THE "HOW-TO-DO-IT" BOOKS

ELECTRICITY FOR BOYS

A working guide, in the successive steps of electricity, described in simple terms

WITH MANY ORIGINAL ILLUSTRATIONS

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CARPENTRY FOR BOYS PRACTICAL MECHANICS FOR BOYS

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TABLE OF CONTENTS

CHAPTER III: MAGNETS, COILS, ARMATURES, ETC.

The Two Kinds of Magnet.—Generally speaking, magnets are of two kinds, namely, permanent and electro-magnetic.

Permanent Magnets.—A permanent magnet is a piece of steel in which an electric force is exerted at all times. An electro-magnet is a piece of iron which is magnetized by a winding of wire, and the magnet is energized only while a current of electricity is passing through the wire.

Electro-Magnet.—The electro-magnet, therefore, is the more useful, because the pull of the magnet can be controlled by the current which actuates it.

The electro-magnet is the most essential of all contrivances in the operation and use of electricity. It is the piece of mechanism which does the physical work of almost every electrical apparatus or machine. It is the device which has the power to convert the unseen electric current into motion which may be observed by the human eye. Without it electricity would be a useless agent to man.

While the electro-magnet is, therefore, the form of device which is almost wholly used, it is necessary, first, to understand the principles of the permanent magnet.

Magnetism.—The curious force exerted by a magnet is called magnetism, but its origin has never been explained. We know its manifestations only, and laws have been formulated to explain its various phases; how to make it more or less intense; how to make its pull more effective; the shape and form of the magnet and the material most useful in its construction.

Fig 5. Plain Magnet Bar

Materials for Magnets.—Iron and steel are the best materials for magnets. Some metals are non-magnetic, this applying to iron if combined with manganese. Others, like sulphur, zinc, bismuth, antimony, gold, silver and copper, not only are non-magnetic, but they are actually repelled by magnetism. They are called the diamagnetics.

Non-magnetic Materials.—Any non-magnetic body in the path of a magnetic force does not screen or diminish its action, whereas a magnetic substance will

In Fig. 5 we show the simplest form of magnet, merely a bar of steel (A) with the magnetic lines of force passing from end to end. It will be understood that these lines extend out on all sides, and not only along two sides, as shown in the drawing. The object is to explain clearly how the lines run.

Fig 6. Severed Magnet

Action of a Severed Magnet.—Now, let us suppose that we sever this bar in the middle, as in Fig. 6, or at any other point between the ends. In this case each part becomes a perfect magnet, and a new north pole (N) and a new south pole (S) are made, so that the movement of the magnetic lines of force are still in the same direction in each—that is, the current flows from the north pole to the south pole.

What North and South Poles Mean.—If these two parts are placed close together they will attract each other. But if, on the other hand, one of the pieces is reversed, as in Fig. 7, they will repel each other. From this comes the statement that likes repel and unlikes attract each other

Repulsion and Attraction.—This physical act of repulsion and attraction is made use of in motors, as we shall see hereinafter.

It will be well to bear in mind that in treating of electricity the north pole is always associated with the plus sign (+) and the south pole with the minus sign (-). Or the N sign is positive and the S sign negative electricity.

CHAPTER IV: FRICTIONAL, VOLTAIC OR GALVANIC, AND ELECTRO-MAGNETIC ELECTRICITY

Three Electrical Sources.—It has been found that there are three kinds of electricity, or, to be more accurate, there are three ways to generate it. These will now be described.

When man first began experimenting, he produced a current by frictional means, and collected the electricity in a bottle or jar. Electricity, so stored, could be drawn from the jar, by attaching thereto suitable connection. This could be effected only in one way, and that was by discharging the entire accumulation instantaneously. At that time they knew of no means whereby the current could be made to flow from the jar as from a battery or cell.

Frictional Electricity.—With a view of explaining the principles involved, we show in Fig. 17 a machine for producing electricity by friction.

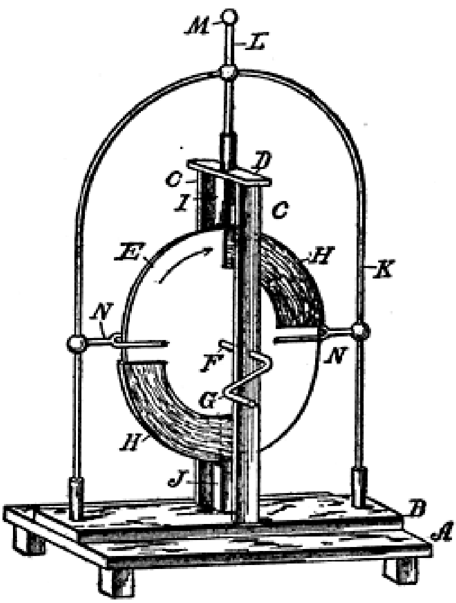

Fig. 17. Friction-Electricity Machine

This is made up as follows: A represents the base, having thereon a flat member (B), on which is mounted a pair of parallel posts or standards (C, C), which are connected at the top by a cross piece (D). Between these two posts is a glass disc (E), mounted upon a shaft (F), which passes through the posts, this shaft having at one end a crank (G). Two leather collecting surfaces (H, H), which are in contact with the glass disc (E), are held in position by arms (I, J), the arm (I) being supported by the cross piece (D), and the arm (J) held by the base piece (B). A rod (K), U-shaped in form, passes over the structure here thus described, its ends being secured to the base (B). The arms (I, J) are both electrically connected with this rod, or conductor (K), joined to a main conductor (L), which has a terminating knob (M). On each side and close to the terminal end of each leather collector (H) is a fork-shaped collector (N). These two collectors are also connected electrically with the conductor (K). When the disc is turned electricity is generated by the leather flaps and accumulated by the collectors (N), after which it is ready to be discharged at the knob (M).

In order to collect the electricity thus generated a vessel called a Leyden jar is used.

Leyden Jar.—This is shown in Fig. 18. The jar (A) is of glass coated exteriorly at its lower end with tinfoil (B), which extends up a little more than halfway from the bottom. This jar has a wooden cover or top (C), provided centrally with a hole (D). The jar is designed to receive within it a tripod and standard (E) of lead. Within this lead standard is fitted a metal rod (F), which projects upwardly through the hole (D), its upper end having thereon a terminal knob (G). A sliding cork (H) on the rod (F) serves as a means to close the jar when not in use. When in use this cork is raised so the rod may not come into contact, electrically, with the cover (C).

The jar is half filled with sulphuric acid (I), after which, in order to charge the jar, the knob (G) is brought into contact with the knob (M) of the friction generator (Fig. 17).

Voltaic or Galvanic Electricity.—The second method of generating electricity is by chemical means, so called, because a liquid is used as one of the agents.

CHAPTER VII: PUSH BUTTONS, SWITCHES, ANNUNCIATORS, BELLS AND LIKE APPARATUS

Simple Switches.—We have now gone over the simpler or elementary outlines of electrical phenomena, and we may commence to do some of the practical work in the art. We need certain apparatus to make connections, which will be constructed first.

A Two-Pole Switch.—A simple two-pole switch for a single line is made as follows:

A base block (A, Fig. 43) 3 inches long, 2 inches wide and ¾ inch thick, has on it, at one end, a binding screw (B), which holds a pair of fingers (C) of brass or copper, these fingers being bent upwardly and so arranged as to serve as fingers to hold a switch bar (D) between them. This bar is also of copper or brass and is pivoted to the fingers. Near the other end of the base is a similar binding screw (E) and fingers (F) to receive the blade of the switch bar. The bar has a handle (G) of wood. The wires are attached to the respective binding screws (B, E).

Double-Pole Switch.—A double-pole switch or a switch for a double line is shown in Fig. 44. This is made similar in all respects to the one shown in Fig. 43, excepting that there are two switch blades (A, A) connected by a cross bar (B) of insulating material, and this bar carries the handle (C).

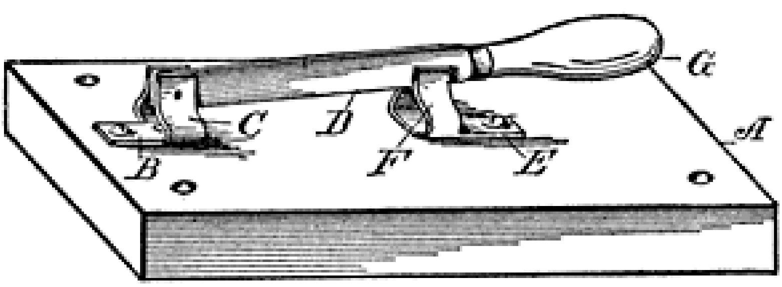

Fig. 43. Two-Pole Switch

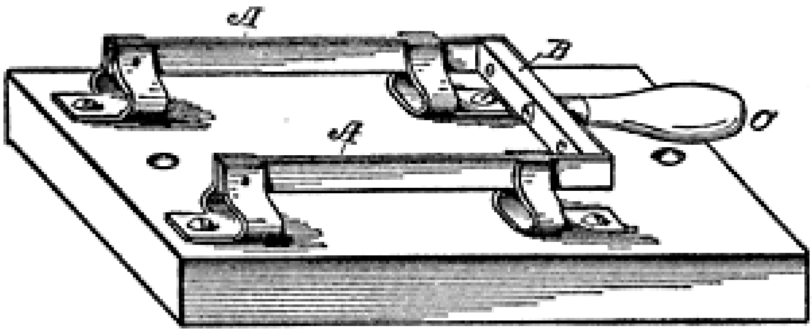

Fig. 44. Double-Pole Switch

Other types of switch will be found very useful. In Fig. 45 is a simple sliding switch in which the base block has, at one end, a pair of copper plates (A, B), each held at one end to the base by a binding screw (C), and having a bearing or contact surface (D) at its other end. At the other end of the base is a copper plate (E) held by a binding screw (F), to the inner end of which plate is hinged a swinging switch blade (G), the free end of which is adapted to engage with the plates (A, B).

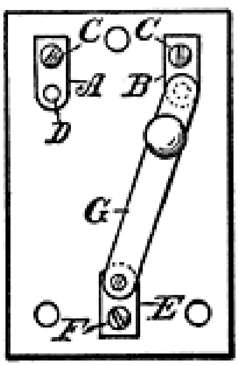

Fig. 45. Sliding Switch

Sliding Switch.—This sliding switch form may have the contact plates (A, B and C, Fig. 46) circularly arranged and any number may be located on the base, so they may be engaged by a single switching lever (H). It is the form usually adopted for rheostats.

Reversing Switch.—A reversing switch is shown in Fig. 47. The base has two plates (A, B) at one end, to which the parallel switch bars (C, D) are hinged. The other end of the base has three contact plates (E, F, G) to engage

CHAPTER XV: ALTERNATING CURRENTS, CHOKING COILS, TRANSFORMERS, CONVERTERS AND RECTIFIERS

Direct Current.—When a current of electricity is generated by a cell, it is assumed to move along the wire in one direction, in a steady, continuous flow, and is called a *direct* current. This direct current is a natural one if generated by a cell.

Alternating Current.—On the other hand, the natural current generated by a dynamo is alternating in its character—that is, it is not a direct, steady flow in one direction, but, instead, it flows for an instant in one direction, then in the other direction, and so on.

A direct-current dynamo such as we have shown in Chapter IV, is much easier to explain, hence it is illustrated to show the third method used in generating an electric current.

It is a difficult matter to explain the principle and operation of alternating current machines, without becoming, in a measure, too technical for the purposes of this book, but it is important to know the fundamentals involved, so that the operation and uses of certain apparatus, like the choking coil, transformers, rectifiers and converters, may be explained.

The Magnetic Field.—It has been stated that when a wire passes through the magnetic field of a magnet, so as to cut the lines of force flowing out from the end of a magnet, the wire will receive a charge of electricity.

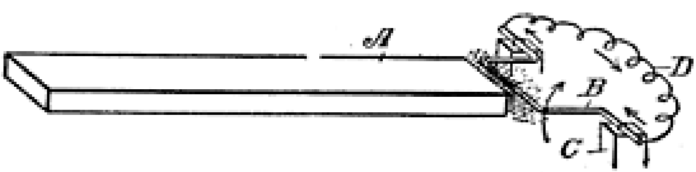

Fig. 102. Cutting a Magnetic Field

To explain this, study Fig. 102, in which is a bar magnet (A). If we take a metal wire (B) and bend it in the form of a loop, as shown, and mount the ends on journal-bearing blocks, the wire may be rotated so that the loop will pass through the magnetic field. When this takes place, the wire receives a charge of electricity, which moves, say, in the direction of the darts, and will make a complete circuit if the ends of the looped wire are joined, as shown by the conductor (D).

Action of the Magnetized Wire.—You will remember, also that we have pointed out how, when a current passes over a wire, it has a magnetic field extending out around it at all points, so that while it is passing through the magnetic field of the magnet (A), it becomes, in a measure, a magnet of its own and tries to set up in business for itself as a generator of electricity. But when the loop leaves the magnetic field, the magnetic or electrical impulse in the wire also leaves it.

The Movement of a Current in a Charged Wire.—Your attention is directed, also, to another statement, heretofore made, namely, that when a current from a charged wire passes by induction to a wire across space, so as to charge it with an electric current, it moves along the charged wire in a direction opposite to that of the current in the charging wire.

Now, the darts show the direction in which the current moves while it is approaching and passing through the magnetic field. But the moment the loop is about to pass out of the magnetic field, the current in the loop surges back in the opposite direction, and when the loop has made a revolution and is again entering the magnetic field, it must again change the direction of flow in the current, and thus produce alternations in the flow thereof.

Let us illustrate this by showing the four positions of the revolving loop. In Fig. 103 the loop (B) is in the middle of the magnetic field, moving upwardly in the direction of the curved dart (A), and while in that position the voltage, or the electrical impulse, is the most intense. The current used flows in the direction of the darts (C) or to the left.

In Fig. 104, the loop (A) has gone beyond the influence of the magnetic field, and now the current in the loop tries to return, or reverse itself, as shown by the dart (D). It is a reaction that causes the current to die out, so that when the loop has reached the point farthest from the magnet, as shown in Fig. 105, there is no current in the loop, or, if there is any, it moves faintly in the direction of the dart (E).

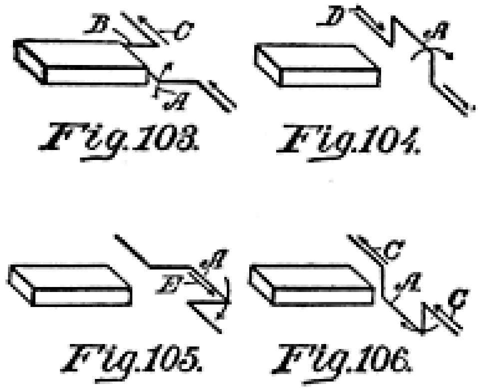

Fig. 103-106. Illustrating Alternations

Current Reversing Itself.—When the loop reaches its lowest point (Fig. 106) it again comes within the magnetic field and the current commences to flow back to its original direction, as shown by darts (C)

Self-Induction.—This tendency of a current to reverse itself, under the conditions cited, is called self-induction, or inductance, and it would be well to keep this in mind in pursuing the study of alternating currents.

You will see from the foregoing, that the alternations, or the change of direction of the current, depends upon the speed of rotation of the loop past the end of the magnet.

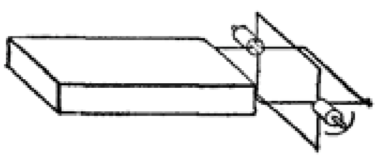

Fig. 107. Form for Increasing Alternations

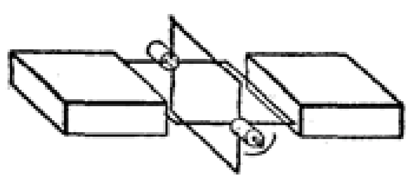

Fig. 108. Form for Increasing Alternations