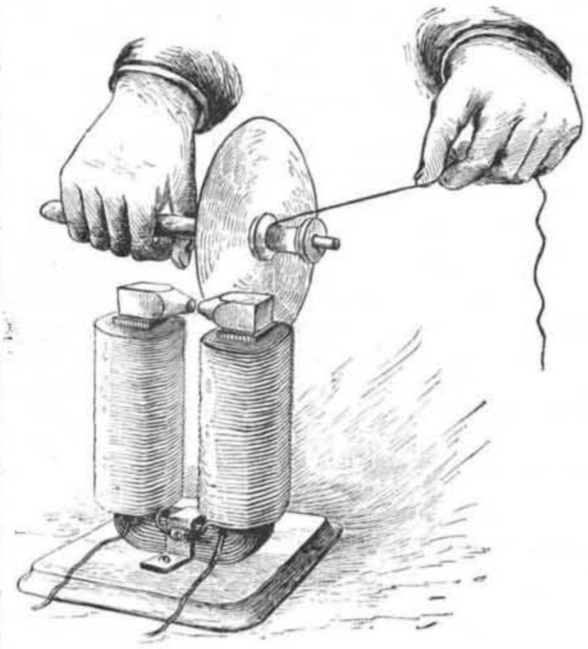


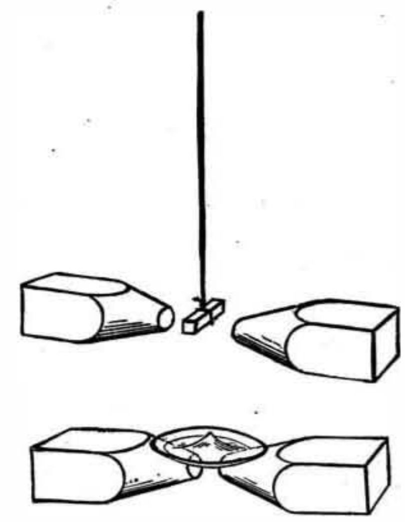
Fig. 3.—FOUCAULT'S EXPERIMENT.

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.

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

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 danger or ignorance of the necessary precautions. In the navy, for instance, every precaution is taken to avoid spontaneous combustion. Thus, all the officers are aware that before packing away the tarpaulins or oiled coats which the sailors wear in bad weather, it is necessary to see that they are thoroughly dried. They should not be packed together in too great numbers. Oils, when drying, undergo a change which is simply a slow combustion at low temperature. If this action is hastened by any cause whatever, it brings about a higher temperature, which may result in fire.

The experiment may be made of producing spontaneous combustion, even in a few yards of cotton cloth, by painting it with linseed oil. M. Chevalier cites an instance of this nature, in the sail room at the arsenal at Brest, where three cases (for sails) of canvas painted with oil had been laid one on the other, after having been dried in the sun two days. Each piece measured about ten yards. Whether in the sun or shade, or under cover or exposed to the air, these pieces of fabric, whether yarn or cotton, can readily take fire, but fortunately very soon attract attention from the dense smoke that is emitted. Cotton fabrics containing oil, however, do not alone take fire in closed chambers and in the holds of ships, for I have seen the phenomenon produced in open air. I witnessed a case in point near the railroad station of l'Ouest, in July, 1878, when the heat was very great. The lamp room is situated at the foot of the Rue de Rome and the Pont de l'Europe. There, in a large sack, were gathered all the useless, greasy rags that had been used for cleaning the lamps. One of these bags had been filled so full that the rags had fallen to the ground, and as I passed by I noticed an odor of burning rags, but after a careful examination discovered no cause for this. Passing the same place five minutes later, I found the odor stronger, and I discovered the rags were just bursting into fire. I called an attendant and showed him the fire, and it was very soon extinguished with the help of a pail of water.

M. Chevalier, in his memoir on fires, instances the experiments of Messrs. Golding and Humphries, who caused spontaneous combustion by shutting up a piece of fabric immersed in linseed oil in a closed box, where it was left for three hours. The fabric commenced to smoke, and as soon as the air was admitted burst into flame.

Messrs. Renouard and Rouen carried still further the experiments of Golding. They mingled a few pieces of oiled cotton with some dry cotton and then put the whole under pressure, and after a few hours fire was discovered. Every one is aware that when cotton is baled, it is subjected to an enormous pressure. If the cotton is greasy, or even damp, it ferments, becomes heated, and then ignited.

A curious instance was reported by Dumas to the Institute in 1844, and cited by M. Fonssagrives. An artist was rubbing with a wad of cotton a painting freshly varnished. When he threw the cotton away, it immediately took fire in mid-air. Later, at the Academy of Sciences in 1879, during a discussion concerning a fire in the floor of a laboratory of a certain botanist, M. Cosson, M. Dumas cited a number of cases which prove that the condensation of the air in porous and combustible bodies frequently produces combustion, if the temperature is sufficiently low. Among these he again cited the case of the wad of cotton taking fire in mid-air. A savant as prominent as Dumas, who repeats the same statement at an interval of thirty years, classes it evidently as an indisputable fact. The temperature of 80° or 100° in the hold of a vessel does not sufficiently explain the cause of a fire in a cargo of damp linen, hemp, manure, oats, grain, or cereals. It is necessary to take into consideration the changed conditions. The rise in the temperature is due to the condensation of gas and to the rapid and powerful oxidation. Thus charcoal, which is very porous, when shut in a closed atmosphere, absorbs a large proportion of gas, which condenses and produces heat.

I cite another case, not so well known: The waste from vulcanized rubber, when thrown, in a damp condition, into a pile, takes fire spontaneously. This occurred at the factory of M. Menier, at Grenelle, in France.

Messrs. Dumas and Chevreul, in treating of this subject of spontaneous combustion before the Institute, stated that when a package from China containing some fresh vegetable matter and some dried substances was opened, they took fire, even before their eyes.

M. Fonssagrives states that the temperature of boxes of figs from Barbary has been so raised by fermentation that you could hardly bear your hand upon them.

There is less surprise in the increase of heat in heaps of coal, whether in storage or in open air. These masses of coal, whether in the quay or in the yard, take fire, nevertheless, without a spark being applied. The complex composition of coal gives a sufficient cause for spontaneous combustion. It contains essential oils, sulphur, and, above all, phosphureted hydrogen and marsh gas, which is spontaneously combustible. The impalpable coal dust also adds another danger of combustion.—*La Nature.*

BRITISH MUSEUM.—At a recent meeting of the electing trustees of this institution, Professor Huxley was elected to the vacancy in the trust caused by the death of Mr. Beresford-Hope.

AN AUSTRALIAN CHLAMYDOSAURUS.

The menagerie of reptiles of the Paris Museum recently came into possession of an Australian lizard, of a singular appearance, which has not heretofore been received in a living state, and which is remarkable, by the presence on the sides of the neck of a broad projecting membrane, toothed along its edges, folding back after the manner of a fan, and, in a state of repose, lying along the neck and forming a sort of collar. This curious lizard is the *Chlamydosaurus kingii*, Gray. The two halves of the collar are continuous beneath the throat, but are separate on the dorsal side, where they slightly overlap. Each consists of a fold of skin covered with large carinate scales, and supported on each side by a subcutaneous thickening, having the appearance of cartilage, and also by a bony projection from the os hyoides that is situated between the two flaps of the fold. Peculiar muscles control the movements of this apparatus, which the animal can thus spread out or fold up.

CHLAMYDOSAURUS KINGII.

We do not think, however, that the animal can spread it out to its full extent, as the number of the radii that support it is too few, and observations made at the menagerie confirm this view. Our lizard, in fact, has at times erected its collar when some one has tried to seize it, but very incompletely.

We lack positive information as to the role that these cutaneous folds play, but, as they are of the same nature as those observed on the sides of the body in other lacertians, such as dragons, for example, or in certain mammals, such as bats, flying phalangers, etc. it is presumable that they serve for analogous purposes, and that they constitute an accessory apparatus of locomotion. In fact, this lizard is essentially a tree inhabiter. The individual seen by us was constantly perched, and it is probable that at the moment that it jumps from one branch to another, it spreads its collar, which serves as a sort of parachute. On another hand, it feeds chiefly upon insects, and perhaps seizes them as they fly, by jumping after them, and using its collar to increase and regulate the length of its leaps.

The chlamydosaurus, which is a great deal stronger, and especially much slenderer, than the lizard of Southern France, attains a total length of 30 inches from the snout to the tip of the tail, which latter is very long. Its legs are very strong, and its claws are curved and sharp, as they need to be in a climbing animal. Its motions are agile and have a certain abruptness. When at rest, it sits upon its haunches, and erects its forelegs and head, which it holds immovable, and seems to be making observations.

During the three weeks that our specimen remained at the menagerie, it absolutely refused all kinds of food, although the keepers offered it everything that they thought capable of exciting its appetite. At the end of this period it succumbed. It seemed to be absolutely harmless, and never tried to bite any one who endeavored to seize it.

Its color was dull, of a pale brown above and lighter under the belly, with irregular and darker blotches on the back and legs, and blackish rings around the tail. The teeth of its collar were white at the tip, and, from a distance, looked like two rows of pearls.

As regards zoological affinities, the chlamydosaurus is quite distant from the lizards of France, and belongs to the family of Agamians, which has few representatives in Europe and none in America. The only species of the genus known is the one under consideration which has hitherto been met with only in Australia and on a few islands to the north of that continent.—*La Nature.*