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By F. F. Mende

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I. Introduction

From the times of Lorenz and Poincare the Lorentz force was introduced as experimental postulate, and up to now there was no explanation of its physical nature. From a physical point of view the force, which acts on the material object, must be connected with its acceleration. Forces can also bear potential nature, being the gradient scalar potential field, in which it to be located. But Lorentz force is not placed in the category of the forces examined and is an exception to these rules. in the article is proven that the Lorentz force is the consequence of the dependence of the scalar potential of charge on the speed. This made possible to explain physics of power interaction of the current carrying systems, and also operating principle of all existing types of unipolar generators. It is shown also, that the ponderomotive action of electromagnetic waves is the consequence of the dependence of the scalar potential of charge on the speed, but not by the consequence of the fact that, as it was considered earlier, electromagnetic wave possesses mechanical impulse.

II. Dynamic Potentials and The Field Of The Moving Charges

As already mentioned, in the classical electrodynamics be absent the rule of the conversion of electrical and magnetic fields on upon transfer of one inertial system to another. This deficiency removes SR, basis of which are the covariant Lorenz conversions. With the entire mathematical validity of this approach the physical essence of such conversions up to now remains unexplained [1].

In this division will made attempt find the precisely physically substantiated ways of obtaining the conversions fields on upon transfer of one IRS to another, and to also explain what dynamic potentials and fields can generate the moving charges. The first step, demonstrated in the works [2-4], was made in this direction a way of the introduction of the symmetrical laws of magnetoelectric and electromagnetic induction. These laws are written as follows [5, 4-9]:

$$\begin{aligned} \oint \mathbf{E}'dl' &= -\int \frac{\partial \mathbf{B}}{\partial t}d\mathbf{s} + \oint [\mathbf{v}\times\mathbf{B}]dl' \\ \oint \mathbf{H}'dl' &= \int \frac{\partial \mathbf{D}}{\partial t}d\mathbf{s} - \oint [\mathbf{v}\times\mathbf{D}]dl' \end{aligned}, \quad (2.1)$$

or

$$\begin{aligned} rot\mathbf{E}' &= -\frac{\partial \mathbf{B}}{\partial t} + rot[\mathbf{v}\times\mathbf{B}] \\ rot\mathbf{H}' &= \frac{\partial \mathbf{D}}{dt} - rot[\mathbf{v}\times\mathbf{D}] \end{aligned}. \quad (2.2)$$

For the constants fields on these relationships they take the form:

$$\begin{aligned} \mathbf{E}' &= [\mathbf{v}\times\mathbf{B}] \\ \mathbf{H}' &= -[\mathbf{v}\times\mathbf{D}] \end{aligned}. \quad (2.3)$$

In relationships (2.1-2.3), which assume the validity of the Galileo conversions, prime and not prime values present fields and elements in moving and fixed IRS respectively. It must be noted, that conversions (2.3) earlier could be obtained only from the Lorenz conversions.

The relationships (2.1-123), which present the laws of induction, do not give information about how arose fields in initial fixed IRS. They describe only laws governing the propagation and conversion fields on in

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the case of motion with respect to the already existing fields.

The relationship (2.3) attest to the fact that in the case of relative motion of frame of references, between the fields $\mathbf{E}$ and $\mathbf{H}$ there is a cross coupling, i.e., motion in the fields $\mathbf{H}$ leads to the appearance fields on $\mathbf{E}$ and vice versa. From these relationships escape the additional consequences, which were for the first time examined in the work [10]. Ifthe chargedrod has alinearcharge g ,its electric field $E = \frac{g}{2\pi\varepsilon r}$ decreases according to the law $\frac{1}{r}$, where r isdistance from the centralaxis of the rodto the observation point.

If we in parallel to the axis of rod in the field E begin to move with the speed Δv another IRS, then in it will appear the additional magnetic field $\Delta H = \varepsilon E \Delta v$. If we now with respect to already moving IRS begin to move third frame of reference with the speed Δv, then already due to the motion in the field ΔH will appear additive to the electric field $\Delta E = \mu\varepsilon E\left(\Delta v\right)^2$. This process can be continued and further, as a result of which can be obtained the number, which gives the value of the electric field $E'_v\left(r\right)$ in moving IRS with reaching of the speed $v = n\Delta v$, when $\Delta v \to 0$, and $n \to \infty$. In the final analysis in moving IRS the value of dynamic electric field will prove to be more than in the initial and to be determined by the relationship:

$$E'\left(r, v_\perp\right) = \frac{gch\frac{v_\perp}{c}}{2\pi\varepsilon r} = Ech\frac{v_\perp}{c}.$$

If speech goes about the electric field of the single charge e, then its electric field will be determined by the relationship:

$$E'\left(r, v_\perp\right) = \frac{ech\frac{v_\perp}{c}}{4\pi\varepsilon r^2},$$

where $v_\perp$ - normal component of charge rate to the vector, which connects the moving charge and observation point.

Expression for the scalar potential, created by the moving charge, for this case will be written down as follows:

$$\varphi'(r, v_\perp) = \frac{ech\frac{v_\perp}{c}}{4\pi\varepsilon r} = \varphi(r)ch\frac{v_\perp}{c}, \qquad (2.4)$$

where $\varphi(r)$ - scalar potential of fixed charge. The potential $\varphi'(r, v_\perp)$ can be named scalar-vector, since it depends not only on the absolute value of charge, but also on speed and direction of its motion with respect to the observation point. Maximum value this potential has in the direction normal to the motion of charge itself. Moreover, if charge rate changes, which is connected with its acceleration, then can be calculated the electric fields, induced by the accelerated charge.

During the motion in the magnetic field, using the already examined method, we obtain:

$$H'(v_\perp) = Hch\frac{v_\perp}{c}.$$

where $v_\perp$ - speed normal to the direction of the magnetic field. The same result can be obtained by another method.

Let us designate field variables in the fixed frame of reference without the prime, and in the mobile – with the prime. In the differential form let us write down the formulas of the mutual induction of electrical and magnetic fields on in the mobile frame of reference as follows:

$$dH' = \varepsilon E' dv_\perp, \quad .. \qquad (2.5)$$

$$dE' = \mu H' dv_\perp. \qquad (2.6)$$

Or otherwise,

$$\frac{dH'}{dv_\perp} = \varepsilon E', \qquad (2.7)$$

$$\frac{dE'}{dv_\perp} = \mu H', \qquad (2.8)$$

where (2.7) it corresponds (2.5), and (2.8) it corresponds (2.6).

After dividing equations (2.7) and (2.8) on E and H, we will obtain respectively:

$$\frac{d\left(H'/E\right)}{dv_\perp} = \varepsilon\frac{E'}{E}, \qquad (2.9)$$

$$\frac{d\left(E'/E\right)}{dv_\perp} = \mu\frac{H'}{H}. \qquad (2.10)$$

Differentiating both parts (2.10), we have:

$$\frac{d^2\left(E'/E\right)}{d^2 v_\perp} = \mu\frac{d\left(H'/E\right)}{dv_\perp}. \qquad (2.11)$$

After substituting (2.9) in (2.11), we will obtain:

Global Journal of Science Frontier Research (A) Volume XVIII Issue V Version I Year 2018

$$\frac{d^2(E'/E)}{d^2 v_\perp} = \mu\varepsilon \frac{E'}{E}. \quad (2.12)$$

The function is the general solution (2.12) of differential equation

$$\frac{E'}{E} = C_2 ch\left(\frac{v_\perp}{c}\right) + C_1 sh\left(\frac{v_\perp}{c}\right), \quad (2.13)$$

where c – the speed of light, C_1, C_2 – arbitrary constants.

Since with $v_\perp = 0$ must be made $E' = E$, that from (2.13) we will obtain:

$$C_2 = 1. \quad (2.14)$$

After substituting (2.14) in (2.13), we finally have the general solution, into which enters one arbitrary constant C_1 :

$$\frac{E'}{E} = ch\left(\frac{v_\perp}{c}\right) + C_1 sh\left(\frac{v_\perp}{c}\right).$$

Selecting $C_1 = 0$, we obtain

$$E' = Ech\left(\frac{v_\perp}{c}\right).$$

If we apply the obtained results to the electromagnetic wave and to designate components fields on parallel speeds IRS as $E_\uparrow$, $H_\uparrow$, and $E_\perp$, $H_\perp$ as components normal to it, then conversions fields on they will be written down:

$$\begin{aligned}
&\mathbf{E}'_\uparrow = \mathbf{E}_\uparrow, \\
&\mathbf{E}'_\perp = \mathbf{E}_\perp ch\frac{v}{c} + \frac{Z_0}{v}[\mathbf{v}\times\mathbf{H}_\perp] sh\frac{v}{c}, \\
&\mathbf{H}'_\uparrow = \mathbf{H}_\uparrow, \\
&\mathbf{H}'_\perp = \mathbf{H}_\perp ch\frac{v}{c} - \frac{1}{vZ_0}[\mathbf{v}\times\mathbf{E}_\perp] sh\frac{v}{c},
\end{aligned} \quad (2.15)$$

where $Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}}$ - impedance of free space, $c = \sqrt{\frac{1}{\mu_0\varepsilon_0}}$ - speed of light.

III. Power Interaction Of The Current Carrying systems, Homopolar Induction And The Pondermotive Forces

It was already said, that Maxwell equations do not include information about power interaction of the current carrying systems. In the classical electrodynamics for calculating such an interaction it is necessary to calculate magnetic field in the assigned region of space, and then, using a Lorentz force, to find the forces, which act on the moving charges. Obscure a question about that remains with this approach, to what are applied the reacting forces with respect to those forces, which act on the moving charges.

The concept of magnetic field arose to a considerable degree because of the observations of power interaction of the current carrying and magnetized systems. Experience with the iron shavings, which are erected near the magnet poles or around the annular turn with the current into the clear geometric figures, is especially significant. These figures served as occasion for the introduction of this concept as the lines of force of magnetic field. In accordance with third Newton's law with any power interaction there is always a equality of effective forces and opposition, and also always there are those elements of the system, to which these forces are applied. A large drawback in the concept of magnetic field is the fact that it does not give answer to that, counteracting forces are concretely applied to what, since. magnetic field comes out as the independent substance, with which occurs interaction of the moving charges.

Is experimentally known that the forces of interaction in the current carrying systems are applied to those conductors, whose moving charges create magnetic field. However, in the existing concept of power interaction of the current carrying systems, based on the concepts of magnetic field and Lorentz force, the positivelyharged lattice, which is the frame of conductor and to which are applied the forces, it does not participate in the formation of the forces of interaction.

That that the positively charged ions take direct part in the power processes, speaks the fact that in the process of compressing the plasma in transit through its direct current (the so-called pinch effect) it occurs the compression also of ions.

Let us examine this question within the framework of the concept of scalar- vector potential. We will consider that the scalar- vector potential of single charge is determined by relationship (2.4), and that the electric fields, created by this potential, act on all surrounding charges, including to the charges positively charged lattices.

Let us examine from these positions power interaction between two parallel conductors (Fig. 1),

Global Journal of Science Frontier Research (A) Volume XVIII Issue V Version I Year 2018

along which flow the currents. We will consider that g_1^+, g_2^+ and g_1^-, g_2^- present the respectively fixed and moving charges, which fall per unit of the length of conductor.

The charges g_1^+, g_2^+ present the positively charged lattice in the lower and upper conductors. We will also consider that both conductors prior to the start of charges are electrically neutral, i.e., in the conductors there are two systems of the mutually inserted opposite charges with the specific density to g_1^+, g_1^- and g_2^+, g_2^-, which electrically neutralize each other.

In Fig. 1 these systems for larger convenience in the examination of the forces of interaction are moved apart along the axis *z*. Subsystems with the negative charge (electrons) can move with the speeds of v_1, v_2. The force of interaction between the lower and upper conductors we will search for as the sum of four forces, whose designation is understandable from the figure. The repulsive forces F_1, F_2 we will take with the minus sign, while the attracting force F_3, F_4 we will take with the plus sign.

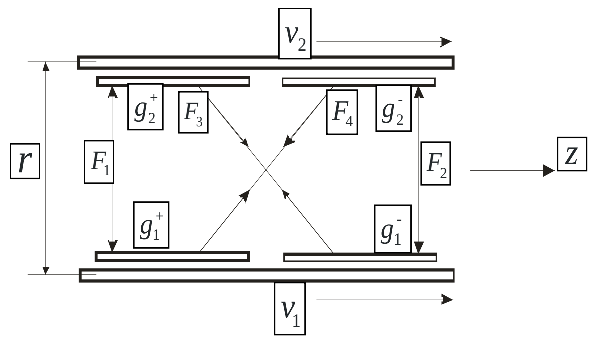

Fig. 1: Schematic of power interaction of the current carrying wires of two-wire circuit taking into account the positively charged lattice

For the single section of the two-wire circuit of force, acting between the separate subsystems, will be written down

$$F_1 = -\frac{g_1^+ g_2^+}{2\pi\varepsilon r}, \quad F_2 = -\frac{g_1^- g_2^-}{2\pi\varepsilon r} ch\frac{v_1 - v_2}{c}, \quad F_3 = +\frac{g_1^- g_2^+}{2\pi\varepsilon r} ch\frac{v_1}{c}, \quad F_4 = +\frac{g_1^+ g_2^-}{2\pi\varepsilon r} ch\frac{v_2}{c}. \qquad (3.1)$$

Adding all force components, we will obtain the amount of the composite force, which falls per unit of the length of conductor,

$$F_\Sigma = \frac{g_1 g_2}{2\pi\varepsilon r}\left(ch\frac{v_1}{c} + ch\frac{v_2}{c} - ch\frac{v_1 - v_2}{c} - 1\right) \qquad (3.2)$$

In this expression as g_1, g_2 are undertaken the absolute values of charges, and the signs of forces are taken into account in the bracketed expression. For the case $v << c$, let us take only two first members of expansion in the series $ch\frac{v}{c}$, i.e., we will consider that $ch\frac{v}{c} \cong 1 + \frac{1}{2}\frac{v^2}{c^2}$. From relationship (3.2) we obtain

$$F_{\Sigma 1} = \frac{g_1 v_1 g_2 v_2}{2\pi\varepsilon c^2 r} = \frac{I_1 I_2}{2\pi\varepsilon c^2 r}, \qquad (3.3)$$

where g_1, g_2 are undertaken the absolute values of specific charges, and v_1, v_2 take with its signs.

Since the magnetic field of straight wire, along which flows the current I, we determine by the relationship

$$H = \frac{I}{2\pi r},$$

From relationship (18.2) we obtain

$$F_{\Sigma 1} = \frac{I_1 I_2}{2\pi\varepsilon c^2 r} = \frac{H_1 I_2}{\varepsilon c^2} = I_2 \mu H_1,$$

where H_1 - the magnetic field, created by lower conductor in the location of upper conductor.

It is analogous

$$F_{\Sigma 1} = I_1 \mu H_2,$$

where H_2 - the magnetic field, created by upper conductor in the region of the arrangement of lower conductor. These relationships completely coincide with the results, obtained on the basis of the concept of magnetic field.

The relationship (3.3) represents the known rule of power interaction of the current carrying systems, but is obtained it not by the phenomenological way on the basis of the introduction of phenomenological magnetic field, but on the basis of completely intelligible physical procedures, under the assumption that that the scalar potential of charge depends on speed. In the formation of the forces of interaction in this case the lattice takes direct part, which is not in the model of magnetic field. In the model examined are well visible the places of application of force. The obtained relationships coincide with the results, obtained on the basis of the concept of magnetic field and by the axiomatically introduced Lorentz force. In this case is undertaken only first member of expansion in the series $ch\frac{v}{c}$. For the speeds $v \sim c$ should be taken all terms of expansion. In terms of this the proposed method is differed from the method of calculation of power interactions by the basis of the concept of magnetic field. If we consider this circumstance, then the connection between the forces of interaction and the charge rates proves to be nonlinear. This, in particular it leads to the fact that the law of power interaction of the current carrying systems is asymmetric. With the identical values of currents, but with their different directions, the attracting forces and repulsion become unequal. Repulsive forces prove to be greater than attracting force. This difference is small and is determined by the expression

$$\Delta F = \frac{v^2}{2c^2}\frac{I_1 I_2}{2\pi\varepsilon c^2 \varepsilon},$$

but with the speeds of the charge carriers of close ones to the speed of light it can prove to be completely perceptible.

Let us remove the lattice of upper conductor (Fig. 2), after leaving only free electronic flux. In this case will disappear the forces F_1, F_3, and this will indicate interaction of lower conductor with the flow of the free electrons, which move with the speed of v_2 on the spot of the arrangement of upper conductor. In this case the value of the force of interaction is defined as:

$$F_\Sigma = \frac{g_1 g_2}{2\pi\varepsilon r}\left(ch\frac{v_2}{c} - ch\frac{v_1 - v_2}{c} \right) \qquad (3.4)$$

Lorentz force assumes linear dependence between the force, which acts on the charge, which moves in the magnetic field, and his speed. However, in the obtained relationship the dependence of the amount of force from the speed of electronic flux will be nonlinear. From relationship (3.4) it is not difficult to see that with an increase in v_2 the deviation from the linear law increases, and in the case, when $v_2 >> v_1$, the force of interaction are approached zero. This is very meaningful result. Specifically, this phenomenon observed in their known experiments Thompson and Kauffmann, when they noted that with an increase in the velocity of electron beam it is more badly slanted by magnetic field. They connected the results of their observations with an increase in the mass of electron. As we see reason here another.

Let us note still one interesting result. From relationship (3.3), with an accuracy to quadratic terms, the force of interaction of electronic flux with the rectilinear to determine according to the following dependence:

$$F_\Sigma = \frac{g_1 g_2}{2\pi\varepsilon r}\left(\frac{v_1 v_2}{c^2} - \frac{1}{2}\frac{v_1^2}{c^2} \right) \qquad (3.5)$$

From expression (3.5) follows that with the unidirectional electron motion in the conductor and in the electronic flux the force of interaction with the fulfillment of conditions $v_1 = \frac{1}{2}v_2$ is absent.

Since the speed of the electronic flux usually much higher than speed of current carriers in the conductor, the second term in the brackets in relationship (3.5) can be disregarded. Then, since

$$H_1 = \frac{g_1 v_1}{2\pi\varepsilon c^2 r}$$

we will obtain the magnetic field, created by lower conductor in the place of the motion of electronic flux

$$F_\Sigma = \frac{g_1 g_2}{2\pi\varepsilon r}\frac{v_1 v_2}{c^2} = g_2 \mu v_2 H.$$

In this case, the obtained value of force exactly coincides with the value of Lorentz force. Taking into account that

$$F_\Sigma = g_2 E = g_2 \mu v_2 H,$$

it is possible to consider that on the charge, which moves in the magnetic field, acts the electric field E, directed normal to the direction of the motion of charge. This result also with an accuracy to of the quadratic terms $\frac{v^2}{c^2}$ completely coincides with the results of the concept of magnetic field and is determined the Lorentz force, which acts from the side of magnetic field to the flow of the moving electrons.

As was already said, one of the important contradictions to the concept of magnetic field is the fact that two parallel beams of the like charges, which are moved with the identical speed in one direction, must be attracted. In this model there is no this contradiction already. If we consider that the charge rates in the upper and lower wire will be equal, and lattice is absent, i.e., to leave only electronic fluxes, then will remain only the repulsive force F_2.

Thus, the moving electronic flux interacts simultaneously both with the moving electrons in the lower wire and with its lattice, and the sum of these forces of interaction it is called Lorentz force. This force acts on the moving electron stream.

Regularly does appear a question, and does create magnetic field most moving electron stream of in the absence compensating charges of lattice or positive ions in the plasma? The diagram examined shows that the effect of power interaction between the current carrying systems requires in the required order of the presence of the positively charged lattice. Therefore most moving electronic flux cannot create that effect, which is created during its motion in the positively charged lattice. At the same time, if we examine two in parallel moving electron streams, then appears the extra force of interaction, which depends on the relative speed of these flows.

Let us demonstrate still one approach to the problem of power interaction of the current carrying systems. The statement of facts of the presence of forces between the current carrying systems indicates that there is some field of the scalar potential, whose gradient ensures the force indicated. But that this for the field? Relationship (3.3) gives only the value of force, but he does not speak about that, the gradient of what scalar potential ensures these forces. We will support with constants the currents I_1, I_2, and let us begin to draw together or to move away conductors. The work, which in this case will be spent, and is that potential, whose gradient gives force. After integrating relationship (3.3) on r, we obtain the value of the energy:

$$W = \frac{I_1 I_2 \ln r}{2\pi\varepsilon c^2}.$$

This energy, depending on that to move away conductors from each other, or to draw together, can be positive or negative. When conductors move away, then energy is positive, and this means that, supporting current in the conductors with constant, generator returns energy. This phenomenon is the basis the work of all electric motors. If conductors converge, then work accomplish external forces, on the source, which supports in them the constancy of currents. This phenomenon is the basis the work of the mechanical generators of emf.

Relationship for the energy can be rewritten and thus:

$$W = \frac{I_1 I_2 \ln r}{2\pi\varepsilon c^2} = I_2 A_{z1} = I_1 A_{z2},$$

where

$$A_{z1} = \frac{I_1 \ln r}{2\pi\varepsilon c^2}$$

is z - component of vector potential, created by lower conductor in the location of upper conductor, and

$$A_{z2} = \frac{I_2 \ln r}{2\pi\varepsilon c^2}$$

is z - component of vector potential, created by upper conductor in the location of lower conductor.

The approach examined demonstrates that large role, which the vector potential in questions of power interaction of the current carrying systems and conversion of electrical energy into the mechanical plays. This approach also clearly indicates that the Lorentz force is a consequence of interaction of the current carrying systems with the field of the vector potential, created by other current carrying systems. Important circumstance is the fact that the formation of vector potential is obliged to the dependence of scalar potential on the speed. This is clear from a physical point of view. The moving charges, in connection with the presence of the dependence of their scalar potential on the speed, create the scalar field, whose gradient gives force. But the creation of any force field requires expenditures of energy. These expenditures accomplishes generator, creating currents in the conductors. In this case in the surrounding space is created the special field, which interacts with other moving charges according to the special vector rules, with which only scalar product of the charge rate and vector potential gives the potential, whose gradient gives the force, which acts on the moving charge. This is a Lorentz force.

In spite of simplicity and the obviousness of this approach, this simple mechanism up to now was not finally realized. For this reason the Lorentz force, until now, was introduced in the classical electrodynamics by axiomatic way.

Let us examine the still one interesting consequence, which escapes from the given examination. If we as the planes of long line use an superconductor, then the magnetic field on its surface, equal to specific current, can be determined from the relationship:

$$H = nev\lambda \tag{3.6}$$

where $\lambda = \sqrt{\frac{m}{ne^2\mu}}$ - depth of penetration of magnetic field into the superconductor.

If we substitute the value of depth of penetration into relationship (3.6), then we will obtain the unexpected result:

$$H = v\sqrt{\frac{nm}{\mu}}.$$

Occurs that the magnetic field strength completely does not depend on the magnitude of the charge of current carriers, but it depends on their mass. Thus, the density energy of magnetic fields

$$W_H = \frac{1}{2}\mu H^2 = \frac{nmv^2}{2} \tag{3.7}$$

is equal to density of the kinetic energy of charges. But the magnetic field, connected with the motion of current carriers in the surface layer of superconductor, exists not only on its surface, also, in the skin-layer. Volume, occupied by magnetic fields, incommensurably larger than the volume of this layer. If we designate the length of the line, depicted in Fig. 2 as l, then the volume of skin-layer in the superconductive planes of line will compose $2lb\lambda$. Density energy of magnetic fields on in this volume we determine from the relationship:

$$W_{H,\lambda} = nmv^2 lb\lambda ,$$

however, density energy of magnetic fields on, accumulated between the planes of line, it will comprise:

$$W_{H,a} = \frac{nmv^2 lba}{2} = \frac{1}{2} lba\mu_0 H . \qquad (3.8)$$

If one considers that the depth of penetration of magnetic field in the superconductors composes several hundred angstroms, then with the macroscopic dimensions of line it is possible to consider that the total energy of magnetic fields on in it they determine by relationship (3.8). Therefore, the formation of magnetic fields on H between the planes of line, which appear in connection with the motion of charges in the skin-layer, it requires the same expenditures of energy, as if entire volume of line was filled with the particles, which move with the speed of v, whose density and mass compose respectively n and m.

Is obvious that the effective mass of electron in comparison with the mass of free electron grows in this case into $\frac{a}{2\lambda}$ of times. This is the consequence of the fact that the mechanical electron motion leads not only to the accumulation of their kinetic energy in the skin-layer, but in the line also occurs accumulation and potential energies, whose gradient gives the force, which acts on the conducting planes of line. Thus, becomes clear nature of such parameters as inductance and the effective mass of electron, which in this case depend, in essence, not from the mass of free electrons, but from the configuration of conductors, on which the electrons move.

The homopolar induction was discovered still by Faraday almost 200 years ago, but in the classical electrodynamics of final answer to that as and why work some constructions of unipolar generators, there is no up to now. Is separately incomprehensible the case, when there is a revolving magnetized conducting cylinder, during motion of which between the fixed contacts, connected to its axis and generatrix, appears emf. Is still more incomprehensible the case, when together with the cylindrical magnet revolves the conducting disk, which does not have galvanic contact with the magnet, but fixed contacts are connected to the axis of disk and its generatrix. In some sources it is indicated that the answer can be obtained within the framework SR, but there are no concrete references, as precisely SR explain the cases indicated. It will be further shown that the concrete answers to all these questions can be obtained within the framework the concept of the dependence of the scalar potential of charge on its relative speed.

Let us examine the case, when there is a single long conductor, along which flows the current. We will as before consider that in the conductor is a system of the mutually inserted charges of the positive lattice g^+ and free electrons g^-, which in the absence current neutralize each other (Fig.2).

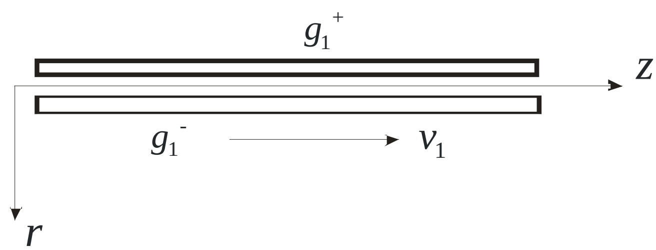

Fig. 2: Section is the conductor, along which flows the current

The electric field, created by rigid lattice depending on the distance r from the center of the conductor that is located along the axis Z it takes the form

$$E^+ = \frac{g^+}{2\pi\varepsilon r} \qquad (3.9)$$

We will consider that the direction of the vector of electric field coincides with the direction r. If electronic flux moves with the speed v_1, then the electric field of this flow is determined by the equality

$$E^- = -\frac{g^-}{2\pi\varepsilon r} ch\frac{v_1}{c} \cong -\frac{g^-}{2\pi\varepsilon r}\left(1+\frac{1}{2}\frac{v_1^2}{c^2}\right) \qquad (3.10)$$

Adding (3.9) (3.10), we obtain:

$$E^- = -\frac{g^- v_1^2}{4\pi\varepsilon c^2 r}$$

This means that around the conductor with the current is an electric field, which corresponds to the negative charge of conductor. However, this field has insignificant value, since in the real conductors $vc\leq$. This field can be discovered only with the current densities, which can be achieved in the superconductors, which is experimentally confirmed in works.

Let us examine the case, when very section of the conductor, on which with the speed v_1 flow the electrons, moves in the opposite direction with speed v (Fig. 3). In this case relationships (3.9) and (3.10) will take the form

$$E^+ = \frac{g^+}{2\pi\varepsilon r}\left(1+\frac{1}{2}\frac{v^2}{c^2}\right) \tag{3.11}$$

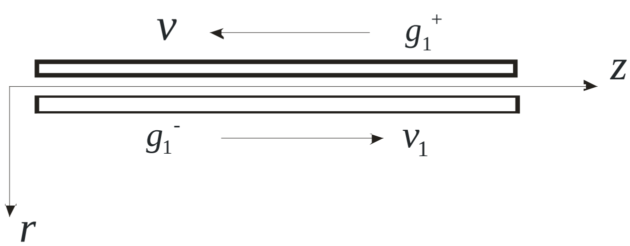

Fig. 3: Moving conductor with the current

$$E^- = -\frac{g^-}{2\pi\varepsilon r}\left(1+\frac{1}{2}\frac{(v_1-v)^2}{c^2}\right) \tag{3.12}$$

Adding (3.11) (3.12), we obtain

$$E^+ = \frac{g}{2\pi\varepsilon r}\left(\frac{v_1 v}{c^2}-\frac{1}{2}\frac{v_1^2}{c^2}\right). \tag{3.13}$$

In this relationship as the specific charge is undertaken its absolute value. since the speed of the mechanical motion of conductor is considerably more than the drift velocity of electrons, the second term in the brackets can be disregarded. In this case from (3.13) we obtain

$$E^+ = \frac{g v_1 v}{2\pi\varepsilon c^2 r}. \tag{3.14}$$

The obtained result means that around the moving conductor, along which flows the current, with respect to the fixed observer is formed the electric field, determined by relationship (3.14), which is equivalent to appearance on this conductor of the specific positive charge of the equal

$$g^+ = \frac{g v_1 v}{c^2}.$$

If we conductor roll up into the ring and to revolve it then so that the linear speed of its parts would be equal v, then around this ring will appear the electric field, which corresponds to the presence on the ring of the specific charge indicated. But this means that the revolving turn, which is the revolving magnet, acquires specific electric charge on wire itself, of which it consists. During the motion of linear conductor with the current the electric field will be observed with respect to the fixed observer, but if observer will move together with the conductor, then such fields will be absent.

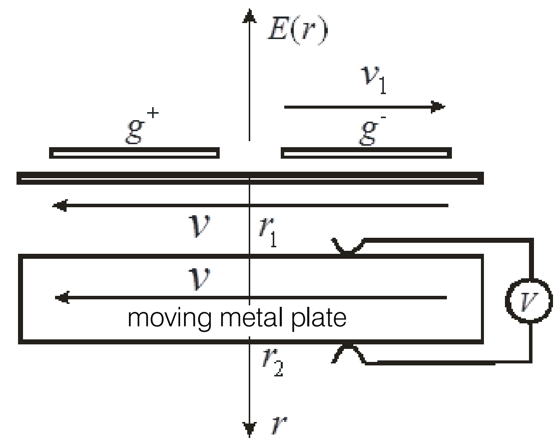

Fig. 4: Diagram of formation emf homopolar induction.

As is obtained the homopolar induction, with which on the fixed contacts a potential difference is obtained, it is easy to understand from Fig. 4.

We will consider that r_1, r_2 of the coordinate of the points of contact of the tangency of the contacts, which slide along the edges of the metallic plate, which moves with the same speed as the conductor, along which flows the current. Contacts are connected to the voltmeter, which is also fixed. Then, it is possible to calculate a potential difference between these contacts, after integrating relationship (3.14):

$$U = \frac{g v_1 v}{2\pi\varepsilon c^2}\int_{r_1}^{r_2}\frac{dr}{r} = \frac{g v_1 v}{2\pi\varepsilon c^2}\ln\frac{r_2}{r_1}.$$

But in order to the load, in this case to the voltmeter, to apply this potential difference, it is necessary sliding contacts to lock by the cross connection, on which there is no potential difference indicated. But since metallic plate moves together with the conductor, a potential difference is absent on it. It serves as that cross connection, which gives the possibility to convert this composite outline into the source emf. with respect to the voltmeter.

Now it is possible wire to roll up into the ring (Fig. 5) of one or several turns, and to feed it from the current source. Moreover contacts 1 should be derived on the collector rings, which are located on the rotational axis and to them joined the friction fixed brushes. Thus, it is possible to obtain the revolving magnet. In this magnet should be placed the conducting disk with the opening, which revolves together with the turns of the wire, which serves as magnet, and with the aid of the fixed contacts, that slide on the generatrix of disk, tax voltage on the voltmeter. As the limiting case it is possible to take continuous metallic disk and to connect sliding contacts to the generatrix of disk and its axis. Instead of the revolving turn with the current it is possible to take the disk, magnetized in the axial direction, which is equivalent to turn with the current, in this case the same effect will be obtained.

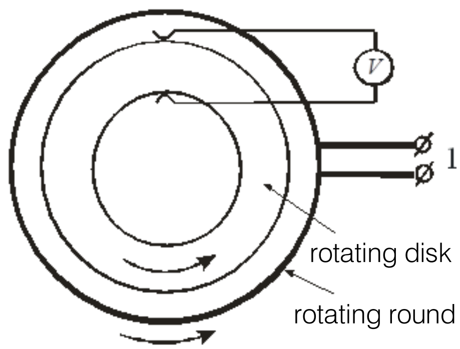

Fig. 5: Schematic of unipolar generator with the revolving turn with the current and the revolving conducting ring.

The case with the fixed magnet and the revolving conducting disk is characterized by the diagram, depicted in Fig. 6, if the conducting plate was rolled up into the ring.

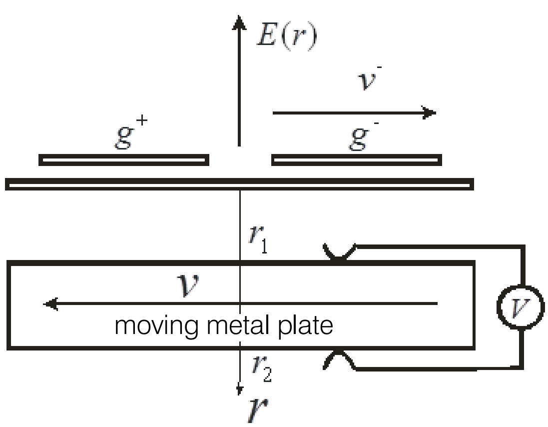

Fig. 6: The case of fixed magnet and revolving disk.

Different combinations of the revolving and fixed magnets and disks are possible.

In this case the following relationships are fulfilled:

The electric field, generated in the revolving disk by the electrons, which move along the conductor, is determined by the relationship

$$E^{-}=-\frac{g^{-}}{2\pi\varepsilon r}ch\frac{v_1-v}{c}=-\frac{g^{-}}{2\pi\varepsilon r}\left(1+\frac{1}{2}\frac{(v_1-v)^2}{c^2}\right),$$

and by the fixed ions

$$E^{+}=\frac{g^{+}}{2\pi\varepsilon r}ch\frac{v}{c}=\frac{g^{-}}{2\pi\varepsilon r}\left(1+\frac{1}{2}\frac{v^2}{c^2}\right).$$

The summary tension of electric field in this case will comprise

$$E_{\Sigma}=\frac{g}{2\pi\varepsilon r}\left(\frac{vv_1}{c^2}\right),$$

and a potential difference between the points r_1 and r_2 in the coordinate system, which moves together with the plate, will be equal

$$U=\frac{g(r_2-r_1)}{2\pi\varepsilon r}\left(\frac{vv_1}{c^2}\right).$$

Since in the fixed with respect to the magnet of the circuit of voltmeter the induced potential difference is absent, the potential difference indicated will be equal by the electromotive force of the generator examined. As earlier moving conducting plate can be rolled up into the disk with the opening, and the wire, along which flows the current into the ring with the current, which is the equivalent of the magnet, magnetized in the end direction.

Thus, the concept of the dependence of the scalar potential of charge on the relative speed gives answers to all presented questions and SR here it is not necessary.

From these positions it is possible to examine the ponderomotive action of electrical and magnetic fields on to any interface. Current in the region of boundary must be scalar multiplied by the vector potential. The gradient of this work will give the forces, which act on the surface. With this approach calculation of the dependence of the potential gradient energy on the coordinate gives information about the internal stresses, which act in the region of boundary.

Is most easy this it is possible to understand based on the example of superconductors, EM of the waves or presence on their surface of constant magnetic or electrical fields on with the drop on them. In the superconductors the current density is unambiguously connected with the vector potential, and the work of current to the vector potential is potential energy. But since currents in the superconductor diminish exponentially, potential energy of these currents diminishes thus, and the potential gradient energy in the surface layer and On the Border superconductor is the reason for the appearance of ponderomotive forces. By here what defined by example means magnetic field and the incident electromagnetic wave exerts pressure on the surface of superconductor.

Potential electric current energy, which flow in the superconductor is determined by the relationship

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$$W = \frac{1}{2}\mu\int \mathbf{jA}dV .$$

Current density in the superconductor changes according to the law

$$\mathbf{j}(z) = \mathbf{j}(0)e^{-\frac{z}{\lambda}} .$$

According to the same law changes the vector potential $\mathbf{A}$. Thus

$$W = \frac{1}{2}\mu\int \mathbf{jA}dV = \frac{1}{2}\mu\int \mathbf{j}(0)\mathbf{A}(0)e^{-\frac{2z}{\lambda}}dz$$

Consequently, ponderomotive force will have a value

$$\mathbf{F} = -gradW = \frac{1}{2}\mu\mathbf{j}(0)\mathbf{A}(0)e^{-\frac{2z}{\lambda}} .$$

In the superconductor the current density is determined by the relationship

$$\mathbf{j} = -\frac{\mu}{L_k}\mathbf{A} ,$$

where $L_k = \frac{m}{ne^2}$ - the kinetic inductance of charges, $\lambda = \sqrt{\frac{L_k}{\mu}}$ - London depth of penetration.

Therefore

$$\mathrm{F} = \frac{1}{2}\mathrm{j}^2(0)L_k e^{-\frac{2z}{\lambda}}$$

This force is equal on the surface

$$\mathrm{F} = \frac{1}{2}\mathrm{j}^2(0)L_k$$

The magnetic field on its surface of superconductor, equal to specific current, can be determined from the relationship
by the current, which flows under the surface

$$H = I = \int j(0)e^{-\frac{z}{\lambda}}dz = \lambda j(0)$$

Is consequently the force applied to the surface of superconductor

$$\mathrm{F} = \frac{1}{2}\mathrm{j}^2(0)L_k = \frac{1}{2}H^2\frac{L_k}{\lambda^2} = \frac{1}{2}\mu H^2$$

If electromagnetic wave is incident on the surface of superconductor, $H = H_0 \sin \omega t$, then it generates on its surface the specific current

$$I = H = H_0 \sin \omega t .$$

Ponderomotive force in this case will be equal

$$\mathrm{F} = \frac{1}{2}\mu H_0^2 \sin^2 \omega t$$

The constant component of this force to be determined by the relationship

$$\mathrm{F} = \frac{1}{4}\mu H_0^2$$

Since the superconductor does not absorb energy of electromagnetic wave, it will be completely reflected. This is equivalent to the elastic reflection of material object from the body surface, whose mass is considerably greater than the mass of the falling body.

IV. Conclusion

From the times of Lorenz and Poincare the Lorentz force was introduced as experimental postulate, and up to now there was no explanation of its physical nature. From a physical point of view the force, which acts on the material object, must be connected with its acceleration. Forces can also bear potential nature, being the gradient scalar potential field, in which it to be located. But Lorentz force is not placed in the category of the forces examined and yav it lyaetsya by exception from the rules indicated. in the article is proven that the Lorentz force is the consequence of the dependence of the scalar potential of charge on the speed. This made possible to explain physics of power interaction of the current carrying systems, and also operating principle of all existing types of unipolar generators. It is shown also, that the ponderomotive action of electromagnetic waves is the consequence of the dependence of the scalar potential of charge on the speed, but not by the consequence of the fact that, as it was considered earlier, electromagnetic wave possesses mechanical impulse.

The most important results obtained in the paper should include the establishment of dependence of the scalar potential of the electric charge of the rate of relative motion. All the phenomena of charge dynamics and their interactions are the result obtained according to that ideology changes electrodynamics. The adoption of the concept of physically justified as a factor of the charge, taking into account its impact on the surrounding charges may be reflected in its energy characteristics, so that the kinetic energy of the growth acceleration during the charge related to the change of its electric field.

Maxwell's equations, leading to a wave equation for the electron, electromagnetic fields, and relationships for the force interaction with the current-carrying systems postulated by the Lorentz force are the basis of the two actually independent sections of classical electrodynamics. The proposed concept of connecting them to a single ideological basis. An important outcome of the work can be considered as justification for a long time the impending need for radical changes not only in classical electrodynamics with its mathematical apparatus, but also in physics in general.

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