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OVER UNITY

ELECTRODYNAMICS

DC MOTOR AND GENERATOR

Kyiv, Ukraine

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United Nations.
Universal Declaration of Human Rights. Article 19

Kyiv, Ukraine, 12 March 2024.

Introduction

Friends, it has happened! I didn't even expect to get such a calculation result using a simple DC motor and generator. We all know from school that there is a DC motor. That it is quite powerful for its small size. Education in its textbooks indicates that this simple motor is used without significant changes in the principle of operation and design. In addition to the DC motor, there is an electromagnetic DC generator. These two machines have a reciprocal effect.

We will look at some interesting questions, ratios and make calculations. If you are interested in electricity for the first time, I hope you will find this material useful.

Let us consider, from the point of view of logic, such phenomena as: Ohm's law; electromagnetic induction (EMF) and amperage. What really distinguishes and unites such devices as a source of electricity: a voltage generator and a current generator. Consider how an electrical circuit works, how a network works, and more.

Today, no scientist can tell you exactly what an electric field or a magnetic field is. At present, all scientific interpretations of the phenomena of electricity and magnetism are based on scientific concepts. Therefore, in this article, I will rely on logic and common sense. Consider this my concept.

The aim is that after reading this book you will be able to understand the phenomena that occur in your socket. You will be able to calculate simple electrical circuits on your own, calculate a simple electric motor or generator. The main thing is that we will calculate the motor and generator in the mode of more than over unity, without violating any postulates of physics.

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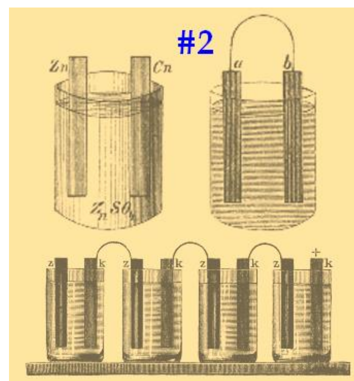
Where to start? I think we should start with the beginning, the discovery of the galvanic battery as a source of direct current. During the experiments with electricity conducted by scientists in the 18th century, they noticed the transfer of electricity from a rubbing glass circle to a conductor. Many times they tried to discharge the "Leiden jar" through a long chain of people holding hands, but no one expressed a clear opinion about the possibility of a long-lasting flow of electricity through conductors. The discovery of electric current was preceded by the experiments of the Italian anatomist Luigi Galvani. On one of the autumn days of 1780, Galvani conducted an experiment to find out whether electricity causes the same movements in the leg of a lightning bolt. To do this, Galvani hung several frogs' legs on brass hooks in a window closed with iron bars. Contrary to his expectations, he found that the frogs' contractions occurred at any time, regardless of the weather. The detection of electric current was still a mystery. Where does the current appear: only in the tissues of the frog's body, only in dissimilar metals, or in a combination of metals and tissues? Fortunately, history has decreed that the results of Galvani's experiments, which he presented in his famous Treatise on Electric Forces in Muscular Movement, published in 1791, came to the attention of the Italian scientist Alessandro Volta. Stunned, Volta re-reads the treatise and finds something that had escaped the author's attention - a mention that the effect of leg tremors was observed only when the legs touched two different metals. Volta decides to perform a modified experiment, not on a frog, but on himself. «*"I confess,"* he wrote*, "I started the first experiments with disbelief and very little hope of success: they seemed so incredible to me, so far from everything we had known about electricity... Now I turned to the experiments, I was an eyewitness, I performed the strange action myself, and I passed from disbelief, perhaps, to fanaticism*! *"*».

From then on, Volta could be seen doing a strange thing: he would take two coins - always made of different metals - and... put them in his mouth, one on his tongue and the other under his tongue. If Volta then connected the coins or circles with a wire, he felt a sour taste, the same taste, but much weaker, that we can feel when we lick two battery contacts at the same time. From his earlier experiments with the electrophoretic cell, Volta knew that this taste was caused by electricity. Volta assumed that the phenomenon observed by Galvani was caused by the presence of two different metals. Guided by this idea, he set up many experiments and finally made an important discovery, which he reported to the Royal Society of London in 1800. Volta wrote that he had found a new source of electricity that acted like a battery of weakly charged "Leyden jars". However, unlike a galvanic battery, his device charges itself and discharges continuously. He also gave a description of his device. Volta arranged his device as follows. He stacked several dozen zinc and copper cups in pairs, separated by paper soaked in salt water. When the experimenter touched the lower copper cup with one hand and the upper zinc cup with the other, he received a strong electric shock. At the same time, the device did not discharge, and no matter how many times he touched the mugs, the shock was repeated, meaning that the charge of electricity was continuously generated. Thus, Volta got the first rather powerful source of electricity - the famous "Voltaic pole", which formed a whole era in the history of physics (Fig. #1) This was the discovery of a new phenomenon - the continuous movement of electricity in a conductor, or electric current. The creation of the first source of electric current played a huge role in the development of the science of electricity and magnetism. A contemporary of Volta's, the French scientist Arago, considered the Voltaic pole to be "*above every single device ever invented by men, not excluding the telescope and the steam engine*".

Immediately following this, Volta made another great invention: he invented a galvanic battery, magnificently called the "crown of vessels", consisting of many series-connected zinc and copper plates, dipped in pairs into vessels with dilute acid - already a fairly solid source of electrical energy (Fig. #2) It can be assumed that from that day on, the sources of direct electric current - the volt pole and the galvanic battery - became known to many physicists and were widely used in further research.

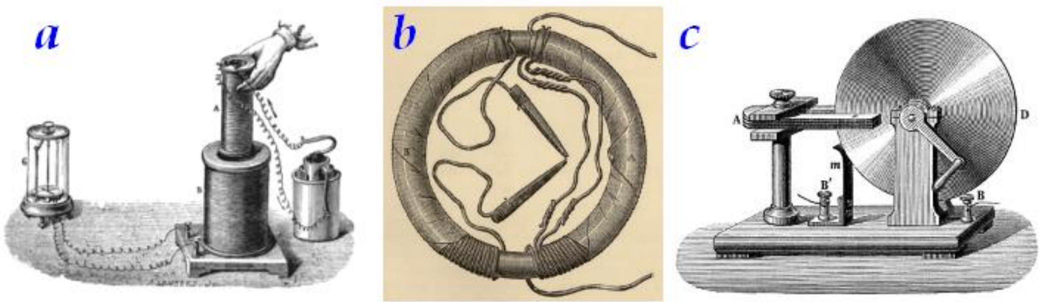


Volta's device inspired scientists to work on the invention of similar current sources. This was the beginning of the era of DC power supplies, which we know as batteries, which we use to power many of our devices, and rechargeable batteries, which serve as a long-term energy storage device. These storage devices and DC power supplies continue to improve today.

The discovery of electromagnetic induction by the Englishman Michael Faraday was made on 29 August 1831 by Michael Faraday. However, the phenomenon was first noticed by another prominent scientist, Hans Christian Ersted. During his experiments, he discovered that if a magnetic arrow is placed near a circuit through which an electric current passes, the arrow deflects. He then suggested that if an electric current can cause the phenomenon of magnetism, then the opposite phenomenon, where a magnetic field causes an electric current, is probably possible.

Ersted was unable to fundamentally prove his assumption, so the glory of discovering the phenomenon of electromagnetic induction went to Faraday, who actually continued the work of his colleague. It is interesting to note that, in addition to Faraday, the American physicist Joseph Henry claimed the palm in this discovery. He was also able to conduct successful experiments on the induction of currents. But while the American was daring to publish the results of his work, Faraday was ahead of him.

Faraday's experiments in induction:



a) When a magnetic core moves inside a wire coil, a current is generated in the coil
б) Faraday coil "the first transformer": when the current in one winding is switched on or off, the current in the other winding is recorded
c) Faraday disc, the first unipolar generator ..

Electromagnetic induction is the phenomenon of electric current (induction current) in a closed conductor (circuit) when it is exposed to a time-varying magnetic field. It does not matter whether the conductor or the source of the magnetic field is moving. This phenomenon has made it possible to operate electric generators and other electrical machines.

Faraday's law of electromagnetic induction is a basic law of electrodynamics that relates to the principles of operation of transformers, chokes, and many types of electric motors and generators. The law states.:
For any closed loop, the induced electromotive force (EMF) is equal to the rate of change of the magnetic flux passing through the entire circuit, taken with a minus sign.
or in other words: The generated emf is proportional to the rate of change of the magnetic flux.

The formula of this law is as follows:

$$E = -\frac{\Delta \Phi}{\Delta t}$$

Where: E – electromotive force (in volts);
$\Delta\Phi$ – magnetic flux (in weber);
Δt - modulus of magnetic flux change rate.

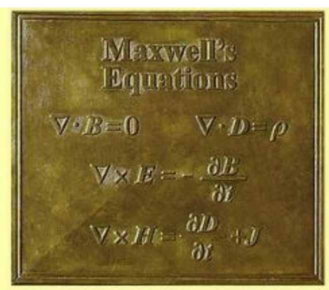
The magnetic flux can be calculated by the formula: $\Phi = BS\ cos\alpha$ (B is the magnetic induction vector (*in tesla*); S is the area of action of the magnetic induction vector in which the conductor is located/moving (m^2); *cos* is the angle [α] at which the action of the magnetic induction vector is directed to the conductor in this flux.

The induction EFM in a closed circuit is equal to the modulo of the rate of change of the magnetic flux through the surface bounded by the magnetic circuit $\Phi = BS$ cosα.

James Clerk Maxwell (13 June 1831, Edinburgh, Scotland - 5 November 1879, Cambridge, England) was a Scottish scientist who created the theory of the electromagnetic field and, based on it, concluded that the alternating electric and magnetic fields are closely related to each other, forming a single electromagnetic field that propagates in the form of electromagnetic waves at the speed of light. Interestingly, Maxwell was born in the year Faraday discovered the phenomenon of electromagnetic induction.

Maxwell's equations are the basic equations of classical electrodynamics that describe the electric and magnetic field created by charges and currents.

$$\nabla \cdot \mathbf{D} = \rho$$
$$\nabla \cdot \mathbf{B} = 0$$
$$\boxed{\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}}$$
$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$$



div D = ρ – (Gauss' law for electricity) The source of the electric field is charges.
div B = 0 – (Gauss's law for magnetic field) There is no magnetic field charge, magnetic field lines are closed field are closed.
curl E = -dB/dt – (Faraday's Law) A time-varying magnetic field causes an eddy current electric field.
curl H = dD/dt + J -(Ampere's law, extended by Maxwell) Electric current and alternating electric field create a magnetic field.

D is electrical induction [C / m^2].
B is magnetic induction [T].
E is electric field strength [V / m].
H is magnetic field strength [A / m].
j is current density [A/m^2].
ρ is the charge density [C / m^3].
∇· is the divergence operator [1/m],
∇× is the rotor operator [1/m]..

A rotator (also known as a rotor differential operator or rotation vector operator) is a vector differential operator used in physics to study vortices and rotational characteristics of vector fields. It is denoted in various ways:

rot (the most common in Russian-language literature)
curl (in the English-language literature, proposed by Maxwell)
$\nabla \times$ (as a differential nabla operator vectorially multiplied by a vector field)

The result of the action of the rotor operator on a particular vector field is called the field rotor and represents a new vector field. This field characterises, in a sense, the rotational component of the field at the corresponding points. Intuitively, the rotor indicates how much and in which direction the field is twisted at each point.

In simple terms, what do scientists mean by,

[$\nabla \cdot D = \rho$]: D — electrical induction [C/m²]; ρ - charge density [C/m³]; $\nabla\cdot$ - divergence operator [1/m].
The source of the electric field is charges.

Electric charge is a physical quantity that characterises the ability of bodies to create electromagnetic fields and participate in electromagnetic interaction. Electric charge is usually denoted by the Latin letters q or the capital letter ***Q***. The unit of electric charge in the SI system is the coulomb. The interaction of electric charges without taking into account their movement is studied by electrostatics, and the movement of charges is studied by electrodynamics. The movement of electric charges is called an electric current.

[$\nabla \cdot B = 0$]: B - magnetic induction [T]; $\nabla\cdot$ - divergence operator [1/m].
No magnetic field charge exists, magnetic field lines are closed.

A magnetic field is a region of an object or electric charge in which a magnetic force acts, with a magnetic induction vector.

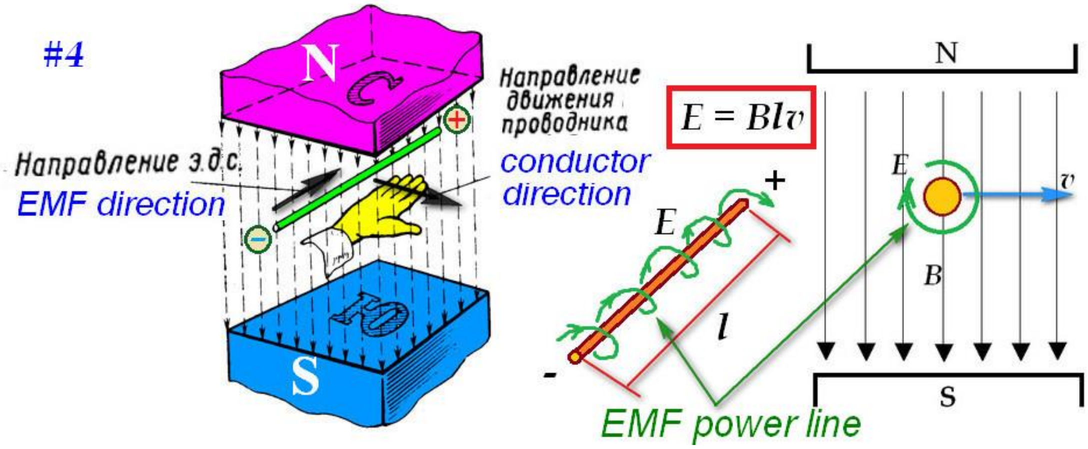
By the way, we still do not know the nature of electric charges or what a magnetic field is. It is only clear that the magnetic field is the result of the action of some source, and the electric field can accumulate and has potentials that can be different in the same field. The magnetic induction of the magnetic poles of one magnetic field source is equal in value and opposite in the action vector. Magnetic induction is a vector physical quantity that characterises the force effect of a magnetic field. In an electric field, there is electric induction (electric displacement), a vector quantity equal to the sum of the electric field intensity vector and the polarisation vector. Electric field - is created by any charged body or by an alternating magnetic field acting on any charged body.

What is clear is that these are different phenomena that interact with each other. The following Maxwell's equations reveal this issue.

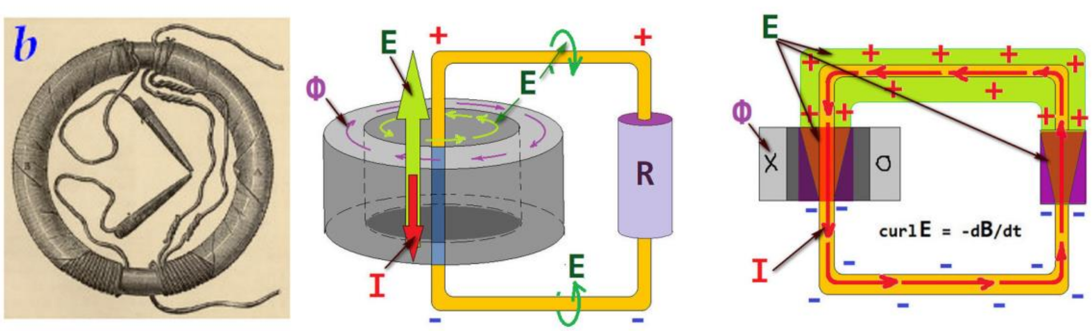
[**curl E = -dB/dt**]:**E** - напруженість електричного поля [В/м]; **B** - магнітна індукція [Тл].

A time-varying magnetic field causes a vortex electric field.

This is exactly the same action when one field gives rise to another, in this case, the magnetic field gives rise to the electric field. What do these two fields have in common? They are united by the presence of induction lines. There is a familiar figure from school (Fig. #4) that explains how an EMF is formed on a conductor moving in a magnetic field. I have added the structure of the power line of the electric field that is formed (*EFM power line*).



Yes, you heard right, an electric induction line has a spiral structure around a conductor. The emf vector can be determined by the right hand or screw rule. The figure shows the contact type of electromagnetic induction, which occurs when power lines cut/cross a conductor. There is another type of electromagnetic induction that is denied by official physics. By the way, Faraday worked with his induction coil (the first electrical transformer). In fact, he was dealing with two types of induction (possibly three): Reciprocal induction and electromagnetic induction (EMF) from a change in the magnetic field without contact. Magnetic lines closed in an annular core cannot physically cross a conductor.



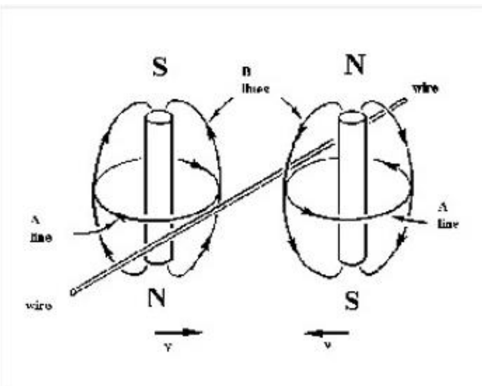
The figure shows the Faraday coil and the principle of operation of the non-contact EMF, which Faraday recorded but unfortunately could not see the difference.

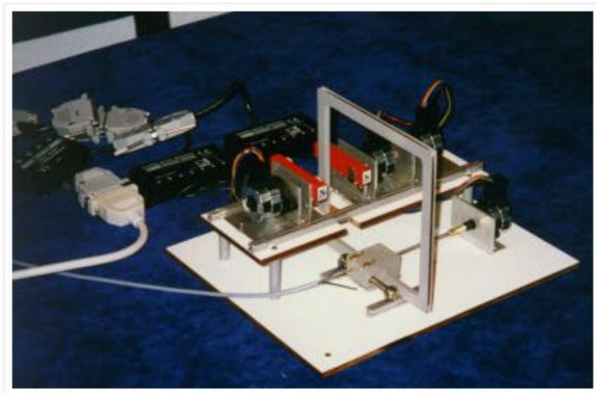
Engineers determine this emf using the transformer formula:

$$E = \frac{2\pi\Phi f}{\sqrt{2}} = 4.44\Phi f$$

Physics does not disclose the phenomenon of this form of EMF, but all synchronous electromagnetic generators with cores, where the coils are wound on rods or embedded in a closed groove, work on the principle of this EMF is a paradox.

The formation of an EMF on the surface of a conductor in the focus of a changing magnetic field was demonstrated in the experiment of Christian MONSTEIN [Switzerland 1997], in which conditions were created for a conductor when it was in the focus of a changing inhomogeneous magnetic flux.





To summarise, electromagnetic induction is a phenomenon where the primary magnetic induction acting on a conductor creates the phenomenon of electric field lines with an electric potential difference at the ends of the conductor. The peculiarity of this phenomenon is that it exists only under an alternating magnetic field acting on the conductor. By its characteristics, the EMF corresponds to the action of electric induction, but its source is an alternating magnetic field, not the electric field of the source.

[**curl H = dD/dt + J**]: H - magnetic field strength [A/m]; D - electric induction [C/m²]; j - current density [A/m²] Electric current and alternating electric field create a magnetic field.

Ampere's law is the law of interaction of direct currents, which was established by Andre-Marie Ampere in 1820. Ampere's law states that parallel conductors with direct currents flowing in one direction are attracted and repelled in the opposite direction.

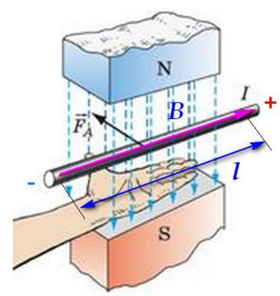
Ampere's law for the circulation of a magnetic field is the statement that the integral of the closed loop of magnetic induction is proportional to the strength of the electric current flowing through the area bounded by the loop.

This is a very interesting equation and law. Let's look at it from a slightly different angle. Let's ask ourselves what phenomenon does the work in our electromagnetic devices that we use every day. You will probably be surprised to learn that the work is done by a magnetic field that forms around a conductor connected to a source of electric voltage with a difference in the corresponding electric potentials. This magnetic field acts exactly in accordance with the magnetic force discovered by Ampère in the law that bears his name. What we can learn about this from a physics textbook:

Amperage is the force with which a magnetic field acts on a conductor carrying a current. It depends on the density of the current flowing through the conductor and the induction of the magnetic field in which the conductor is located. Ampere's force was discovered by French physicist Andre Marie Ampere. To determine it, Ampere's law is used, and the direction is determined using the left-hand rule.

What does the value of Ampere force depend on?

$$F(A) = BIl \sin \propto (1), \text{де}$$

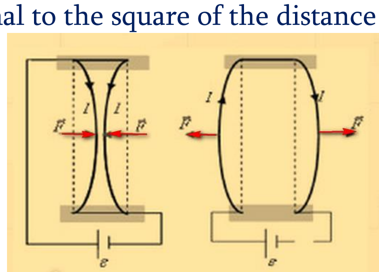


- *F(A)* — Ampere power;
- B — induction of the magnetic field in which the conductor is located;
- I — current strength in the conductor;
- l — length of the active part of the conductor (i.e. the part of the conductor located in the magnetic field);
- α — is the angle between the direction of the magnetic induction vector and the direction of the current in the conductor.

<u>The left hand rule:</u>
If the left hand is positioned so that the lines of the magnetic field enter the palm of the hand, and the four extended fingers indicate the direction of current in the conductor, then the thumb bent 90° will indicate the direction of the Ampere force.

That's all well and good, but Ampere first established in 1820 the force interaction between two parallel conductors with a current

Two infinitesimal elements of conductors with current interact with each other with a force that is directly proportional to the lengths of these elements, the currents in them, and inversely proportional to the square of the distance between them (Ampere's law, 1820).



$$\Delta F = \mu\mu_0 \frac{I_1 \Delta l_1 I_2 \Delta l_2}{r^2} sin\alpha_1 sin\alpha_2$$

Ampere's law plays the same role in magnetostatics as Coulomb's law in electrostatics. (i.e., Ampere's law can be used to calculate the force of interaction between two parallel conductors of finite length with currents $\boldsymbol{I_1}$, $\boldsymbol{I_2}$, the distance between which is $\boldsymbol{r}$)

$$F = \frac{\mu\mu_0 I_1\, I_2\, l}{2\pi r}$$

This is all well and good, but what is the strangeness of this current, which physics defines as a flow of charged electric particles, which, according to their interpretation, forms a vortex magnetic field around a conductor.

Using the similarity between electric and magnetic fields, let's introduce a quantity that quantifies the magnetic field:

Electric field - the strength of the electric field:

$$E = \frac{F}{q}\ [\, 1V = \frac{1N}{1C}\,]\ (2)$$

Magnetic field - magnetic induction (power characteristic):

$$B = \frac{F}{Il}\left[1T = \frac{1N}{1A * 1m}\right](3)$$

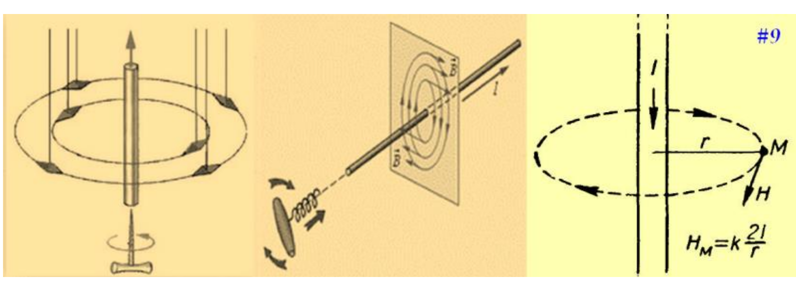
The second formula is also known as the Ampere Force Modulus, which is equal to the product of the current in the conductor, the magnetic induction vector, the length of the conductor and the sine of the angle between the directions of the magnetic induction and current vectors of the conductor:

$$F(A) = BIl\ sin \propto (4)$$

To understand the difference between formulas (1) and (4), we need to understand one more fundamental law of electrodynamics.

The Bio-Savar-Laplace law is a law that defines magnetic induction around a conductor in which an electric current flows.

Initially, Jean-Baptiste Bio and Félix Savard formulated a law based on their experiments that determined the strength of the magnetic field around a very long straight conductor with a current. This law is called the Bio-Savar law. Pierre-Simon Laplace generalised the results of Bio and Savard by formulating a law that determined the magnetic field strength at any point around a circuit with a current of arbitrary shape. Although historically the law was formulated for magnetic field strength, the modern formulation uses magnetic induction.



За законом Біо-Савара:

$$B = k\frac{I}{2r}\text{ (5), де}$$

$\boldsymbol{B}$ — магнітна індукція в точці **M** на відстані r від прямолінійного провідника із струмом $\boldsymbol{I}$ (мал.#9); $\boldsymbol{k}$ — коефіцієнт пропорційності, величина і розмірність якого залежать від вибору системи фізичних величин, $\boldsymbol{r}$ — радіус-вектор.
У Міжнародній системі величин (ISQ): $\boldsymbol{k = \mu_0 / 4\pi}$ (6), де $\boldsymbol{\mu_0}$ — магнітна стала.

In fact, this law converts the indicator of current strength I (A), the electrical measurement system, into the indicator of the magnetic induction vector Bi (T) around the conductor. I propose to denote magnetic induction from electric current by the letters of the English alphabet [***Bi***.], and magnetic induction from an external magnetic field by the letters [***Bm***]. This is very important for the further use of the force module and amperage in electrical engineering practice.

If you follow the logic, the following algorithm of Ampere's (Bio-Savar's) law and Maxwell's equation emerges. I also believe that this is also electromagnetic induction only in the opposite direction of Faraday's electromagnetic induction. The formula for this induction should be written in the following form:

$$curl\ B\text{i} = -\frac{dE}{dt} \qquad (7)$$

I believe that my concept of the law of electromagnetic induction (7), which combines Ampere's Law, Bio-Savar's Law, and Ohm's Law for a complete circuit, is logical and well-reasoned. An applied formula for formula (7) can be derived if necessary. I believe that it currently provides an understanding of what happens in an electrical circuit under current.

Maxwell's formula for this induction remains in the values for electrical measurement:

$$curl\ H = \frac{dD}{dt} + J \qquad (8)$$

The magnetic field intensity H (A/m) at a point located at a distance r from an infinite straight conductor with a current I is calculated by the formula:

$$H = \frac{I}{2\pi r} \qquad \text{(9), де}$$

I - current strength, Ampere; r - distance, metre.

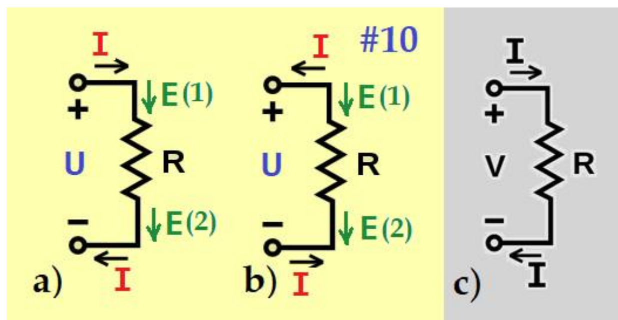
If you look at Maxwell's formula (8) and the formula for the magnetic intensity of a conductor under current (9), these are equations for an electrical measurement system. Formula (7), which I have proposed, essentially states the same thing, but transfers the phenomenon to the category of electromagnetic induction from an electric field to a magnetic field. It is this component that is missing in electrodynamics.

Where can we see this? Then let's move on to Ohm's Law.

Georg Simon Ohm, a German physicist (*16 March 1787, Erlangen - 7 July 1854, Munich*), conducted research on the flow of current in an electric circuit in the early 19th century. He had to overcome many obstacles on his way to establishing the law. To conduct research and establish the law, he needed measuring instruments, current sources with standard properties that would not change over time, and standard conductors. All of this had to be created or improved.

Ohm's law is a statement about the proportionality of the current in a conductor to the applied voltage, which is valid for metals and semiconductors for not very large applied voltages. If Ohm's law is true for an element of an electrical circuit, then this element has a linear volt-ampere characteristic.

More precisely, Ohm's law states that the current I [A] in a conductor between two points (Fig. #10, c) is directly proportional to the voltage U [V] at these two points. By introducing a proportionality constant, the resistance R [Ω], we can arrive at a simple mathematical equation that shows this relationship. In addition, the direction of current is correct as shown in Figure (#10, b), traditionally the direction of current is indicated as in Figures (#10, a,c). We will find out all this further.



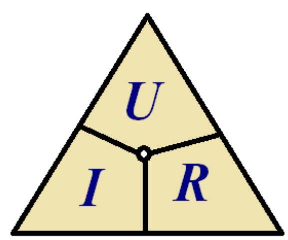
In electrical engineering, it is customary to write Ohm's law in an integral form:

I=U/R (10), where

I - current, U - applied voltage, R - electrical resistance of the conductor.

When analysing electrical circuits, the three equivalent expressions of Ohm's law are used interchangeably:

I=U/R *or* U=I*R (11) *or* R=U/I (12)



At the same time, Ohm's law states that R is constant in this respect and does not depend on the current. If the resistance is not constant, the previous equation cannot be called Ohm's law, but it can still be used as a definition of constant resistance.

Ohm's law is an empirical relationship that accurately determines the conductivity of the vast majority of conductive materials over many orders of magnitude of current. However, some materials do not obey Ohm's law; they are called neomic.

Thus, resistance is a characteristic of a conductor, not a material, and depends on the length and cross-section of the conductor. Therefore, in physics, Ohm's law is used in a differential form:

$$\boldsymbol{j} = \boldsymbol{\sigma E} \qquad (13), \text{ where}$$

j is the current density, ***σ*** is the specific conductivity of the material,
E is the electric field strength.

Equivalence of two forms of recording:

The difference in electric potentials (voltage) at the ends of a conductor of length ***l***:

$$U = \Delta\varphi = El$$

If a conductor has a cross-sectional area S, then the current in it is related to the current density by the formula: ***I = jS.***

Based on Ohm's law in form: ***j= σE*** by substituting values ***j = I/S*** та ***E = U/l***, we obtain the equation ***I / S = σ (U/l)***, or

$$U = \frac{l}{\sigma S} I = RI$$

where the resistance ***R*** is determined through the specific conductivity by the formula ***R=l / σ S = ρ l / S***, here ***ρ =1 / σ*** — resistivity.

In electrical engineering, there is a moment when the voltage drop across the load of an eclectic circuit is calculated. The following mathematical formula is used to calculate the voltage drop across a resistor:

$$U_{[R]} = I\,R \quad (14), \text{ where}$$

$U_{[R]}$- це падіння напруги на резисторі, у вольтах; I - сила електричного струму, у Амперах, яка проходить через нього; R - опір деталі, у Омах [Ω]

In Ohm's law, the value of the effective voltage U applied to the load R is used to determine the current I. At first glance, formulas 14 and 11 are the same, but they calculate different indicators The calculation of voltage drop is one of the fundamental ones for the calculation of electrical circuits. There is a current formula for a complete electrical circuit with a load and an EMF source.

$$I = \frac{\varepsilon}{R+r} \quad (15), \text{ where}$$

I is the current in a closed circuit, amps; ***ε*** is the electromotive force, volts;
R is the load resistance, Ω; ***r*** is the source resistance, Ω.

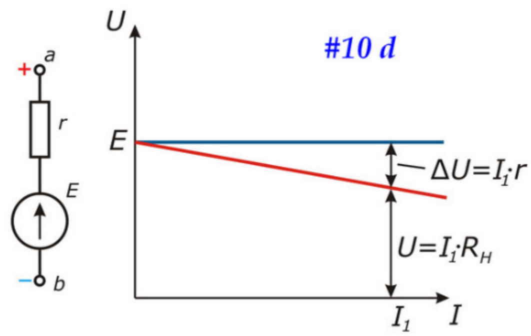
Let's consider what happens on a simple example of an electrical circuit. The most understandable type of source is a galvanic cell to which a light bulb is connected as a load R

A galvanic cell is a chemical power source that uses the difference in electrode potentials of two metals immersed in an electrolyte. A galvanic cell is a non-rechargeable chemical source of electricity.

An electric battery is a rechargeable chemical source of electric current, the peculiarity of which is the reversibility of internal chemical processes, which ensures its repeated cyclical use (through charge-discharge) for the accumulation of electric energy and autonomous power supply of various electrical devices and systems. An electric battery belongs to the category of chemical voltage sources.

A voltage source or voltage generator is an element of an electrical circuit (circuit) that provides a certain voltage value at its terminals that does not depend on the current in the circuit. Another term used in electricity is a current source that provides a certain value of current in a circuit.

An ideal voltage source is characterised by a certain value of electromotive force and zero internal resistance. The current flowing through such a source is completely determined (according to Ohm's law) by the load circuit:



I=E/R, where E is the electromotive force and R is the electrical resistance of the load.

Real voltage sources have finite values of internal resistance.

The graph (Fig. #10d) shows the load characteristics of an ideal voltage source (EMF source) (blue line) and a real voltage source (red line).

E = ΔU+Ui, where ΔU=Ir is the voltage drop across the internal resistance of the source; Ui=IR is the voltage drop across the load.

In case of a short circuit ($R_{LOAD} = 0$), E = ΔU, i.e. all the power of the energy source is dissipated at its internal resistance. In this case, the current $I_{[short\text{-}circuit]}$ will be the maximum for a given EMF source. Knowing the no-load voltage and the short-circuit current, the internal resistance of the voltage source can be calculated:

$$r = U_{[no\text{-}load]} / I_{[short\text{-}circuit]}.$$

The current formula for a complete circuit should be written in the following form:

$$I = \frac{\Delta U + Ui}{R + r} \quad (16)$$

Thus, formulas (15) and (16) are identical.

Let's look at the operation of a closed electrical circuit with an active load. The active load has a thermal characteristic of operation determined by the Joule-Lenz law.

> The Joule-Lenz law is a physical law that quantifies the thermal effect of electric current. The law was experimentally established in 1841 by the English physicist James Prescott Joule and independently by Emil Lenz, a German-born scientist of the Russian Empire, in 1842.
>
> The wording of the law is as follows: The amount of heat released in a conductor with a current is directly proportional to the current strength, voltage and time the current passes through the conductor.
>
> The mathematical expression of the law:
>
> $$\boldsymbol{Q = I * Ui * t} \quad (17), \text{ where}$$
>
> $\boldsymbol{I}$ is the current, $\boldsymbol{Ui}$ is the voltage drop across the circuit, and $\boldsymbol{t}$ is the time of current flow.
>
> Applying Ohm's law to a section of a circuit, the Joule-Lenz law can be written as
>
> $$\boldsymbol{Q = I^2 R t} \quad (18), \text{ where } \quad \boldsymbol{R} \text{ — conductor resistance.}$$

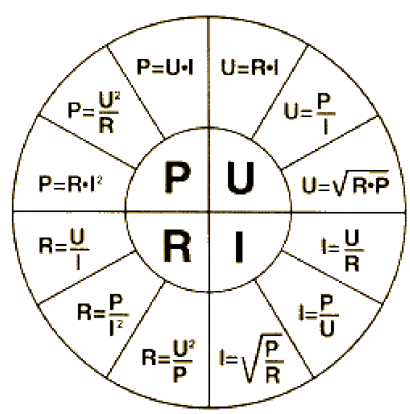
If you look at the components of the calculation, the amount of heat corresponds to the value of power in time, i.e. it is the value of the amount of power or the amount of energy.

Power (N, P, W) - work performed per unit of time or energy transferred per unit of time. Unit of measurement SI: W (Other values: hp, V-A, etc.):

$$N = \frac{A}{t} \quad (19), \text{ where}$$

N is the power, ***A*** is the work performed,
t is the time period during which the work was performed.

Energy [to act, activity] is a scalar physical quantity, a general quantitative measure of movement and interaction, or of all kinds of matter (it is understood that physics also counts fields as matter). The concept of energy is related to the ability of a physical body or system to perform work. In the process, the body or system partially loses energy, spending it on changes in surrounding bodies.



Energy in simple terms, the application of power to perform work, measured in joules (***J***), then in relation to power: ***1 J = 1 Ws***. Thus, Ohm's Law has adopted a modern form of calculation.

An example of calculating the power consumption of a resistor. Let's say a resistor has a resistance of 10 Ω, the current passing through the resistor is 1.2 A. The resistor is connected to the load for 1 hour (3600 seconds), let's calculate the work done using the formula (18):

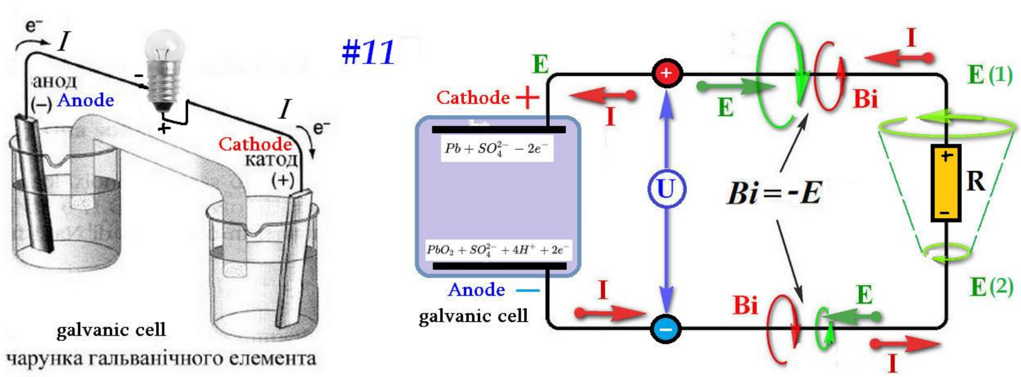
$$Q = I^2Rt = 1{,}2^2\ A * 10\ \Omega * 3600\ s = 51\ 840\ J \text{ or } 14{,}4\ Wh$$

If you need to determine the work of a resistor in terms of thermal energy (e.g. calories), there is a calculation system: 1 J equals 0.239 Calories [Cal], тобто

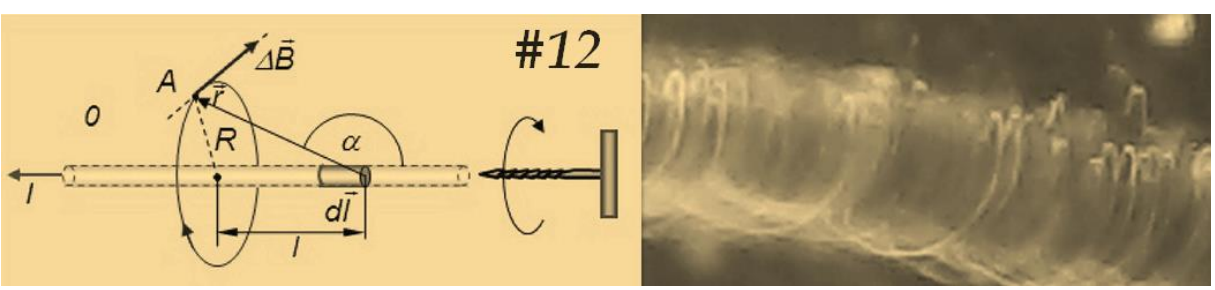
$$51\ 840\ J * 0{,}239\ Cal = 12381{,}771456\ Cal$$

51,840 J or 14.4 W*h is an indicator of how much electromagnetic power in the circuit was dissipated in the form of infrared radiation from the resistor, and the measurement in calories is for comparison only.

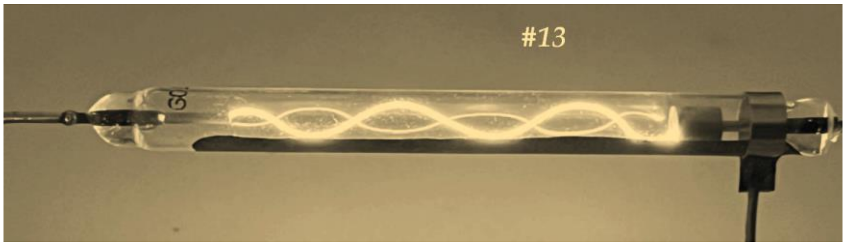
It remains to find out what exactly performs the work in an electric circuit. Let's perform our study using the example of the simplest circuit in which the following is included: source - galvanic cell and load - incandescent light bulb (Fig. #11).



What does a magnetic field look like around a conductor with a current? In textbooks, we are shown closed magnetic field lines in the form of rings. If so, why does the current and magnetic induction have a uniform factor throughout the circle? The researchers took a picture of a wire under direct current by dipping it in a magnetic liquid (Fig. #12):



We can see that the magnetic force lines are in the form of a spiral around the conductor. The second researcher took a photo of the voltage and current in a glass flask with gas, which was connected to an alternating current circuit (Fig. #13):

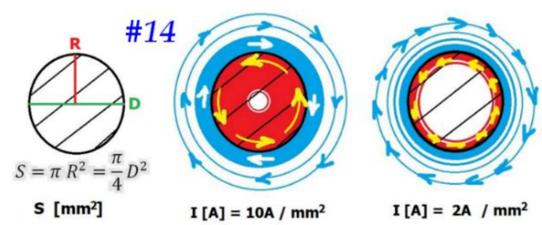


Another spiral, this time two spirals of plasma. The physicist will argue that the two spirals are a flow of protons and electrons, as the concept of official physics states. Well, what do other physicists think about this? A quote from one of the forums where this issue was discussed: «*Free electrons move in the cross-section of a conductor with a drift velocity of 0.6-0.8 mm per second, in 1 minute the electrons will travel 6 cm, in 1 hour 3.6 metres. And when we turn on the light switch on the wall, the light comes on instantly, something is wrong here*».

The current density is a vector physical quantity that has the meaning of the strength of the electric current flowing through a surface element of unit area. If the current density is uniformly distributed and directed with the normal to the surface through which the current flows, the following equations are fulfilled for the current density vector:

j = I/S, where ***I*** *is the current (A) through the cross-section of the conductor with area* ***S*** (*mm*^{2})

The figure (#14) shows how the conductor cross-section is calculated and how the current is distributed (in red) in different states: for DC I = 10A/mm^2 and high-frequency AC I = 2A/mm^2.



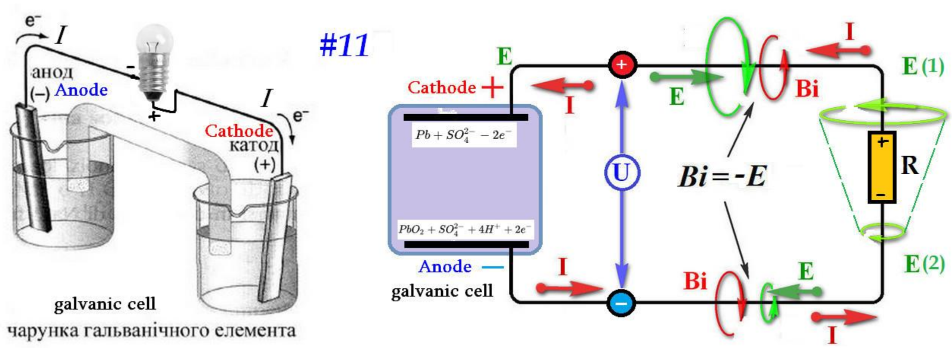
The AC resistance value of the same conductor may be higher than the DC resistance value.

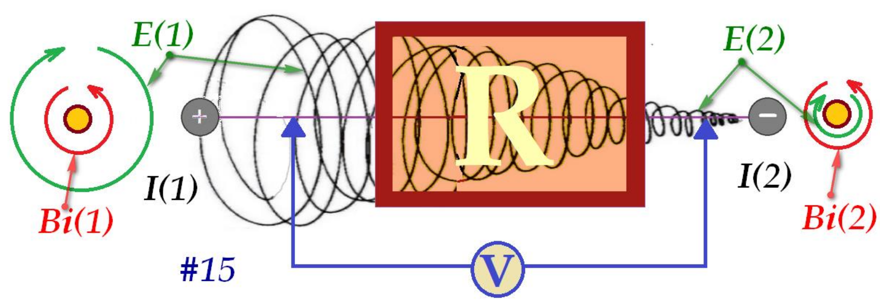
The resistance of a conductor to alternating current is called active resistance. The resistance that this conductor would have to direct current is called ohmic resistance. The ratio of the active resistance of a conductor ***Ra*** to its ohmic resistance ***Ro*** is called the surface effect coefficient

$$k_S \; (k_S = Ra/Ro).$$

The skin effect is more pronounced the larger the wire diameter, its specific conductivity, magnetic permeability and the higher the AC frequency. The skin effect becomes very noticeable at sufficiently high frequencies, when a very thin surface layer is applied to the surface of the conductor due to the displacement of high-frequency currents, and there is no current inside the conductor. That is, the higher the frequency of the alternating current in the conductor, the thinner the skin layer, and I have shown the possibility of current passage in the figure on the right as an example 2A/mm^2.

I believe that the strength of the current (magnetic induction Bi) depends on the magnetic properties of the conductor material around which the magnetic vortex field is excited. The magnetic field itself exists as long as it is fed by an electric field, through the electromotive force (E), which manifests itself as the closure of electric field lines of force between different potentials of the same electric field source. Let's look at figure (#11) again, this time at its right-hand side. I have additionally indicated the direction of the lines of emf and eddy magnetic induction. The resistance R indicates that there is a decrease in the amplitude of the EMF lines: E(1) > E(2). In contrast to the decrease in the amplitude of the EMF lines, the magnetic induction lines are the same at the beginning and end of the circuit connected to the voltage source: Bi(1) = Bi(2).





In Figure (#15), I have shown how the spiral of the EMF power lines between the contacts of the voltage source looks like. The amplitude of the EMF lines drops at the load R. On the left and right, I have indicated the direction (vector) of action of the EMF lines [E] and magnetic induction of the transformation [Bi], which are opposite to each other. Therefore, the assumption that electromagnetic induction of the transformation of an electric field into a magnetic field occurs on a wire connected to a source of electric potential difference can be considered logical and accepted as a concept. We can write this phenomenon in the following form, as proposed earlier (7):

$$curl\ B\mathrm{i} = -\frac{dE}{dt} \quad (7)$$

Maxwell's equation for an electrical measurement system, expressed as for the action of electromagnetic induction:

$$\boxed{curl\ H = dD/dt + J} \longrightarrow \boxed{crul\ Bi = -\ dE\ /\ dt}$$

We can write the equation in a new form:

- div D = ρ
- div B = 0
- curl E = -dBm /dt
- crul Bi = -dE /dt

In this variant, for electromagnetic inductions, we introduce the following types: magnetic induction from an external magnetic field (Bm) and magnetic induction (Bi) around a conductor, from the EMF of the voltage source to which the conductor is connected. It is noteworthy that magnetic induction from an external magnetic field does not have a direct reverse effect, while electromagnetic induction around a conductor has a reverse effect. The reverse effect is manifested in the phenomenon of self-induction.

I believe that all the necessary and controversial issues for further consideration of the topic have been clarified. We also found out that there is a voltage source (voltage generator) in the form of an electrochemical device, a galvanic battery or a battery. We will come back to clarify the features of this device in the case of switching power lines of emf and magnetic induction around a conductor. We don't know what the power lines of the electric and magnetic fields consist of. We can see that in the air gaps of the electrical circuit, these lines have a plasma structure, which are used in electrical engineering as spark gaps (arresters) and gaps with a plasma arc (metal welding).

The conclusions are very logical and understandable: electric polarisation is the appearance of a zone of electric charge at the electrically conductive poles of a polarised object, with a corresponding vector and density of electric induction. When these electrically polarised zones are closed by a conductor, the power lines are focused in the form of a spiral and tend to reach the end of this conductor (to close). Thus, the connected wires to the voltage source at the ends of these connected wires are energised by the source. This action is called "electromotive force" in electrodynamics.

If a conductor is subjected to an alternating magnetic induction vector from an external magnetic field, an electric induction line appears on the surface of the conductor. The force acting on the conductor around this line is also called the "electromotive force".

In the direction opposite to the vector of the electric induction line, magnetic field lines are formed in a closed electrical circuit from a source of electric potentials or an external magnetic field. In electrical engineering, prior to our study, this action is called the emergence of a current force that forms a magnetic field.

In my opinion, the new interpretation is more logical and consistent with the factors we observe in electrical circuits.

It can also be concluded that there are two types of magnetic fields: the static field that we observe when permanent magnets are in operation or in a ferromagnetic core when it is excited, and the dynamic magnetic field (or phenomenon) that we observe directly around a conductor during the phenomenon of electromagnetic induction.

We have just clarified this point by replacing Maxwell's equation with Ampere's law (extended by Maxwell): "An electric current and an alternating electric field create a magnetic field".

Let's also assume that in a static magnetic field, power lines are closed either between their own poles or between the poles of other sources. In a dynamic magnetic field, power lines can be closed for current generators or open for voltage generators. In the electrical measurement system, the dynamic magnetic field corresponds exactly to the phenomenon of current, which is measured in amperes. Ampere's law corresponds to the action of the dynamic magnetic fields of two conductors or a conductor with a dynamic magnetic field in a static magnetic field.

The power lines of an electric field (charge poles) are not closed, they tend to be closed. According to Coulomb's law, electric charges of different names are attracted to each other. If the intensity of electric induction reaches a point where the lines of force can close, an electric discharge phenomenon occurs with the formation of a dynamic magnetic field along the line of closure of the electric field lines of force, which is called the electromotive force. In this case, the electric energy of the gap is used to generate a dynamic magnetic field, a phenomenon known as the electric current phenomenon.

Next, we will consider a simpler electromagnetic generator. I guarantee you another interesting point about how a conductor with a current in a magnetic field works. In electrical engineering, an electromagnetic generator is considered a current source (current generator). It's interesting to wonder what a current is, but the name is correct and we'll find out. Get ready for a lot of maths. I would advise you to take a pencil and a notebook and do the maths following my examples with other initial data. A design engineer starts with a task or idea, then drawings and calculations, and only then metalworking, installation and launch.

A simpler DC electromagnetic generator.

You are probably familiar with the general interpretation of the principle of operation of a DC generator:

> A direct current generator is an electromechanical machine that converts mechanical energy supplied by the primary motor into electrical energy, which is removed from the armature winding by means of a collector and brushes. Electricity consumers (electrical load) are connected to the generator brushes.

We are familiar with the formula for calculating electrical power [Pe] in a DC circuit:

$$Pe = IU \qquad (20)$$

The formula for calculating mechanical power [Pk] is as follows:

$$Pk = Fv \qquad (21)\text{, wheree}$$

$\boldsymbol{F}$ - applied force, N; $\boldsymbol{v}$ - speed of force application, m/s.

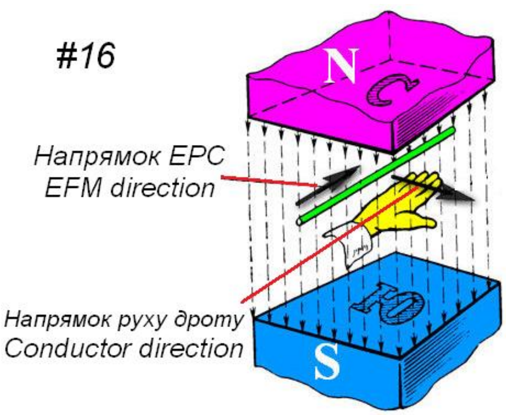
Can someone please explain to me how mechanical power is converted into electrical power if the generator is powered by the phenomenon of electromagnetic induction, which produces an electromotive force in the generator winding when the magnetic field changes. The time and rate of change of the magnetic field are conditions and there need not be mechanical rotation of the rotor in the stator. This is a point where the official interpretation does not correspond to reality.

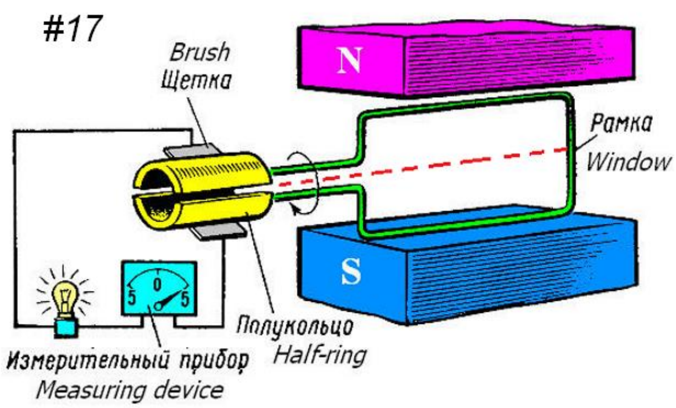
For further understanding, we will interpret the function of an electromagnetic generator as follows: an electromagnetic generator converts the energy of a magnetic field into the electromagnetic energy of an electric circuit. In an electromagnetic generator, electromagnetic inductions are performed: generation of EMF (electric potential difference) and generation of current (dynamic magnetic field of an electromagnetic circuit).

The principle of operation of the DC generator

The principle of operation of the electric generator is based on the use of the phenomenon of electromagnetic induction, which consists in the following. If you move a conductor in the magnetic field of a permanent magnet so that it crosses the magnetic flux, an electromotive force (EMF) will arise in the conductor, which is called induction EMF (induction - from the Latin word inductio - guidance, inducement), or induced EMF. The electromotive force also occurs when the conductor remains stationary and the magnet moves. The phenomenon of induced EMF in a conductor is called electromagnetic induction. If a conductor in which an emf is induced is included in a closed electric circuit, then under the action of the emf a current will flow in the circle, which is called an induced current.

It was found experimentally that the magnitude of the induced EMF that occurs in a conductor during its movement in a magnetic field increases with an increase in the induction of the magnetic field, the length of the conductor, and the speed of its movement. Induced emf occurs only when a conductor crosses a magnetic field. During the movement of the conductor along the magnetic lines of force, EMF is not induced in it. The direction of the induced EMF and current is easiest to determine by the right-hand rule (Fig. #16): if the palm of the right hand is held so that the magnetic lines of force of the field enter it, the bent thumb would show the direction of movement of the conductor, then the remaining outstretched fingers would indicate the direction of action of the induced emf and the direction of the current in the conductor. Magnetic lines of force are directed from the north pole of the magnet to the south.

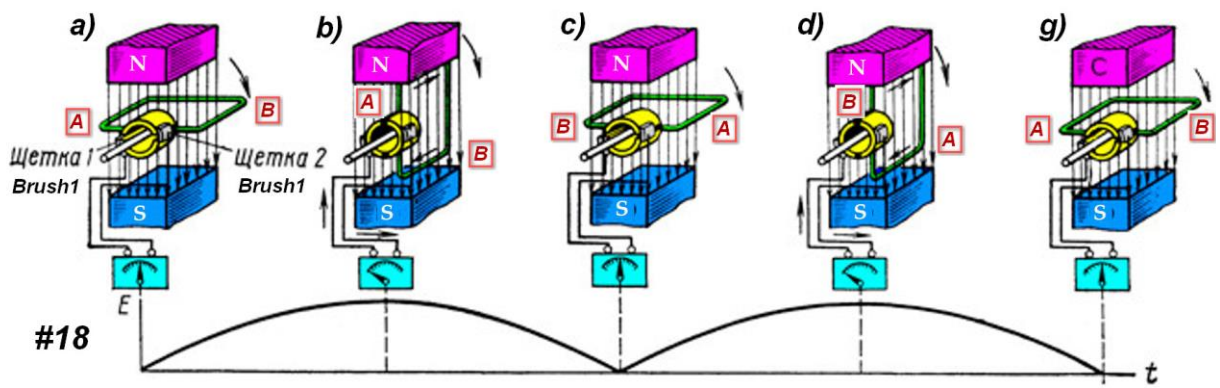




Having a general idea of electromagnetic induction, consider the principle of operation of the simplest generator (fig. #17). The conductor in the form of a frame made of copper wire is fixed on an axis and placed in a magnetic field. The ends of the frame are attached to two isolated halves (half rings) of one ring. Contact plates (brushes) slide on this ring. Such a ring consisting of isolated half-rings is called a collector, and each half-ring is a collector plate. Brushes on the collector should be located in such a way that during the rotation of the frame they simultaneously pass from one half-ring to another exactly at those moments when the emf induced in each side of the frame is zero, that is, when the frame passes its horizontal position.

With the help of the collector, the alternating EMF induced in the frame is rectified, and a current that is constant in direction is created in the external circuit. By connecting to the contact plates an external circuit with an electrical measuring device that records the magnitude of the induced current, we make sure that the device in question is really a direct current generator.

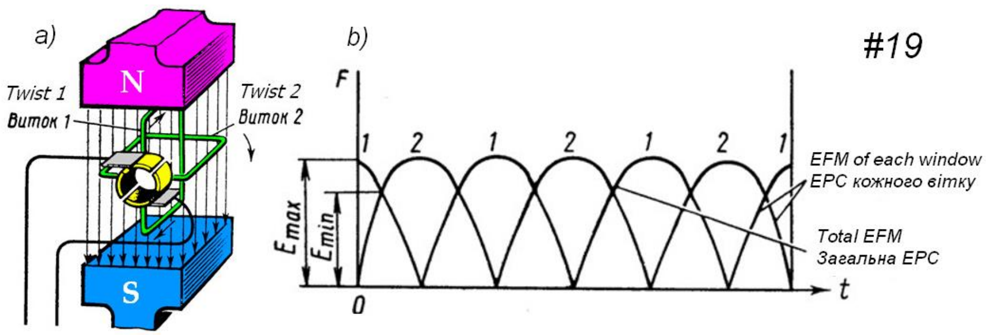
At any moment of time t, the emf [E] (Fig. #18) arising in the working side L [A] of the frame is opposite in direction to the emf arising in the working side L [B]. EMF direction. on each side of the frame is easy to determine using the right-hand rule. The emf induced by the entire frame is equal to the sum of the emfs arising in each of its working sides. The magnitude of the emf in the frame changes continuously. At the time when the frame approaches its vertical position, the number of lines of force crossing the conductors in 1 s will be the largest and the maximum EMF will be induced in the frame. When the frame passes a horizontal position, its working sides slide along the lines of force without crossing them, and the emf. not induced. During the movement of side B of the frame to the south pole of the magnet (Fig. #18, a, b), the current in it is directed towards us. This current flows through the half ring, brush 2, the meter to the brush /to the [A] side of the frame. In this side of the frame, the current is induced in the direction away from us. The EMF in the frame reaches its greatest value when its sides are located directly under the poles (Fig. #18, b).



With further rotation of the frame, the EMF in it decreases and becomes zero after a quarter of a turn (Fig. #18, c). At this time, the brushes move from one semi-ring to another. Thus, for the first half of the revolution of the frame, each half-ring of the collector came into contact with only one brush. The current passed through the external circuit in one direction from brush 2 to brush 1. We will continue to rotate the frame. The electromotive force in the frame begins to increase again, as its working sides will cross the magnetic field lines. However, the direction of the emf is reversed because the conductors cross the magnetic flux in the opposite direction. The current induced on the other side [A] of the frame is now directed towards us. But due to the fact that the frame rotates together with the collector, the half-ring connected to side A of the frame is now in contact not with brush 1, but with brush 2 (fig. #18, d) and the current of the same passes through the external circuit direction, as well as the time in the first half of the revolution. Therefore, the collector rectifies the current, that is, it ensures the passage of the induced current in the external circuit in one direction. By the end of the last quarter of a revolution (fig. #18, g), the frame returns to its initial position (fig. #18, a), after which the entire process of changing the current in the circuit is repeated.

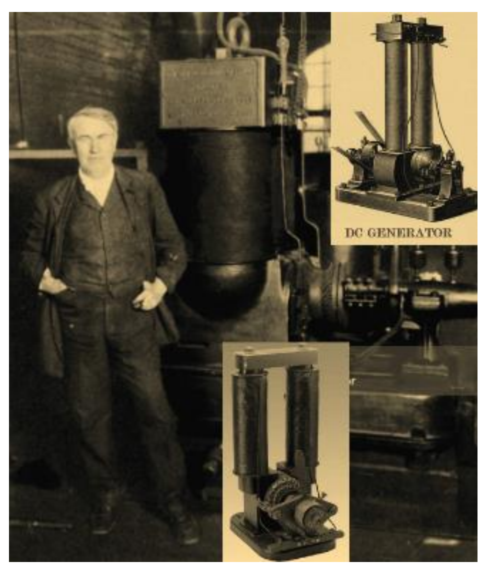
Thus, there is a constant EMF in the direction between brushes 2 and 1, and the external circuit current always flows in one direction - from brush 2 to brush 1. Although this current remains constant in direction, it varies in magnitude, that is, it pulses. Such a current is practically difficult to use.

Let's consider how it is possible to obtain a current with a small pulsation, that is, a current whose value does not change much during the operation of the generator. Let's imagine a generator consisting of two turns located perpendicular to each other (Fig. #19, a). The beginning and end of each turn are connected to the collector, which now consists of four collector plates.



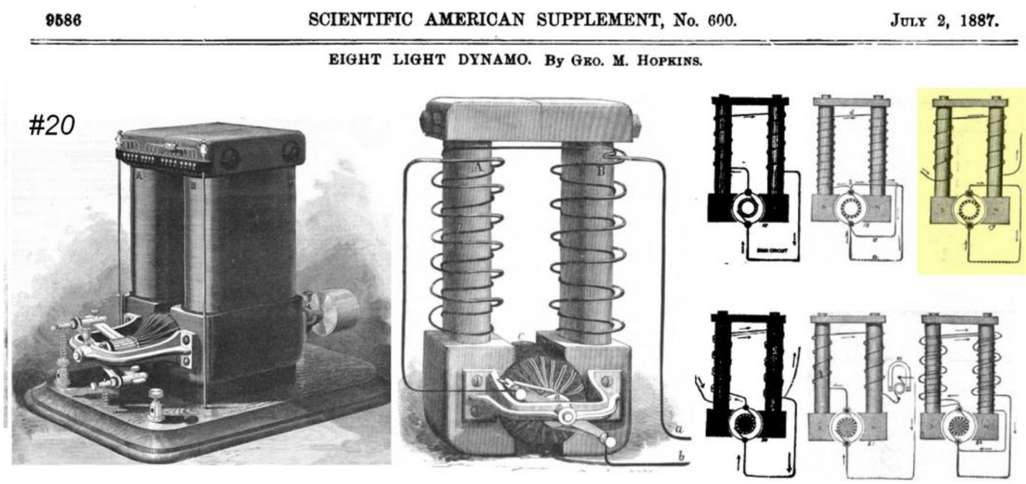
When these coils rotate in a magnetic field, an emf occurs in them. However, the emfs arising in each turn do not reach their zero and maximum values simultaneously, but later one after the other during the time corresponding to the turn of the turns by a quarter of a full turn, that is, by 90°. In the position shown in (Fig. 19), a, the maximum EMF, equal to ***E max***, occurs in turn 1. In turn 2, EMF is not induced, since its working sides slide along the lines of force of the magnetic field without crossing them. The EMF value of the turns is shown in (Fig. No. 19, b). As the turns turn, the EMF of turn 1 decreases. When turning the turns by 1/8 of a turn, the EMF of 1 turn is E min. At this moment, the brushes switch to the second pair of collector plates connected to coil 2. Coil 2 has turned 1/8 of a turn, crosses the magnetic field lines, and an emf equal to the same Emach value is induced in it. . With further turning of turns E.R.S. turn 2 increases to the largest Emah value. Thus, the brushes are permanently connected to the turns, in which an emf with a value from ***E min*** to ***E max*** is induced.

If you think that this is a theoretical interpretation of the operation of a direct current electromagnetic generator, you are mistaken. At the end of the 21st century and the beginning of the 20th century, direct current was used. Direct current generators of various powers were produced industrially. In the photo on the right, Thomas Edison against the background of a powerful direct current generator of the end of the 21st century (approximately 1890-99). We will consider the construction of these generators in more detail, only a smaller copy of it, which is also in the photo (in the lowlands).



There is a description for the independent manufacture of an electromagnetic dynamo in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 600. JULY 2, 1887. (p.9586 - 9590) EIGHT LIGHT DYNAMOS. Gro. M. HOPKINS.

[Eight Light Dynamo - Scientific American Supplement № 600 July 2, 1887]



The material of the yoke, the rods of the excitation coils and the pole tips are made of metal. It is interesting how the anchor is made and how the windings are wound, let's take a closer look.

The armature shaft (1) is mounted to rotate freely on the bearings, with about one inch of clearance between the periphery of the armature and the magnet. On the area of the armature shaft lying between the poles of the excitation magnet, a wooden cylinder (2) made of thoroughly dried hardwood of the above size is placed. On this wooden cylinder are thirty-nine iron rings or washers (3) with intermediate paper rings (4) of the same size and about one-thirty-second inch thick. Brass rods are drilled in the iron rings at diametrically opposite points, with the help of which the entire series is fastened. Each of these rods is enclosed along its entire length in a tube of hard rubber or paper, and the nuts at opposite ends of the rods are electrically separated from the end washers by washers of an insulating material such as mica, vulcanite, or vulcanized fiber. The location of the parts of the armature core is shown in fig. 2, in which some of the iron rings are separated from each other to illustrate the construction more clearly.

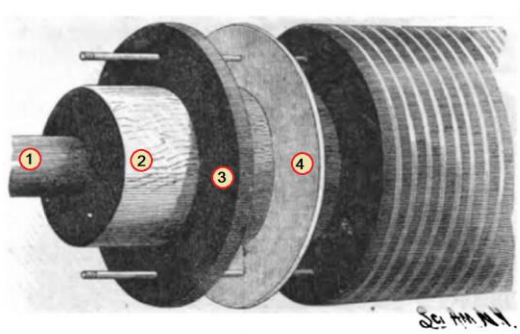
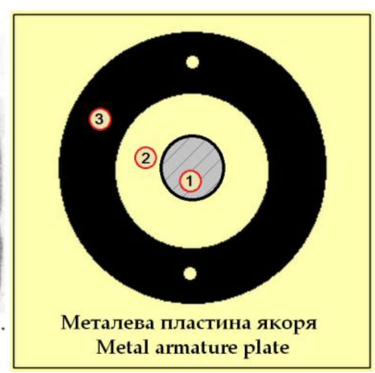


FIG. 2.—PARTS OF ARMATURE CORE.



A row of iron rings is attached to a wooden cylinder and shaft by two pins passing through the rings, wooden cylinder and shaft.

The windings are wound over the armature, forming the same rotating frames from the conductor, which we considered in the description of the theory of such a generator.

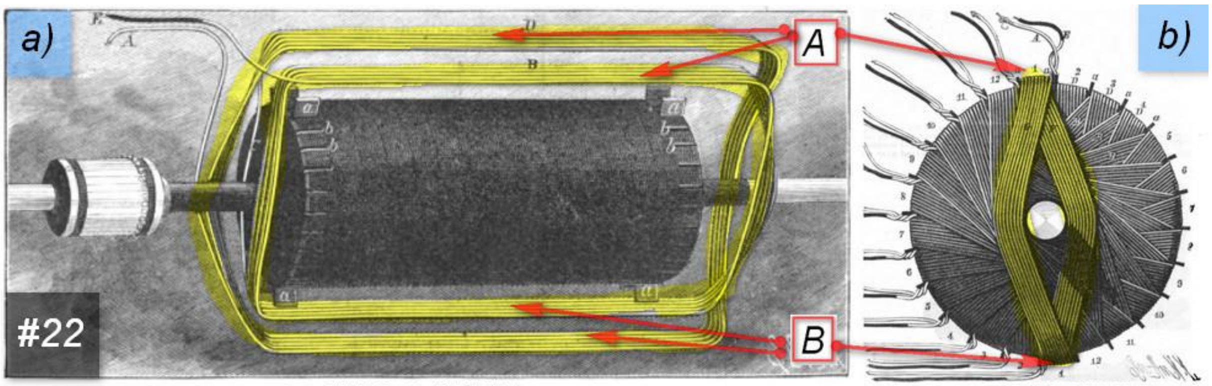
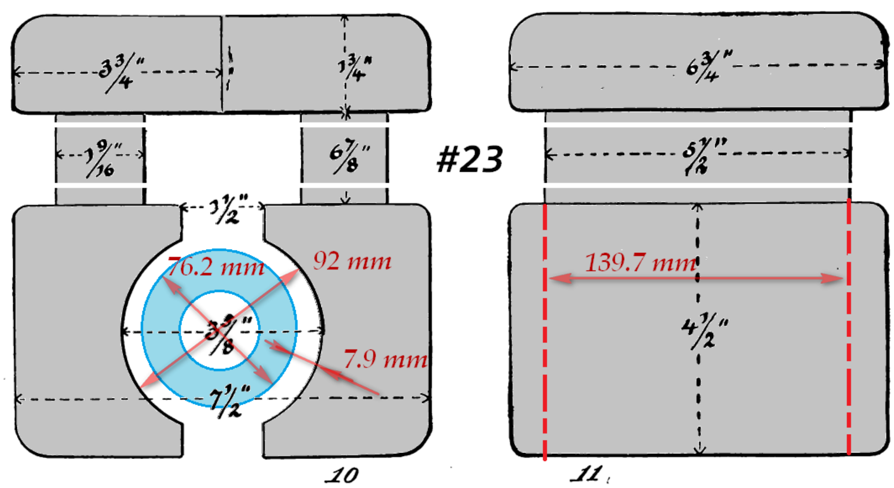


Fig. 4.—THE FIRST COIL ON ARMATURE. Fig. 5.—STARTING THE OUTER SERIES OF COILS.

It is necessary to clarify the dimensions. The main ones are the dimensions of the anchor and the gap, the rest is formed according to these dimensions. In the publication, the dimensions are in inches, I converted them to millimeters (in red in the picture).



The diameter of the metal ring of the anchor is 76.2 mm;
The diameter of the distance between the pole tips is 92.007 mm;
The gap between the ring and the pole is 7.9 mm;
The length of the anchor that contacts the pole tips is 139.7 mm.

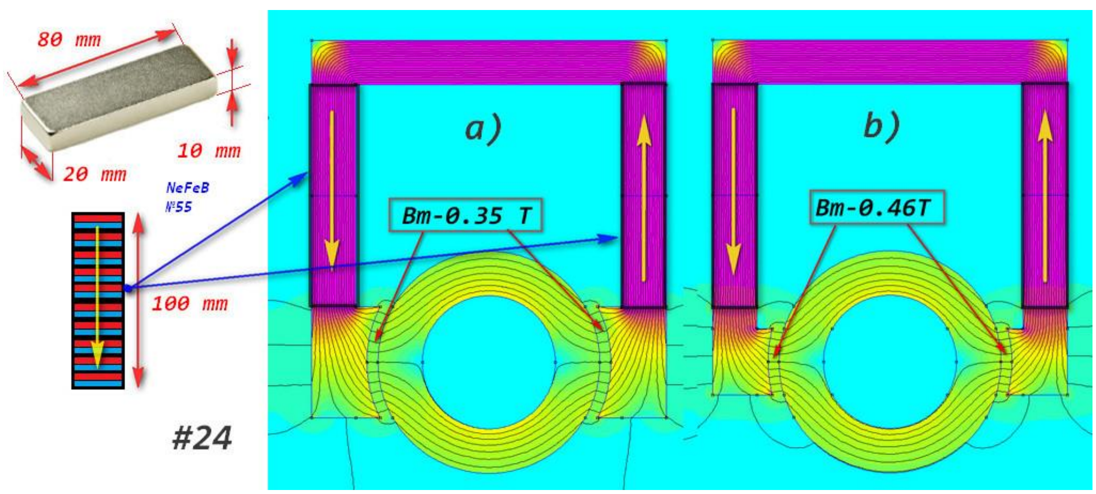
Excitation from permanent magnets will be used for the calculation. Instead of excitation coils, we will calculate the required number of magnets. I took into account the dimensions of commercially available neodymium magnets of 80 x 20 x 10 mm (#55). If we add two magnets lengthwise, then we get the length of the active side of the winding frame: 80 mm * 2 = 160 mm.

We will determine the diameter of the anchor, we will take the value of 100 mm. Next, we need to determine the value of the magnetic induction in the gap. For the calculation, I used the FEMM software (Fig. #24).

To calculate the maximum EMF, we use the EMF formula for a conductor in a magnetic field:

$$E = Bm * l * v \qquad (22)$$

In this matter, there is a golden rule of the generator, the resistance of the conductor must be kept to zero. To fulfill this rule, you need to increase the cross-section and decrease the length. A constructive feature of the generator, which is designed is a collector commutator, which does not really like the high speed of rotation of the generator. Let's take as a point of calculation the speed of rotation of the armature of 900 revolutions per minute. Only the magnetic induction indicator remains. Therefore, I planned to obtain between the stator and the armature values of magnetic induction in the range of 0.4 - 0.5 tesla.



#24

As you can see in the diagram of the magnetic field of our generator system, when applying a larger contact area through the gap between the pole pads and the armature, the magnetic field spreads across the contact plane, which affects the value of the magnetic induction in the gap. I reduced the contact plane almost to the intersection of the magnetic circle of the magnets and the yoke, in the intersection of which the magnetic induction is 1.4 tesla, and I got the planned dimension of the magnetic induction. In the final version, the calculated magnetic induction in the gap is equal to:

$$Bm = 0{,}46 \text{ T}$$

Next, we clarify the technical task of designing the generator:

- The total power of one [Pg] winding is 40 W;
- The voltage in the [U] circuit is 12V;

Made a calculation table in Excel, entered calculation formulas and values:

WINDOW DC GENERATOR

#	designation	Position	Meaning	unit
1	D	Anchor diameter	0,102	m
2	l	Active window length	0,16	m
3	v	Field change rate	4,80	m/s
4	n	Rotation frequency	900	rpm
5	f		15	Hz
6	k	Winding coefficient	1	
7	B	Magnetic induction in the circuit	0,45	T
8	n	Number of phase slots	2	PCS
9	w	Number of turns in the window	37	PCS
10	e	EMF of the window (branch)	0,692	V
11	E	EMF (phases)	**25,60**	V
12	La	Coil length active	0,32	m
13	Lr	Turn length passive	0,102	m
14	L	Phase length total	11,942	m
15	dL	Wire phase diameter	0,8	mm
16	pL	Number of bundle cores	1	PCS
17	sL	Phase wire cross section	0,502	mm^2
18	Sl	Total phase cross section	0,50	mm^2
19	I(sL)	Permissible current per wire section	5,02	A
20	I(Sl)	Permissible Current per harness section	5,02	A
21	R(L1m)	Resistance 1m wire	0,036	ohm/m
22	R(L)	Core resistance	0,428	ohm
23	Rq	Other (connection resistance)	0,050	ohm
24	Rz	*Resistance Load* ***Rz=U²/P*** *at* ***P(kW)***	3,600	ohm
25	R	Total Loop Resistance:	**4,1**	ohm
26	U	Voltage: battery / mains	**12,0**	V
27	I(max)	Maximum calculated current pulse	**3,33**	A
29	I(Rz)	Maximum load current	3,33	0,00
30	I(i)	Permissible impulse current	5,02	**1,69**
28	P(i)	Peak power	**40,01**	W

We check the basic calculations. To calculate the emf of one turn of the frame, we need to calculate the speed of rotation of the frame in meters per second. There is a suitable formula for this in electrical engineering:

$$v = 2\pi \frac{n}{30} \qquad (23)$$

$\boldsymbol{v}$ = 2 * 3.14 * (900 rpm / 30) = 4.8 m /s

The active length of the conductor consists of two segments 0.16 meters long:

$\boldsymbol{l}$ = 2 * 0.16 m = 0,32 m.

We calculated the magnetic induction earlier: Bm = 0.46 Тл (let's add - 0,45 Тл)

We calculate the emf of one turn according to the formula (22)

E = 0,45 T * 0,32 m * 4,8 m /s = 0.692 V.

The load resistance is calculated according to the basic formula:

I = U^2/ P = 12^2V / 40W = 144V / 40W = 3.6 Ω

The load current is calculated according to the basic formula of Ohm's Law:

I = U / R = 12 V / 3.6 Ω = 3.33 A

Next, we must fulfill the condition of matching the load current with the full circuit current, which is calculated by the formula (16):

$$I = \frac{\Delta U + Ui}{R + r} = \frac{U}{R}$$

Engineers practice another formula that also calculates the correspondence between the load current and the current in the complete circuit:

$$I = \frac{E - U}{R + r} = \frac{U}{R} \qquad (24)$$

This correspondence equation is just evidence that the EMF is converted into a current. We found out earlier that the current in the electrical computing system is magnetic induction around the conductor. This is precisely the statement that was in front of our eyes all the time. In our calculation, these are the following values:

(25.6V -12V = **13.6V**) / (3.6Ω + 0.448Ω =4.048Ω) = 12V / 3.6Ω = 3.33A

13.6 V is just the level of drop in the EMF level that is added to the full EMF at idle. This drop can be calculated using the drop formulas for the winding wire and the load: (ΔU = 3.333A * 0.448Ω =1.5V) + (Ui = 3.333 A * 3.6 Ω = 12.1V) = 13.6V

Why calculations? An electromagnetic generator is a current source. The principle of operation consists in the generation of full emf, which partially, when the load resistance is connected, turns into a current - magnetic induction around the conductor. An important condition for the presence of operating voltage in the circuit is to fulfill the conditions of Ohm's law in the part of the circuit with the load.

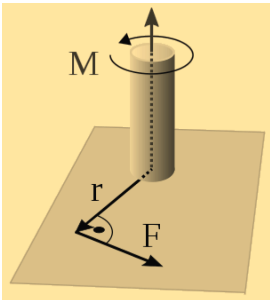
The difference from a galvanic battery is that in the electric circuit to which the generator winding is connected, the magnetic induction power lines are closed to each other, and in a galvanic battery, the magnetic induction power lines operate from one electric pole (-) to the second electric pole (+) voltage sources.

> An electromagnetic generator and a galvanic element in electrical engineering are sources of voltage and current. The difference lies in the principle of action. A galvanic cell creates that part of the emf that is not enough to maintain the electrical voltage at the battery terminals, so it is called a voltage generator. An electromagnetic generator first creates a full emf, which is later converted into a current due to a voltage drop. It is for this reason that it is called a current generator.
>
> In both devices, EMF is converted into CURRENT (MAGNETIC INDUCTION AROUND THE CONDUCTOR).

The magnetic induction in the generator winding forms an interaction with the magnetic induction of the external magnetic field. This interaction creates an electromagnetic moment on the generator shaft, which prevents the armature from rotating.

> For some reason, this force action is associated with Lenz's rule, which is related precisely to the actions of electric and magnetic induction vectors transformed into one another.

The electromagnetic force [$\boldsymbol{F_A}$] is directly related to the moment of force (torque) in mechanics due to the rotation of the armature or rotor.



Moment of force (torque) is a vector physical quantity characterizing the action of force on a mechanical object, which can cause its rotational movement. It is defined as the vector product of the radius vector of the force application point [r] by the force vector [F]. The moment of force arising under various conditions is called torque in engineering.

The moment of force is denoted by the symbol [M] or [τ] (tau).

SI unit: Nm (Newton meter).

$$[M] \ or \ [\tau] = Fr \qquad (25)$$

There are formulas that list mechanical power [Pk] in watts, torque [τ] in Newton meters, and vice versa:

$$\tau = \frac{9{,}55 \cdot Pk}{n} \quad (26) \qquad Pk = \frac{\tau \cdot n}{9{,}55} \quad (27)$$

Let's remember once again that Power (N, P, W) is work [A] performed per unit of time [t], or energy transferred per unit of time:

N=A/t, where

N is the power, A is the work performed, t is the time period during which this work is performed.

In the SI system, power is measured in watts. Another unit of measurement that is still widely used today is horsepower (1 hp = 735.5 watts).

Power in mechanics, if a force acts on a moving body, then this force does work. The power in this case is equal to the scalar product of the force vector by the velocity vector with which the body moves:

$$Pk = F \cdot v \cdot cos\alpha$$

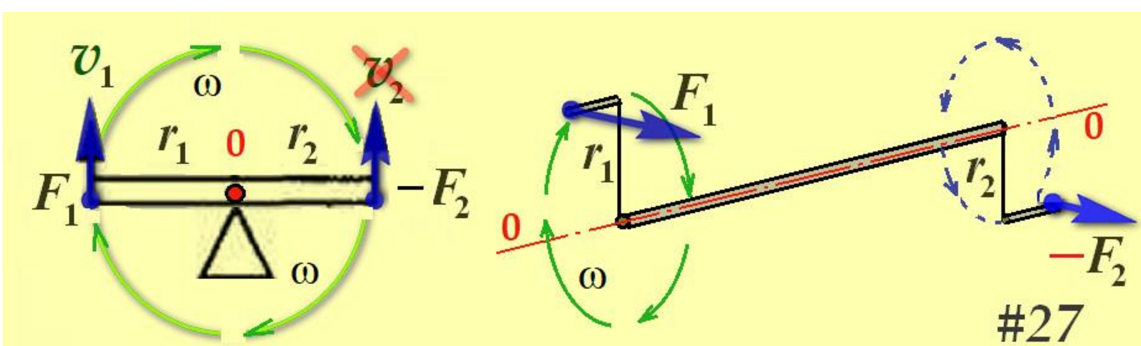
Where: ***F*** — force, ***v*** — speed, α — the angle between the velocity and force vector.

A special case of mechanical power [Pk] during rotational motion:

$$\mathrm{Pk} = \tau\omega = \frac{\pi\tau n}{30} \quad (28)$$

where, τ is the moment, ω is the angular velocity, π is the pi number 3.14159265358979323, n is the rotation frequency (number of revolutions per minute, rpm).

We have already found out that an electromagnetic generator, when working with a connected load, creates a magnetic induction around the conductor. The condition for performing this work with a mechanical electric generator is the rate of change of the magnetic field, which is achieved by the speed of rotation of the conductor frame on the armature. To rotate the generator armature, it is necessary to apply the mechanical power of external engines: hydro turbines, gas turbines, wind turbines, internal combustion engines, etc. How it all looks, in the case of work, is shown in the picture (#27). The electromagnetic force [-F_2] has a minus sign because it prevents the mechanical force of the motor [F_1] from rotating the axis [**0**] of the mechanical motor-generator system.



The electromagnetic moment of the electric generator [$\tau g = F_2 \cdot r_2$] consists of the Ampere force [$-F_2$] and the radius of the vector [r_2]. The direction of action of the Ampere force is opposite to the direction of the moment of force (torque) of the motor [$\tau m = F_1 \cdot r_1$], in which the armature of the generator rotates. Assume that the radius vectors of the engine and generator are equal. For the rotation of the mechanical system, the idle torque [τ_0] must also be taken into account. The required engine torque should be calculated using the formula [$\tau_m = \tau_g + \tau_0$]. The task of the moment of the engine force is to compensate the electromagnetic moment of the generator and ensure rotation of the armature with an angular speed that provides the calculated speed of rotation, to perform the phenomenon of electromagnetic induction of the set level.

Let's calculate the magnetic moment of the calculated direct current generator (*page 28*). Let's write the appropriate formula for calculation:

$$\tau = Fa \cdot r = Bm \cdot 2l \cdot I \cdot \frac{D}{2} \cdot w \qquad (29)$$

where: ***Bm*** is the magnetic induction of the external field in the area of action on the current-carrying conductor; ***I*** - current strength of the conductor; ***l*** - the length of the active conductor; ***w*** is the number of conductors in the frame winding; ***D*** is the diameter of the anchor.

Let's count:

$$\tau_g = 0.45 \text{ T} * 2 * 0.16 \text{ m} * 3.36 \text{ A} * (0.102 \text{ m} / 2) * 37 \text{ turns} = 0.913 \text{ Nm}$$

Let's convert it into a measure of mechanical power [Pk_g] using the formula (27):

$$Pk_g = \tau_g n / 9.55 = (0{,}913 \text{ Nm} * 900 \text{ rpm}) \ / \ 9{,}55 = 86.04 \text{ W}$$
$$Pk_g = \pi \tau_g n / 30 = 3.14 * 0.913 \text{ Nm} * 900 \text{ rpm} / 30 = 86.04 \text{ W}$$

We obtained the result of the value of the mechanical power of the electromagnetic moment of the generator $Pk_g = 86$ W, greater than the electric power $Pe_g = 40.3$ W.

I have researched this issue, which you can read by following the link:

AMPERE STRENGTH https://rakatskiy.blogspot.com/p/ampere-force.html

The dependence of the resulting effect of Ampere's force on the level of voltage drop on the current-carrying conductor is revealed. This dependence can be calculated using the formula:

$$k_R = \frac{U}{E} \qquad (30)$$

where: k_R is the dependence coefficient; ***E*** – emf without connected load; ***U*** is the operating voltage at the terminals of the generator with a load.

Let's calculate the dependence coefficient: $k_R = U / E = 12 \text{ V} / 25.6 \text{ V} = 0.469$

We add it to the calculated electromagnetic moment of the generator according to the formula (29)

$$\tau = k_R \cdot Fa \cdot r = Bm \cdot 2l \cdot I \cdot \frac{D}{2} \cdot w \qquad (29.1)$$

τ_g = 0.469 * 0.45 T * (2 * 0.16 m) * 3.36 A * (0.102 m / 2) * 37 turns = 0.43 Nm

Let's turn it into a measure of mechanical power using the formula (27):

$Pk_g = k_R * \tau_g n$ / 9.55 = 0.469 * (0.913 Nm * 900 rpm) / 9.55 = 40.3 W

In electrical engineering, the formula Pe(g) = EI = 25.6V * 3.36A = 86 W is used to calculate the full electrical power of the generator, which does not correspond to the actual electrical power that performs work on the load,

$Pe_{[LOAD]}$ = UI = 12B * 3.36A = 40.3 W.

In mechanics, there is a concept of potential and kinetic energy. Potential together with kinetic energy takes into account not only the position of bodies in space, but also movement, potential energy constitutes the mechanical energy of a physical system.

$$Ek = \frac{1}{2}mv^2, \qquad (30)$$

where: ***Ek*** is the kinetic energy of the body; ***m*** is body mass; ***v*** is the speed of movement of the body.

Rotational Kinetic Energy: Things that roll without slipping have some of their energy as translational kinetic energy and the rest as rotational kinetic energy. The ratio depends on the moment of inertia of the rolling object:

$$Ek = \frac{1}{2}J\omega^2 \qquad (31)$$

where: ***ω*** is the angular velocity and ***J*** is the moment of inertia around the axis of rotation.

The mechanical work applied during rotation is the torque (τ) greater than the angle of rotation (θ):W=τθ

The instantaneous power of an angularly accelerating body is a torque times the angular velocity: P=τω

The general formula of the linear vector of potential mechanical energy has the algorithm of the product of the mass of the body by the square of the speed:

$E = mv^2$, (32); for the universe $E = mc^2$, (33)

where: E – use of mechanical energy (J); m – body mass (kg); v - speed of movement of the body (m/s); c – speed of light (m/s).

By analogy with the mechanical system, the electromagnetic energy system for the electromagnetic generator can be written:

Electric field potential:

$$Ee = EI, \qquad (34)$$

Working electromagnetic field:

$$Ee = \frac{1}{2}EI, \quad (35) \text{ or } Ee = UI, \qquad (36)$$

Where: Ee - electromagnetic energy performing work (J); E - electrodestructive force of the circuit without connecting the load support (B); U - operating voltage at the generator terminals when the load resistance is connected (V); I - current strength or magnetic field around the conductor (system of electrical measurements), which is the result of the transformation of EMF around the conductor (A).

This interpretation is just a logical mathematical proof that part of the electric potential field of the system E (EMF) is converted into a magnetic field around the conductor Bi (A) which does the work.

Thus, a new version of Maxwell's equations:

- curl E = -dBm /dt
- crul Bi = -dE /dt

are fully confirmed on the example of the operation of a simpler electromagnetic generator with a connected load.

Earlier, we considered that the rotation of the generator armature requires a drive motor that provides a moment of force (torque) to overcome the electromagnetic force of the generator and rotate the generator armature at a certain angular speed under load and idling.

Usually, for this task, engines are used that have mechanical power for rotation from steam or gas pressure, water pressure, wind, etc. For the calculation of the mechanical part, all actions of the power influence of the sources are converted into torque (*Nm*) and mechanical power (*W*).

All actions of a mechanical system are associated with frictional and rotational losses in idle mode and under load. The idle mode is the mechanical power that requires the rotation of the armature with the calculated angular speed of rotation. Let us consider the possibility of using an electric motor as a drive motor.

The design of the electric motor is very similar to the design of the generator, but it has the reverse effect of the electric generator.

An electric motor is an electric machine that converts electromagnetic energy into mechanical energy to drive various mechanisms. This statement is absolutely true, in comparison with the action of an electric generator, in which mechanical force is only a condition for performing electromagnetic induction.

The electric motor is the main element of the electric drive. As a rule, an electric motor consists of two main components - an armature (rotor) and a stator.

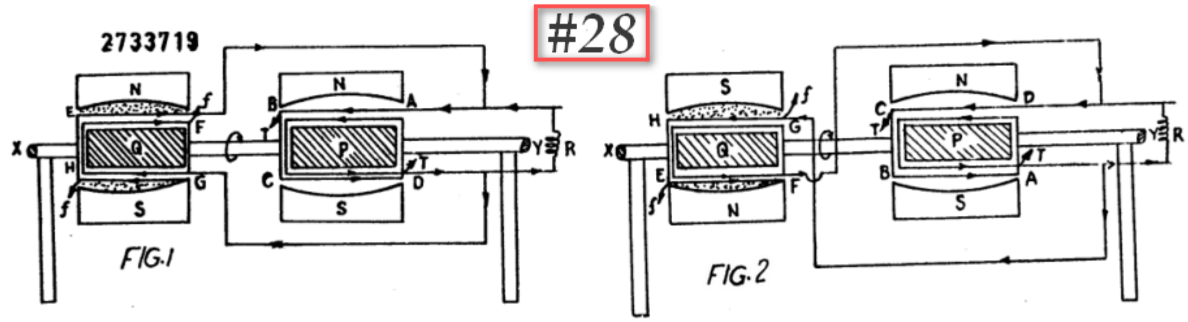
Modern official science denies the use of an electric motor as a drive motor for an electric generator to obtain an efficiency ratio of more than 100%. Scientists attribute this action to the capabilities of the system as a "perpetual engine", which, according to scientists, is impossible. We will check it to confirm or deny this statement. To do this, let's take for consideration an interesting patent, which is exactly the opposite of the statements of scientists.

Patent DE2733719A1, which was published on 1979-02-15 in Germany, by the inventor: Chitta Ranjan Mukherjee. *Category: H02K53/00 Anticipated dynamo-electric perpetual motion machines.*

An electric generator without an external source of mechanical energy - uses a conventional generator and an electric unit with excitation magnets and an armature

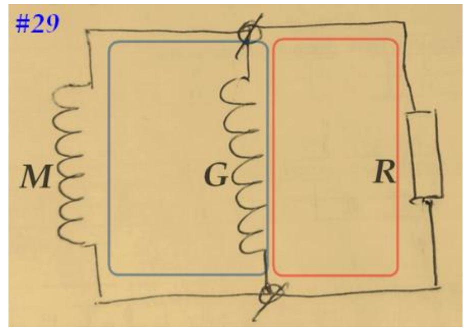
Abstract: A machine for converting magnetic energy into electrical energy, for example, a generator, is designed in such a way that, unlike conventional generators, which require the input of an external source of mechanical energy into the generator to obtain electrical energy, to obtain electrical energy, energy from any what external source, in addition to the generator itself, to obtain electrical energy. Thus, the invention includes a conventional electric generator and an electric unit equipped with excitation magnets (fields) and an armature containing conductors through which an electric current passes, counteracting the counterforce produced on the shaft of a conventional generator, to create the driving force necessary for rotation of the generator shaft. The electric unit is installed on the generator shaft, rotates with the shaft and continuously creates a driving force on the shaft.

#28



If you are interested, you can read the original patent:
https://worldwide.espacenet.com

As we look at the drawings from the patent in figure (#28), we see two frame windings, on the same axis, rotating in the magnetic fields of permanent magnets. The frame windings are connected in parallel, and a load R is connected to this connection. On the electrical diagram, it looks very simple and very implausible (Fig. #29).



When calculating the generator, we used the circuit marked in red in the figure. We need to find out the possible operation of the circle, which is marked with a blue outline, taking into account the torque of the engine and the electromagnetic moment of the generator.

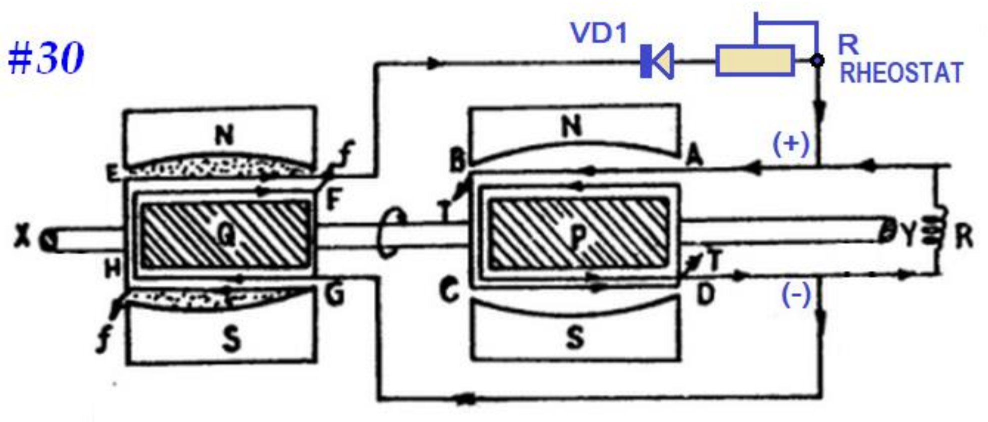
First, let's find out the electrical parameters of the engine, such as the load. Let's calculate the indicators of a direct current motor with a power of Pe - 40 W, with a voltage in the circuit U - 12 V. We need to calculate the resistance and current:

$$R = U^2 / Pe = (12V)^2 / 40W = 3.6\ \Omega$$
$$I = U / R = 12\ V / 3.6\ \Omega = 3.33\ A$$

The resistance of the winding wire of the generator frame r = 0.428 Ohm. To fulfill the condition of the machine as a 40W DC motor, we need to add an additional resistance of 3.12 ohms to the electromechanical machine circuit. In this way, the resistance conditions for the motor as a load will be met:

$$R_{motor} = r_L + R_{rheostat} = 0.428\ \Omega + 3.12\ \Omega = 3.6\ \Omega$$

Suppose we untwisted the system and connected the two machines through the shaft, closed the contacts (fig. #30) and added a rheostat and diode so that the motor current in the motor winding had the intended direction.



Let's calculate the electrical and mechanical indicators of such a system. I compiled the calculation module in Excel and entered the relevant data for the generator and engine.

Tabl.#34

#	Position	designation	unit	Generator		Motor	
1	Anchor diameter	*D*	*mm*	102		102	
2	Active window length	*l*	*mm*	160		160	
3	Rotation frequency	*RPM*	*rpm*	900		900	
4	Magnetic induction in the circuit	*B*	*tesla*	0,45		0,45	
5	Number of phase slots	*n*	*pieces*	2		2	
6	Number of turns in the window	*w*	*pieces*	37		250	
7	Wire phase diameter	*d*	*mm*	0,8		0,35	
8	Winding coefficient	*k(w)*	*number*	1		1	
9	Number of bundle cores	*	*pieces*	1		1	
10	Permissible current per wire section	*I(Sd)*	*A*	10		10	
11	Connection resistance / Rheostat	*R(j)*	*Ω*	0,05		3,17	
12	Load power	*P(Load)*	*W*	40		40	
13	Voltage: battery / mains	*U*	*V*	12		12	
14	Power with power factor	*k(P)*	*number*	1		1	
						1	**2**
15	Total Loop Resistance:	*R*	*Ω*	4,08		3,60	3,60
16	Permissible Current per harness section	*I [w]*	*A*	5,02		5,02	5,02
16	Maximum Load current	*I [LOAD]*	*A*	3,33	0,00	3,33	3,33
17	Maximum calculated current pulse	*I*	*A*	**3,33**	1,69	**3,34**	**3,34**
17	Peak power	*Pg[Pm]*	*W*	**40,01**		**40,02**	**40,02**
18	Electromagnetic torque on the shaft	*Tg[Tm]*	*Nm / W*	-0,42	-40,03	0,91	0,42
18	Torque (conversion formula) Tg = (9550*kW) / n	*Tg[Tm]*	*Nm /W*	*0,42*	*40,01*	*0,42*	*0,42*

I have obtained data that correspond to the reversibility of electromechanical machines. Indicators for the engine, marked with a red frame (1), are made without setting the compliance factor $\boldsymbol{k_R}$, blue (2) with an application designed for a generator. In the future, we will use the application of the compliance factor to calculate the engine.

We see that in order to use the generator as a motor, it is necessary to adjust the resistance of the motor circuit. For this, rheostats are used in electrical engineering, which I indicated in the diagram (#30).

Let's assume that the idling speed of the system is 20% of the generator's power. A motor is required for the system to operate: 40 W * 1.2 = 48 W.

Let's calculate the indicators of a direct current motor with a power of Pe - 48 W, with a voltage in the circuit U - 12 V. We need to calculate the resistance and current:

$$R = U^2 / Pe = (12V)^2 / 48W = 3.0\ \Omega$$
$$I = U / R = 12\ V / 3.0\ \Omega = 4.0\ A$$

We can put our motor into 48W power mode by reducing the rheostat resistance to: 3.0 ohms – 0.428 ohms = 2.572 ohms. But in this case, the motor and generator current will increase, we will get a balance. The system will not work as planned.

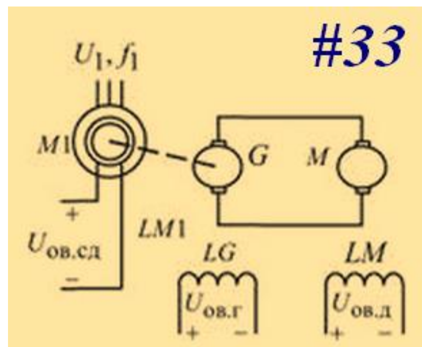
Thus, it is impossible to connect them with each other in one circle. For the robot, you need to connect the motor to the circuit with the power source, and connect the generator to the load. Efficiency 80%. For high power it is still done in some cases.

SYSTEMS "DC CONVERTER-MOTOR

Adjustable converters of different physical nature are used to regulate the speed of the DC motor on the armature winding circuit by changing the voltage:

- electric machines, performed according to the "generator-engine" system;
- semiconductor with thyristor converters of alternating voltage to regulated constant, which are performed according to the thyristor converter-motor system (TP-D);
- semiconductor with transistor voltage regulators, performed according to the "width-pulse converter-motor" system (ШИП-Д).

The scheme of the power chains of the G-M system is shown in fig. (#33).



In contrast to relay-contact circuits for controlling DC motors, the G-M system does not have bulky starting rheostats, as well as energy losses in them during starts, reverses, braking, as well as during speed control. The range of speed control is usually not more than 1/30.

The main disadvantage of G-M systems is two rotating units in the converter. The power of the executive (drive) engine is two to three times greater than the power of the output generator.

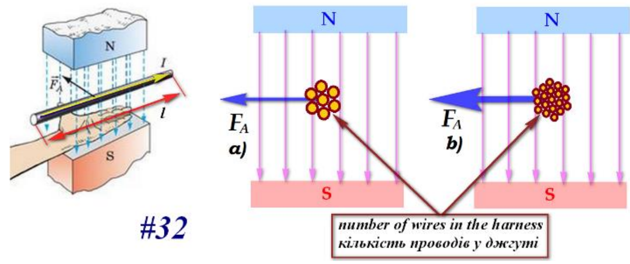
We previously calculated the possible reversibility of DC machines by including a rheostat in the motor circuit. Everything happens in accordance with the laws applied in electrical engineering.

What task do we need to solve? We need to increase the resistance of the load (motor winding) with a simultaneous decrease in the electric power of excitation and the main increase in Ampere force, which will entail an increase in torque.

In electrical engineering, the method of calculating the ampere strength of the wire with the winding current is used by calculating the amperes of the turns. Let's recall the formula (29.1):

$$\tau = k_R \cdot Fa \cdot r = Bm \cdot 2l \cdot I \cdot \frac{D}{2} \cdot w \qquad (29.1)$$

We have an indicator of current strength [***I***], which must be reduced to reduce the applied electric power, and the number of turns [***w***], which can be increased by reducing the cross-section of the conductor by also adding ohmic resistance to the calculation of the motor (Fig. #32).



#32

Let's try to calculate the engine so that the engine power is 10 W:

[10 W = 12 V * 0.83 A] [I = U/I = 12 V / 0.83 A = 14.45 Ω]

We use the formula (29.1) so that the number of turns and the rheostat corresponds to the resistance of the DC motor with a power of 10 W. We use a wire for winding with a diameter of 0.4 mm (maximum current strength 1.26 A).

Tabl: #35

#	Position	designation	unit	Generator		Motor	
1	Anchor diameter	*D*	*mm*	102		102	
2	Active window length	*l*	*mm*	160		160	
3	Rotation frequency	*RPM*	*rpm*	900		900	
4	Magnetic induction in the circuit	*B*	*tesla*	0,45		0,45	
5	Number of phase slots	*n*	*pieces*	2		2	
6	Number of turns in the window	*w*	*pieces*	37		250	
7	Wire phase diameter	*d*	*mm*	0,8		0,4	
8	Winding coefficient	*k(w)*	*number*	1		1	
9	Number of bundle cores	*	*pieces*	1		1	
10	Permissible current per wire section	*I(Sd)*	*A*	10		10	
11	Connection resistance / Rheostat	*R(j)*	*Ω*	0,05		2,92	
12	Load power	*P(Load)*	*W*	40		10	
13	Voltage: battery / mains	*U*	*V*	12		12	
14	Power with power factor	*k(P)*	*number*	1		1	
15	Total Loop Resistance:	*R*	*Ω*	4,08		14,40	
16	Permissible Current per harness section	*I [w]*	*A*	5,02		1,26	
16	Maximum Load current	*I [LOAD]*	*A*	3,33	0,00	0,83	
17	Maximum calculated current pulse	*I*	*A*	**3,33**	1,69	**0,83**	0,00
17	Peak power	*Pg[Pm]*	*W*	**40,01**		**10,00**	
18	Electromagnetic torque on the shaft	*Tg[Tm]*	*Nm / W*	-0,42	-40,03	0,72	67,61
18	Torque (conversion formula) Tg = (9550*kW) / n	*Tg[Tm]*	*Nm /W*	*0,42*	*40,01*	*0,11*	10,00
19	Electrical power difference (generator - motor)	*Pg - Pm*	*W*	30,01			
20	Torque difference (generator - motor)	*(-Tg)+Tm*	*Nm*	0,29		COP = **4,0**	

$$\tau_m = 0.469 * 0.45\ T * (2 * 0{,}16\ m) * 0.83\ A * (0.102\ m / 2) * 250\ turns = 0{,}72\ Nm$$

We check according to the transfer formula: τ = 9.55 Pe / n = 9.55 * 10 W / 900 rpm = 0,11 Nm

$$Pk = \tau_m * n / 9{,}55 = 0{,}72\text{Н·м} * 900\ \text{об/хв} / 9{,}55 = 67.5\ \text{Вт}$$

Thus, we can conclude that we managed to calculate the action of a direct current motor, with an indicator above unity of the conversion of electrical power into a mechanical moment of force:

$$\eta = Pk / Pe = 67.5 \text{ W} / 10 \text{ W} = 6{,}75 * 100 \% = 675 \%.$$

We also take into account that the idling torque of the system will be equal to 20% of the generator torque 0.42 Nm * 0.2 = 0.084 N·m, then we can further reduce the electric power of the electric motor, calculated the resistance of the motor, added a rheostat to the circuit (Fig. # 30).

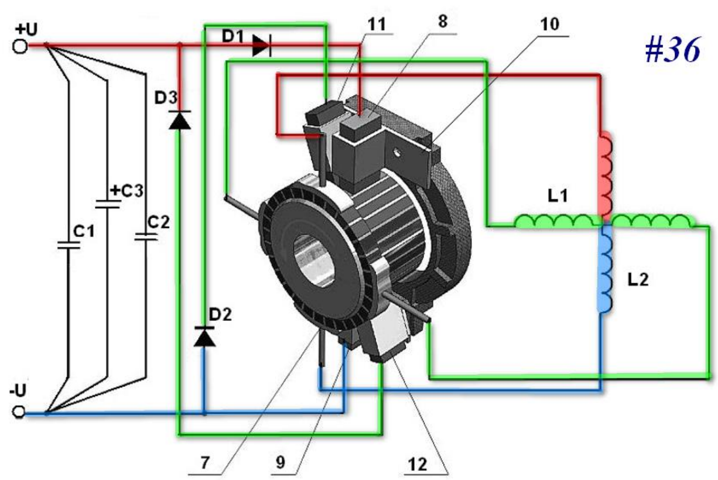
We increased the number of wire turns in the motor frame. When the current is turned off, self-induction EMF will be formed in the winding. This is exactly the same case of the reverse action of electromagnetic induction in Maxwell's electrodynamics (has an incorrect interpretation) that I specified earlier, written in the form:

$$\boxed{\text{crul Bi} = - \text{dE} / \text{dt} \quad \rightarrow \quad \text{crul E} = - \text{dBi} / \text{dt}}$$

Thus, a system for removing the voltage of the electric field from the armature winding, which is disconnected from the power source, is necessary. A similar solution for removing EMF of self-induction was developed by F.M. Kanaryov and his team:

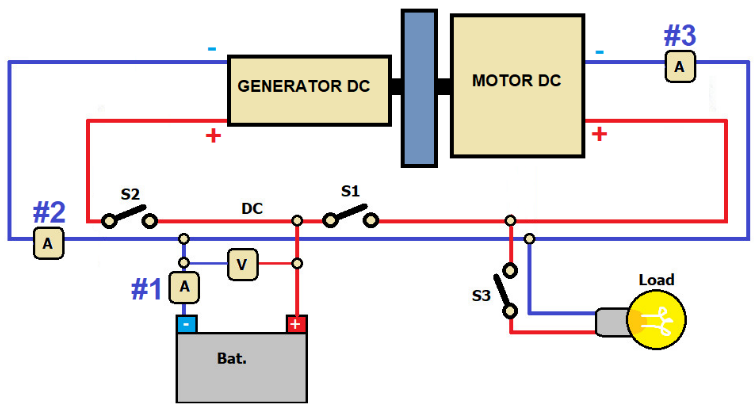
«Self-rotating electric pulse generator (RU 2460200)».

Collector 7 (fig. #36) is installed on the rotor shaft. Brushes 8 and 9 are fixed in the brush assembly 10 attached to the housing 4 of the motor-generator. Two pairs of brushes are installed in the brush unit 10. Brushes 8 and 9 transmit the voltage from the power source in the sector of the lamellas, which correspond to the convergence of the magnetic poles of the rotor and stator of the motor-generator to the position of their symmetrical arrangement. The following lamellas of the collector begin to come into contact with brushes 11 and 12 (Fig. #36), through which the EMF pulse of self-induction -Uc, which occurs in the rotor excitation winding at the moment of stopping the supply of the +U voltage pulse to the rotor winding through brushes 11 and 12, is transferred to capacitors C1, C2 and C3 (fig. #36) of the rotor power supply unit, and in this way part of the energy spent on the formation of excitation in the rotor winding is recovered.



A simpler electrical diagram of a direct current generator motor.

I always insist that a DC circuit must have an energy buffer that will be the reference voltage for that circuit. If it is important to prove "above unity", connect several ammeters in a circuit and check the direction and strength of the current in the circuit while working on each ammeter:

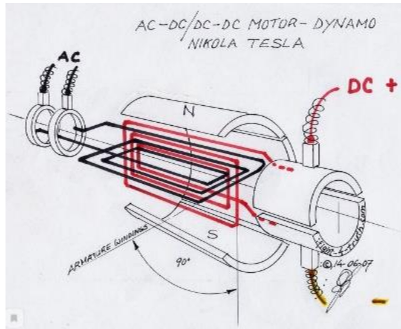


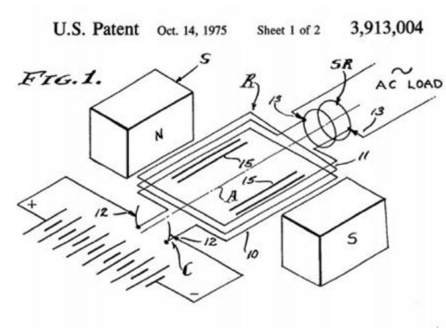
#1 (battery), #2 (generator phase), #3 (motor).

The battery can work only in the source mode or in the charge (consumer) mode. If the current flows in the direction of charge, the battery is in load mode. If the current is in the opposite direction, the battery is in source mode. If the ammeter reads zero, it means that the output current of the generator has charged the battery and all other loads are receiving current from the generator. If the current produced by the generator is not sufficient to load the circuit, the battery will begin to discharge (generate a compensating emf), ammeter #1 will immediately respond, indicating the direction and magnitude of the current. Everything is very simple and clear.

In our case, I would direct the self-induction pulse to a separate capacitor. Depending on the operating voltage and the capacity accumulated on the capacitor, I decided how to return this energy to the common circuit. A step-down DC-DC converter may be required.

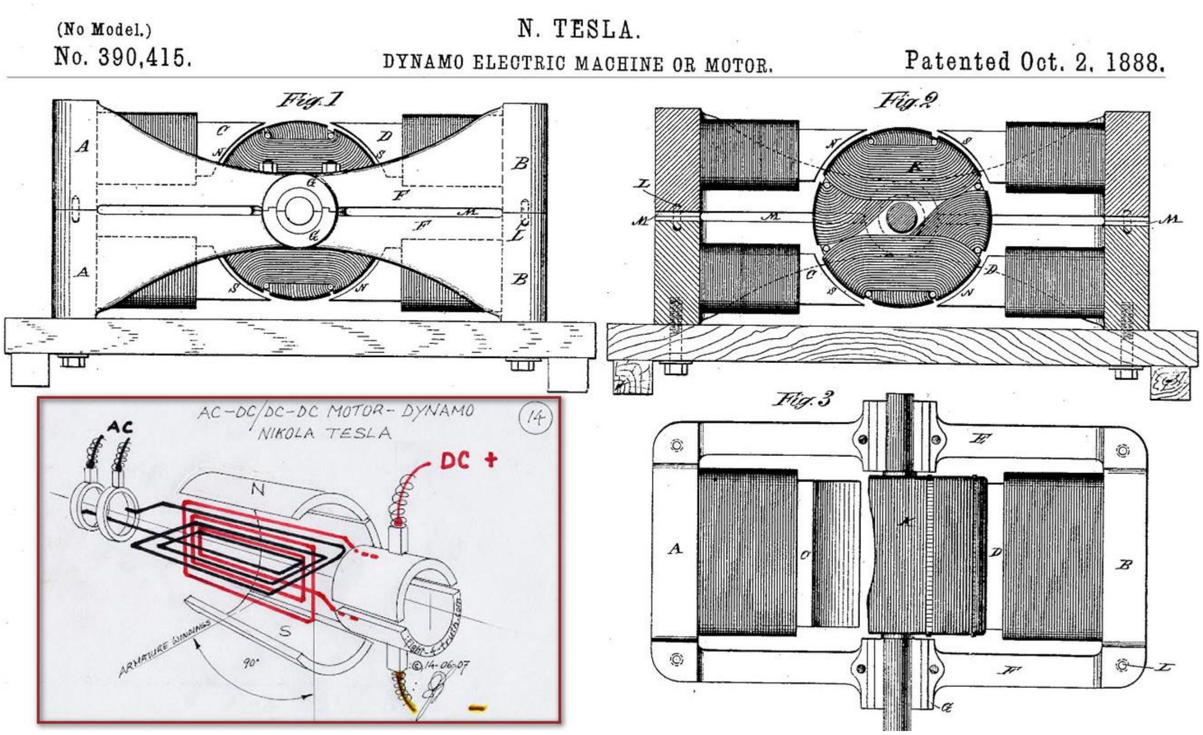
There are three interesting episodes in the world history of dynamo converters: The legend of Nikola Tesla's dynamo motor, the Lockridge converter and the inventor Robert Alexander.





Surprisingly, such a wonderful project of the converting machine of Robert Alexander - 1975 disappeared from development, as well as the project of Nikola Tesla - 1931. If you think logically, then the possibility of the identity of the technology of these devices is obvious, it is enough to look at the picture. Visually, the artist depicted the principle of operation of such a machine, which we considered and calculated the absolute possibility of creating such a machine. For the first machine you try to make, the output phase should be DC. Its placement should be done if there is a desire to try on one anchor at an angle of 90o relative to each other. The artist depicted this moment on a model of Nikola Tesla's dynamo engine.

While there is no official documentation or evidence that Tesla's dynamo in working order ever existed, only Tesla's reasoning for how he thought his dynamo could be converted into an electric machine - a DC to AC converter with this [DYNAMO-ELECTRIC MACHINE OR ENGINE (US390415 of October 2, 1888)]



There are evidences of the presence of such devices in action.

An incredible story I heard in late 1982 from a World War II veteran. In the fall of 1982, he started working as an electrician in the electrical workshop of a transport company. A veteran of the Second World War worked in the brigade, to whom he sometimes recalled the incredible story that was before his eyes. In 1945, they captured a German reconnaissance group. The group had a portable radio which included a curious device similar to an electromechanical transducer which was activated by the rotation of a shaft when the cord was wound on the shaft. The veteran claimed that the device rotated itself and supplied electricity to the radio station. No one believed in this story, they simply attributed this story to the status of a veteran. He was a local inventor at the company, developing all kinds of devices to facilitate the repair of bus equipment. I was young, so I didn't pay attention to the phenomenon of evidence of the free energy device.

There is an interesting story that was described in 2010 in an illustrated lecture by Peter Lindemann, PhD (full content http://www.free-energy.ws/) we will just prove the description of the Lockridge device:

Secrets of electric motors (part two) Understanding the principle of operation of the Lockridge device

"During the clean-up operations that followed the end of World War II, American soldiers searched all over Germany to make sure there were no more enemy combatants left. Germany operated under 'blackout' conditions at night for months, so cities were not easy targets for bombing. Besides moreover, most utilities were completely out of order, and fuel was also in short supply.

This situation inspired the genius engineer with the idea of making some light for himself in his own basement, the windows of which were completely covered with curtains.

When the American soldiers got to this house, the machine was working in the basement, working by itself and lighting light bulbs with a power of about 300 watts.

Before you is the heart of the machine.

The car was based on a Bosch car generator, most likely taken from a limited-edition Volkswagen of the time. The stator windings were modified and their location in the housing was changed. Slots were made in the case to separate the magnets into two halves. One part was repurposed for engine operation, and the other half remained as a generator. The armature windings have not been changed.

The commutator brushes have also been modified to accommodate the new coil positions and new motor features.

The American soldier who found the car was named Lockridge. Instead of handing the car over to his superiors, he packed it in a box and sent it home. Back home in Boise, Idaho, Lockridge rebuilt the machine, building working replicas throughout the 1950s and selling them to weekend campers for camping lights. Today, not a single working model has survived.

In 1980, another Boise resident, a friend of John Bedini, began trying to piece together all the surviving information. He had never seen a working model, although he found people who were known to have had working units at one time, but were unwilling to discuss their experiences with him.

30 years later, the evidence trail has cooled, and most of the eyewitnesses have passed away. The remainder of the project was handed over to John Bedin in 2008."

It didn't end there, in October 1975, Californian inventor Robert Alexander presented an improved power unit for an electric car. According to the idea of the inventor, such an electric drive was supposed to save car owners in the near future from the need to use burnt fuel, from excessive noise and from the need to constantly recharge batteries.

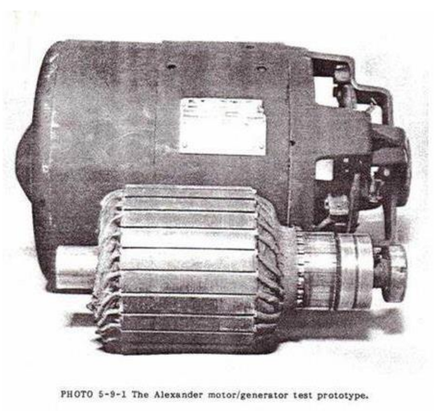
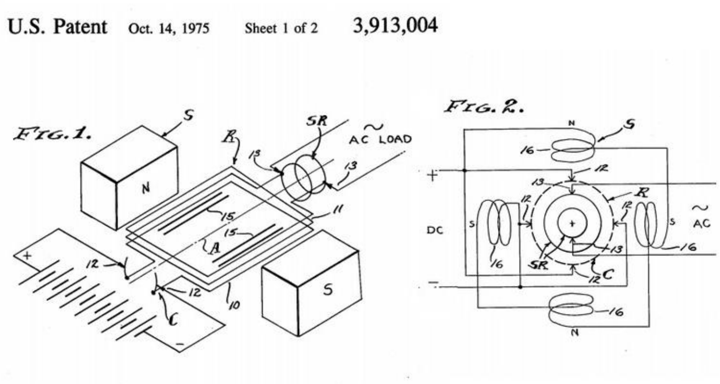


PHOTO 5-9-1 The Alexander motor/generator test prototype.



The National Tattler (11 November 1973), p. 6

"A car driven by a fuelless system" by Tom Valentine

You'll never have to drive to the gas station again if Robert Alexander's fuel-free car goes into production. Alexander invented a self-propelled system that uses a combination of electricity, air, and hydraulics. His car can run without fuel, without noise, without pollution and without the need to recharge the batteries every day. Experts are puzzled by how he manages to get energy from "nothing", but he does it. Tattler visited Pasadena, Calif., for a demo ride in an old beat-up Volkswagen that goes 36 mph but doesn't need any fuel. The engineer and physicist who accompanied Tattler was amazed. "It's wrong," he said, "You can't drive like that." Oleksandr smiled and put a finger to his lips. "Sh-sh-sh! Don't say it so loud - the machine doesn't know that." A small 7/8 horsepower electric motor provides initial power. "For the demonstration, we had to reduce the 24-volt output of the electric motor to 12 volts because we were getting too much energy," Alexander explained. Alexander, his two sons and partner James Smith of Montebello built the fuel-free VW in about 45 days, primarily to demonstrate that they had an answer to the problems of automobile pollution and fuel shortages.

Large mass media do not like to pay attention to such devices for their readers. We have all these scraps of information thanks to the efforts of those who care. The system is not interested in devices that reduce the fuel dependence of households and industry, which will pay a lot of money for energy (electricity, heat, etc.). The cost of selling electricity is only increasing, as are its needs.

I hope the material was interesting and useful for you. If you want to check whether this really happens with the power of Ampere in an engine that was manufactured at the end of the 19th century, or according to your own design, keep in mind that you need to have reliable initial data for the calculation.

Electricity and rotating mechanical devices are dangerous for the person who builds and uses them. Since you do not have experience, you need to undergo training on the safety rules of construction and use of electromechanical devices and operation of electrical power networks. The current is dangerous to life, in addition, it can cause fires if the electrical circuit is incorrectly calculated. Electricity and mechanical devices require professional knowledge and responsibility.

EMF and CURRENT
AMPERE STRENGTH
The invention of the electromagnetic generator
Electromagnetic generator
Transformer?

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