Updated electrodynamics

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Abstract

The concept of scalar-vector potential is the consequence of the symmetrical laws of the magnetoelectric and electromagnetic induction, introduction of which served the work of Faraday and Maxwell. Contemporary classical electrodynamics consists of two not connected together parts: from one side this Maxwell equations, the describing wave processes in the material media, from other side this is the Ampere law, which describes power interaction of the current carrying systems. Up to now there was no concept, which could combine these two odd parts of the electrodynamics. The concept of scalar-vector potential, is the basis of all its dynamic laws, it combined these odd parts, after making electrodynamics united ordered science. This concept explains physics of power interaction of the current carrying systems, physics of emission and scattering of electromagnetic waves, phase aberration of light, Doppler transverse effect, describes the operating principle of unipolar generators.

The keywords: Ampere law, Faraday law, Maxwell equations, laws of induction, scalar-vector potential, phase aberration, Dopler transverse effect.

1. Introduction

The vector analysis is the basic mathematical apparatus for electrodynamics. This apparatus began to be formed still from the works of ampere and Maxwell and in that form, which we now use was formed by Heaviside. Such vector quantities, as force, speed, acceleration, electric field and current demonstrate well the physical nature of these values. However, with the use of a vector apparatus for describing the physical processes are introduced such of vector, which do not reflect the physical essence of those processes, which they describe. We will call such vectors vector- phantoms. Let us give several examples.

If is located the disk, which revolves with the angular velocity ω, then they depict this process as the vector, which coincides with the rotational axis of disk and rests in its center. It does ask itself, is there this vector in reality and that it does represent? There is no doubt about the fact that this vector can be introduced by arrangement, but any physical sense as, for example, velocity vector, it it does not have. Thus the vector of momentum is accurately introduced. This vector also coincides with the rotational axis, it rests in the center of the plane of rotation and it is equal to the work of radial velocity to a radius. Similarly is introduced the vector of the magnetic dipole moment, which for the ring current is equal to the work of the current strength to the area of the circle streamlined with current. This vector coincides with the rotational axis of circle and rests on its plane. But any physical sense these a vector do not have.

Let us recall what is the vector is, which presents rotor. This vector is introduced as follows

$$rot\ \vec{a} = \begin{pmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ a_x & a_y & a_z \end{pmatrix}.$$

In order to explain the geometric sense of rotor let us examine solid body, which revolves with the angular velocity ω around the axis z. Then the linear speed of the body v at point (x, y, z) is numerically equal

$$v = \omega r = \omega\sqrt{x^2 + y^2}\ ,$$

and component it along the axes, for the right-handed coordinate system, will be equal

$$v_x = -\frac{vy}{\sqrt{x^2 + y^2}} = -\omega y,$$

$$v_y = -\frac{vx}{\sqrt{x^2 + y^2}} = -\omega x,$$

$$v_z = 0.$$

the vector components $rot\ v$ in this case to be determined by the relationships:

$$rot_x v = rot_y v = 0$$

$$rot_z v = \frac{\partial v_y}{\partial x} - \frac{\partial v_x}{\partial y} = 2\omega$$

is again obtained the vector, directed in parallel to rotational axis and normal toward the plane of rotation. This vector also is introduced by arrangement and of any physical sense it does not have.

The same argument can be extended to the vector product.

Thus, with the use of vector analysis for describing the physical phenomena are introduced two types of vectors. The first of them represents the real physical of vector, which characterize physical quantity itself taking into account of its value and direction (for example, the vector of force, speed, acceleration, tension of electric field and current). Another category of vectors - this those of vector, which can be presented with the aid of the operation of rotor or vector product. These vector do not represent physical quantities and they are introduced by arrangement, being vector-phantoms. Specifically, the vector of such type includes magnetic field.

Magnetic field is introduced or with the aid of the rotor of the electric field

$$\frac{\partial \vec{H}}{\partial t} = -\frac{1}{\mu} rot\vec{E},$$

or as the rotor of the vector potential

$$\vec{H} = rot\vec{A}_H .$$

This means that the magnetic field is not physical field, but represents the certain vector symbol, which is introduced by arrangement and of physical sense it does not have.

However, that does occur further? During writing of Maxwell's equations rotor from the magnetic field they make level to the full current

$$rot\vec{H} = rot\ rot\vec{A}_H = \vec{j}_\Sigma$$

is obtained so that rotor from the vector $\vec{H}$, which is introduced by arrangement, gives the real physical vector of current density. Thus, the vector of magnetic field represents typical vector- phantom.

It is possible to give another example. The Lorentz force, which acts on the moving charge, is determined by the vector product of the real velocity vector and of magnetic field:

$$\vec{F} = \mu\left[\vec{v} \times \vec{H}\right]$$

is again obtained so that the operation of vector product, which itself physical sense does not have, with the participation of real vector and vector of phantom it gives real physical force taking into account of its value and direction. Of this consists the sense of introduction in vector analysis of such operations as rotor and vector product. If we look to the mathematical apparatus for physics in connection with to vector analysis, then it appears that this apparatus represents the mixture of real physical vectors and vectors of the phantoms, the relation between which it is regulated with the aid of the, including and operations indicated.

But then question arises, and is it possible generally in the electrodynamics to exclude vector- phantoms, and to build it without their use. In works [6-10] it is shown that the electrodynamics can be built without the use of an operation of rotor and vector product and this concept as magnetic field. In this case as its basis must be assumed such fundamental concepts as scalar potential and the electric field, and also the concept of scalar-vector potential, which assumes the dependence of the scalar potential of charge on the speed.

The first work, in which were introduced the concept of scalar-vector potential, the assuming dependence of the scalar potential of charge on the speed, it was published in 1988 [1]. The concept of scalar-vector potential is the consequence of the symmetrical laws of the magnetoelectric and electromagnetic induction, introduction of which served the work of Faraday and Maxwell. Further development of the concept of scalar-vector potential, its theoretical substantiation and practical use obtained in works [2-26]. Contemporary classical electrodynamics consists of two not connected together parts: from one side this of Maxwell's equation, the describing wave processes in the material media, from other side this is the Ampere law, which describes power interaction of the current carrying systems. Up to now there was no concept, which could combine these two odd parts of the electrodynamics. The concept of scalar-vector potential, is the basis of all its dynamic laws, it combined these odd parts, after making electrodynamics united ordered science. This concept explains physics of power interaction of the current carrying systems, physics of emission and scattering of electromagnetic waves, phase aberration of light, Doppler transverse effect, describes the operating principle of unipolar generators.

2. Induction fields their shaping and the conversion

The Maxwell equations do not give the possibility to write down fields in the moving coordinate systems, if fields in the fixed system are known. This problem is solved with the aid of the conversions of Lorenz, however, these conversions from the classical electrodynamics they do not follow. Question does arise, is it possible with the aid of the classical electrodynamics to obtain conversions fields on upon transfer of one inertial system to another, and if yes, then, as must appear the equations of such conversions. Indications of this are located already in the law of the Faraday induction. Let us write down Faraday law:

$$\oint \vec{E}' d\,\vec{l}' = -\frac{d\,\Phi_B}{d\,t}. \qquad (2.1)$$

As is evident in contrast to Maxwell equations in it not particular and substantive (complete) time derivative is used.

The substantional derivative in relationship (2.1) indicates the independence of the eventual result of appearance emf in the outline from the method of changing the flow, i.e. flow can change both due to the local time derivative of the induction of and because the system, in which is measured , it moves in the three-dimensional changing field . The value of magnetic flux in relationship (2.1) is determined from the relationship

$$\Phi_B = \int \vec{B}\, d\, \vec{S}', \tag{2.2}$$

where the magnetic induction $\vec{B} = \mu \vec{H}$ is determined in the fixed coordinate system, and the element $d\,\vec{S}'$ is determined in the moving system. Taking into account (2.2), we obtain from (2.1)

$$\oint \vec{E}' d\,\vec{l}' = -\frac{d}{d\,t}\int \vec{B}\, d\,\vec{S}', \tag{2.3}$$

and further, since $\frac{d}{d\,t} = \frac{\partial}{\partial\,t} + \vec{v}\ grad$, let us write down

$$\oint \vec{E}' d\,\vec{l}' = -\int \frac{\partial\,\vec{B}}{\partial\,t}\ d\,\vec{S} - \int \left[\vec{B}\times\vec{v}\right]\ d\,\vec{l}' - \int \vec{v}\ div\ \vec{B}\ d\,\vec{S}'. \tag{2.4}$$

In this case contour integral is taken on the outline $d\,\vec{l}'$, which covers the area $d\,\vec{S}'$. Let us immediately note that entire following presentation will be conducted under the assumption the validity of the Galileo conversions, i.e., $d\,\vec{l}' = d\,\vec{l}$ and $d\,\vec{S}' = d\,\vec{S}$. From relationship (2.6) follows

$$\vec{E}' = \vec{E} + \left[\vec{v}\times\vec{B}\right]. \tag{2.5}$$

If both parts of equation (2.6) are multiplied by the charge, then we will obtain relationship for the Lorentz force

$$\vec{F}_L' = e\ \vec{E} + e\ \left[\vec{v}\times\vec{B}\right]. \tag{2.6}$$

Thus, Lorentz force is the direct consequence of the law of magnetoelectric induction.

For explaining physical nature of the appearance of last term in relationship (2.5) let us write down $\vec{B}$ and $\vec{E}$ through the magnetic vector potential $\vec{A}_B$:

$$\vec{B} = rot\ \vec{A}_B, \qquad \vec{E} = -\frac{\partial \vec{A}_B}{\partial t}. \tag{2.7}$$

Then relationship (2.5) can be rewritten

$$\vec{E}' = -\frac{\partial \vec{A}_B}{\partial t} + \left[\vec{v} \times rot\ \vec{A}_B\right] \tag{2.8}$$

and further

$$\vec{E}' = -\frac{\partial \vec{A}_B}{\partial t} - \left(\vec{v}\ \nabla\right)\vec{A}_B + grad\ \left(\vec{v}\ \vec{A}_B\right). \tag{2.9}$$

The first two members of the right side of equality (2.9) can be gathered into the total derivative of vector potential on the time, namely:

$$\vec{E}' = -\frac{d\ \vec{A}_B}{d\ t} + grad\ \left(\vec{v}\ \vec{A}_B\right). \tag{2.10}$$

From relationship (2.9) it is evident that the field strength, and consequently also the force, which acts on the charge, consists of three parts.

First term is obliged by local time derivative. The sense of second term of the right side of relationship (2.9) is also intelligible. It is connected with a change in the vector potential, but already because charge moves in the three-dimensional changing field of this potential. Other nature of last term of the right side of relationship (2.9). It is connected with the presence of potential forces, since. potential energy of the charge, which moves in the potential field $\vec{A}_B$ with the speed $\vec{v}$, is equal $e\ \left(\vec{v}\ \vec{A}_{\mathbf{B}}\right)$. The value $e\ grad\ \left(\vec{V}\ \vec{A}_B\right)$ gives force, exactly as gives force the gradient of scalar potential.

Taking rotor from both parts of equality (2.10) and taking into account that $rot\ grad \equiv 0$, we obtain

$$rot\ \vec{E}' = -\frac{d\ \vec{B}}{d\ t}\ . \tag{2.11}$$

If there is no motion, then relationship (2.11) is converted into the Maxwell first equation. Relationship (2.11) is more informative than Maxwell equation

$$rot\ \vec{E} = -\frac{\partial\ \vec{B}}{\partial\ t}.$$

Since in connection with the fact that $rot\ grad\ \equiv 0$, in Maxwell equation there is no information about the potential forces, designated through $e\ grad\ \left(\vec{v}\ \vec{A}_B\right)$.

Let us write down the amount of Lorentz force in the terms of the magnetic vector potential:

$$\vec{F}_L^{\prime} = e\ \vec{E} + e\ [\vec{v} \times rot\ \vec{A}_B] = e\ \vec{E} - e(\vec{v}\ \nabla)\vec{A}_B + egrad\ (\vec{v}\ \vec{A}_B)\,. \qquad (2.12)$$

Is more preferable, since the possibility to understand the complete structure of this force gives.

Faraday law (2.2) is called the law of electromagnetic induction, however this is terminological error. This law should be called the law of magnetoelectric induction, since the appearance of electrical fields on by a change in the magnetic caused fields on.

However, in the classical electrodynamics there is no law of magnetoelectric induction, which would show, how a change in the electrical fields on, or motion in them, it leads to the appearance of magnetic fields on. The development of classical electrodynamics followed along another way. Ampere law was first introduced:

$$\oint \vec{H}\ d\ \vec{l} = I\,, \qquad (2.13)$$

where I is current, which crosses the area, included by the outline of integration. In the differential form relationship (2.13) takes the form:

$$rot\ \vec{H} = \vec{j}_\sigma\,, \qquad (2.14)$$

where $\vec{j}_\sigma$ is current density of conductivity.

Maxwell supplemented relationship (2.14) with bias current

$$rot\ \vec{H} = \vec{j}_\sigma + \frac{\partial\ \vec{D}}{\partial\ t}. \qquad (2.15)$$

If we from relationship (2.15) exclude conduction current, then the integral law follows from it

$$\oint \vec{H} d\vec{l} = \frac{\partial \Phi_D}{\partial t}, \qquad (2.16)$$

where $\Phi_D = \int \vec{D}\, d\vec{S}$ the flow of electrical induction.

If we in relationship (2.16) use the substantional derivative, as we made during the writing of the Faraday law, then we will obtain [1-10]:

$$\oint \vec{H}' d\vec{l}' = \int \frac{\partial \vec{D}}{\partial t} d\vec{S} + \oint [\vec{D} \times \vec{v}] d\vec{l}' + \int \vec{v}\, div\, \vec{D}\, d\vec{S}'. \qquad (2.17)$$

In contrast to the magnetic fields, when $div\vec{B} = 0$, for the electrical fields on $div\vec{D} = \rho$ and last term in the right side of relationship (2.8) it gives the conduction current of and from relationship (2.7) the Ampere law immediately follows. In the case of the absence of conduction current from relationship (2.17) the equality follows:

$$\vec{H}' = \vec{H} - [\vec{v} \times \vec{D}]. \qquad (2.18)$$

As shown in the work [27], from relationship (2.18) follows and Bio-Savara law, if for enumerating the magnetic fields on to take the electric fields of the moving charges. In this case the last member of the right side of relationship (2.17) can be simply omitted, and the laws of induction acquire the completely symmetrical form [1-10]

$$\begin{aligned} \oint \vec{E}' dl' &= -\int \frac{\partial \vec{B}}{\partial t} d\vec{s} + \oint \left[\vec{v} \times \vec{B}\right] dl'\vec{H} \\ \oint \vec{H}' dl' &= \int \frac{\partial \vec{D}}{\partial t} d\vec{s} - \oint \left[\vec{v} \times \vec{D}\right] dl'\vec{H}' \end{aligned}, \qquad (2.19)$$

or

$$\begin{aligned} rot\vec{E}' &= -\frac{\partial \vec{B}}{\partial t} + rot\left[\vec{v} \times \vec{B}\right] \\ rot\vec{H}' &= \frac{\partial \vec{D}}{dt} - rot\left[\vec{v} \times \vec{D}\right] \end{aligned}. \qquad (2.20)$$

For dc fields on these relationships they take the form:

$$\vec{E}' = \left[\vec{v}\times\vec{B}\right]$$
$$\vec{H}' = -\left[\vec{v}\times\vec{D}\right] \quad . \qquad (2.21)$$

In relationships (2.19-2.21), which assume the validity of the Galileo conversions, prime and not prime values present fields and elements in moving and fixed inertial reference system (IS) respectively. It must be noted, that conversions (2.21) earlier could be obtained only from the Lorenz conversions.

The relationships (2.19-2.21), which present the laws of induction, do not give information about how arose fields in initial fixed IS. They describe only laws governing the propagation and conversion fields on in the case of motion with respect to the already existing fields.

The relationship (2.21) attest to the fact that in the case of relative motion of frame of references, between the fields $\vec{E}$ and $\vec{H}$ there is a cross coupling, i.e. motion in the fields $\vec{H}$ leads to the appearance fields on $\vec{E}$ and vice versa. From these relationships escape the additional consequences, which were for the first time examined in the work [10].

The electric field $E=\frac{g}{2\pi\varepsilon r}$ outside the charged long rod with a linear density g decreases as $\frac{1}{r}$, where r is distance from the central axis of the rod to the observation point.

If we in parallel to the axis of rod in the field E begin to move with the speed Δv another IS, then in it will appear the additional magnetic field $\Delta H=\varepsilon E\Delta v$. If we now with respect to already moving IS 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 $\Delta E=\mu\varepsilon E(\Delta v)^2$. 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 $E'_v(r)$ in moving IS with reaching of the speed $v=n\Delta v$, when $\Delta v\to 0$, and $n\to\infty$. In the final analysis in moving IS the value of dynamic electric field will prove to be more than in the initial and to be determined by the relationship:

$$E'(r,v_\perp)=\frac{g\,ch\frac{v_\perp}{c}}{2\pi\varepsilon r}=E\,ch\frac{v_\perp}{c}.$$

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

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

where $v_\perp$ is 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:

$$\varphi'(r,v_\perp)=\frac{e\,ch\frac{v_\perp}{c}}{4\pi\varepsilon r}=\varphi(r)ch\frac{v_\perp}{c}\,, \tag{2.22}$$

where $\varphi(r)$ is 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 $v_\perp$ is speed normal to the direction of the magnetic field.

If we apply the obtained results to the electromagnetic wave and to designate components fields on parallel speeds IS as $E_\uparrow$, $H_\uparrow$, and $E_\perp$, $H_\perp$ as components normal to it, then with the conversion fields on components, parallel to speed will not change, but components, normal to the direction of speed are converted according to the rule

$$\begin{aligned}\vec{E}'_\perp &= \vec{E}_\perp ch\ \ \frac{v}{c}+\frac{v}{c}\vec{v}\times\vec{B}_\perp sh\frac{v}{c}\,,\\ \vec{B}'_\perp &= \vec{B}_\perp ch\ \ \frac{v}{c}-\frac{1}{vc}\vec{v}\times\vec{E}_\perp sh\frac{v}{c}\,,\end{aligned} \tag{2.23}$$

where c is speed of light.

Conversions fields (2.23) they were for the first time obtained in the work [1].

However, the iteration technique, utilized for obtaining the given relationships, it is not possible to consider strict, since its convergence is not explained

Let us give a stricter conclusion in the matrix form [24].

Let us examine the totality IS of such, that IS K_1 moves with the speed Δv relative to IS K, IS K_2 moves with the same speed Δv relative to K_1 , etc. If the module of the speed Δv is small (in comparison with the speed of light c), then for the transverse components fields on in IS K_1, K_2,…. we have:

$$\begin{aligned} \vec{E}_{1\perp} &= \vec{E}_{\perp} + \Delta\vec{v} \times \vec{B}_{\perp} & \vec{B}_{1\perp} &= \vec{B}_{\perp} - \Delta\vec{v} \times \vec{E}_{\perp} / c^2 \\ \vec{E}_{2\perp} &= \vec{E}_{1\perp} + \Delta\vec{v} \times \vec{B}_{1\perp} & \vec{B}_{2\perp} &= \vec{B}_{1\perp} - \Delta\vec{v} \times \vec{E}_{1\perp} / c^2 \end{aligned} . \tag{2.24}$$

Upon transfer to each following IS of field are obtained increases in $\Delta\vec{E}$ and $\Delta\vec{B}$

$$\Delta\vec{E}=\Delta\vec{v}\times\vec{B}_{\perp}, \qquad \Delta\vec{B}=-\Delta\vec{v}\times\vec{E}_{\perp}/c^2, \tag{2.25}$$

where of the field $\vec{E}_{\perp}$ and $\vec{B}_{\perp}$ relate to current IS. Directing Cartesian axis x along $\Delta\vec{v}$, let us rewrite (4.7) in the components of the vector

$$\Delta E_y=-B_z\Delta v, \qquad \Delta E=B_y\Delta v, \qquad \Delta B_y=E_z\Delta v/c^2. \tag{2.26}$$

Relationship (2.26) can be represented in the matrix form

$$\Delta U = AU\Delta v \qquad \begin{pmatrix} 0 & 0 & 0 & -1 \\ 0 & 0 & 1 & 0 \\ 0 & 1/c^2 & 0 & 0 \\ -1/c^2 & 0 & 0 & 0 \end{pmatrix} \qquad U = \begin{pmatrix} E_y \\ E_z \\ B_y \\ B_z \end{pmatrix}.$$

If one assumes that the speed of system is summarized for the classical law of addition of velocities, i.e. the speed of final IS $K'=K_N$ relative to the initial system K is $v=N\Delta v$, then we will obtain the matrix system of the differential equations of

$$\frac{dU(v)}{dv}=AU(v), \tag{2.27}$$

with the matrix of the system v independent of the speed A . The solution of system is expressed as the matrix exponential curve $\exp(vA)$:

$$U'\equiv U(v)=\exp(vA)U, \qquad U=U(0), \tag{2.28}$$

here U is matrix column fields on in the system K, and U' is matrix column fields on in the system K'. Substituting (2.28) into system (2.27), we are convinced, that U' is actually the solution of system (2.27):

$$\frac{dU(v)}{dv}=\frac{d[\exp(vA)]}{dv}U=A\exp(vA)U=AU(v).$$

It remains to find this exponential curve by its expansion in the series:

$$\exp(va)=E+vA+\frac{1}{2!}v^2A^2+\frac{1}{3!}v^3A^3+\frac{1}{4!}v^4A^4+...$$

where E is unit matrix with the size 4×4. For this it is convenient to write down the matrix A in the unit type form

$$A=\begin{pmatrix}0 & -\alpha\\ \alpha/c^2 & 0\end{pmatrix}, \qquad \alpha=\begin{pmatrix}0 & 1\\ -1 & 0\end{pmatrix}, \qquad 0=\begin{pmatrix}0 & 0\\ 0 & 0\end{pmatrix}.$$

then

$$A^2=\begin{pmatrix}-\alpha^2/c^2 & 0\\ 0 & -\alpha/c^2\end{pmatrix}, \qquad A^3=\begin{pmatrix}0 & \alpha^3/c^2\\ -\alpha^3/c^4 & 0\end{pmatrix},$$

$$A^4=\begin{pmatrix}\alpha^4/c^4 & 0\\ 0 & \alpha^4/c^4\end{pmatrix}, \qquad A^5=\begin{pmatrix}0 & -\alpha^5/c^4\\ \alpha^5/c^6 & 0\end{pmatrix}.....$$

And the elements of matrix exponential curve take the form

$$[\exp(vA)]_{11}=[\exp(vA)]_{22}=I-\frac{v^2}{2!c^2}+\frac{v^4}{4!c^4}-....,$$

$$[\exp(vA)]_{21}=-c^2[\exp(vA)]_{12}=\frac{\alpha}{c}\left(\frac{v}{c}I-\frac{v^3}{3!c^3}+\frac{v^5}{5!c^5}-.....\right),$$

where I is the unit matrix 2×2. It is not difficult to see that $-\alpha^2=\alpha^4=-\alpha^6=\alpha^8=....=I$, therefore we finally obtain

$$\exp(vA) = \begin{pmatrix} Ich\ \ v/c & -c\alpha sh\ \ v/c \\ (\alpha sh\ \ v/c)/c & Ich\ \ v/c \end{pmatrix} =$$

$$\begin{pmatrix} ch\ \ v/c & 0 & 0 & -csh\ \ v/c \\ 0 & ch\ \ v/c & csh\ \ v/c & 0 \\ 0 & (ch\ \ v/c)/c & ch\ \ v/c & 0 \\ -(sh\ \ v/c)/c & 0 & 0 & ch\ \ v/c \end{pmatrix}.$$

Now we return to (4.10) and substituting there $\exp(vA)$, we find

$$\begin{array}{ll} E'_y = E_y ch\ \ v/c - cB_z sh\ \ v/c, & E'_z = E_z ch\ \ v/c + cB_y sh\ \ v/c, \\ B'_y = B_y ch\ \ v/c + (E_z/c)\, sh\ \ v/c, & B'_z = B_z ch\ \ v/c - (E_y/c)\, sh\ \ v/c \end{array},$$

or in the vector record

$$\begin{aligned} \vec{E}'_\perp &= \vec{E}_\perp ch\ \ \frac{v}{c} + \frac{v}{c}\vec{v}\times\vec{B}_\perp sh\frac{v}{c}, \\ \vec{B}'_\perp &= \vec{B}_\perp ch\ \ \frac{v}{c} - \frac{1}{vc}\vec{v}\times\vec{E}_\perp sh\frac{v}{c}, \end{aligned} \qquad (2.29)$$

This is conversions (2.23).

Earlier has already been indicated that solution of problems interactions of the moving charges in the classical electrodynamics are solved by the introduction of the magnetic field or vector potential, which are fields by mediators. To the moving or fixed charge action of force can render only electric field. Therefore natural question arises, and it is not possible whether to establish the laws of direct action, passing fields the mediators, who would give answer about the direct interaction of the moving and fixed charges. This approach would immediately give answer, also, about sources and places of the application of force of action and reaction. Let us show that application of scalar- vector potential gives the possibility to establish the straight laws of the induction, when directly the properties of the moving charge without the participation of any auxiliary fields on they give the possibility to calculate the electrical induction fields, generated by the moving charge.

Let us examine the diagram of the propagation of current and voltage in the section of the long line, represented in Fig. 1.

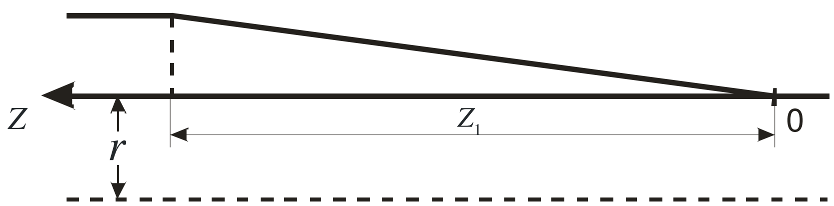

Fig. 1. Current wave front, which is extended in the long line.

In this figure the wave front occupies the section of the line of the long z_2, therefore, the time of this transient process equally $t=\frac{z_2}{c}$. This are thing time, for which the voltage on incoming line grows from zero to its nominal value. The duration of transient process is adjustable, and it depends on that, in which law we increase voltage on incoming line. In this case linear law is accepted. Let us show how is formed electrical induction field near the section examined. This exactly are that question, to which, until now, there is no physical answer. Let us assume that voltage on incoming line grows according to the linear law also during the time Δt it reaches its maximum value U, after which its increase ceases. Then in line itself transient process engages the section $z_1=c\Delta t$. In the section z_1 proceeds the acceleration of charges from their zero speed (more to the right the section z_1) to the value of speed, determined by the relationship

$$v=\sqrt{\frac{2eU}{m}} ,$$

where e and m are charge and the mass of current carriers, and U is voltage drop across the section z_1. Then the dependence of the speed of current carriers on the coordinate will take the form:

$$v^2(z)=\frac{2e}{m}\frac{\partial U}{\partial z}z . \qquad (2.34)$$

Since we accepted the linear dependence of stress from the time on incoming line, the equality occurs

$$\frac{\partial U}{\partial z}=\frac{U}{z_2}=E_z ,$$

where E_z is field strength, which accelerates charges in the section z_1. Consequently, relationship (2.34) we can rewrite

$$v^2(z)=\frac{2e}{m}E_z z\,.$$

Using for the value of scalar-vector potential relationship (2.22), let us calculate it as the function z on a certain distance r from the line

$$\varphi(z)=\frac{e}{4\pi\ \varepsilon_0 r}\left(1+\frac{1}{2}\ \frac{v^2(z)}{c^2}\right)=\frac{e}{4\pi\ \varepsilon_0 r}\left(1+\frac{eE_z z}{mc^2}\right). \tag{2.35}$$

For the record of relationship (2.35) are used only first two members of the expansion of hyperbolic cosine in series.

Using the formula $E=-grad\ \varphi$, and differentiating relationship (2.35) on z, we obtain

$$E_z'=-\frac{e^2E_z}{4\pi\ \varepsilon_0 rmc^2}\,, \tag{2.36}$$

where E_z' is the electric field, induced at a distance r from the conductor of line. Near E we placed prime in connection with the fact that calculated field it moves along the conductor of line with the speed of light, inducing in the conductors surrounding line the induction currents, opposite to those, which flow in the basic line. The acceleration a, tested by the charge e in the field E, is determined by the relationship $a_z=\frac{eE_z}{m}$. Taking this into account from (2.36) we obtain

$$E_z'=-\frac{ea_z}{4\pi\ \varepsilon_0 rc^2}\ . \tag{2.37}$$

Thus, the charges, accelerated in the section of the line z_1, induce at a distance r from this section the electric field, determined by relationship (2.37). Direction of this field conversely to field, applied to the accelerated charges. Thus, is obtained the law of direct action, which indicates what electric fields generate around themselves the charges, accelerated in the conductor. This law can be called the law of electro-electrical induction, since it, passing fields mediators (magnetic field or vector potential), gives straight answer to what electric fields the moving electric charge generates around itself. This law gives also answer about the place of the application of force of interaction between the charges. Specifically, this relationship, but not Faraday law, we must consider as the fundamental law of induction, since specifically, it establishes the reason for the appearance of induction electrical fields on around the moving charge. In what the difference between the proposed approach and that previously existing consists. Earlier we said that the moving charge generates vector potential, and the already changing vector potential generates electric field. Relationship (2.37) gives the possibility to exclude this intermediate operation and to pass directly from the properties of the moving charge to the induction fields. Let us show that relationship it follows from this and the introduced earlier phenomenologically vector potential, and, therefore, also magnetic field. Since the connection between the vector potential and the electric field is determined by relationship (2.7), equality (2.37) it is possible to rewrite

$$E_z' = -\frac{e}{4\pi\ \varepsilon_0 r c^2}\frac{\partial v_z}{\partial t} = -\mu\frac{\partial A_H}{\partial t},$$

from where, integrating by the time, we obtain

$$A_H = \frac{e v_z}{4\pi r}.$$

This relationship corresponds to the determination of vector potential. It is now evident that the vector potential is the direct consequence of the dependence of the scalar potential of charge on the speed. The introduction also of vector potential and of magnetic field this is the useful mathematical device, which makes it possible to simplify the solution of number of electrodynamic problems, however, one should remember that by fundamentals the introduction of these fields on it appears scalar- vector potential.

3. Phase aberration of electromagnetic waves and the Doppler transverse effect

The relationships (2.23) it is possible to explain the phenomenon of phase aberration, which did not have within the framework existing classical electrodynamics of explanations [2-10]. We will consider that there are components of the plane wave H_z, E_x, which is extended in the direction y, and primed system moves in the direction of the axis x with the speed v_x. Then components fields on in the prime coordinate system in accordance with relationships (2.23) they will be written down:

$$E'_x = E_x,$$

$$E'_y = H_z sh\frac{v_x}{c},$$

$$H'_z = H_z ch\frac{v_x}{c}.$$

Thus, is a heterogeneous wave, which has in the direction of propagation the component E'_v.

Let us write down the summary field E' in moving IS:

$$E' = \left[\left(E'_x\right)^2 + \left(E'_y\right)^2\right]^{\frac{1}{2}} = E_x ch\frac{v_x}{c}. \tag{3.1}$$

If the vector $\vec{H}'$ is as before orthogonal the axis y, then the vector $\vec{E}'$ is now inclined toward it to the angle α, determined by the relationship:

$$\alpha \cong sh\frac{v}{c} \cong \frac{v}{c}. \tag{3.2}$$

This is phase aberration. Specifically, to this angle to be necessary to incline telescope in the direction of the motion of the Earth around the sun in order to observe stars, which are located in the zenith.

The Poynting vector is now also directed no longer along the axis y, but being located in the plane xy, it is inclined toward the axis y to the angle, determined by relationships (3.2). However, the relation of the absolute values of the vectors $\vec{E}'$, $\vec{H}'$ in both systems they remained identical. However, the absolute value of the very Poynting vector increased. Thus, even transverse motion of inertial system with respect to the direction of propagation of wave increases its energy in the moving system. This phenomenon is understandable from a physical point of view. It is possible to give an example with the rain drops. When they fall vertically, then is energy in them one. But in the inertial system, which is moved normal to the vector of their of speed, to this speed the velocity vector of inertial system is added. In this case the absolute value of the speed of drops in the inertial system will be equal to square root of the sum of the squares of the speeds indicated. The same result gives to us relationship (3.1).

Is not difficult to show that, if we the polarization of electromagnetic wave change ourselves, then result will remain before. Conversions with respect to the vectors $\vec{E}$, $\vec{H}$ are completely symmetrical, only difference will be the fact that to now come out the wave, which has to appear addition in the direction of propagation in the component H'_v.

Such waves have in the direction of its propagation additional of the vector of electrical or magnetic field, and in this they are similar to E, H of the waves, which are extended in the waveguides. In fact obtained wave is the superposition of plane wave with the phase speed $c=\sqrt{\frac{1}{\mu\varepsilon}}$ and additional wave of plane wave with the infinite phase speed orthogonal to the direction of propagation.

Let us examine one additional case, when the direction of the speed of the moving system coincides with the direction of propagation of electromagnetic wave. We will consider that there are components of the plane wave E_x, H_z, and also component of the speed $\pm v_y$. Taking into account that in this case is fulfilled the relationship $E_x=\pm Z_0 H_z$, we obtain:

$$E_x' = E_x\left(ch\frac{v_y}{c}-sh\frac{v_y}{c}\right) = E_x\exp\left(\mp\frac{v_y}{c}\right),$$

$$H_z' = H_z\left(ch\frac{v_y}{c}-sh\frac{v_y}{c}\right) = H_z\exp\left(\mp\frac{v_y}{c}\right).$$

I.e. amplitudes fields on exponentially they diminish or they grow depending on direction of motion.

The transverse Doppler effect, who long ago is discussed sufficiently, until now, did not find its confident experimental confirmation. For observing the star from moving IS it is necessary to incline telescope on the motion of motion to the angle, determined by relationship (3.2). But in this case the star, observed with the aid of the telescope in the zenith, will be in actuality located several behind the visible position with respect to the direction of motion. Its angular displacement from the visible position in this case will be determined by relationship (3.2). But this means that this star with respect to the observer has radial speed, determined by the relationship

$$v_r=v\sin\alpha$$

Since for the low values of the angles $\sin\alpha\cong\alpha$, and $\alpha=\frac{v}{c}$, Doppler frequency shift will compose

$$\omega_{d\perp}=\omega_0\frac{v^2}{c^2} \tag{3.3}$$

This result numerically coincides with results special relativity (SR), but it is principally characterized by results fact that it is considered into SR that the Doppler transverse effect, determined by relationship (3.3), there is in actuality, while in this case this only apparent effect. If we compare the results of conversions fields on (2.5) with conversions SR, then it is not difficult to see that they coincide with an accuracy to the quadratic members of the ratio of the velocity of the motion of charge to the speed of light.

Conversion SR, although they were based on the postulates, could correctly explain sufficiently accurately many physical phenomena, which before this explanation did not have. With this circumstance is connected this great success of this theory. Conversions (2.4) and (2.5) are obtained on the physical basis without the use of postulates and they with the high accuracy coincided with SR. Difference is the fact that in conversions (2.5) there are no limitations on the speed for the material particles, and also the fact that the charge is not the invariant of speed.

4. Emission laws and scattering in the concept of the scalar-vector potential

Since fields on any process of the propagation of electrical and potentials it is always connected with the delay, let us introduce the being late scalar- vector potential, by considering that the field of this potential is extended in this medium with a speed of light [9,10]:

$$\varphi(r,t)=\frac{g\ ch\dfrac{v_{\perp\left(t-\frac{r}{c}\right)}}{c}}{4\pi\ \varepsilon_0 r}, \tag{4.1}$$

where $v_{\perp\left(t-\frac{r}{c}\right)}$ - component of the charge rate g, normal to the vector $\vec{r}$ at the moment of the time $t'=t-\dfrac{r}{c}$, r is distance between the charge and the observation point.

Using a relationship $\vec{E}=-grad\ \ \varphi(r,t)$, let us find field at point 1 (Fig. 2 The gradient of the numerical value of a radius of the vector $\vec{r}$ is a scalar function of two points: the initial point of a radius of vector and its end point (in this case this point 1 on the axis x and point 0 at the origin of coordinates). Point 1 is the point of source, while point 0 - by observation point. With the determination of gradient from the function, which contains a radius depending on the conditions of task it is necessary to distinguish two cases:

1. The point of source is fixed and $\vec{r}$ is considered as the function of the position of observation point; and

2. Observation point is fixed and $\vec{r}$ is considered as the function of the position of the point of source.

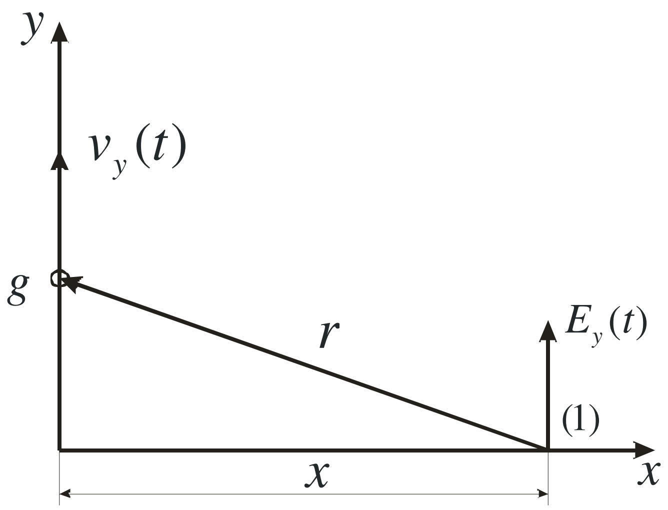

Fig. 2 Diagram of shaping of the induced electric field.

We will consider that the charge e accomplishes fluctuating motion along the axis y, in the environment of point 0, which is observation point, and fixed point 1 is the point of source and $\vec{r}$ is considered as the function of the position of charge. Then we write down the value of electric field at point 1:

$$E_y(1) = -\frac{\partial \varphi_\perp(r,t)}{\partial y} = -\frac{\partial}{\partial y} \frac{e}{4\pi\varepsilon_0 r(y,t)} \; ch \frac{v_y\left(t - \frac{r(y,t)}{c}\right)}{c}.$$

When the amplitude of the fluctuations of charge is considerably less than distance to the observation point, it is possible to consider a radius vector constant. We obtain with this condition:

$$E_y(x,t) = -\frac{e}{4\pi\varepsilon_0 cx} \frac{\partial v_y\left(t - \frac{x}{c}\right)}{\partial y} sh \frac{v_y\left(t - \frac{x}{c}\right)}{c}, \qquad (4.2)$$

where x is some fixed point on the axis x.

Taking into account that $\frac{\partial v_{y\left(t-\frac{x}{c}\right)}}{\partial y}=\frac{\partial v_{y\left(t-\frac{x}{c}\right)}}{\partial t}\frac{\partial t}{\partial y}=\frac{\partial v_{y\left(t-\frac{x}{c}\right)}}{\partial t}\frac{1}{v_{y\left(t-\frac{x}{c}\right)}}$,

we obtain from (4.2)

$$E_y(x,t)=\frac{e}{4\pi\varepsilon_0 cx}\frac{1}{v_{y\left(t-\frac{x}{c}\right)}}\frac{\partial v_{y\left(t-\frac{x}{c}\right)}}{\partial t}sh\frac{v_{y\left(t-\frac{x}{c}\right)}}{c}. \quad (4.3)$$

This is a complete emission law of the moving charge.

if we take only first term of the expansion $sh\frac{v_{y\left(t-\frac{x}{c}\right)}}{c}$, then we will obtain from (4.3):

$$E_y(x,t)=-\frac{e}{4\pi\varepsilon_0 c^2 x}\frac{\partial v_{y\left(t-\frac{x}{c}\right)}}{\partial t}=-\frac{ea_{y\left(t-\frac{x}{c}\right)}}{4\pi\varepsilon_0 c^2 x}, \quad (4.4)$$

where $a_{y\left(t-\frac{x}{c}\right)}$ is being late acceleration of charge. This relationship is wave equation and defines both the amplitude and phase responses of the wave of the electric field, radiated by the moving charge.

If we as the direction of emission take the vector, which lies at the plane xy, and which constitutes with the axis y the angle α, then relationship (4.4) takes the form:

$$E_y(x,t,\alpha)=-\frac{ea_{y\left(t-\frac{x}{c}\right)}\sin\alpha}{4\pi\varepsilon_0 c^2 x}. \quad (4.5)$$

The relationship (4.5) determines the radiation pattern. Since in this case there is axial symmetry relative to the axis y, it is possible to calculate the complete radiation pattern of this emission. This diagram corresponds to the radiation pattern of dipole emission.

since $\frac{ev_{z\left(t-\frac{x}{c}\right)}}{4\pi x}=A_{H\left(t-\frac{x}{c}\right)}$ is being late vector potential, relationship (4.5) it is possible to rewrite

$$E_y(x,t,\alpha)=-\frac{ea_{y\left(t-\frac{x}{c}\right)}\sin\alpha}{4\pi\varepsilon_0 c^2 x}=-\frac{1}{\varepsilon_0 c^2}\frac{\partial A_{H\left(t-\frac{x}{c}\right)}}{\partial t}=-\mu_0\frac{\partial A_{H\left(t-\frac{x}{c}\right)}}{\partial t}$$

is again obtained complete agreement with the equations of the being late vector potential, but vector potential is introduced here not by phenomenological method, but with the use of a concept of the being late scalar-vector potential. It is necessary to note one important circumstance: in Maxwell's equations the electric fields, which present wave, vortex. In this case the electric fields bear gradient nature.

Let us demonstrate the still one possibility, which opens relationship (4.5). Is known that in the electrodynamics there is this concept, as the electric dipole and the dipole emission, when the charges, which are varied in the electric dipole, emit electromagnetic waves. Two charges with the opposite signs have the dipole moment:

$$\vec{p}=e\vec{d}\ , \tag{4.6}$$

where the vector $\vec{d}$ is directed from the negative charge toward the positive charge. Therefore current can be expressed through the derivative of dipole moment on the time

$$e\vec{v}=e\frac{\partial\vec{d}}{\partial t}=\frac{\partial\vec{p}}{\partial t}\ .$$

Consequently

$$\vec{v}=\frac{1}{e}\frac{\partial\vec{p}}{\partial t}\ ,$$

and

$$\vec{a}=\frac{\partial\vec{v}}{\partial t}=\frac{1}{e}\frac{\partial^2\vec{p}}{\partial t^2}\ .$$

Substituting this relationship into expression (4.5), we obtain the emission law of the being varied dipole.

$$\vec{E}=-\frac{1}{4\pi r\varepsilon_0 c^2}\frac{\partial^2 p_{(t-\frac{r}{c})}}{\partial t^2}\ . \tag{4.7}$$

This is also very known relationship [1].

In the process of fluctuating the electric dipole are created the electric fields of two forms. First, these are the electrical induction fields of emission, represented by equations (4.4), (4.5) and (4.6), connected with the acceleration of charge. In addition to this, around the being varied dipole are formed the electric fields of static dipole, which change in the time in connection with the fact that the distance between the charges it depends on time. Specifically, energy of these fields on the freely being varied dipole and it is expended on the emission. However, the summary value of field around this dipole at any moment of time defines as superposition fields on static dipole fields on emissions.

The laws (4.4), (4.5), (4.7) are the laws of the direct action, in which already there is neither magnetic fields on nor vector potentials. I.e. those structures, by which there were the magnetic field and magnetic vector potential, are already taken and they no longer were necessary to us.

Using relationship (4.5) it is possible to obtain the laws of reflection and scattering both for the single charges and, for any quantity of them. If any charge or group of charges undergo the action of external (strange) electric field, then such charges begin to accomplish a forced motion, and each of them emits electric fields in accordance with relationship (4.5). The superposition of electrical fields on, radiated by all charges, it is electrical wave.

If on the charge acts the electric field, then the acceleration $E'_y = E'_{y0} \sin \omega t$ charge is determined by the equation

$$a = -\frac{e}{m} E'_{y0} \sin \omega t \,.$$

Taking into account this relationship (4.5) assumes the form

$$E_y(x,t,\alpha) = \frac{e^2 \sin\alpha}{4\pi\varepsilon_0 c^2 m x} E'_{y0} \sin\omega(t - \frac{x}{c}) = \frac{K}{x} E'_{y0} \sin\omega(t - \frac{x}{c}) \,, \tag{4.8}$$

where the coefficient $K = \frac{e^2 \sin\alpha}{4\pi\varepsilon_0 c^2 m}$ can be named the coefficient of scattering (re-emission) single charge in the assigned direction, since it determines the ability of charge to re-emit the acting on it external electric field.

The current wave of the displacement accompanies the wave of electric field:

$$j_y(x,t) = \varepsilon_0 \frac{\partial E_y}{\partial t} = -\frac{e \sin\alpha}{4\pi c^2 x} \frac{\partial^2 v_{y\left(t - \frac{x}{c}\right)}}{\partial t^2} \,.$$

If charge accomplishes its motion under the action of the electric field $E' = E'_0 \sin \omega t$, then bias current in the distant zone will be written down as

$$j_y(x,t) = -\frac{e^2 \omega}{4\pi c^2 m x} E'_{y0} \cos\omega\left(t - \frac{x}{c}\right). \tag{4.9}$$

The sum wave, which presents the propagation of electrical fields on (4.8) and bias currents (4.9), can be named of the elektrocurent wave. In this current wave of displacement lags behind the wave of electric field to the angle equal $\frac{\pi}{2}$.

In parallel with the electrical waves it is possible to introduce magnetic waves, if we assume that

$$\vec{j}=\varepsilon_0\frac{\partial\vec{E}}{\partial t}=rot\vec{H}\,, \qquad (4.16),$$

$$div\vec{H}=0\,,$$

introduced thus magnetic field is vortex. Comparing (4.9) and (4.10) we obtain:

$$\frac{\partial H_z(x,t)}{\partial x}=\frac{e^2\omega\ \sin\alpha}{4\pi c^2 mx}E'_{y0}\cos\omega\left(t-\frac{x}{c}\right).$$

Integrating this relationship on the coordinate, we find the value of the magnetic field

$$H_z(x,t)=\frac{e^2\ \sin\alpha}{4\pi cmx}E'_{y0}\sin\omega\left(t-\frac{x}{c}\right). \qquad (4.11)$$

Thus, relationship (4.8), (4.9) and (4.11) can be named the laws of electrical induction, since they give the direct coupling between the electric fields, applied to the charge, and by fields and by currents induced by this charge in its environment. Charge itself comes in the role of the transformer, which ensures this reemission. The magnetic field, which can be calculated with the aid of relationship (4.11), is directed normally both toward the electric field and toward the direction of propagation, and their relation at each point of the space is equal

$$\frac{E_y(x,t)}{H_z(x,t)}=Z_0\,.$$

Wave drag determines the active power of losses on the single area, located normal to the direction of propagation of the wave:

$$P=\frac{1}{2}Z_0E^2{}_{y0}\,.$$

Therefore electrocurent wave, crossing this area, transfers through it the power, determined by the data by relationship, which is located in accordance with By Poynting's theorem about the power flux of electromagnetic wave. Therefore, for finding all parameters, which characterize wave process, it is sufficient examination only of electrocurent wave and knowledge of the wave drag of space. In this case it is in no way compulsory to introduce this concept as "magnetic field" and its vector potential, although there is nothing illegal in this. In this setting of the relationships, obtained for the electrical and magnetic field, they completely satisfy Helmholtz's theorem. This theorem says, that any single-valued and continuous vectorial field $\vec{F}$, which turns into zero at infinity, can be represented uniquely as the sum of the gradient φ a certain scalar function $\vec{C}$ and rotor of a certain vector function , whose divergence is equal to zero:

$$\vec{F}=grad\varphi+rot\vec{C},$$

$$div\vec{C}=0.$$

Consequently, must exist clear separation fields on to the gradient and the vortex. It is evident that in the expressions, obtained for those induced fields on, this separation is located. Electric fields bear gradient nature, and magnetic – vortex.

Thus, the construction of electrodynamics should have been begun from the acknowledgement of the dependence of scalar potential on the speed. But nature very deeply hides its secrets, and in order to come to this simple conclusion, it was necessary to pass way by length almost into two centuries. The grit, which so harmoniously were erected around the magnet poles, in a straight manner indicated the presence of some power fields on potential nature, but to this they did not turn attention; therefore it turned out that all examined only tip of the iceberg, whose substantial part remained invisible of almost two hundred years.

Taking into account entire aforesaid one should assume that at the basis of the overwhelming majority of static and dynamic phenomena at the electrodynamics only one formula (4.1), which assumes the dependence of the scalar potential of charge on the speed, lies. From this formula it follows and static interaction of charges, and laws of power interaction in the case of their mutual motion, and emission laws and scattering. This approach made it possible to explain from the positions of classical electrodynamics such phenomena as phase aberration and the transverse Doppler effect, which within the framework the classical electrodynamics of explanation did not find. After entire aforesaid it is possible to remove construction forests, such as magnetic field and magnetic vector potential, which do not allow here already almost two hundred years to see the building of electrodynamics in entire its sublimity and beauty.

Let us point out that one of the fundamental equations of induction (4.4) could be obtained directly from the Ampere law, still long before appeared Maxwell's equations. The Ampere law, expressed in the vector form, determines magnetic field at the point [28]

$$\vec{H}=\frac{1}{4\pi}\int\frac{Id\vec{l}\times\vec{r}}{r^3},$$

where I is current in the element $d\vec{l}$, $\vec{r}$ is vector, directed from $d\vec{l}$ to the point x,y,z.

It is possible to show that

$$\frac{[d\vec{l}\vec{r}]}{r^3}=grad\left(\frac{1}{r}\right)\times d\vec{l},$$

and, besides the fact that

$$grad\left(\frac{1}{r}\right)\times d\vec{l}=rot\left(\frac{d\vec{l}}{r}\right)-\frac{1}{r}rot\ d\vec{l}.$$

But the rotor $d\vec{l}$ is equal to zero and therefore is final

$$\vec{H}=rot\int I\left(\frac{d\vec{l}}{4\pi r}\right)=rot\ \vec{A}_H,$$

where

$$\vec{A}_H=\int I\left(\frac{d\vec{l}}{4\pi r}\right). \qquad (4.12)$$

The remarkable property of this expression is that that the vector potential depends from the distance to the observation point as $\frac{1}{r}$. Specifically, this property makes it possible to obtain emission laws.

Since $I=gv$, where g is linear charge, from (4.12) we obtain:

$$\vec{A}_H=\int\frac{gv\ d\vec{l}}{4\pi r}.$$

For the single charge e this relationship takes the form:

$$\vec{A}_H = \frac{e\vec{v}}{4\pi r},$$

and since

$$\vec{E} = -\mu \frac{\partial \vec{A}}{\partial t},$$

that

$$\vec{E} = -\mu \int \frac{g \frac{\partial v}{\partial t} \, d\vec{l}}{4\pi r} = -\mu \int \frac{ga \, d\vec{l}}{4\pi r}, \qquad (4.13)$$

where a is acceleration of charge.

This relationship appears as follows for the single charge:

$$\vec{E} = -\frac{\mu e \vec{a}}{4\pi r}. \qquad (4.14)$$

Taking into account the delay $\left(t - \frac{r}{c}\right)$ of relationship (4.13) and (4.14) will be written down:

$$\vec{E} = -\mu \int \frac{g a_{(t-\frac{r}{c})} \, d\vec{l}}{4\pi r} = -\int \frac{g a_{(t-\frac{r}{c})} \, d\vec{l}}{4\pi \varepsilon_0 c^2 r}, \qquad (4.15)$$

$$\vec{E} = -\frac{e \vec{a}_{(t-\frac{r}{c})}}{4\pi \varepsilon_0 c^2 r}, \qquad (4.16)$$

where $\frac{1}{\varepsilon_0 c^2} = \mu$.

The relationship (4.15-4.16) represent the solution of Maxwell's equations, but in this case they are obtained directly from the Ampere law, not at all coming running to Maxwell's equations. To there remains only present the question, why electrodynamics in its time is not banal by this method?

Given examples show as electrodynamics in the time of its existence little moved. The phenomenon of electromagnetic induction Faraday opened into 1831, and already almost 200 years its study underwent practically no changes, and the physical causes for the most elementary electrodynamic phenomena, until now, were misunderstood. Certainly, for his time Faraday was genius, but that they did make physics after it? There were still such brilliant scientists as Maxwell, Hertz, Heaviside, but even they could not understand that the basis of all dynamic laws of classical electrodynamics, charges connected with the motion, is the dependence of the scalar potential of charge on the speed.

5. Problem of magnetic field and power interaction of the current carrying systems

From relationship (2.22) follows that if there are two charges, which move with the relative speed $\vec{v}$, then the force of their interaction will be determined not only absolute values of charges, but also by relative speed of their motion. The new value of force is determined by the relationship [7-9]

$$\vec{F} = \frac{e_1 e_2 \, ch \, \frac{v_\perp}{c}}{4\pi \, \varepsilon_0} \cdot \frac{\vec{r}_{12}}{r_{12}^3}, \qquad (5.1)$$

where $\vec{r}_{12}$ is vector, which connects charges, $v_\perp$ is component of the speed $\vec{v}$, normal to the vector $\vec{r}_{12}$.

The relationship (5.1) is precise Coulomb law.

When relative motion achieve opposite charges, the force of their attraction increases and, on the contrary, if relative motion achieve like charges, then the force of their repulsion increases. In the case, when $\vec{v} = 0$, relationship (5.1) passes into Coulomb law.

Using relationship (5.1) it is possible to introduce the new value of the potential $\varphi(r)$ at the point, where it is located the charge e_2, considering its fixed and considering that relative motion achieves only a charge e_1

$$\varphi(r) = \frac{e_1 \, ch \, \frac{v_\perp}{c}}{4\pi \, \varepsilon_0 r}.$$

The potential interaction energy of charges in this case will be written down

$$W = \frac{g_1 \; g_2 \; ch \frac{v_\perp}{c}}{4\pi \; \varepsilon_0 r}.$$

If we use ourselves the obtained relationships for enumerating the forces of interaction of conductors with the current, then it is possible to obtain the laws of power interaction of the current carrying systems.

Let us examine power interaction of two conductors, located at a distance z (Fig. 1.1) and we will consider that along the conductors move the electrons with the speeds v_1, v_2. The linear charges in conductors denoted g_1, g_2.

It is possible to find in two ways from the point of view of the existing theory of the electromagnetism of the force of interaction of conductors.

The first of them consists in the fact that one of the conductors (for example, lower) creates in the location of upper conductor the magnetic field $H(r)$, which is determined by the relationship

$$H(r) = \frac{g_1 \; v_1}{2\pi \; r}.$$

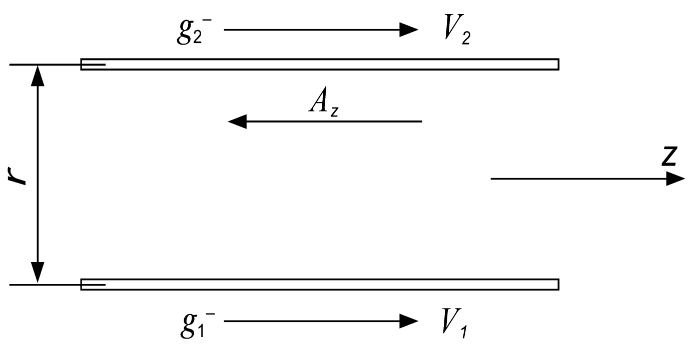

Fig. 3 Schematic of power interaction of the current carrying wires of two-wire circuit on the basis of the existing model.

In the coordinate system, which is moved together with the charges of upper conductor, appears the field E', determined by the relationship

$$E' = v_2 \mu \; H(r) \tag{5.2}$$

i.e. the charges, which are moved in the upper conductor, experience the action of Lorentz force. The value of linear force will be equal

$$F=\frac{\mu\ g_1\ v_1\ g_2\ v_2}{2\pi\ r}=\frac{I_1\ I_2}{2\pi\ \varepsilon_0\ c^2\ r} \tag{5.3}$$

This relationship can be obtained by another way. Is possible to consider that the lower conductor creates in the region of the arrangement of upper wire the vector potential, z is component of which will be written down

$$A_Z=-\frac{g_1 v_1\ \ln r}{2\pi\ \varepsilon_0\ c^2}=-\frac{I_1\ \ln r}{2\pi\ \varepsilon_0\ c^2}\ .$$

The potential energy of the single section of the upper conductor, along which flows the current I_2, in the field of the vector potential A_z will be determined by the relationship

$$W=I_2 A_Z=-\frac{I_1\ I_2 \ln r}{2\pi\ \varepsilon_0\ c^2}\ .$$

Since the force is defined as the derivative of potential energy by the coordinate, undertaken with the opposite sign, it will be written down

$$F=-\frac{\partial\ W}{\partial\ r}=\frac{I_1\ I_2}{2\pi\ \varepsilon_0\ c^2 r} \tag{5.4}$$

Both examinations show that the force of interaction of two conductors appears as the result of interaction of the moving charges, since some of them create fields, and others with these fields interact. The fixed charges, which present lattice, in this diagram of interaction do not assume participation. However, the forces, which appear with magnetic interaction of conductors, are applied precisely to the lattice. A question about how the moving charges transfer the applied to them forces to lattice, in the classical electrodynamics is not examined.

Let us note also that the diagrams of interaction examined include one insoluble contradiction, which the specialists in the classical electrodynamics usually hush up. It is connected with the presence of the forces of interaction between two in parallel by the moving charges. From the point of view of the diagrams examined, between such two charges must exist the attraction. Actually, the induction B, created by the moving charge g_1 at a distance r from it, is written

$$B=\frac{g_1 \ v}{2\pi \ \varepsilon_0 \ c^2 r^2} \ .$$

If is located another charge g_2, which is moved with the same speed v, as first also in the same direction at a distance r from the first charge, then due to the presence in this point of the induction B on it will act attracting force to the first charge

$$F=\frac{g_1 \ g_2 v^2}{4\pi \ \varepsilon_0 \ c^2 r^2} \ .$$

Such charges, besides the presence of the forces of Coulomb repulsion must additionally be attracted from the point of view of fixed observer. However, from the point of view of observer, which is moved together with the charges, is only Coulomb repulsion and there are no extra forces of attraction. Let us note that this contradiction insoluble not only within the framework of classical electrodynamics, but also within the framework the special theory of relativity.

The introduction of magnetic fields on there is simply the statement of the specific experimental facts, however, we of these times we do not understand from a physical point of view, from where these fields are taken.

Let us examine in the concept of scalar-vector potential interaction between two conductors, on which with the speeds v_1, v_2 move charges (Fig. 4).

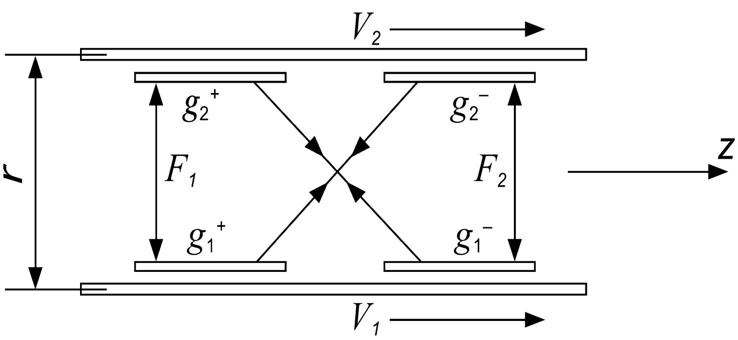

Fig. 4. Schematic of power interaction of the current carrying wires of two-wire circuit taking into account the positively charged lattice.

We will consider that in the conductors are fixed and moving linear charges g_1^+, g_2^+ and g_1^-, g_2^-. 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 were electrically neutral, i.e., a quantity of positive and negative charges in them equally and in both systems is two systems of the mutually inserted opposite charges with the linear density g_1^+, g_1^- and g_2^+, g_2^-. In Fig. 4 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 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 Fig. 4. By pointers in the figure is marked the direction of these forces. The repulsive forces and we will take with the plus sign, while the attracting force and we will take with the minus sign.

In accordance with relationship (5.1) the forces, which act between the separate subsystems of charges, will be written down

$$F_1 = -\frac{g_1^+ g_2^+}{2\pi\ \varepsilon_0\ r},$$

$$F_2 = -\frac{g_1^- g_2^-}{2\pi\ \varepsilon_0\ r} ch\frac{v_1 - v_2}{c},$$

$$F_3 = +\frac{g_1^- g_2^+}{2\pi\ \varepsilon_0\ r} ch\frac{v_1}{c},$$

$$F_4 = +\frac{g_1^+ g_2^-}{2\pi\ \varepsilon_0\ r} ch\frac{v_2}{c}.$$

Adding four forces and taking into account that the fact that the work of opposite charges corresponds to attracting forces, and similar corresponds to repulsive forces, we will obtain the amount of the summary force gradient, which falls per unit of the length of conductor,

$$F_\Sigma = \frac{g_1\ g_2}{2\pi\ \varepsilon_0\ r}\left(ch\frac{v_1}{c} + ch\frac{v_2}{c} - ch\frac{v_1 - v_2}{c} - 1 \right). \tag{5.5}$$

In this expression as and are undertaken the absolute values of charges, and the signs of forces are taken into account in the bracketed expression. Considering that $v \ll c$, let us take only two first members of arrangement in a number $ch\frac{v}{c}$, i.e. we will consider that $ch\frac{v}{c} \cong 1 + \frac{1}{2}\frac{v^2}{c^2}$. From relationship (5.5) we obtain

$$F_{\Sigma 1}=\frac{g_1\ v_1\ g_2 v_2}{2\pi\ \varepsilon_0\ c^2 r}=\frac{I_1\ I_2}{2\pi\ \varepsilon\ c^2 r},$$

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

We see that expressions (5.2), (5.4) and (5.5) coincide, although are obtained they all by completely different ways. In this case we obtained one and the same value of the force of interaction between the current carrying systems by already three completely different methods. Moreover, last method not at all requires the introduction of this concept as magnetic field. Furthermore, in the formation of the forces of interaction in this method most direct part takes lattice, which is not in the first two methods.

However, on the way of introduction into the life of the third proposed model to eat one essential obstacle. It consists of the following. Actually, if we place $g_2^+ = 0$ and $v_2 = 0$, i.e., to examine the case of interaction, for example, of the lower current carrying system with the fixed charge g_2^-, then for the force of interaction we will obtain

$$F_{\Sigma 2}=-\frac{1}{2}\cdot\frac{g_1\ g_2 v_1^2}{2\pi\ \varepsilon_0\ c^2 r}.$$

This means that with the flow of the current through conductor it ceases to be electrically neutral, and the electric field is formed around the conductor

$$E_{\perp}=\frac{g_1\ v_1^2}{4\pi\ \varepsilon_0\ c^2 r},$$

which is equivalent to appearance on the conductor of the additional specific static charge

$$g = -g_1\frac{v_1^2}{c^2}. \tag{5.6}$$

However, in practice, before the appearance works [29], electric fields, generated by direct by the currents taking place, were not observed.

When by Faraday and by Maxwell were formulated the fundamental laws of electrodynamics, to experimentally confirm relationship (5.6) it was impossible, since. the current densities, accessible in the usual conductors, are too small for the experimental detection of the effect in question. Thus, position about the independence of scalar potential and charge from the speed and the subsequent introduction of magnetic field they were made volitional way on the phenomenological basis.

The current density, which can be achieved in the superconductors, make it possible to experimentally detect corrections to the charge $\sim g\frac{v_1^2}{c^2}$. Specifically, this circumstance at first made it possible to consider the results of work [29] confirmation of the fact that the magnitude of the charge depends on speed. As we already indicated, the author of this work also experimentally investigated this problem [30]. Moreover, in contrast to work [29] current into the superconductive winding was introduced by inductive noncontact method. In this case even with this method of the introduction of current at the winding appeared charge [30]. All studies, whose results are given in these works, were conducted on the composite superconductive wires, in particular, on the niobium-titanium wires with the copper coating. Therefore up to now thus far not clearly which mechanism of the appearance of a charge on the winding. Possibly it is connected with the level shift of Fermi in the copper coating due to the mechanical deformations. In order to explain this, should be conducted experiments on the superconductive wires without the metallic coatings. We will not dot on experimental studies in this region, since. from the point of view of fundamental physics their continuation has important significance.

6 . Problem of homopolar induction and its solution

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 [27]. 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. Let us show that the concrete answers to all these questions can be obtained within the framework the concept of scalar- vector potential [10,13,17,19].

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. 5).

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

$$E^{+}=\frac{g^{+}}{2\pi\varepsilon_0 r} \tag{6.1}$$

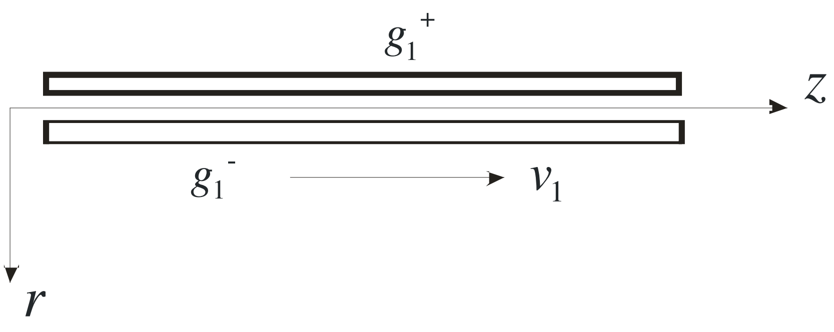

Fig. 5. Section is the conductor, along which flows the current.

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

$$E^{-}=-\frac{g^{-}}{2\pi\varepsilon_0 r}ch\frac{v_1}{c}\cong-\frac{g^{-}}{2\pi\varepsilon_0 r}\left(1+\frac{1}{2}\frac{v_1^{2}}{c^{2}}\right). \tag{6.2}$$

Adding (6.1) and (6.2), we obtain:

$$E^{-}=-\frac{g^{-}v_1^{2}}{4\pi\varepsilon_0 c^{2}r}.$$

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 $v \ll c$.

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. 6 . In this case relationships (6.1) and (6.2) will take the form

$$E^{+}=\frac{g^{+}}{2\pi\varepsilon_0 r}\left(1+\frac{1}{2}\frac{v^{2}}{c^{2}}\right), \tag{6.3}$$

$$E^{-}=-\frac{g^{-}}{2\pi\varepsilon_0 r}\left(1+\frac{1}{2}\frac{(v_1-v)^2}{c^2}\right). \quad (6.4)$$

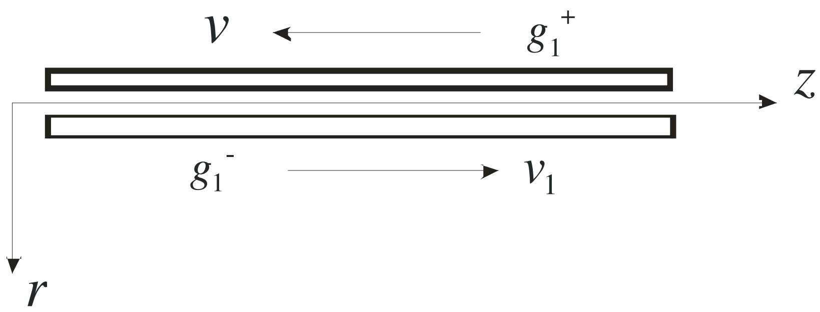

Fig. 6 . Moving conductor with the current.

Adding (6.3) and (6.4), we obtain:

$$E^{+}=\frac{g}{2\pi\varepsilon_0 r}\left(\frac{v_1 v}{c^2}-\frac{1}{2}\frac{v_1^{\,2}}{c^2}\right). \quad (6.5)$$

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 (6.5) we obtain

$$E^{+}=\frac{g v_1 v}{2\pi\varepsilon_0 c^2 r}. \quad (6.6)$$

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 (6.6), 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.

As is obtained the homopolar induction, with which on the fixed contacts a potential difference is obtained, it is easy to understand from Fig. 7.

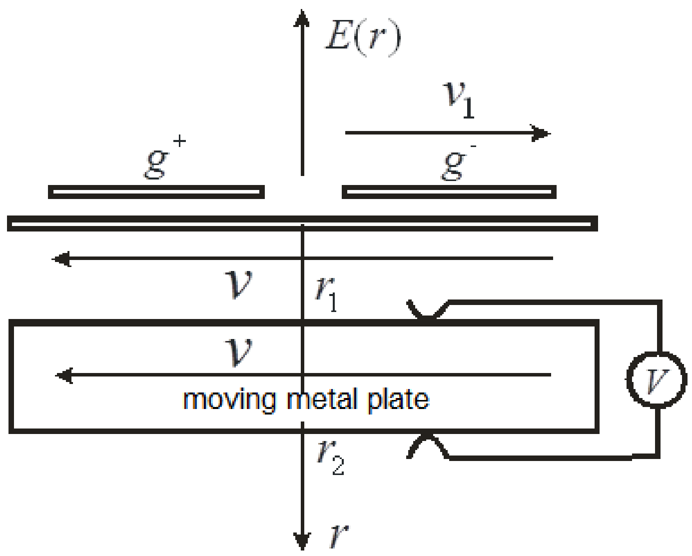

Fig. 7. Diagram of formation emf. homopolar induction.

We will consider that r_1 and 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 (6.6):

$$U = \frac{g v_1 v}{2\pi\varepsilon_0 c^2} \int_{r_1}^{r_2} \frac{dr}{r} = \frac{g v_1 v}{2\pi\varepsilon_0 c^2} \ln\frac{r_2}{r_1}.$$

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. 8) 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

(Fig. 8), that revolves together with the turns of magnet, and with the aid of the fixed contacts, that slides 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.

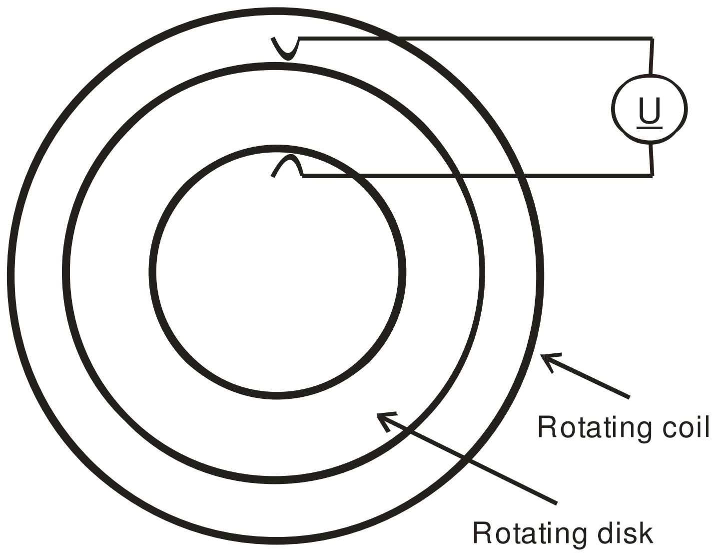

Fig. 8. Schematic of unipolar generator with the revolving turn with the current and the revolving conducting ring.

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

The case with the fixed magnet and the revolving conducting disk is characterized by the diagram, depicted in Fig. 9, if the conducting plate was rolled up into the ring.

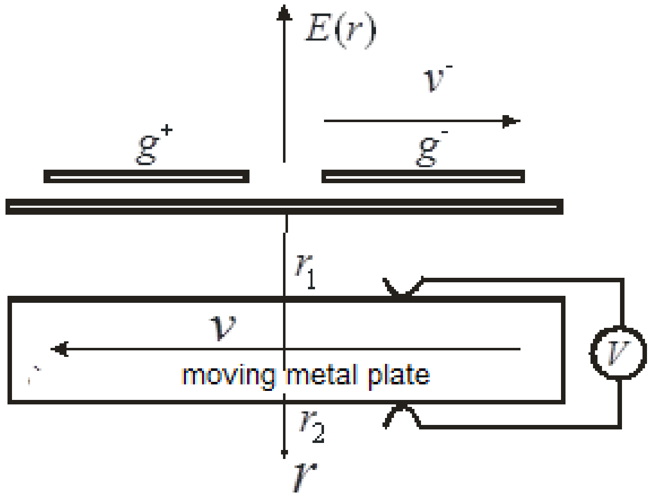

Fig. 9. Case of fixed magnet and revolving disk.

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

$$E^{-}=-\frac{g^{-}}{2\pi\varepsilon_0 r}ch\frac{v_1-v}{c}=-\frac{g^{-}}{2\pi\varepsilon_0 r}\left(1+\frac{1}{2}\frac{(v_1-v)^2}{c^2}\right),$$

and by the fixed ions

$$E^{+}=\frac{g^{+}}{2\pi\varepsilon_0 r}ch\frac{v}{c}=\frac{g^{-}}{2\pi\varepsilon r}\left(1+\frac{1}{2}\frac{v^2}{c^2}\right).$$

The summary tension of electric field in this case will comprise

$$E_{\Sigma}=\frac{g}{2\pi\varepsilon_0 r}\left(\frac{vv_1}{c^2}\right),$$

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

$$U=\frac{g(r_2-r_1)}{2\pi\varepsilon_0 r}\left(\frac{vv_1}{c^2}\right).$$

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 scalar-vector potential gives answers to all presented questions.

7. Electrical impulse of nuclear explosion

According to the program *Starfish* USA exploded in space above Pacific Ocean H-bomb. Explosion was produced at the height of 400 km, it TNT equivalent was 1.4 Mt. This event placed before the scientific community many questions. In 1957 future Nobel laureate doctor Hans Albrecht Bethe gave the forecast of the consequences of such explosion. It predicted that with this explosion on the earth's surface will be observed the electromagnetic pulse (EMP) with the tension electrical fields not more than 100 V/m. But with the explosion of bomb discomfiture occurred, fields on the tension of electrical, beginning from the epicentre of explosion, and further for the elongation of more than 1000 km of it reached several ten thousand volt per meters. Actual chart area and value of tensions fields on given in Fig. 10

Fig. 10. Map of tests according to the program *Starfish.*

IN the USSR for *Program K* not far from Dzhezkazgan at the height of 290 km was exploded H-bomb with the TNT equivalent 0.3 Mt. Actual chart area with the indication of the values of tensions pour on, obtained with this explosion, it is shown in Fig. 12 comparing data with respect to the tensions pour on, given on these two maps, it is possible to see that the values of tensions pour on in Fig. 10 diminish with an increase in the distance from the epicentre of explosion, while on the map, depicted in Fig. 12, these values grow. From this it is possible to draw the conclusion that on the second map are cited the data on the measurement by the horizontal intensity of electrical fields on.

Fig. 12. Map of tests according to the program *Program K.*

To Fig. 13 is given the graph of EMP, recorded at a distance 1300 km from the epicentre of explosion, obtained with the tests according to the program *Starfish.* It is evident from the given figure that EMP has not only very large amplitude, but also very short duration.

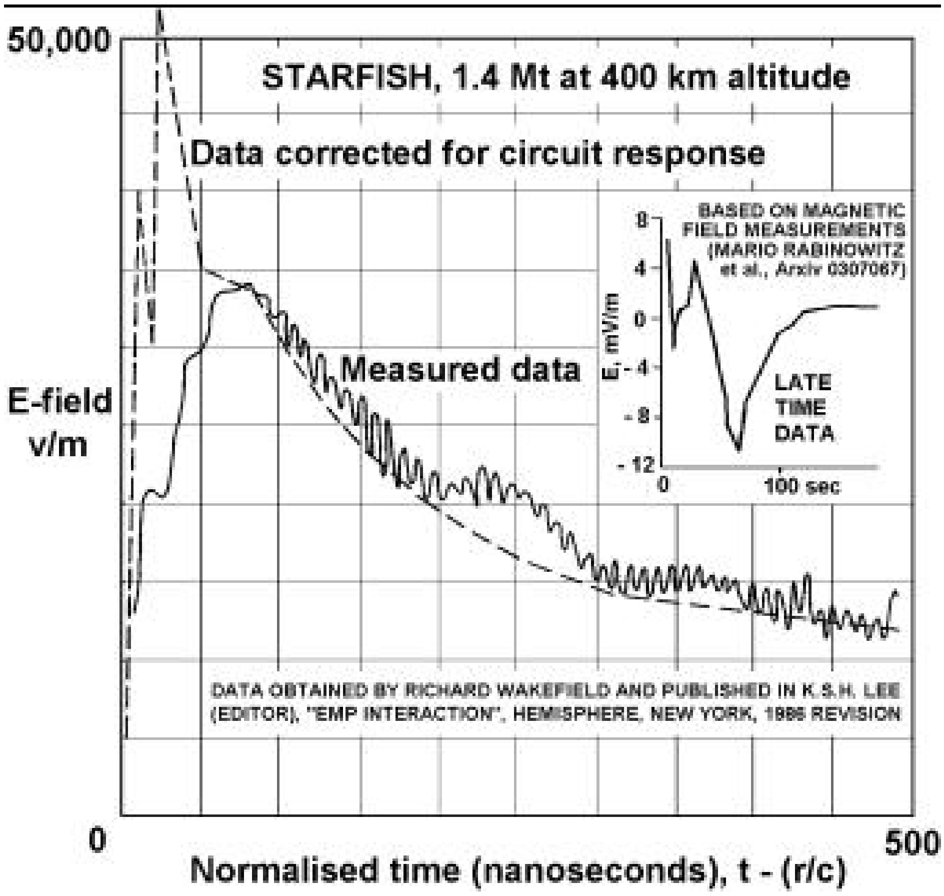

Fig. 13. Experimental dependence of amplitude EMP on the time, obtained with the tests according to the program *Starfish.*

It is known that problem EMP together with my students attempted to solve academician I. B. Zeldovich [31]. However, in the scientific literature there is no information about the fact that this problem was solved by it. And only in 2013 in the periodical Engineering physics appeared the first publication, in which was given an attempt at the explanation of the phenomenon [12]. In the paper it is shown that as a result nuclear explosion appears not the electromagnetic, but electric pulse, the vector of electric field of which is directed toward the point of impact. For explaining physical nature of electric pulse are used the concept of scalar-vector potential, the assuming dependence of the scalar potential of charge on its relative speed.

In the introduction in Fig. 2 solid line showed the dependence of the pulse amplitude on the time, recorded on the oscilloscope face, obtained with the tests according to the program

Starfish, and dotted line showed the shape of pulse, corrected taking into account the parameters of the input circuits of oscillograph.

With the detonation the products of explosion heat to the high temperature, and then occurs their gradual cooling, during which the explosive energy returns to environment. The dependence of the pulse amplitude on the time repeats the process indicated, and possible to assume that precisely the temperature of plasma determines its amplitude. In the time of the detonation of the charge ~ 25 ns is a sharp increase in the pulse amplitude, and then there is a slower process, with which in the time ~ 150 ns the amplitude decreases two. We will consider that the sum of these times represents the time, for which it occurs the emission of a basic quantity of energy, obtained with the explosion.

If we consider that one ton of trotyl is equivalent 4.6×10^{9} J, then with the explosion of bomb with the TNT equivalent 1,4 Mt are separated 6.44×10^{15} J. Consequently explosive force in the time interval indicated will compose ~ 3.7×10^{22} W. For the comparison let us point out that the power of the radiation of the Sun ~ 3.9×10^{26} W.

Let us examine a question, where how, in so short a time, can be the intake, isolated with this explosion. With the explosion in the atmosphere the energy is expended on the emission and on the creation of shock wave. In space shock wave is absent; therefore explosive energy is expended on the electromagnetic radiation.

In accordance with Stephan-Boltzmann equation the power, radiated by the heated surface, is proportional to the fourth degree of its temperature

$$P=\sigma ST^{4},$$

where σ is Stephan-Boltzmann constant, and S is area of radiating surface.

In order to calculate temperature with the known radiated power it is necessary to know the surface of radiating surface. As this surface let us select sphere with the surface ~ 3 m^2. Knowing explosive force and size of radiating surface, we find the temperature of the cloud of the explosion

$$T=\sqrt[4]{\frac{P}{\sigma S}}.$$

With the explosive force ~ 3.7×10^{22} W we obtain the value of temperature equal to ~ 8.6×10^{6} K.

In the concept of scalar-vector potential, the scalar potential of charge g it is determined from the relationship

$$\varphi(r)=\frac{g\ ch\frac{v_\perp}{c}}{4\pi\ \varepsilon_0 r} \tag{7. 1}$$

where, r is the distance between the charge and the observation point, $v_\perp$ is the component of the charge, normal to the vector $\vec{r}$, ε_0 is dielectric constant of vacuum.

According to the estimations at the initial moment of thermonuclear explosion the temperature of plasmoid can reach several hundred million degrees. At such temperatures the electron gas is no longer degenerate and is subordinated to of the Boltzmann distribution. The most probable electron velocity in this case is determined by the relationship

$$v=\sqrt{\frac{2k_BT}{m}}, \tag{7.2}$$

where T is temperature of plasma, k_B is Boltzmann constant, m is the mass of electron.

Using Eqs. (7.1) and (7.2), and taking into account with the expansion in the series of hyperbolic cosine the terms $\sim \frac{v^2}{c^2}$, we obtain the value of increase in the scalar potential at the observation point

$$\Delta\varphi\cong\frac{Nek_BT}{4\pi\varepsilon_0 rmc^2}, \tag{7.3}$$

where N is quantity of electrons in the cloud of explosion, e is electron charge. We determine from the formula the tension of radial electric field, which corresponds to this increase in the potential

$$E=\frac{Nek_BT}{4\pi\varepsilon_0 r^2 mc^2}=\frac{\Delta q}{4\pi\varepsilon_0 r^2} \tag{7.4}$$

where

$$\Delta q = \frac{Nek_B T}{mc^2} \qquad (7.5)$$

is an equivalent charge of explosion.

One should say that with the warming-up of plasma the ions also acquire additional speed, however, since their mass considerably more than the mass of electrons, increase in their charges can be disregarded.

For enumerating the quantity of electrons it is necessary to know a quantity of atoms, which with the warming-up formed the cloud of explosion. Let us assume that the total weight of bomb and launch vehicle, made from metal with the average density of the atoms ~ 5×10^{22} $1/sm^3$, is 1000 kg. General of a quantity of free electrons in the formed plasma, on the assumption that all atoms will be singly ionized with the specific weight of the metal ~ 8 g/cm3 , will comprise ~ 5×10^{27}.

In accordance with Eq. (7.4) the tension of radial electric field at a temperature of the cloud of the explosion ~ 8.6×10^6 K will comprise: in the epicentre of the explosion ~ 6.9×10^4 V/m, at a distance in 870 km from the epicentre ~1.2×10^4 V/m and at a distance 1300 km from the epicentre ~ 6×10^3 V/m. It is evident that in the epicentre the computed values of electrical pour on the earth's surface they are close to the experimental values. The ratio of calculated values to those measured they comprise: in the epicentre of explosion is 13.5, at a distance 870 km from this place is 4.5, at a distance 1300 km is 2.4. Certainly, are unknown neither the precise initial of the temperature of plasmoid nor mass of bomb and launch vehicle, in which it undermine nor materials, from which are prepared these elements. Correcting these data, it is possible sufficiently simply to obtain values pour on those being approaching experimental values. But calculated three-dimensional dependence pour on strongly it is differed from experimental results. Let us attempt to explain the reason for such divergences.

Let us first examine the case, when charge is located above the metallic conducting plane (Fig. 14). The distribution of electrical fields on above this plane well known [27].

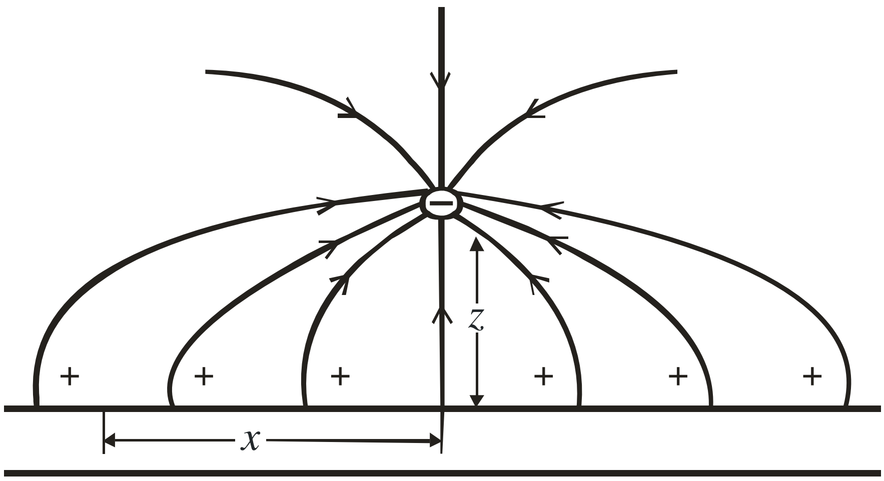

Fig. 14. Negative charge above the limitless conducting plane.

The horizontal component of electric field on the surface of this plane is equal to zero, and normal component is equal

$$E_{\perp}=\frac{1}{2\pi\varepsilon_0}\frac{zq}{\left(z^2+x^2\right)^{\frac{3}{2}}} \tag{7.6}$$

where q is magnitude of the charge, z is distance from the charge to its epicentre, x is distance against the observation points to the epicentre.

Lower than conducting plane electric fields be absent, but this configuration pour on equivalent to the presence under the conducting plane of the positive charge of the same value and at the same distance as initial charge. The pair of such charges presents the electric dipole with the appropriate distribution of electrical pour on. This configuration pour on connected with the fact that charge, which is been located above the conducting plane, it induces in it such surface density of charges, which completely compensates horizontal and vertical component of the electric field of charge in the conducting plane and lower than it. The dependence of the area of the charge density from the coordinate x also is well known [27]

$$\sigma(x)=\varepsilon_0 E_{\perp}=\frac{1}{2\pi}\frac{zq}{\left(z^2+x^2\right)^{\frac{3}{2}}}. \qquad (7.7)$$

If we integrate $\sigma(x)$ with respect to the coordinate x, then we will obtain magnitude of the charge, which is been located above the conducting plane. In such a way as not to pass the electric fields of the charge q through the conducting plane, in it must be contained a quantity of free charges, which give summary charge not less than the charge q. In this case two cases can realize. With the low charge density, which occurs in the poor conductors, it will arrive to move up to the significant distances significant quantities of charges. But in this case of charges it can and not be sufficient for the complete compensation. With the high charge density, it is possible to only insignificantly move charges in the plane. This case realizes in the metallic conductors.

If we periodically draw near and to move away charge from the plane, then in it will arise the periodic horizontal currents, which will create the compensating surface charges. The same effect will be observed, if charge at the particular point can be born and disappear. If at the assigned point above the plane charge suddenly in some time arises, then, so that the fields of charge would not penetrate through the conducting plane, in the same time on the conducting plane the compensating charges, which correspond to relationship must appear (7.7). The surface density of these charges corresponds to relationship (7.7). This means that the strength of currents, which create the compensating charges, there will be the greater, the greater charge itself and the less the time of its appearance. However, with the low charge density can realize another case. With a very rapid change in the electric field the charges will not have time to occupy the places, which correspond to the complete compensation for electrical pour on, and then the fields of external charge partially will penetrate through conductor, and compensation will be not complete. Then the fields of external charge partially penetrate through conductor, and compensation will be not complete. Specifically, this case realizes in the case of the explosion of nuclear charge in space, since between it and earth's surface is located the ionosphere, which possesses not too high a conductivity (Fig. 15).

If charge will appear at the indicated in the figure point, thus it will gather under itself the existing in the ionosphere free charges of opposite sign for compensating those pour on, which it creates in it. However, if a total quantity of free positive charges in the ionosphere will be less than the value of charge itself, or their displacement is insufficient in order to fall into the necessary point at the assigned moment, then their quantity will not be sufficient for the complete compensation pour on the appearing charge and its fields will penetrate through the ionosphere. In this case the fields will penetrate through the ionosphere. In this case the penetrated fields, in view of the screening effect of the ionosphere, can be less than the field above it. In this case maximum compensation pour on it will occur in the region, situated directly under the charge. This process will make the dependence of electrical pour on from the distance by smoother, that also is observed during the experiment. Entire this picture can be described only qualitatively, because are accurately known neither thickness of the ionosphere nor degree of its ionization on the height.

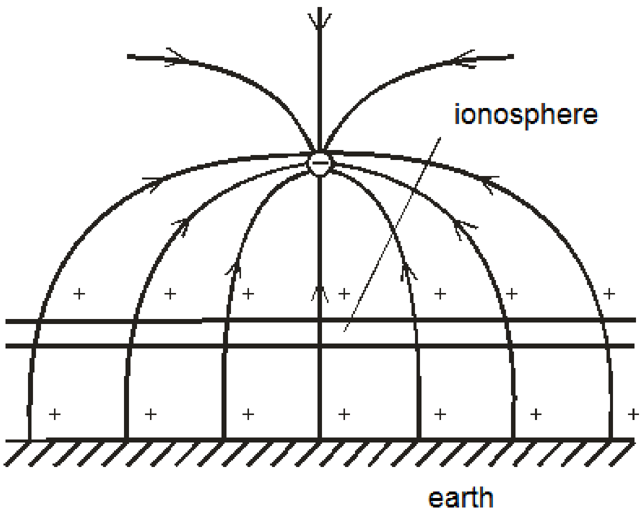

Fig. 15. Negative charge above the earth's surface with the presence of the ionosphere.

The sphericity of the ionosphere also superimposes its special features on the process of the appearance of the compensating surface charges. This process is depicted in Fig. 16

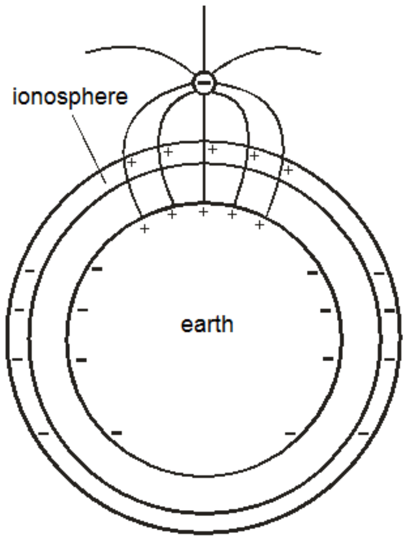

Fig. 16. Negative charge above the earth's surface with the presence of the ionosphere.

The tendency of the emergent charge to gather under itself the compensating charges will lead to the longitudinal polarization of the substantial part of the ionosphere. The compensating positive charges in the ionosphere will in essence appear directly in the epicentre, where they will be in the surplus, while beyond the line-of-sight ranges in the surplus will be negative charges. And entire system the ionosphere - the earth will obtain additional dipole moment.

The model examined speaks, that nuclear explosion will lead not only to the appearance in the zone of straight visibility, but also to the global ionospheric disturbance. Certainly, electric fields in space in the environments of the explosion, where there is no screening effect of the ionosphere, have high values and present large danger to the automatic spacecraft.

In accordance with Eq. (7.4) the pulse amplitude is proportional to the temperature of plasma. Consequently, according to the graph, depicted in Fig. 12, it is possible to judge the knocking processes of nuclear charge and the subsequent cooling of the cloud of explosion. From the figure one can see that two peaks are visible in the initial section of the dependence of the amplitude of electric field. The first peak presents nuclear blast, which ignites thermonuclear charge, the second peak presents the knocking process of thermonuclear fuel. The rapid decrease, which characterizes the process of cooling cluster, further goes. It is evident that it occurs very rapidly. Naturally to assume that this is that period, when basic energy losses are connected with the radiant losses caused by the rigid X-radiation.

Thus, the presence of the pulse indicated they are the properties of explosion itself, but not second phenomenon.

Now should be made one observation apropos of term itself the electromagnetic pulse EMP, utilized in the literary sources. From this name should be excluded the word magnetic, since this process presents the propagation only of radial electrical fields on, and in this case magnetic fields be absent. It is known that the amplitude of the electric field of pulse can reach values ~ 50000 V/m. But if pulse was actually electromagnetic, then the tension of magnetic field would compose ~ 1.3×102 A/m. For obtaining this value should be the tension of electric field divided into the wave drag of free space. In this case the power, determined by the Poytning vector would be ~ 5 MW, which is commensurate with the power of small power station.

It is not difficult to calculate that energy, which with the nuclear explosion is expended on obtaining of electric pulse. The pulse duration is ~ 150 ns. If we consider that the pulse is extended with the speed of light, then its extent in the free space composes d=45 m. At a distance R=400 km from the point of impact the tension of electric field was ~ 50000 V/m. Specific electric field energy composes

$$W=\frac{1}{2}\varepsilon_0 E^2 .$$

The total energy U of the electric field of pulse we obtain by the way of the multiplication of specific energy by the volume of the spherical layer $4\pi r^2 d$

$$U=2\pi r^2 d\varepsilon_0 E^2 .$$

Substituting in this formula the values indicated, we obtain energy ~ 10^{12} J. If we consider that with the explosion is separated energy ~ 6.4×10^{15} J, then energy of electric pulse composes ~ 0.016% of the general explosive energy.

It is another matter that electric fields can direct currents in the conducting environments, and these currents will generate magnetic fields, but this already second phenomenon.

Since the tension of electrical pour on near the nuclear explosion it is great it can reach the values of the breakdown tension of air (300000 V/m), with the explosions, achieved in immediate proximity from the earth's surface, this can lead to the formation of lightning, that also is observed in practice.

The concept of scalar-vector potential can serve and for explaining the cable is special effect. Actually, if in the process of the appearance of the cloud of explosion in it excess charge is formed, then this charge on the ropes must flow into the earth, and this in turn will lead to their additional warming-up.

8. Conclusion

The first work, in which were introduced the concept of scalar- vector potential, the assuming dependence of the scalar potential of charge on the speed, it was published in 1988 [1]. The concept of scalar- vector potential is the consequence of the symmetrical laws of the magnetolectric and electromagnetic induction, introduction of which served the work of Faraday and Maxwell. Further development of the concept of scalar- vector potential, its theoretical substantiation and practical use obtained in works [2-26]. Contemporary classical electrodynamics consists of two not connected together parts: from one side this of Maxwell's equation, the describing wave processes in the material media, from other side this is the Ampere law, which describes power interaction of the current carrying systems. Up to now there was no concept, which could combine these two odd parts of the electrodynamics. The concept of scalar- vector potential, is the basis of all its dynamic laws, it combined these odd parts, after making electrodynamics united ordered science.

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