THE IMPROVED INDUCTION COIL

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The Improved Induction Coil by Henry M. Noad

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HENRY M. NOAD

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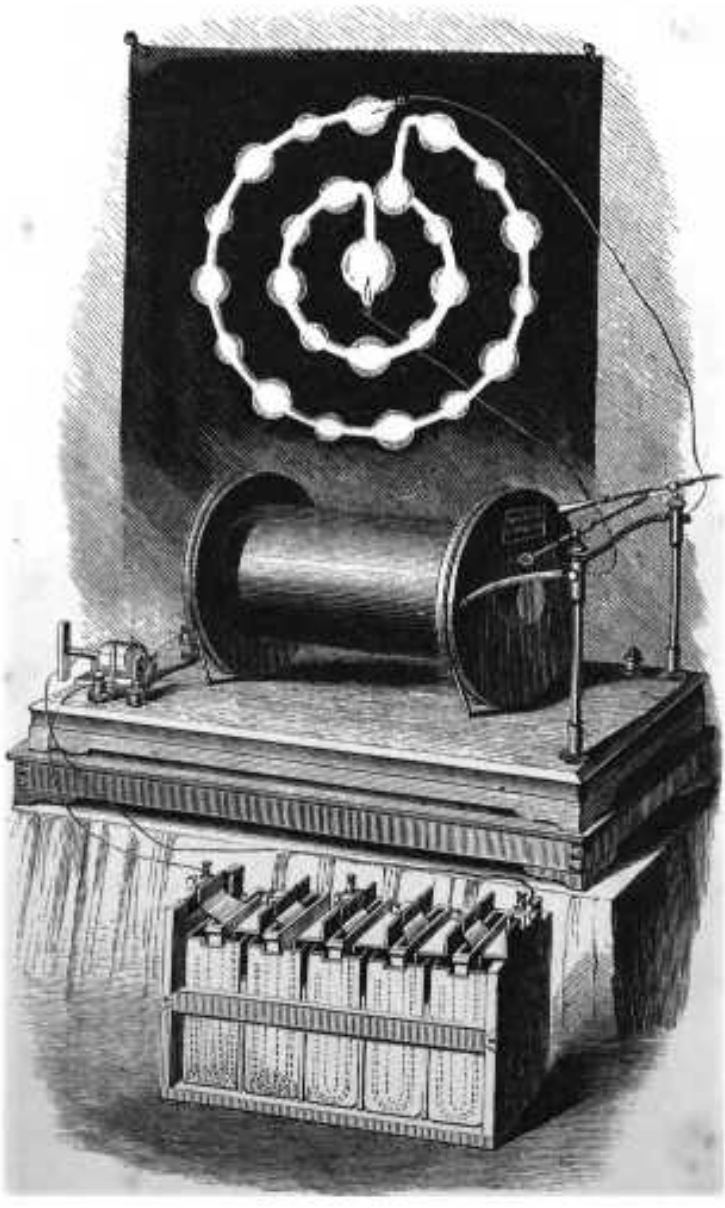
Frontispiece.



THE

Improved Induction Coil;

BEING

A POPULAR EXPLANATION

OF THE

ELECTRICAL PRINCIPLES

ON WHICH IT IS CONSTRUCTED.

WITH

THE DESCRIPTION OF A SERIES OF BEAUTIFUL AND INSTRUCTIVE EXPERIMENTS,

ILLUSTRATIVE OF

The Phenomena of the Induced Current.

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THE

IMPROVED INDUCTION COIL.

1.—Discovery of Electro-Magnetism.

In the year 1820, Professor Oersted, of Copenhagen, announced his famous discovery of the reciprocal force exerted between magnetic bars and wires uniting the opposite terminals of a voltaic battery, and thus laid the foundation of a new science — that of Electro-Magnetism. The discovery of the Danish philosopher was thus simply stated :—When a properly-balanced magnetic needle is placed in its natural position in the magnetic meridian, immediately under, and parallel to, a wire along which a current of voltaic electricity is passing, that end of the needle which is situated next to the negative side of the battery immediately moves to the *west;* if the needle is placed parallel to and over the wire, the same pole moves to the *east.* When the uniting wire is situated in the same horizontal plane as that in which the needle moves, no declination takes place, but the needle is inclined, so that the pole next to the negative end of the wire is depressed when the wire is situated on the west side, and elevated when situated on the east side. To assist the memory in retaining the directions of these deviations, Ampere devised the following formula :—"Let any one identify himself with the current, or let him suppose himself

lying in the direction of the positive current, his head representing the copper and his feet the zinc plate, and looking at the needle; its *north* pole will always move towards his right hand."

2.—Electro-Magnetic Rotation.

Reasoning on the fact that this action of a conducting wire on a magnet is not a directly attractive or a repulsive one, Faraday was led to the conclusion that if the action of the voltaic current could be confined to one pole of the magnet, that pole ought, under proper conditions, to rotate round the wire; and conversely, if the magnet were fixed and the conducting wire moveable, the wire ought to rotate round the magnetic pole; both of these phenomena he realised, and described the apparatus for exhibiting them in the "Quarterly Journal of Science," Vol. XII., p. 283 (January, 1822). Ampere subsequently caused a magnet to rotate round its own axis; and Barlow devised an ingenious apparatus for exhibiting the rotation of a conducting body round its axis.

3.—The Galvanometer.

Shortly after the discovery of Oersted, Schweigger, a German physicist, applied it to the construction of an apparatus for indicating the direction and measuring the intensity of voltaic currents. This instrument is called the multiplier or rheometer, or more popularly the galvanometer. In its original form it consisted of a rectangular coil of silk or cotton-covered copper wire, in the centre of which was suspended, on a pivot, a magnetic needle, and a card graduated into 360 degs.; the instrument being so placed that the needle lies parallel to the coil; on causing a current of electricity to circulate through the latter, the needle becomes

violently affected, even by very feeble currents, it being obvious, from a consideration of Oersted's fundamental law, that the needle, being placed between the two horizontal branches of the conducting wire, will be impelled in the same direction by the current traversing the wire above and below it. A great improvement was subsequently made in the instrument by Cumming and Nobili, who applied the astatic needle to the multiplier, thereby greatly increasing its sensibility, by annulling the directive action of the earth on the needle. There appears to be scarcely any limit to the sensibility which the galvanometer may be made to attain; as far as experiment has yet gone, it increases in delicacy in proportion to the length, purity, and insulation of the copper wire composing the coil. Du Bois-Reymond constructed, for his researches on the currents of electricity existing in animal structures, a multiplier, the length of which was 16,752 feet long, and passed round the frame 24,160 times; the sensibility of this instrument is almost incredible. The galvanometer is an indispensable instrument to those engaged in electrical researches.

4.—Electro-dynamics.

When two wires are traversed simultaneously by an electrical current, attractions or repulsions ensue, similar to those which take place between the poles of two magnets. If the currents are moving in the same direction in the two wires, they mutually attract; if in a contrary direction, they mutually repel. This discovery we owe to Ampere, and the discussion of the phenomena to which it gave rise constitutes the science of electro-dynamics. The analogy between wires conducting electricity and magnets is strikingly illustrated by turning the wires corkscrew fashion, making them helices. A helix has, indeed, all the properties of a

magnet, but the nature of the pole at either end will depend on the direction of the turns of the helix; if these be from left to right, then the extremity at which the current enters will have the magnetic properties of a north pole; but if the helix be a left-handed one, then the extremity at which the current enters will have the properties of a south pole, and that at which it goes out those of a north pole. The analogy extends to fracture. If a magnetic bar be broken in two, each piece is a perfect magnet, and the fractured parts have opposite poles; so it is with a helix, which, if divided in the middle, exhibits attraction between the fractured ends. If a helix be suspended vertically and loosely, its upper end being held by a binding screw, and its lower end dipping into mercury; and if a voltaic current be passed along it whilst thus suspended, there will be mutual attraction manifested between the coils, and the helix will be contracted.

5.—Ampere's Theory of Magnetism.

On the analogy which exists between helices and magnets Ampere founded his theory of magnetism. According to this theory, the phenomena of magnetism depend on voltaic currents circulating round the molecules of the magnetic bodies. In their unexcited state these molecular currents move in all directions, and thus neutralise one another; but when the bar becomes a magnet, the currents move parallel to each other, and in the same direction, and the effect produced is that of a uniform current moving corkscrew fashion round the bar, which thus becomes in effect a helix, and the attractions and repulsions of the magnet are consequences of the actions of the currents on each other. In applying this theory to the explanation of the phenomena of terrestrial magnetism, it is necessary to suppose the incessant circulation of electrical currents round the globe

from east to west perpendicular to the magnetic meridian.

6.—Magnetism excited by Electricity.

A consideration of the influence exerted by electrical currents on magnets, leads naturally to the conclusion that the neutral condition of bodies susceptible of magnetism would be disturbed by an electrical current, and that they would become magnetic, and the fact is easily verified by plunging the wire uniting the opposite poles of a voltaic battery into iron filings, which attach themselves to the wire, and remain adhering to it as long as the current continues to circulate, but drop off the moment the circuit is interrupted; filings of copper or tin exhibit no such action. The magnetising power of electricity is also illustrated by winding a silk or cotton-covered copper wire round a glass tube enclosing an unmagnetised steel needle and connecting the ends of the helix with the terminal plates of the voltaic battery; the needle becomes magnetised to saturation even by a momentary passage of the current through the helix; the magnetisation of the needle also takes place if, instead of passing the current from a voltaic battery along the helix, a Leyden phial be discharged through it, an interesting experiment, as proving the magnetising power of ordinary (statical) as well as of voltaic (dynamical) electricity. The sense in which the needle will be magnetised will depend on the nature of the helix; if it be a right-handed one, as—

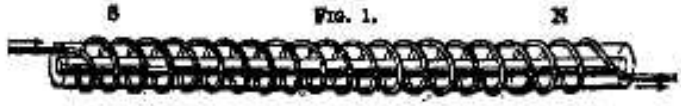

Fig. 1.

the north pole of the needle will be formed towards