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Induced Current Electricity

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active and properly directed and controlled."

The brief space alloted to this article does not permit a discussion of this very important health ideal. The American public seems woefully ignorant of the principles of sex hygiene. Millions of lives are ruined annually thru ignorance.

Most of us think we are healthy, but the majority of us never have and never will know the joys of complete health. The real test for us at present concerns what we are doing to see that the schools of the present day turn out healthy students. H. Earl Rath.

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INDUCED CURRENT ELECTRICITY

In the May Number of the Science Bulletin, the writer gave a brief outline of the historical development of our present knowledge of the magnetic properties of an electric current. In tracing this development from an experimental point of view, a brief statement was made of the contributions of each of the following renowned scientists: Oersted, Arago, Ampere, Faraday and Henry. In this article of the May Number no reference was made to current induction as one of the magnetic effects of an electric current.

It is no exaggeration to say that this age of electricity owes its material greatness almost wholly to the discovery of the law of current induction. Michael Faraday of England and Joseph Henry of our own country were contemporaneous discoverers of this principle of induction. It is true that the discovery of current induction is generally credited to Faraday in our texts on physics since he was the first to publish the facts of the phenomena involved. However, every high school teacher should stress the fact that Joseph Henry, a professor of Princeton University, discovered the principle of current induction one year before Faraday published the results of his work. Faraday published a description of his experiments in 1831. The experimental records of Joseph Henry proclaim the fact that Henry made the discovery of current induction in 1830 but failed to publish it to the world. The discovery of the law of current induction was hailed by Tyndail, a contemporary of Faraday, as the greatest experimental result ever attained up to that time in the history of the modern world.

We will consider briefly now the two main experiments performed by Faraday which led to the discovery of the principle of current induction. In one of these experiments Faraday used a closed iron ring, Fig. 1. Two separate coils A and B were wrapped upon the ring, one on each side as illustrated. The ends of coil A were connected to a battery of ten cells. The ends of coil B were connected to the galvanoscope, G, consisting of a coil of wire enclosing a suspended magnetic needle. Faraday found that at the instant the battery circuit was closed, there was an abrupt deflection of the needle of the galvanoscope, showing that a current was produced in the coil surrounding it. Again when the key of the battery circuit was opened there was another deflection of the magnetic needle but in the opposite direction. Faraday correctly inferred that the currents induced in coil B which passed also through the galvanoscope were due to the magnetism set up in the iron ring by the battery current passing through coil A. Faraday was also quick to see that these currents in coil B were momentary, lasting only as long as the duration of the change in the magnetic field of the ring. When the battery key is closed the magnetic field rises quickly from zero value to a maximum. When the battery key is opened the magnetism of the ring falls from a maximum almost to zero value.

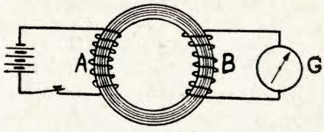

Fig. 1

A second experiment performed by Faraday is illustrated in Figure 2.

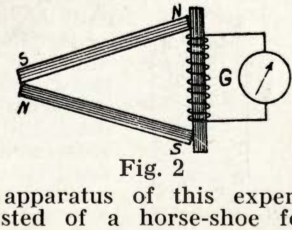

Fig. 2

The apparatus of this experiment consisted of a horse-shoe formed permanent magnet and its armature bar. A coil of insulated wire was wrapped around the central portion of the armature bar. The ends of the coil were connected to the galvanoscope G, forming a circuit. The method of the experiment was simple. It consisted merely in placing the armature bar in contact with the poles of the magnet and then pulling it off. When the armature was placed in sudden contact with the poles of the magnet, the needle of the galvanoscope was deflected in one direction and when the armature bar was pulled off the needle was deflected in the opposite direction. As in the first experiment the currents flowing through the galvanoscope were momentary, lasting only as long as the magnetic field in the armature bar was in a state of change.

This second experiment was performed by Joseph Henry one year before Faraday's achievement. Joseph Henry used an electro-magnet of horse-shoe form with the result that his induced currents were quite intense. In view of the fact that Henry made his discovery independently in 1830, one year before Faraday's accomplishment, it seems only fitting that his name should be linked with that of Faraday in the discussion of current induction in our high schools. There are no two men in the history of science whose lives are more inspirational to the aspiring student than those of Faraday and Henry.

The usual method of demonstrating the phenomena of current induction in the classroom is illustrated in figures 3 and 4. The apparatus in fig. 3 consists of two coils of insulated conducting wire wrapped upon hollow wooden spools. These coils are usually designated as a primary coil and a secondary coil. The secondary coil B is connected to a sensitive galvanometer G. Fig. 3.

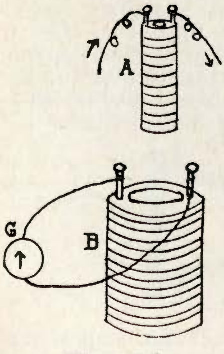

Figure 3

The primary coil, A should be connected to two good dry cells. When the primary coil is thrust down into the secondary coil a momentary current is induced in the secondary coil causing a deflection of the galvanometer. When the primary coil is drawn up out of the secondary coil, a momentary current is again induced in the secondary causing an opposite deflection of the galvanometer. The currents induced and the deflections produced will be many times stronger when the primary coil carries a soft iron core.

A duplication of Faraday's first experiment can be obtained by means of these coils in the following manner. Place the primary into the secondary and let it rest. When the key to the battery circuit connected with primary is suddenly closed a violent deflection of the galvanometer will take place. When the key is opened another deflection of the galvanometer will occur opposite in direction to the first.

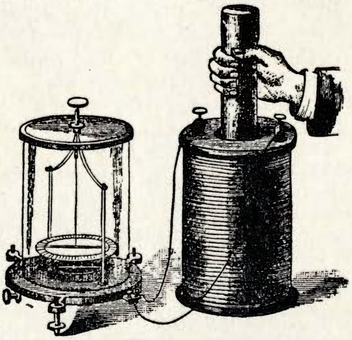

Figure 4

Another of Faraday's experiments is illustrated in Fig. 4. In this experiment we have a clear demonstration of the fact that the magnetic field is the cause of the current induction. In this demonstration, one of the pole ends of a steel bar magnet is thrust quickly into the secondary coil causing a deflection of the galvanometer. When the pole end is drawn out a second deflection opposite to the first occurs. As usual, the currents are momentary lasting only as long as the number of lines of the magnetic field threading the secondary coil are increasing or decreasing. In performing this last experiment one cannot help observing that the intensity of the current induced varies with the rapidity with which the magnet is thrust into the coil or taken out of it. When the pole of the bar magnet is thrust into the coil quickly the deflection of the galvanometer is much more violent than when the motion is slow.

Finally, the discovery of Faraday made clear the fact that an induced current can be produced in a closed coil of wire by increasing or decreasing the number of lines of magnetic force threading the coil. We know also from Ohm's law that the magnitude of an electric current produced in a coil, where the resistence is constant, varies directly as its electro-motive force. We know also now that what really is induced in the Faraday experiments is electric pressure, or electro-motive force. Faraday's discovery in more specific terms means that the E. M. F. of an induced current varies directly as the rate of change of the number of magnetic lines of force threading the circuit of the coil affected. When this rate equals 10,000,000 lines of magnetic force per second there will be just one volt of E. M. F. induced.

The principle of current induction is no doubt the most important of all the principles of current electricity and every teacher should make a special effort to present it clearly to a class. The apparatus represented in figure 3 consisting of a primary and a secondary coil is listed at $4.50 in the catalog of the Central Scientific Company of Chicago, Ill. A galvanometer, sufficiently sensitive for these experiments would cost about $10.00. The writer will continue this discussion in a later article.

L. Begeman.

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SUGGESTIONS FOR THE TEACHING COLLECTION IN BIOLOGY

There is nothing in the Biology course which can take the place of carefullly planned and directed field work. The students should be encouraged to observe carefully and accurately for themselves and be given every opportunity to become acquainted with living things in their natural surroundings. The aquarium and terrarium can be made to supply much interesting material for study and should be in the laboratory wherever possible. In addition to these devices there are collections which can be prepared at small cost and which will supplement the field work and provide material for review or more extended study than is possible in the field. The students can assist in building up and maintaining these collections in connection with their outdoor activities and will benefit by the repeated contact with the materials. The collections can be started on a modest scale and additions can be made from year to year as the seasons permit.

An herbarium of common tree leaves can be built up with very little trouble and expense. The leaves, which should be carefully selected for type, are first dried carefully between blotters or paper towelling or newspapers under sufficient weight to press them flat and smooth. They should be changed to fresh blotters or papers frequently to hasten drying and to preserve the natural color as much as possible. After the leaves are thoroughly dried they can be kept in shallow boxes or envelopes of proper size and are available for use at any time. Since the leaves are very brittle when dry they will not stand much handling unless mounted and covered in some way. Riker mounts can be secured from any supply house and are very convenient and durable but are quite expensive if the collection is very large. Very durable mounts can be made by gluing the leaves to stiff, white cardboard and then covering the leaf with a piece of glass cut to proper size. The edges are then covered with tirro tape and with reasonable care the mount can be used for years. The leaves may be mounted separately but large sized mounts (12x16 inches) make it possible to place together for comparison leaves of trees from a large group. Blueprints of leaves are quite satisfactory for recognition work and when mounted on large cardboards permit the display of leaves from a whole family. Prints of leaves made with mimeograph ink on regular mimeograph paper show nearly all the details which are necessary for the recognition of leaves.

A collection of the fruits of different plants can be started in the fall or winter and continued through