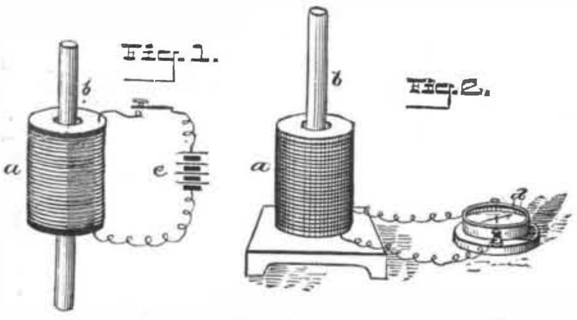
EXPERIMENTS ILLUSTRATING THE PRINCIPLE OF THE DYNAMO.

BY GEO. M. HOPKINS.

I.

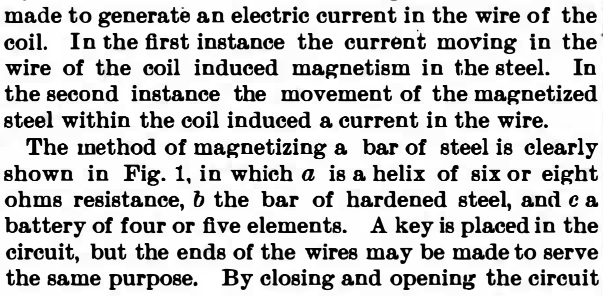
The great development of electricity in recent years, especially in the line of electric illumination, has served to add luster to the name of the immortal Faraday, and to show with what wonderful completeness he exhausted the subject of magneto-electric induction. Since the close of his investigations no new principles have been discovered. Physicists and electrical inventors have merely amplified his discoveries and inventions, and applied them to practical uses. The number of those who are familiar with the discoveries of Faraday and their bearing on modern electrical science is not only large, but rapidly increasing, but there are those who are still learners, to whom new things, or old things placed in a new light, are ever welcome. To such the simple experiments here given may be an aid to the understanding of induction as developed in dynamos and motors.

Any one at all acquainted with electrical phenomena knows that a hardened steel bar surrounded by a coil of wire which is traversed by an electric current becomes permanently magnetic. It is perhaps unnecessary to reiterate the accepted theories of this action, as they are well established and appear in almost every text book of physics. The fundamental magneto-electrical experiment of Faraday was exactly the reverse of the operation of producing a magnet by means of an electrical current. That is, it was the production of an electrical current by means of a magnet and coil. In the first instance the magnetizing power of the electric current is employed to bring about the molecular change in the steel bar, which manifests itself in polarity. In the second instance the magnetized steel bar is made to generate an electric current in the wire of the coil. In the first instance the current moving in the wire of the coil induced magnetism in the steel. In the second instance the movement of the magnetized steel within the coil induced a current in the wire.



1. MAGNETIZATION OF STEEL BAR. 2. MAGNETO-ELECTRIC INDUCTION.

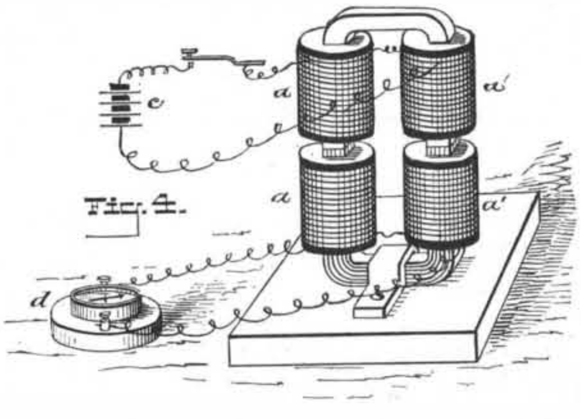
The method of magnetizing a bar of steel is clearly shown in Fig. 1, in which *a* is a helix of six or eight ohms resistance, *b* the bar of hardened steel, and *c* a battery of four or five elements. A key is placed in the circuit, but the ends of the wires may be made to serve the same purpose. By closing and opening the circuit while the steel bar is within the coil as shown, the bar instantly becomes magnetic. When the coil is disconnected from the battery and connected with a galvanometer, *d*, as shown in Fig. 2, and the magnet, *b*, is suddenly inserted in the coil, the needle of the galvanometer will be deflected; but the action is only momentary. The needle returns immediately to the point of starting. When the magnet is quickly withdrawn from the coil the needle is deflected for an instant, but in the opposite direction, and, as before, it immediately returns to the point of starting. It is obvious that if these electric pulsations can be made with sufficient rapidity to render them practically continuous, and if they can be corrected so that pulsations of the same name will always flow in the same direction, the current thus produced may be utilized.



MAGNETIC INDUCTION.

Before proceeding further with the consideration of magneto-electric induction, it will be necessary to briefly examine the subject of magnetic induction, as it is intimately connected with the action of the dynamo. In Fig. 3 is illustrated the usual experiment exhibiting this phenomenon. An electro-magnet like that described on page 214 of the current volume of the SCIENTIFIC AMERICAN is connected with a suitable battery, and a bar of soft iron is held near but not in contact with one of the poles of the magnet. It becomes magnetic by induction, the end nearest the magnet being of a name different from that of the pole by which the induction is effected. The end of the bar remote from the magnet exhibits magnetism like that of the magnet pole of the magnet.

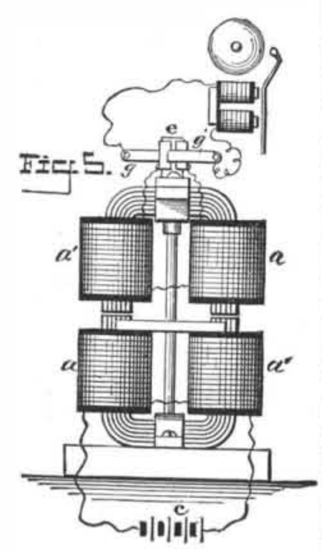
The relation of magnetic induction to magneto-electric induction is clearly shown by the experiment illustrated in Fig. 4. In this case two electro-magnets are arranged with their poles in contact. One of them is connected with a galvanometer, and the other with a battery. When the circuit of the upper magnet is closed, the core of that magnet becomes magnetic, the core of the lower magnet becomes magnetic by induction, and the galvanometer needle is deflected. When the circuit of the upper magnet is broken, the galvanometer needle is deflected in the opposite direction, showing that the results are precisely the same as in the experiment illustrated by Fig. 2. In this case no mechanical movement is necessary, as the magnetism is introduced into the coils of the lower magnet by induction. It is thus shown that it is not necessary to move any matter to secure magneto-electric induction.



INDUCED CURRENT FROM INDUCED MAGNETISM.

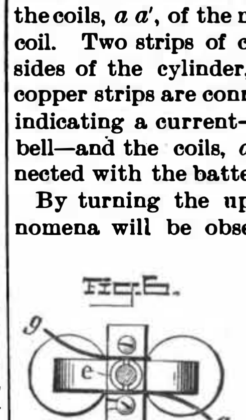
In Fig. 5 is shown an arrangement of electro-magnets in which one is fixed, while the other can be revolved. It is a device intended simply for showing how two ordinary electro-magnets may be utilized to advantage in experiments in induction.

To the polar extremities of the fixed magnet is fitted a wooden cross bar, having in its center an aperture for receiving the vertical spindle, the lower end of which is journaled in the clamp that holds the fixed magnet to the base. The upper end of the spindle is provided with a yoke for holding the movable magnet. The cross bar which clamps the magnet in the yoke is held in place by two screws, as shown in Fig. 7, and to the center of the cross bar is attached a wooden cylinder, *e*, axially in line with the spindle. To the wooden cylinder are secured two curved brass plates which are connected electrically with the terminals of the coils, *a a'*, of the movable magnet, one plate to each coil. Two strips of copper, *g g'*, held upon opposite sides of the cylinder, complete the commutator. The copper strips are connected with any device capable of indicating a current—in the present case an electric bell—and the coils, *a a'*, of the fixed magnet are connected with the battery, *c*.



SIMPLE CURRENT GENERATOR.

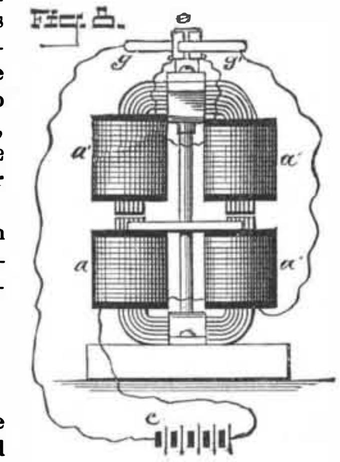
By turning the upper magnet, the following phenomena will be observed: 1. When, by turning the movable magnet, its poles are pulled away from the fixed magnet, the departure of the induced magnetism from the core of the movable magnet produces an electric pulsation in the coil which operates the electric bell. When, by a continued movement of the magnet in the same direction, the poles exchange position, another electrical impulse will be induced, and the bell will be again operated. 2. By examining these impulses by means of a galvanometer introduced into the circuit, it will be found that they are of the same name. 3. When the magnet is turned a little faster, these two impulses will blend into one, so that for each half of the revolution of the magnet the bell yields but one stroke. 4. By whirling the magnet quite rapidly, the current through the bell magnet is made practically continuous, so that the bell armature is drawn forward toward the magnet and held there.



DETAILS OF GENERATOR.

From what has been said, it will be seen that all of the positive electrical impulses are generated upon one side of the poles of the fixed magnet, and all the negative impulses are generated upon the other side of the fixed magnet, and that the curved plates of the commutator conduct all of the positive electrical impulses to one of the strips, *g g'*, and all of the negative impulses to the other strip.

In Fig. 8 is shown an arrangement of connections to convert the device into a motor.



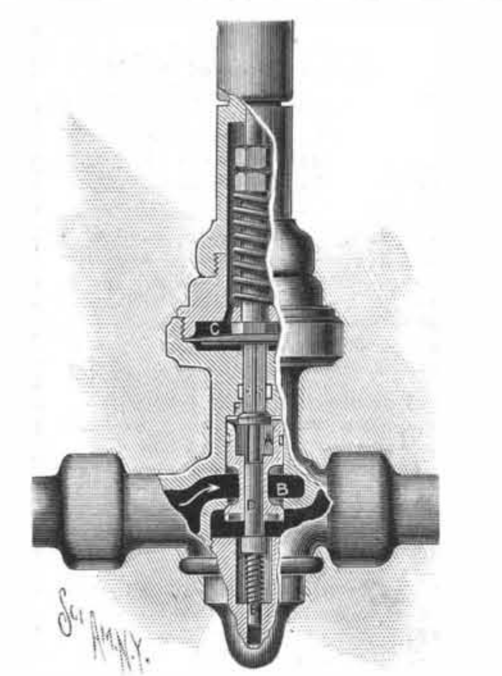
MOTOR.

Rendering Jewels Phosphorescent.

The collection of the Greek alchemists found in certain MSS. of the 13th and 15th centuries, in the National Library, describes processes used for the artificial coloration of factitious jewels, emeralds, carbuncles, and hyacinths. Stones were to be made luminous in the night by dyeing them with a mixture of copper rust and of the gall of the tortoise. A finer color was obtained by using the sea medusa instead of the tortoise. This coloration was, of course, not permanent, but it was easily reproduced.—*M. Berthelot.*

AN IMPROVED AIR PUMP GOVERNOR.

A governor especially adapted for the air pumps of locomotives, for preventing an excess of air pressure in the train pipes, and to cause an accumulation in the reservoir while the brakes are applied, is illustrated herewith, and has been patented by Mr. Edward G. Moore, of No. 505 Lombard Street, Wilmington, Del. The governor casing has a steam inlet pipe connected by a valve seat, B, with the steam outlet pipe leading to the pump. On the under side of the valve seat is held a valve with an upwardly extending hub carrying a piston, A, held to slide in an aperture not steam tight in an extension of the governor casing, so that steam may leak into the space above the piston. The valve and its hub are held to slide centrally on a spindle, D, having its bearing at the lower end in a nut, E, there being a coiled spring around the lower end of the spindle, while on its upper end rests a stem supporting the valve, F, held on a valve seat in an aperture leading to a space in the upper part of the governor casing. The valve, F, has upwardly extending wings, on the top of which rests a disk supporting a diaphragm, C, the diaphragm being held in place on the disk by a nut screwing on the lower end of a stem, around which is a coiled spring, one end resting in the bottom of the opening and the other end against a nut screwing on the stem near its upper end. The spring which holds the diaphragm in its upper position is set to a normal tension of say about seventy pounds, the diaphragm being forced downward when the pressure exceeds this amount, and imparting a sliding motion to the valve, F, allowing the steam on the upper side of the valve to escape through the waste pipe, and cutting off the steam supply from the pump. When the pressure in the train pipes is diminished, the diaphragm is restored to its former position, and a passage is opened for the steam through the inlet to the outlet and to the pump, until the air pressure is again restored to the required limit. By this device also the speed of the pump is limited and its wear reduced.



MOORE'S AIR PUMP GOVERNOR.