Maxwell's Equations and the Permanent Magnet

Wise Eye OverUnity **may, 2025** **Serge Rakarsky**

Friends, this is such an interesting topic about the basic equations of electrodynamics, one of which can be written as induction and change our idea of what happens in an electrical circuit.

2.5.2. Maxwell's equation

J. K. Maxwell wrote down his ingenious equations in 1865 Maxwell's equations are the fundamental equations of electrodynamics that describe electromagnetic phenomena in any medium. They summarize the experimental and theoretical works of physicists of the first half of the XIX century. and, above all, the research of M. Faraday. Maxwell formulated the basic laws of electrodynamics in the form of four equations, which are presented in an integral form, as in the simplest and most visual.

Maxwell's first equation relies on **the Biot-Savart-Laplace** law and the concept of displacement current. Let us select in a conductor in which there is an alternating current, an arbitrary site S, bounded by a l circuit Then

$$\int_l H_l \cdot dl = \int_S (j_n + \frac{\partial D_n}{\partial t}) dS, \qquad (2.88)$$

where H_l is the projection of the magnetic field intensity vector in the direction tangent to the circuit l at a given point, j_n is the component of the conduction current density normal to the selected site, D_n and is the component of the electrical induction vector normal to the site. The partial derivative of dD/dt is used here to account for the fact that D is dependent on both time and space. The displacement current only occurs when D changes over time. This equation shows that the magnetic field is vortex and that it occurs regardless of the presence of permanent magnets. The occurrence of a magnetic field is due to two factors: the movement of electric charges (conduction current) and a change in time of the electric field (displacement current).

The second equation reflects Faraday's law of electromagnetic induction:

$$\varepsilon_i = -\frac{\partial \Phi}{\partial t} = -\frac{\partial}{\partial t}\int_S B dS = -\frac{\partial}{\partial t}\int_S B_n dS.$$

EMF, as you know, is equal to the work of extraneous forces to move a unit charge, that is $\int_l E_l dl$, , therefore we will have

$$\int_l E_l dl = -\partial\Phi/\partial t \rightarrow \int_l E_l dl = -\int_S (\partial \boldsymbol{B}_n / \partial t) dS, \tag{2.89}$$

where E_l is the projection of the electric field strength vector on the direction tangent to the circuit at a given point, B_n is the normal component of the magnetic induction vector to the surface. From this equation it can be seen that in addition to the electrostatic field, there is an electric field in nature, the source of which is an alternating magnetic field. Any change in the electric field causes the appearance of an alternating magnetic field, the lines of intensity of which are closed and cover the lines of the electric field (the first equation); Any change in the magnetic field causes the appearance of an alternating electric field, the lines of intensity of which are closed and cover the magnetic field lines (the second equation).

Maxwell's third equation shows that the source of the electric field is electric charges:

$$\int_S D_n dS = q.$$

The left side of this equation is the flux of the electric field induction vector through a closed surface of area 5.

The fourth equation reflects the fact that there are no magnetic charges. The total flux of the magnetic induction vector **B** through a closed surface with area S is zero:

$$\int_S B_n dS = 0.$$

The above Maxwell equations do not take into account the structure of matter and the interaction of the electromagnetic field with particles of matter. The influence of the medium on the electromagnetic field is given by its electrical conductivity, as well as dielectric ε and magnetic μ constant. Therefore, three more equations must be added to Maxwell's equations, which are called material:

$$\boldsymbol{D} = \varepsilon\varepsilon_0 \boldsymbol{E},$$
$$\boldsymbol{B} = \mu\mu_0 \boldsymbol{H},$$
$$\boldsymbol{j} = \sigma \boldsymbol{E}.$$

Maxwell's equations describe a huge range of phenomena (electrodynamics, optics, electrical engineering, radio engineering, astrophysics, plasma physics, etc.). Maxwell's theory not only explained already known facts, but also predicted new and important phenomena. Completely new in this theory was Maxwell's assumption about the magnetic fields of displacement currents. Based on this assumption, Maxwell predicted the existence of electromagnetic waves, that is, an alternating electromagnetic field that propagates in space at a certain speed. The theoretical study of the properties of electromagnetic waves subsequently led Maxwell to the creation of the electromagnetic theory of light. Later, the experimental managed to obtain electromagnetic waves and conduct experiments that brilliantly confirmed the electromagnetic theory of light, and with it the entire theory of Maxwell.

***Maxwell's first level** of**view from AI** :*

Maxwell's equations, including Ampère's law, describe electromagnetic fields and their relationship to electric charges and currents. Ampère's law in integrated form states:

$$\oint B\, dl = \mu_0 (I + \varepsilon_0\, d\Phi E/dt),$$

*where **B** is the induction of the magnetic field, dl is the element of the circuit length, μ_0 is the magnetic constant, I is the amperage, ε_0 is the electric constant,?*

What is the essence of Ampère's law: Ampère's law predicts that the magnetic field is created by electric currents and alternating electric fields (displacement current). It connects the magnetic field lines that form a closed circuit with currents that flow through the area bounded by that circuit.

Maxwell's changes: Initially, Ampère's law did not take into account changes in the electric field over time. Maxwell made an amendment by introducing the concept of "displacement current", which takes into account the change in the electric field in capacitors. This displacement current makes Ampère's law more complete and accurate by describing the magnetic fields that occur when the electric field changes.

Short and clear: Ampère's law in Maxwell's equations states that the magnetic field is generated by changing currents and electric fields. This means that if the current flows through a conductor or the electric field changes (for example, in a capacitor), then a magnetic field is created in its vicinity. Maxwell extended Ampère's law to include in it the concept of " displacement current " , which makes it more complete and allows describing the magnetic fields that during changes in the electric field.

Consider the magnetic field that forms around a conductor with current. The Biot-Savard law was published in 1820 (11 years before the discovery of EMI by Faraday in 1831), Maxwell's equations were first published in 1861, so consider this law:

The magnetic field around a rectilinear conductor according to the Bio-Savard law:

B = kI / 2r , the unit of emiu Tesla, (magnetic induction)

H = I / 2πr unit of emiu Amperes per meter; (mannitol tension)

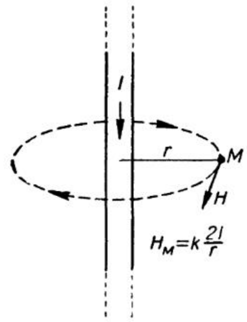


Fig. 1

where B is magnetic induction at point M at a distance r from a rectilinear conductor with current I (Fig. 1); k is the coefficient of proportionality, the magnitude and dimensionality of which depend on the choice of the system of physical quantities, r is the radius vector. In the International System of Quantities (ISQ), k = μ0 / 4π, where μ0 is the magnetic constant. In the Gaussian system, k = 1 / s, where c is the speed of light.

The Biot-Savart-Laplace law is a fundamental law of electromagnetism that describes the relationship between electric current and the magnetic field it creates. It allows you to calculate the characteristics of the magnetic field for conductors of arbitrary configuration. The law states that magnetic induction at a point in space is proportional to the magnitude of the current and inversely proportional to the square of the distance from the conductor. This law is also analogous to Coulomb's law in electrostatics, where the principle of superposition is valid for magnetic fields.

Ampère's law is the law of interaction of direct currents, established by André-Marie Ampère in 1820. From Ampère's law, it follows that parallel conductors with direct currents that flow in one direction are attracted, and repelled in the opposite direction. Ampère's law is also called the law that determines the force with which a magnetic field acts on a small segment of a conductor with current (the modern formula is below).

$$F_{12} = \frac{\mu_0}{4\pi}\frac{2I_1 I_2}{r}\cdot L.$$

The law of interaction of two elementary electric currents, known as Ampère's law, was actually later proposed by Hermann Grassmann (that is, it would be more correct to call it Grassmann's law).

$$\mathrm{d}^2\mathbf{F}_{12} = \frac{\mu_0 I_1 I_2}{4\pi}\frac{(\mathbf{r}_1-\mathbf{r}_2)}{|\mathbf{r}_1-\mathbf{r}_2|^3}\left(2(\mathrm{d}\mathbf{r}_1,\mathrm{d}\mathbf{r}_2) - 3\frac{(\mathbf{r}_1-\mathbf{r}_2,\mathrm{d}\mathbf{r}_1)(\mathbf{r}_1-\mathbf{r}_2,\mathrm{d}\mathbf{r}_2)}{|\mathbf{r}_1-\mathbf{r}_2|^2}\right)$$

Maxwell proposed the most general form of the law of interaction of two elementary conductors with current, which has a coefficient k (it cannot be determined without some assumptions based on experiments in which an active current forms a closed circuit)[3]:

$$d^2\mathbf{F}_{12} = \frac{1}{2}\frac{\mu_0 I_1 I_2}{4\pi}\left((3-k)\frac{(\mathbf{r}_1-\mathbf{r}_2)(d\mathbf{r}_1, d\mathbf{r}_2)}{|\mathbf{r}_1-\mathbf{r}_2|^3} - 3(1-k)\frac{(\mathbf{r}_1-\mathbf{r}_2)(\mathbf{r}_1-\mathbf{r}_2, d\mathbf{r}_1)(\mathbf{r}_1-\mathbf{r}_2, d\mathbf{r}_2)}{|\mathbf{r}_1-\mathbf{r}_2|^5} - \right.$$
$$\left. - (1+k)\frac{d\mathbf{r}_1(\mathbf{r}_1-\mathbf{r}_2, d\mathbf{r}_2)}{|\mathbf{r}_1-\mathbf{r}_2|^3} - (1+k)\frac{d\mathbf{r}_2(\mathbf{r}_1-\mathbf{r}_2, d\mathbf{r}_1)}{|\mathbf{r}_1-\mathbf{r}_2|^3} \right)$$

In his own theory, Ampère took k = −1, Gauss took k = +1, like Grassmann and Clausius. In non-etheric electron theories, Weber accepted k = −1 and Riemann accepted k = +1. Ritz left k = +1uncertain in his theory.

For the force of interaction of two closed circuits C1 and C2 with k= +1, a standard expression k= +1 is obtained.

But what we are seeing is that the occurrence of magnetic induction around a conductor with current is established by Biot Savard Laplace's law . Ampère's law (and similar interpretations) determine the action of two conductors with current and with what force they do it. Previously, such a relationship was established for electrical charges. **Coulomb's law** is one of the basic laws of electrostatics, which determines the magnitude and direction of the force of interaction between two stationary[1] point charges. Experimentally with satisfactory precision, the law was first established by Henry Cavendish in 1773. He used the spherical capacitor method, but did not publish his results. In 1785, the law was established by Charles Coulomb using special torsional balances. Ampère's law (for two conductors with current) is identical to Coulomb's Law (for two electric charges).

Coulomb's Law: $F_{12} = k \cdot \frac{q_1 \cdot q_2}{r_{12}^2}$ Ampere's Law: $F_{12} = \frac{\mu_0}{4\pi}\frac{2I_1 I_2}{r} \cdot L.$

The reason why the effect of magnetic induction occurs has not been disclosed. The movement of electric charges, which prompts the manifestation of the phenomenon of magnetic induction, is a very uncertain interpretation. Where did the interpretation of the current separate from the voltage come from. This interpretation was introduced by Georg Ohm. In 1825-1827, he conducted experiments with an EMF source in the form of a thermocouple, a galvanometer and a metal wire. He discovered that the current through the wire in his experiments was well described by a linear law based on three parameters, and in 1827 he published the results in the form of the work Die galvanische Kette, mathematisch bearbeitet. Georg Ohm's experiments were carried out before the birth of Kirchhoff's theory of circuits and rules (1845-1847), the theory of the electromagnetic field (1864), Maxwell's equations

(1861-1884) and Drude's theory (1900). More precisely, Ohm's law states that the current strength in the conductor between two points (Fig. 1) is directly proportional to the voltage at these two points. By introducing the constant of proportionality - resistance [R], you can come to the usual mathematical equation, which shows this dependence I = U / R. Modern physics explains the occurrence of current by the movement of electric charges.

The strength of an electric current (**current** strength or simply **current**) is a quantitative characteristic of the electric current in a conductor, scalar value **I = Δq / Δt**, which corresponds to the amount of charge (**Δq**) passing through the cross-section of the conductor in time (**Δt**) divided by this time period. The unit of current strength is taken as the current at which segments of parallel conductors 1 m long, located at a distance of 1 m from each other, interact with a force of $2 \cdot 10^{-7}$ N. Current strength is also called the value that determines the rate of charge transfer by particles that create current through the cross-section of the conductor. Current is the orderly movement of charged particles. In the SI system, amperage is measured in amperes (**designation A**). Accordingly, the current density is measured in **A/m²**. If for each period of time **Δt** the charge **Δq** is the same and the direction of the current is unchanged, then such a current is called direct.

For a classical system of charged particles with a charge of [**e**] an infinitesimally small charge [**dQ**] carried in time [**dt**] through an elementary pad [**dS**] perpendicular to the direction of the average velocity v particles is defined as:

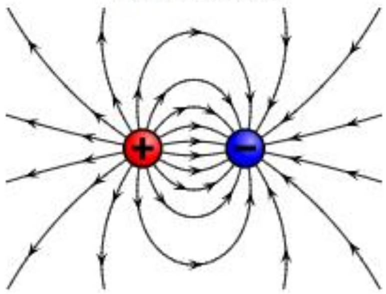
dQ = e*n*v*dS*dt, where **e** is the charge of the particles, **v** is the speed of the particles, and **n** is their number per unit volume. The current **strength dI** through the **platform dS** is determined by the ratio **dI = e*n*v*dS**, from where for the current density: **-j = e*n*v** is the density of electric current, where the dash above the symbols is the average.

That is, the movement of particles of electric charge **e** in the corresponding amount **of n** per volume, with a velocity **v,** through the corresponding cross-section of the conductor **S** [**dI =e*n*v*dS**] prevents the occurrence of the phenomenon of magnetic induction **B** ? What signs do we know of electric and magnetic fields?

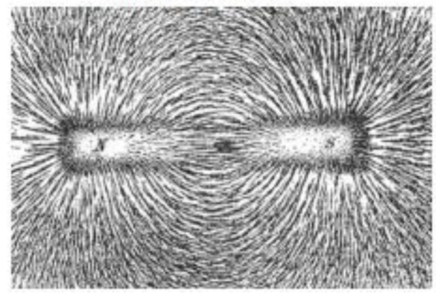
Electric charge is a physical quantity that characterizes the ability of bodies to create electromagnetic fields and participate in electromagnetic interaction. Electric charge is usually denoted by the Latin letters **q** or capital **letter Q**. The unit of measurement of electric charge in the SI system of units is the coulomb. The interaction of electric charges without taking into account their motion is studied by electrostatics, and moving charges - electrodynamics. The movement of electric charges is called electric current. There is another thing that is not paid attention to, and this is **The line of force** of a vector field is **an imaginary line in space**, the tangent to which at any point coincides with the direction of the field at that point. The concept of lines of force helps to visualize vector fields in space. charge, either at infinity, and ending at the points where the negative charge is located, or at infinity.

The lines of force of the magnetic field begin at the poles of the magnet and lead to opposite poles, never going to infinity. The lines of force of a vortex field are closed. These lines are drawn and magnetic lines of force are visualized, but this is still an imaginary line in physics.

Electric field:



Magnetic field:



Further, we have, in fact, three types of induction in electromagnetism: electrostatic, magnetic, and electromagnetic.

Electrostatic induction occurs when another charged body is brought to a body. If there are free charges in such a body, they flow from one part of the body to another. in a neutral body, will flow into the part of the body closer to the positive charge, leaving the distant part positively charged. Thus, the induced charge is formed. Electrostatic induction occurs in conductors because they have free charge carriers. In dielectrics, polarization occurs in the electric fields of other bodies. The flow of charge in conductors continues until the electrostatic potential of all points in the conductor becomes the same, since electric currents stop when the potential is equal. (*The measurement is not listed in the source, but the electrical intensity is measured* ***in volts per meter*** $\boldsymbol{E = q / \varepsilon_0 r^2}$)

This phenomenon is subjected in Maxwell's equation $\boldsymbol{D = \rho\ [\oint DdS = q]}$ *or* $\boldsymbol{E = q / \varepsilon_0 r^2}$, on Gauss's theorem that the source of the electric field (intensity) is the electric charges $\boldsymbol{q}$. Electric charge is a physical quantity that characterizes the property of particles and bodies to enter into electromagnetic interaction. That is, this is the level of potential of a single object. How does this thread interact? The phenomenon of Electrostatic Induction or Electrification is the process of acquisition of an electric charge by macroscopic bodies.

Magnetic induction (magnetic field induction) is a vector physical quantity, the main characteristic of the magnitude and direction of a magnetic field. The force of the magnetic field on charged particles and bodies that have a magnetic moment and move relative to a given magnetic field. The magnetic induction vector is usually denoted by the Latin letter B. In the SI system, the magnetic induction of the field is measured in teslas (T). In the CGS system, it is in gauss (Gs).

This phenomenon includes the effect **of magnetization of ferromagnets** - when a ferromagnetic sample is placed in an external magnetic field, the domains, the magnetic moments of which are oriented in the direction of this field, increase due to a decrease in domains with a different orientation of magnetic moments. There is also a partial rotation of the magnetic moment in each domain

Electromagnetic induction is the phenomenon of creating a vortex electric field in space by an alternating magnetic flux. One of the consequences of electromagnetic induction is the coupling between alternating electric and magnetic fields in an electromagnetic wave, another consequence that is practically important for the generation of electric current is the occurrence of an electromotive force in the conductive circuit, through which the magnetic flux changes. The units of measurement of electromagnetic induction are tesla (in the SI system), gauss (in the CGS system); 1 T = 10^4 Gs.*

But I don't like this interpretation. First of all, in this case, it is creation or transformation. The units of measurement should be according to the final phenomenon that arises, and the electromotive force that arises in this case .

Electromotive force is a quantitative measure of the work of extraneous forces to move the charge, a characteristic of the current source. It is denoted mostly by the letter E or E, sometimes stylized as a handwritten ε, measured in the SI system in volts. Usually, the electromotive force is abbreviated in texts to **e.r.s. (EMF).** The electromotive force of a section of a circle is equal to the energy received by a unit charge after passing this section of the circle. For a closed circuit, where **f** is the extraneous force:

$$\mathcal{E} = \oint_C \mathbf{f} d\mathbf{l}$$

The phenomenon of electromagnetic induction was discovered in 1831 by Michael Faraday. Before that, it was known that the electric current in the conductor creates a magnetic field. However, the reverse phenomenon was not observed. A constant magnetic field does not create an electric current. Faraday found that current occurs when the magnetic field changes. If you bring and move a permanent magnet to the frame made of conductive material, then the needle of the voltmeter connected to the frame will deviate, detecting an electric current. This phenomenon is even better manifested if you insert (remove) a magnetic core into a coil with a coil wound in the conductor.

The physicist Faraday established the quantitative law of electromagnetic induction, describing it with the equation: ***E=−N (dΦ / *dt)***, where ***E*** is the electromotive force (EMF) in volts, which occurs in a coil in an alternating magnetic field, in volts, **N** is the number of turns in the coil, ***Φ*** is the magnetic flux in webers.

If an electromotive force occurs in a conductor, then accordingly, the current induced in it will be determined by Ohm's law by the formula ***I = E / R***, where ***R*** is the resistance of the conductor. Such a current is called induction current.

The physicist Faraday established the quantitative law of electromagnetic induction, describing it with the equation: ***E=−N (dΦ / *dt),*** where ***E*** is the electromotive force (EMF) *in volts*, which occurs in a coil in an alternating magnetic field, in volts, ***N*** is the number of turns in the coil, ***Φ*** is the magnetic flux in webers. If an electromotive force occurs in a conductor, then accordingly, the current induced in it will be determined by Ohm's law by the formula ***I = E / R***, where ***R*** is the resistance of the conductor. Such a current is called induction current.

But in this case, the state is described when the electrical circuit is closed in a circuit with a load ***R***. EMF occurs in a changing magnetic flux at the ends of the generator winding, even when they are not closed in a circuit with a load. This EMF in electrical engineering is called idle EMF in Idle Mode.

The no-load EMF (EMF XX) is the voltage that can be measured at the terminals of the power supply when the circuit is open, that is, when the current in the circuit is zero. This voltage shows the maximum voltage (electromotive force) that the source can provide in the absence of a load.

Idle speed *is the operation of an electrical device in an unloaded state, i.e. when the output load is zero. This is a general definition in electrical engineering and such a term means the state of any device in which there is no load at the output (the resistance of the electrical load is infinitely large, due to the lack of connection of the load to this device, there is no torque at the output shaft of the electric motor, etc.). Often, instead of the term "idle mode", an abbreviation is used: mode XX or EMF XX.*

There is no current in a closed circuit yet, and the difference in electrical potentials ***E*** has already been generated. The question is, what is moving there and where?

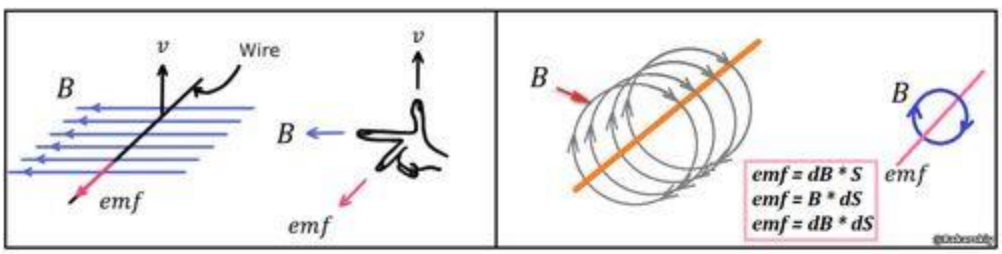
This Law of Michael Faraday (Law of Electromagnetic Induction) in Maxwell's equations is expressed quite clearly: $\nabla\times\boldsymbol{E} = -\,\Delta\boldsymbol{B} / \Delta\boldsymbol{t}$, a changing magnetic field (in the expression of the action of changing magnetic induction ***B***) gives rise to an electric field (*in the expression of electric intensity* ***E****. Electrical intensity is equal in static form* $\boldsymbol{E} = \boldsymbol{q} / \varepsilon_0 r^2$). But if we consider exactly where this charge ***q*** is located on the example of a capacitor, we will see that the source of electrical intensity in the capacitor is a polarized dielectric element between metal covers, which has its own dielectric constant **index ε**. The air around the conductor does not have such an index of dielectric constant, and cannot be resolved to the state of an independent source. Thus, there is only one explanation that some process forms ***E*** on a wire under the influence of an alternating magnetic field, or rather a variable vector of action of magnetic induction, which is denoted as the action of the corresponding force from the outside . But a wire cannot have such a number of "free charges". For electrical induction, the metal base is a surface effect. EMF lines of force rotate around the wire, and the source of these lines is the alternating state of the magnetic induction lines of force. How this is carried out and on what grounds is unknown. In addition, there is no evidence that the quantitative characteristic of magnetic induction ***B*** is converted into a quantitative characteristic of electrical intensity ***E***.

In electrical engineering, two formulas for calculating EMF are used, based on Faraday's formula: The first formula for EMF when a conductor moves in a magnetic field; The second formula of transformer EMF when changing the magnetic flux that surrounds the conductor. The formation of EMF in this case proceeds from the phenomenon of changing the Anapole moment.

$$\mathcal{E} = \frac{\Delta\Phi}{\Delta t} = Bl\upsilon\sin\alpha \qquad \mathcal{E} = \frac{\Delta\Phi}{\Delta t} = \frac{2\pi\Phi f}{\sqrt{2}} = 4.44\Phi f$$

.

These two formulas are completely different in principle of operation. If when moving in a magnetic field, it is more or less somehow clear, but with the phenomenon of the transformer formula in the general formation there are no materials. It is used to calculate EMF XX in alternators with closed magnetic circuits. Generators are installed at all power plants. A striking example of such an alternator is a turbogeneator.



It is possible to conclude that the phenomenon of electromagnetic induction, discovered by Michael Faraday, is the phenomenon of the formation of electrical tension by the action of a change in magnetic flux (magnetic induction) on a conductor (conductor nano) under appropriate conditions. Maxwell's equations, including the Maxwell-Faraday equations, describe the relationship between alternating magnetic and electric fields.

Let's go back well to Maxwell's equation on Ampère's Law in the form we know:

$\nabla\times H = \partial E/\partial t + J$ another notation taking into account Biot-Savart's law: **$\nabla\times B = \mu_0(J + \varepsilon_0\,\partial E/\partial t)$**.

You are familiar with the method of calculating electrical circuits with current, if the geoer is an electrical genealogist, then you should know that the current strength is equal to the incidence voltage in the circuit.

For the current strength to appear in the circuit, a certain measure of EMF must disappear: $\Delta U = IR$. To calculate the full current in the circuit with the generator and the load, we must complete the equation for the complete circuit and for the section:

$$I = \varepsilon / (R + r) = U / R.$$

The formula for the voltage drop for a complete circuit is as follows: $\Delta U = I\,(R + r)$. Dividing the voltage drop formula into source and load zones, we get the expression: $\Delta U = I\,R + I\,r$. For a section of the circuit, the current will have identical values $I = U / R = \Delta U / R$, where - U is the level of the applied voltage of which is measured at the load terminals, and ΔU is the level that is measured already by the current at the level of the fall. If we need to calculate the full EMF, then we get: $E = \Delta U + U$. Next, to perform the correct notation, $I = \varepsilon / (R + r) = U / R$. we replace ε with ΔU and get the expression

$$I = \Delta U / (R + r) = U / R \quad \text{or} \quad I = (E - U) / (R + r) = U / R.$$

An example of calculation with an example from real practice at the link - **EMF, CURRENT, VOLTAGE, RESISTANCE** .

I have only one explanation for what was formed in the circuit - the lines of force of electric induction E turned into the lines of force of magnetic induction B. But the magnetic field around the conductor is not the same field that exists in ferromaterials. Therefore, it must be given the symbol B_i. The action that is performed in a circuit with current is electromagnetic induction, which has the expression:

$$\nabla \times B_i = -\partial E / \partial t$$

A feature of the recorded electromagnetic induction is that a quantitative characteristic of the transformation is performed. The magnetic induction formed around the conductor excites magnetic induction in the cores of the ferromaterial, which must be given a different symbol to separate them B_m. We rewrote Maxwell's equation to the Ampère-Biot-Savard law to the phenomenon of electromagnetic induction by the fact of action, known since 1820, but for some reason no one has the courage to Suffice it to admit it. The stereotype of a particle as the basis of electricity and magnetism dominates with a bunch of contradictions and ambiguities.

It remains to answer the question of what kind of phenomenon is the magnetic field in permanent magnets and magnetically conductive materials (ferromagnets) . We have found out the nature of magnetic induction around the conductor. found out that this induction itself does not exist without a source and former. In electrical engineering, two types of sources are used as a source of magnetic field: an electromagnet and a permanent magnet. Both sources are superconnected. In the core of the electromagnet, magnetic induction is formed at times greater intensity than is inserted from the wires of the electromagnet winding:

[Wise Eye OverUnity: Magnetization of steel. Magnetic permeability]

Ferromagnetic materials are widely used in various electrical machines and apparatuses to strengthen the magnetic field and give it a certain shape: iron, cobalt, nickel and their alloys - steel, etc. obtained as a result of adding magnetic fields (magnetic moments) of individual atoms.

Example:

The strength of the magnetic field H, created in the annular core when current I flows through the winding, can be calculated by the formula:

$H = N * I / l$, where: N is the number of turns; I is the current in the wire, Ampere; l is the length of the ring along the midline, meters.Suppose we have 75 turns, with a current in the wire equal to 1 Ampere and a midline length of the ring core of 100 mm (0.1 meter): $H = N * I / l = 75 * 1 / 0.1 = 750$ A / m

Source voltage $U = 5$, power is $W = UI = 5 * 1 = 5$ W

Absolute magnetic permeability:

air = 1.25663753*10−6 (0.000001257) gn/m,
core = 0.0008792 gn/m,

it remains only to calculate the magnetic induction at a magnetic field strength of the winding equal to 750 A/m:

Without a core: $B = \mu a H = 0.00000125663753 * 750 = 0.000942478$ T,
With a core: $B = \mu a H = 0.0008792 * 750 = 0.6594$ T.

With the same power consumed by a 5 W source, we obtained a 700-fold increase in the resulting magnetic induction.

What is the source of magnetic induction in the material of permanent magnets is not known. Residual magnetization. This is rather due to ignorance and production technology, in order to induce magnetic induction in the material of a permanent magnet, it is necessary to give an electromagnetic impulse, which forms a magnetic flux greater than that launched in the material of a permanent magnet. There are also technologies where large permanent magnets trigger small permanent magnets. That is, more questions than answers. Therefore, I propose to write the magnetic field source in the expressions:

A. $\nabla\times B_m = QE/\infty$ For a permanent magnet, when the source is unknown where Bm magnetic induction, ***QE*** - Ether [physics] EN (luminous ether, from Ancient Greek αἰθήρ, upper layer of air; Latin aether) is a hypothetical omnipermeable medium, the vibrations of which manifest themselves as electromagnetic waves (*in including as visible light), ∞ is the time of action (this is cold magnetic induction, since the magnetic induction of a ferromagnet is highly dependent on temperature*)

B. $\nabla\times\boldsymbol{B_m} = \boldsymbol{\mu B_i}$ For a field in a ferromagnetic medium with a source of disturbance of a given field by an electromagnet; where $\boldsymbol{B_i}$ is magnetic induction around a conductor "with current" (*this is hot magnetic induction, since the existence of this type of magnetic induction does not depend on high temperatures, including in the plasma state*)

C. The notation of Maxwell's ***equation divB = 0*** indicates that there is no magnetic field as the primary source of magnetic induction, or the conditions for such a source are not yet known.

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This is a look at the four equations of electrodynamics. I agree that some interpretations of the phenomena challenge the accepted postulates of electrodynamics. I still think it is possible to consider this concept. All the actions in an electric circuit are completely consistent with what I have described. The phenomenon of a magnetic field around a conductor is not a movement of charges, but a kind of electromagnetic induction.

Sincerely

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