Science Bulletin

Volume 3 | Number 9 Article 12

5-1931

The Magnetic Effect of an Electric Current

L. Begeman
Iowa State Teachers College

tudes, middle latitudes could be introduced. Of course, these terms will not in themselves give the children the correct ideas of climatic conditions in the various zones but at least they do not hamper by implication.

This investigation might with profit be carried much further if those interested would give the test to their students and send in the results.

Alison E. Aitchison.

o

THE MAGNETIC EFFECT OF AN ELECTRIC CURRENT

From a practical point of view, the magnetic property of an electric current is of great value to man. It is this property that is utilized in the dynamo for the generation of large currents of electricity. It is also this property that enables man to utilize the driving power of the electric motor in the manufacturing industries.

It may be interesting to know that the magnetic property of an electric current was not discovered until twenty years after Volta invented the electric pile, by means of which the first real current of electricity was experimentally produced. It was in the year 1819 that Christian Oersted, a professor in the University of Copenhagen, first demonstrated that an electric current running through a conductor held over and parallel to a magnetic needle would cause the needle to rotate from a north and south position into an east and west position. A description of this experiment is found illustrated in most high school texts on physics. The experiment is readily duplicated in a simple way by bringing a magnetic compass (fig. 1) inside a coil of copper wire through which the current from a single dry cell is passing. When the current is passing from north to south over the compass needle, the north-seeking end of the needle will deflect to the east. As soon as the current is reversed the north-seeking end will deflect to the west. The right-hand rule for determining the direction of deflection of the needle in this experiment was first stated by Ampere.

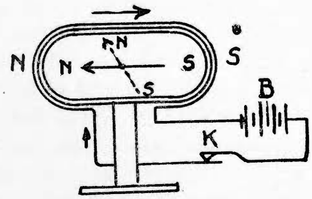

Fig. 1

In important electrical work it is often necessary to know the direction of a current in a wire when the generator, battery, or dynamo, is not at hand. Oersted's experiment gives one a sure method of solving the problem. All one needs to do is to turn a part of the conductor carrying the current into a north and south direction and bring a magnetic compass under it. If the north-seeking end of the compass needle turns to the east, the current is flowing from north to south. If the north-seeking end turns west the current is flowing in the contrary direction. Oersted showed that the magnetic effect of an electric current upon a magnetic needle is unhindered when glass, wood, stone and various other materials are brought between them. Oersted's experiment created much enthusiasm throughout the scientific world. It was repeated everywhere in scientific circles and created much zeal for further research on the subject.

A year after Oersted's discovery, Arago, a noted Parisian astronomer and physicist, found experimentally that a conductor carrying an electric current would attract iron filings. (Figure 2).

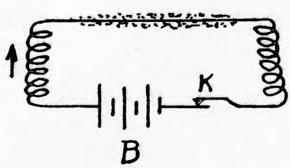

Fig. 2

He was the first to state definitely that an electric current is a magnet. In 1822 Sir Humphrey Davy, the noted English scientist, found that the filings attracted by a conductor carrying an electric current arranged themselves in circles. This was the first hint of the fact that the magnetic field of an electric current (figure 3) consists of circular lines of force. The simple apparatus illustrated here consists of a piece of cardboard firmly fixed in a horizontal position. A fixed copper wire passes perpendicularly through its center. When a current from two dry cells is sent through the wire, very fine iron filings sifted over the cardboard will arrange themselves in concentric circles around the wire when the cardboard is gently tapped.

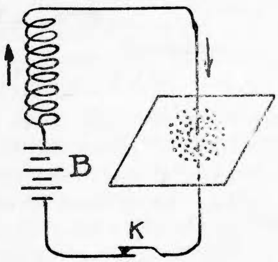

Fig. 3

Ampere was struck by the fact that the magnetic force of an electric current acted in a plane at right angles to the direction of the current. This led him to try to intensify the magnetic effect of a current upon a magnetic needle by winding the conducting wire into a coil. He found that the effect was greatly increased. By this experiment he laid the foundation for the electromagnet.

Ampere added another contribution to the knowledge of electro magnetism when he stated the laws of parallel currents. In figure 4 two parallel wires are strung side by side and are supposed to be free to move laterally either toward or away from each other. Ampere discovered that when the currents are flowing in the same directions in two such wires they attract and approach each other. Also, when the currents are flowing in opposite directions, the wires repel each other and move apart. He rightly observed that this mechanical attraction and repulsion of two such wires carrying currents is due to the interaction of the magnetic fields which surround the wires. A beautiful experiment illustrating the mechanical attraction of currents of electricity can be performed by means of a loosely wound coil of wire suspended perpendicularly from a support. The lower end of the coil should dip into a cup of mercury. When a current is sent through such a coil, it at once contracts in length due to the attracting force between its successive turns.

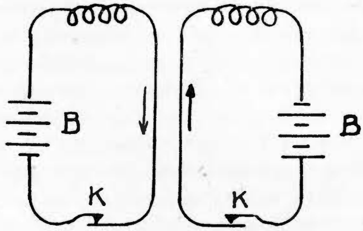

Fig. 4

The renowned Faraday, known as the foremost experimentalist of the nineteenth century, also contributed largely to the fundamental concepts of electromagnetism. He devised the experi-

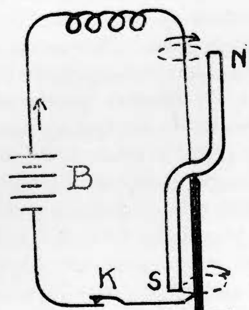

Figure 5

ment (fig. 5) which demonstrates that a magnet pivoted parallel to an electric conductor will rotate when a current is sent through the wire. When the magnet has its north-seeking pole at the top and the current is sent down the wire, the rotation will be clockwise to one looking downward. From this experiment we get the first suggestion of the modern electric motor. It will be impossible in this brief article to go into the more important work of Faraday pertaining to current induction, which led to the modern dynamo.

Both Ampere and Arago found by experiment that an elongated coil (fig. 6) when carrying a current possesses

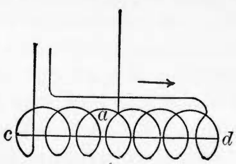

Figure 6

all the properties of a bar magnet. A coil of this kind is called a solenoid. When delicately suspended it will turn and take a north and south direction with reference to the earth's surface. It is evident that the solenoid is the simplest form of an electromagnet.

It was not until 1825 that William Sturgeon, a shoemaker of Lancashire, England, described the first real electromagnet, consisting of a solenoid with a soft iron core. Sturgeon's magnet could lift nine pounds, which was about twenty times its own weight. Sturgeon's description of his electromagnet created a tremendous amount of interest in scientific circles.

A student in general science or high school physics should be given the opportunity of constructing for himself a small electromagnet. Nothing will contribute more to his interest in the subject. Such a magnet can be made in a few minutes by simply wrapping about twenty turns of cotton-covered wire around a wrought iron bar about three inches long and one-fourth inch in diameter. The pole of a small electromagnet of this kind will pick up many more iron tacks than the pole of a large steel bar magnet.

The complete development of the electromagnet for practical uses must be credited to Joseph Henry, an American physicist. Henry was the first to use silk-wound insulated wire around his iron cores. In 1829 he constructed magnets with many layers of wire in their windings. These magnets were extremely powerful, lifting as much as fifty times their own weight. It was Henry also who first used the electromagnet for transmitting signals to a distance, thus laying the foundation for the telegraph, invented by Morse in 1837.

A more complete study of the history of electromagnetism and of the biographies of the scientists mentioned above would make an excellent project for a high school class in physics.

L. Begeman.

STIMULANTS

The state law requires the teaching of the effects of narcotics and stimulants. Most teachers would be glad to comply with the law if they were certain that they could present reliable information. The difficulty in the past has been that most of the information available was merely propaganda and not based on scientific fact. The tobacco companies have always been able to secure statements from people of prominence who were tobacco users to the effect that tobacco not only did them no harm but actually proved of value. Their statements were not based on scientific evidence, and many of them were undoubtedly purchased. On the other hand much of the "anti" literature has been just as ridiculous, unscientific, and untruthful. Boys have been