THE METHOD OF EXPLANATING THE ELECTROMAGNETIC INDUCTION PHENOMENON

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Abstract: We know that a large part of the consumption source of modern equipment and technologies is the electricity source. Most devices and technologies that work with electricity work on the basis of the law of electromagnetic induction. In addition, when obtaining electrical energy, the conversion of mechanical energy into electrical energy is carried out on the basis of Fvrvdey's law. It is important to explain to students the nature of the laws and regulations that occur in this process, and to develop skills in them. In connection with these, this article describes the scientific views of the authors on the description of the phenomenon of electromagnetic induction.

Key words: induction current, electric driving force, magnetic field, flux, voltage, electric current, magnetic flux, electromagnetic induction, charge flow, Lorentz force.

Intraduction

It is known that in today's developing world, electricity supply is very important. We use various technical technologies to facilitate our lifestyle and increase our work efficiency. At present, we use about 90 percent of the traditional sources of electricity, and the rest are alternative sources of energy. Conventional electricity generation and the operation of various techniques and technologies are mainly carried out at the expense of the phenomenon of electromagnetic induction. Let's look at the history of the origin of the phenomenon of electromagnetic induction. It all started with the creation of a magnetic field around Oersted's electric circuit when an electric current flows through it. M. Faraday, who was aware of this phenomenon, thought about getting an electric current due to the opposite magnetic field and carried out research. At this time, Ampere was also conducting research on the generation of electric current due to the magnetic field. But as a result of many years of research, Faraday managed to obtain an electric current due to the magnetic field. The inventor spent 10 years on this, and was often seen wandering the streets and parks of London, holding a permanent magnet and a coil in his hand, pondering the idea of generating electricity. At that time, Ampere and Faraday also performed the same experiment, but the galvanometer, which detects the presence of electric current, was placed in the next room because it was very sensitive to various external influences. Since Ampere performed all his experiments alone without partners, he could not observe the formation of an induction current when introducing a permanent magnet into the coil, because the device that records the formation of an electric current at that time was very sensitive to external influences, so he installed a galvanometer in the next room and could not observe the formation of the current. And Faraday did all the experiments together with Anderson as a team. Let's look at Faraday's experiments:

Method

If a closed circuit is formed by connecting a coil to a galvanometer, and a permanent magnet is introduced into the coil, we can see that an electric current is generated in the galvanometer when the magnetic field crosses the coil (Fig. 1).

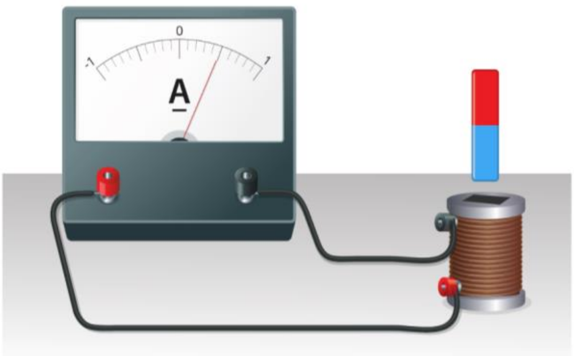

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Figure 1. Observing the phenomenon of electromagnetic induction.

The value of the induced current generated here is directly proportional to the strength of the acting magnetic field, the number of windings of the coil, and the magnitude of the magnetic current crossing the coil.

Electromagnetic induction current is generated by changing the contour area without introducing a permanent magnet into the coil (Fig. 2).

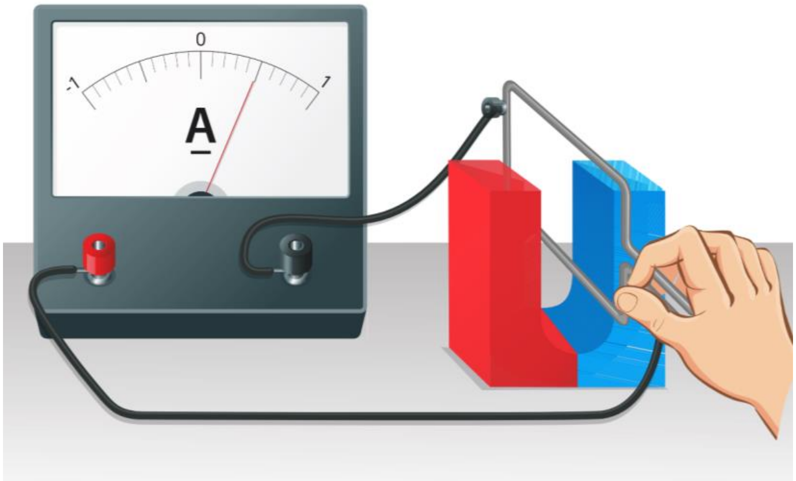

Figure 2. Formation of induction electric force.

If the location of the coil is changed in a constant magnetic field, the phenomenon of electromagnetic induction is observed and an induced current is created (Fig. 3).

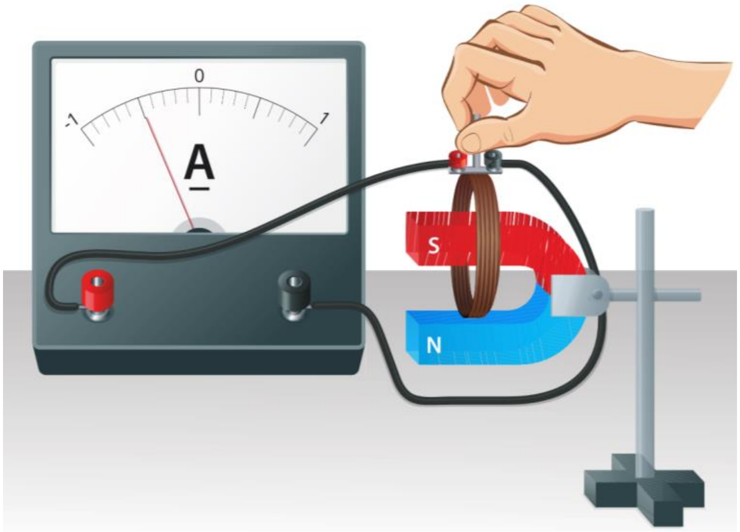

Figure 3. Generation of induction current.

When performing his experiments, Faraday puts forward the following theory, if a permanent magnet is applied to a coil, an induction current is generated, which means that it is not necessary to have a permanent magnet, instead, he sets himself the task of creating an induction current if another coil that creates a magnetic field is used instead, and conducts the following experiment [1-3]. If a coil is connected to a galvanometer to form a closed circuit, another coil is inserted into the coil and if we connect it to a DC power source, we can see that an induction current is generated in the first coil when the second coil is turned off by connecting the second coil to the current source (Fig. 4). He observed that induction current is formed when the first coil is connected to a constant power source and when it is inserted into the second coil [3-5].

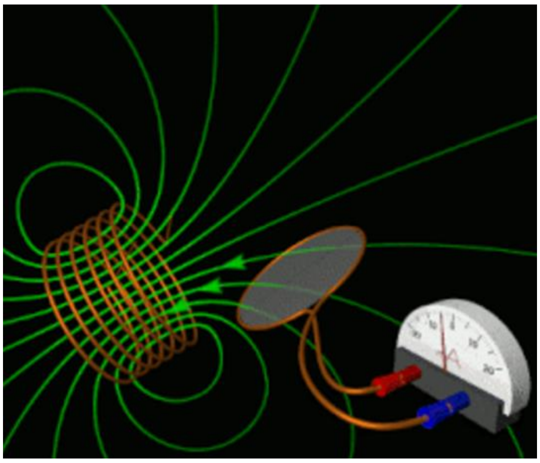

Figure 4. Faraday's experiment.

Following this phenomenon, the following question arises, what causes the generation of induced current? Is it the movement of the permanent magnet and the electromagnet that is inserted into the coil, or is there another reason? If we insert an electromagnet into the coil, connect the electromagnet to a direct current source through a rheostat and change the resistance of the rheostat, we can see the formation of an induced current (Fig. 5).

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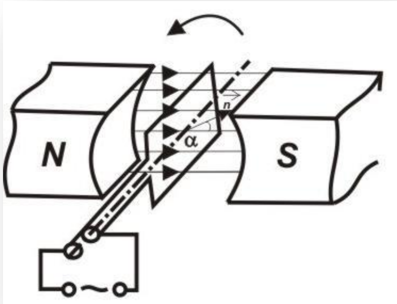

Figure 5. Implementation of Faraday's law.

In short, if a coil of variable size is brought closer to a non-moving permanent magnet, the coil of variable size is changed over the entire area, and by rotating the orientation of the coil relative to the magnetic field, an induction current is generated due to the change in the angle of the magnetic field with respect to the normal [6-8]. Magnetic field induction, the change of the angle of the magnetic induction relative to the field normal, the surface of the field affected by the magnetic induction, represents the magnetic field current.

$$\Phi = \vec{B} S cos\alpha \qquad (1)$$

The change of the magnetic flux over time represents the value of the induced current generated due to the electromagnetic induction phenomenon.

$$\varepsilon_{ind} = \frac{d\Phi}{dt} \qquad (2)$$

The direction of the generated induction current is determined based on the Lentz rule. The direction of the generated induced current is directed in such a way that the magnetic field of the generated induced current opposes the change in the value of the generated magnetic field. In that case, 2 expressions appear as follows [9-11].

$$\varepsilon_{ind} = -\frac{d\Phi}{dt} \qquad (3)$$

If the magnetic field flux is passing through the surface bounded by the surface, the magnetic flux is expressed as

$$\Phi = \int_S \vec{B} S cos\alpha \qquad (4)$$

If an alternating current is applied to the coil, the magnetic field generated is determined by the following expression.

$$\varepsilon_{ind} = -N\frac{d\Phi}{dt} = -\frac{d\psi}{dt} \qquad (5)$$

Here $d\psi$ is the induced emf developed in the coil.

If the circuit is fixed and an alternating current is applied to the circuit, the expression (5) represents part of Faraday's law. Faraday's law for this process is calculated using the following equation written by Maxwell [12-13].

$$rot\vec{E} = -\frac{\partial \vec{B}}{\partial t} \qquad (6)$$

The integral form of the equation is written as follows.

$$\oint_{\partial S} \vec{E} d\vec{l} = -\frac{\partial}{\partial t}\int_S \vec{B} d\vec{S} \qquad (7)$$

Conclusion

With the help of these equations, it is possible to accurately calculate the values of the induction electric force that occurs during the arbitrary generation of the electromagnetic induction phenomenon. The electromotive force generated in Faraday's experiments based on two coils proves that the movement of charge carriers in the first coil is generated by the Lorentz force.

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