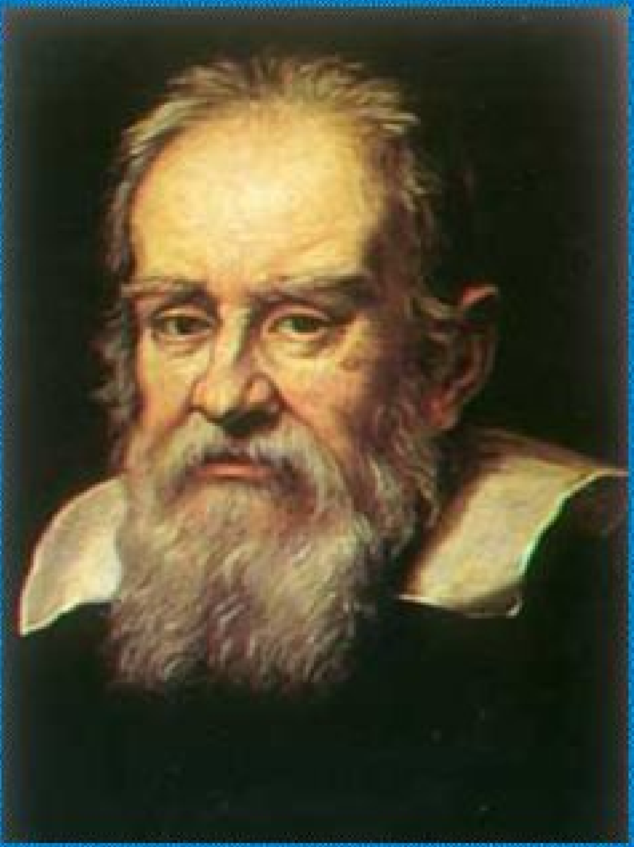
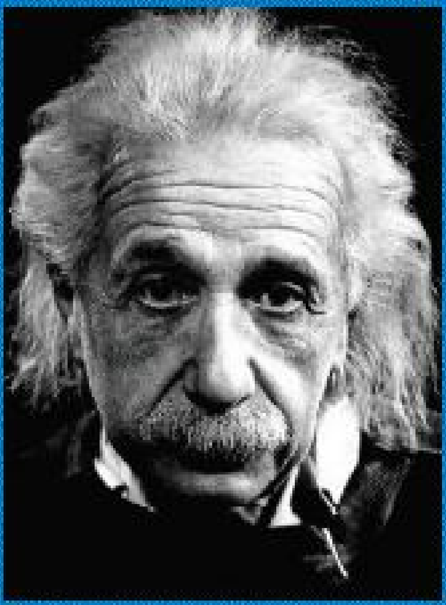


F. F. MENDE

NEW IDEAS AND TECHNICAL SOLUTIONS IN THE ELECTRODYNAMICS



F. F. Mende

NEW IDEAS AND TECHNICAL SOLUTIONS IN THE ELECTRODYNAMICS

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Mende F. F.

New ideas and the technical solutions in the electrodynamics. Monograph, Kharkov –2018, - 154 p.

Monograph presents the collection of the articles, in which are reflected the results, obtained by the author for posledie two years. These are the following articles:

1. As the first in the world interferometer with the mechanical division of laser beam was created

2 Mende interferometer and the experimental refutation of the transformation of Lorenz and principle of the invariance of the speed of light

3. New methods of the solution of the problem of emission and propagation of the electromagnetic waves

4. Transformation of Mende in the concept of the scalar- vector potential

5. From the electrodynamics of Maxwell, Hertz, Heaviside to the trans-coordinate electrodynamics

6. Is there a dispersion of the dielectric constant of material media?

7. Operating principle and the mathematical model of belt generator

8. Parametric electric generator of Mende

9. Electrization of plasma with its warming-up

10. Electrodynamics and the earthquake

1. As the first in the world interferometer with the mechanical division of laser beam was created

The special theory of relativity (STR) was developed by Albert Einstein in 1905. Its basis are the postulates, one of which (the so-called second postulate) says, that the speed of set is invariant, i.e., it does not depend on observation system. This means that under no circumstances the speed of light cannot exceed its standard value s, which in the vacuum is equal 299 792 458 ± 1,2 m / s (it is rounded 300000 m / s). Second postulate STR contradicts the common sense, since the speed is a value relative. The same projectile, released from the gun, with respect to it has one speed, and with respect to the aircraft, which flies away from the gun, it has another speed. Passenger, edushchiy in the railroad car of train, with respect to the railroad car is fixed, whereas according to the relation to the station buildings it moves with the speed of train. In all STR this not thus. If inside the railroad car light beam moves with a speed s, then with respect to the station buildings it moves with the same speed.

From the moment of creation STR were carried out the numerous experiments, in which the experimenters attempted to prove the inaccuracy of the second postulate. For this they used radiation sources, which moved with respect to the observation system with the given speed, but all their attempts proved to be not successful. Values of the speed of light in the observation system obtained in such experiments proved to be equal to the standard value of the speed of light [1-9].

Such experiments in the diverse variants were carried out and outstanding scientific Michaelson, with the aid of the invented by it interferometer, but also these experiments also ended by failure.

Michelson interferometer was invented by American physicist by Albert Abrakham Michaelson at the beginning of past century. A number of important scientific and applied problems was solved with the aid of this interferometer, the speed of light was in particular with the high accuracy measured. However, in the experiments, conducted by Michaelson, that are concerned checking second postulate STR, were significant errors. It completed these errors, when it attempted to prove that the speed of electromagnetic (EM) wave is added to the speed of its source, which contradicted the second postulate. Michaelson considered to the end of his life that there is an elastic medium, in which are extended EM of wave (ether). Therefore the results of the experiments, which it conducted together with Morley [10] for the detection of this medium, were for it large unexpected contingency. Attempting to improve experiment, it attempted as the radiation source to use light of star, but it it here awaited still large failure. Studies showed that the measured speed of light, does not depend on the speed of star and is equal to the previously measured by it value, which corresponded to the special theory of relativity, which life it so did not recognize to the end.

In order to understand, in than Michaelson's error consisted, let us examine the principle of the work of its interferometer, whose schematic is given in Fig. 1.

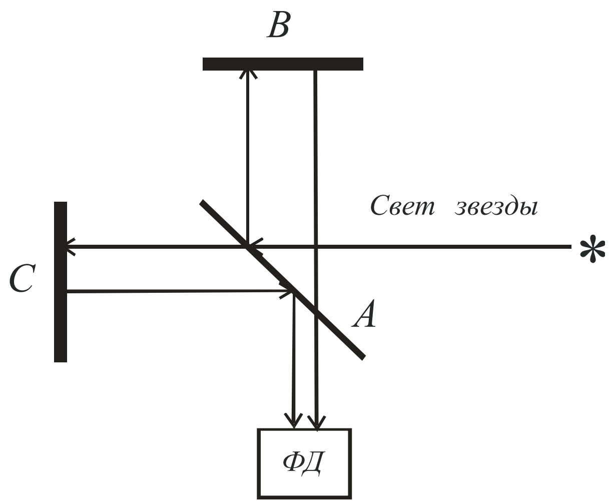


Fig. 1. Schematic of Michelson interferometer

The electromagnetic (EM) wave, which arrived from the star and reflected from the dividing mirror A falls on the reflecting mirror B and, being that reflected from it, it falls on photodetector. The special feature of this process is the fact that the mirror B is located in the same inertial reference system (IRS), in which is located interferometer itself. This means that, whatever there was the speed EM of the wave, which arrived from the star, its speed after reflection from the mirror B will be equal to the speed of light in IRS of interferometer.

The second part EM of the wave, which arrived from the star, penetrating the dividing mirror A, also falls on reflective mirror C. After reflection from this mirror the wave will also have a speed equal to the speed of light in the system of interferometer. But a question consists in what speed will have the electromagnetic wave after the passage of dividing mirror indicated.

Let us examine the flow chart of the ray through the dividing mirror, taking into account that the fact that the reflecting layer on it is substituted to the transparent of the glass- specific thickness. Since glass- is the dielectric, which possesses the dielectric constant, different from air, the trajectory of the motion of ray will depend on the refractive index of glass. This trajectory is shown in Fig. 2.

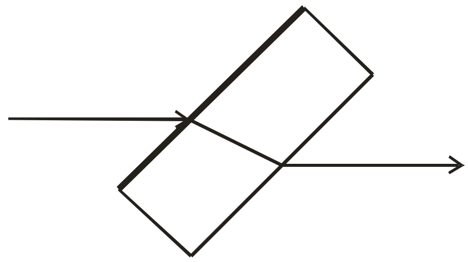


Fig. 2. Propagation of light beam through the glass plate

Light beam falls on the glass plate and, refracting twice, it leaves from it in the same direction. During the reverse motion of ray its trajectory remains constant, changes only direction of its motion. In this case the ray moves in accordance with the law Snel [11] and sharply changes its direction after entrance and output from the plate. But this refraction is connected with the fact that the electric fields of the wave, passing through the plate, make it necessary to kolebatsya the bound charges in the dielectric, which re-emit these fields. And if prior to the entrance into the plate wave had a speed different from the speed of light in the frame of reference of interferometer, then after the passage of the wave through the plate its speed will be equal to the speed of light in the system of its counting. These special features of the work of Michelson interferometer indicate that with his aid it is not possible to measure the speed EM of wave to its contact with dividing mirror. Michaelson did not consider these circumstance, of than consisted its error.

In the consequence were invented different modifications of Michelson interferometer [11], such as the interferometer of Roghestvensky, Fabry-Perot and other instruments with repeatedly divided light beams. But in all these instruments for division and separation of light rays are used the semi-transparent layers of metals, substituted to the glass plates, or interfaces between the dielectrics with different dielectric constant. Therefore all interferometers indicated suffer the same deficiencies, as Michelson interferometer.

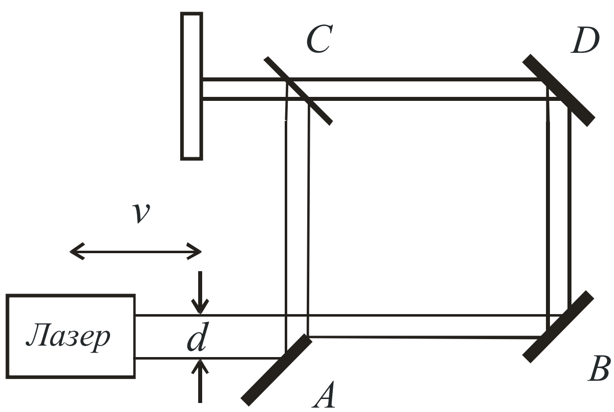


Fig. 3. Schematic of interferometer with the mechanical division of laser beam

Output from the prevailing situation was to be searched for on the way of creating the interferometer, in which dividing mirrors would be absent, and the division of ray would be accomplished by another method, with which was not lost the information about the beam velocity, which entered the interferometer. And this output was found in the work [12], where the division of ray it was achieved by a mechanical method. The operating principle of this interferometer can be understood from the diagram, represented in Fig. 3.

Laser beam, whose diameter is equal d, it partially overlaps the reflecting mirror A. This mirror the part of the ray it located so that reflects in the normal direction with respect to the primary direction of the motion of ray. The second part of the ray continues to move in the perezhnem direction with the previous speed and, falling on the reflecting mirror v, it is reflected in the normal direction with respect to the initial direction of motion. Further rays, after passing ways indicated in the diagram, where D - the reflecting mirror, and C - dividing mirror, fall on the screen, where is reproduced the picture of their interference. In the diagram examined the laser, which is radiation source, can be fixed or move with the given speed. On the spot laser also can be located the mirror, which reflects the ray of fixed laser, in this case the mirror also can be fixed or move according to the assigned law.

The schematic of interferometer with the mechanical division of the ray, in which is used the fixed laser, whose ray is reflected from the fixed or moving mirror, it is depicted in Fig. 4. On this diagram the laser beam has the assigned diameter, which is equal to the distance between the lines, which emerge from the laser.

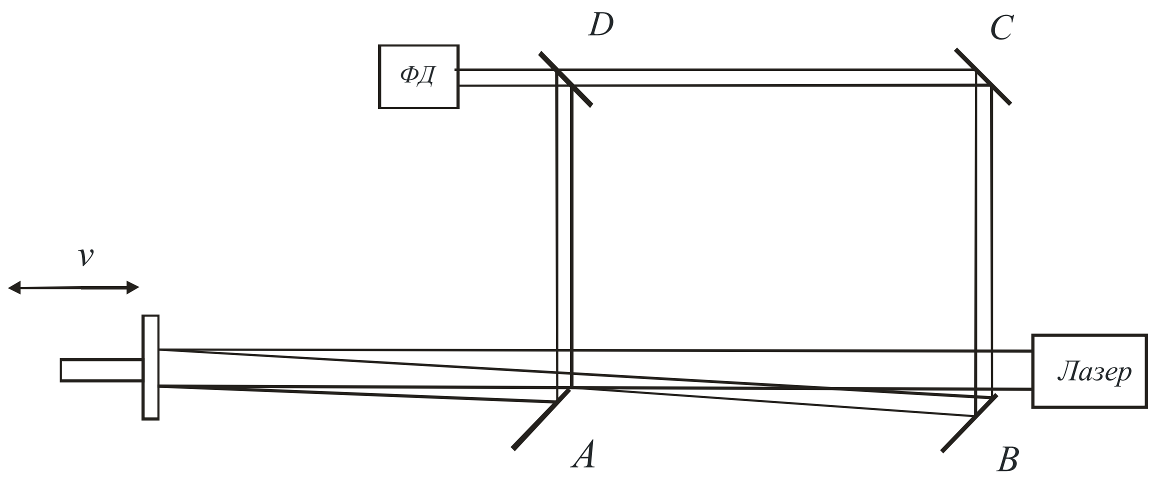


Fig. 4. Schematic of interferometer with the reflective mirror

This case is equivalent to the case examined with the only difference that it is used the ray, reflected from the moving reflective mirror. The advantage of interferometer with the mechanical division of ray is the fact that in it for the separation of ray are not used the dividing mirrors, but the division of ray is produced by the method of its overlap. This method allows to split ray in any proportions with the way of the mechanical displacement of the first mirror, without requiring in this case the replacement of dividing mirror.

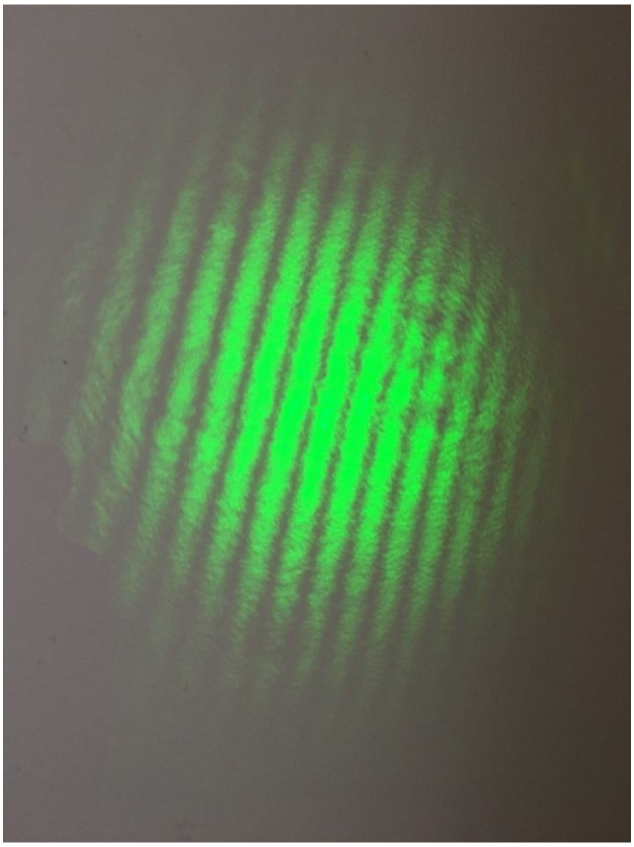
But to propose new idea this still not all, was required to prepare the mock-up of interferometer, and with its aid to prove the inaccuracy of the second postulate.

It the one who dealt concerning the interferometers, he knows, how not simple this task. Standard interferometers use the massive steel bed, where are cut by T – descriptive grooves, on which can be moved the clamps with the dividing and reflecting mirrors, laser and photodetector. Fastening mirrors on these clamps must allow their fixed turning in two planes to the preset angle with the accuracy several tens of seconds. All these complex technical problems under the force only to important Scientific Research Institute, which has the appropriate production base.

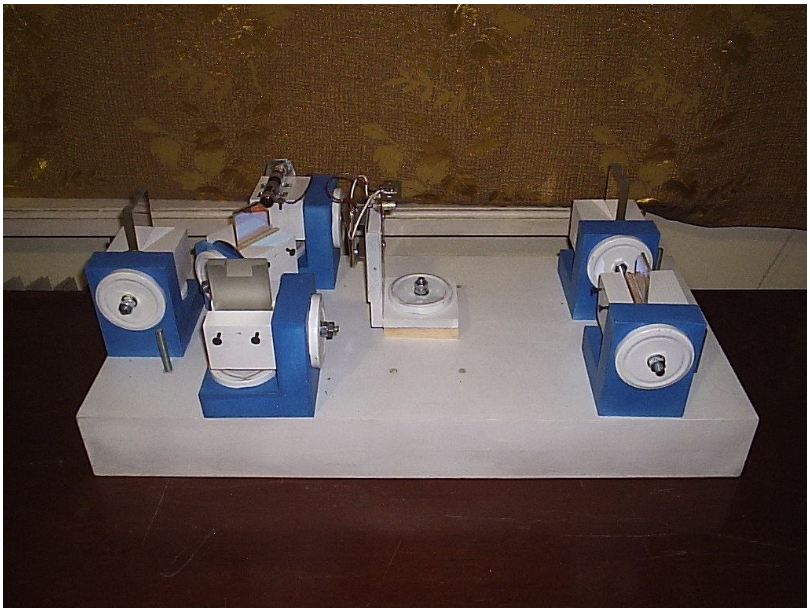
But the author of the future interferometer of this base did not have. And nevertheless how ended this history, and it did be possible to prepare interferometer with the necessary parameters and to conduct so the long-awaited experiment. Yes it succeeded, and in this sincere and honest friendship helped. Valerie Alexandrovich Nevolnichenko - the chief of the joiner production of firm Lana in Kharkov helped to solve this probleiu. But here joiner production and interferometer, indeed in joinery steel bed and component interferometers do not mill with than. And the call of the entire history of the creation of interferometers was here cast, and it was decided to prepare all components of interferometer from the solid rocks of the wood of oak and ash. And Valerie Alexandrovich this task lustrously it managed, and it made this with the large enthusiasm and it is completely unselfish. And if not its friendly aid, then this uncommon interferometer would not be born.

In the following photographs it is shown the common form of interferometer, and also its separate units.

The common form of interferometer with the mechanical division of ray is depicted on this photograph, in the photograph is not shown the vibrator, on which is located reflective mirror. Vibrator is located on the separate plate, which is placed on the separate table.

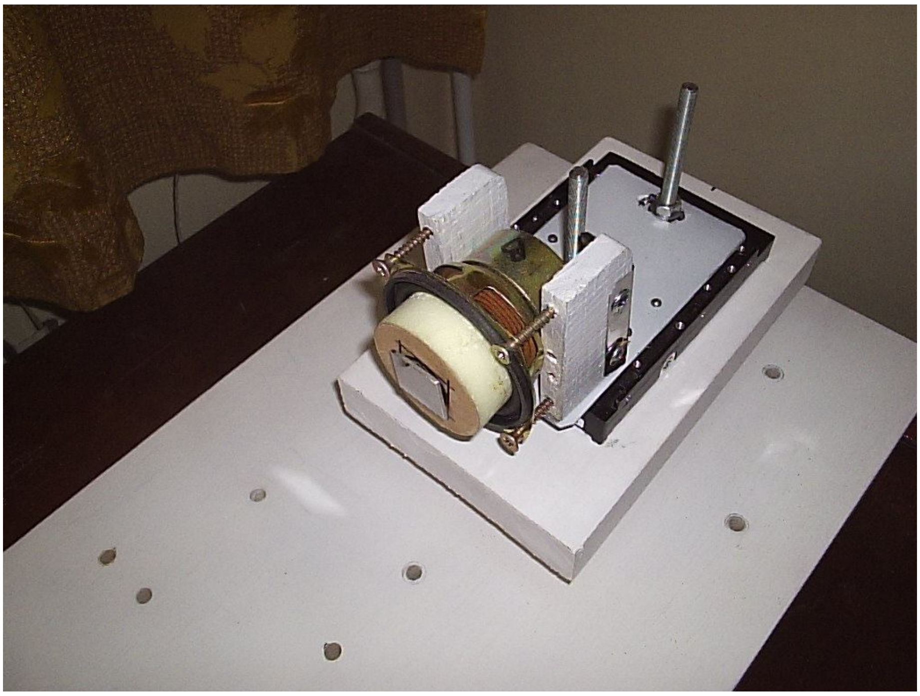


This photo shows an interference pattern obtained on an interferometer.

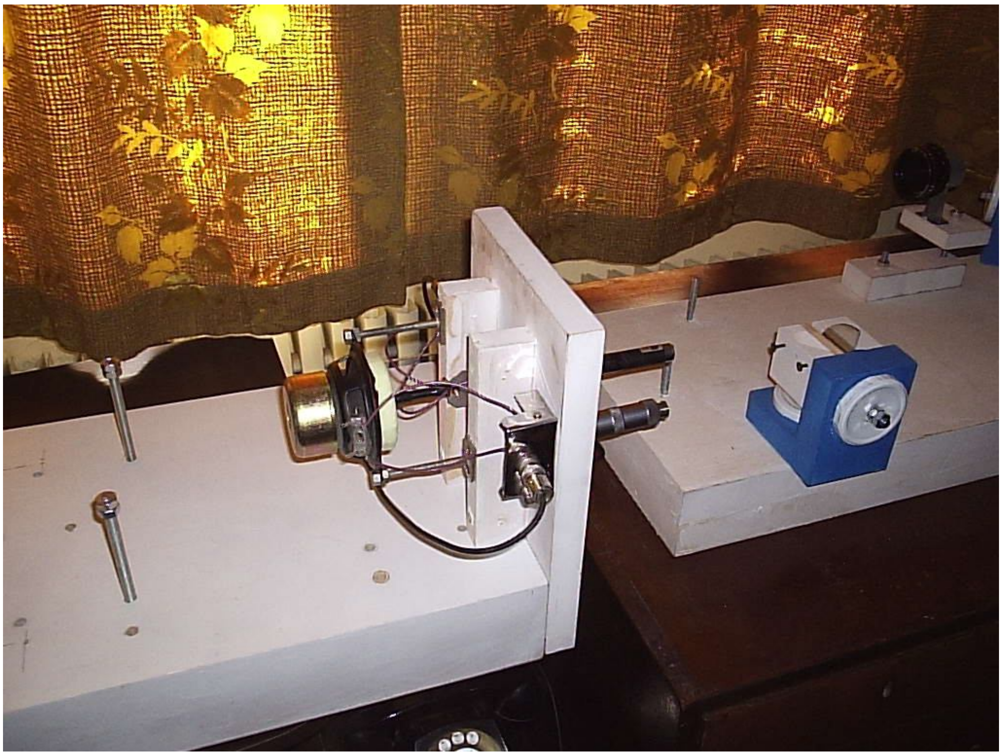


On this photograph is depicted the Michelson interferometer assembled on the mounting plate. It is to the left in the foreground visible two reflecting mirrors, dividing mirror is located between them. The laser is visible after the dividing mirror, to the right of dividing mirror is located photodetector. On right to edge located two spare mirrors. Mirrors are located on the hinges, which make it possible to revolve mirrors in the ortoganalnykh directions. Hinges I provide the possibility to achieve angular turning of mirrors with the accuracy of the order several tens of seconds. Any desired configuration of interferometer can be assembled on the platform.

The working Michelson interferometer is depicted on this photograph. Ray from the laser (to the right in the background) comes to the reflecting mirror (to shine by green color) and, after being reflected from it comes the dividing mirror (in the center in the foreground). Then, after being reflected from two mirrors, through the dividing mirror, and then the objective falls on the reflecting mirror (in the background round mirror with the opening). After being reflected from it, rays are projected on the oppositely located screen, where is formed interference picture.



The vibrator and the laser are depicted on these photographs



The vibrator, which ensures the vibration of laser, is depicted in these photographs in two foreshortenings.

2. Mende interferometer and the experimental refutation of the transformation of Lorenz and principle of the invariance of the speed of light

1. Introduction

The interferometer of the American physicist Albert Michaelson's Abrakhama made it possible to solve a number of important scientific and applied problems, in particular, the high-precision measurement of the speed of light. However, with the measurement of the dependence of the speed of light on the motion of frame of reference Michaelson and Morley committed critical error. To the end of the life Michaelson considered light the fluctuations of special elastic medium (luminiferous ether), but the results of experiment 1 and its later experiment, which uses as the radiation source light of star, they contradicted ether concept. The measured speed of light did not depend on the speed of the Earth relative to star and was equal to the previously measured by it value. On this empirical basis is postulirovan the principle of the invariance of the speed of light in the special theory of relativity (STR), which Michaelson did not recognize to the end of the life.

Michaelson did not understand, that his interferometer was not suitable for the solution of the problems by the proof of the inaccuracy of postulate about the invariance of the speed of light, that also is proven in the work [2].

But there is still one circumstance, which should be considered during setting of such experiments.

The phenomenon of phase aberration of light consists in the fact that with the astronomical observations this aberration leads to a change in the observed position of stars on the celestial sphere as a result of a change in the direction of the speed of the motion of the Earth_ . In astronomy the frame of reference, connected with the solar system, is used, since it is possible to consider it with the high accuracy inertial . Star atlases are comprised precisely in it. The diurnal aberration is small, and even angle of annual aberration is not great; its greatest value, on the condition that that the motion of the Earth is perpendicular to beam direction, composes a total of approximately one 20,5 second . The star, which is located in the pole of the ecliptic , rays of which are perpendicular to the plane of the earth's orbit in the frame of reference of the sun, will be observed during the entire year by that being distant behind its true position for 20,5 seconds, i.e. describe a circle by diameter 41 second. This apparent way for other stars will already represent not circle, but the ellipsis . The semimajor axis of this ellipsis is equal $20{,}5''$ and semiminor axis it is equal $20{,}5''\sin\beta$, where β - the ecliptic latitude of the observed celestial body. If star is located on ecliptic itself, i.e. annual motion, as a result of the light aberration, will be the visible section of straight line, the being appeared arc of ecliptic on the celestial sphere, and star goes along this section first to one side, then into another. But aberration of light in a straight manner indicates the addition of velocities of light with the speed of the Earth. Let us examine this question in more detail.

In Fig. 1 is depicted the diagram of the aberration of light of the star, when it is located in the pole of the ecliptic , and its rays are perpendicular to the plane of the earth's orbit. In the frame of reference of star its ray moves with the speed of light c vertically with respect to the earth's surface. If the Earth moves, as shown in figure to the right with speed v_0 , the vector addition of the beam velocity of star and speed of the Earth in the frame of reference of the Earth occurs according to the summation rule of vectors, as shown in figure. This means that the summary beam velocity v will be determined in accordance with the relationship $v=\sqrt{c^2+v_0^2}$. This speed is more than the speed of light c .

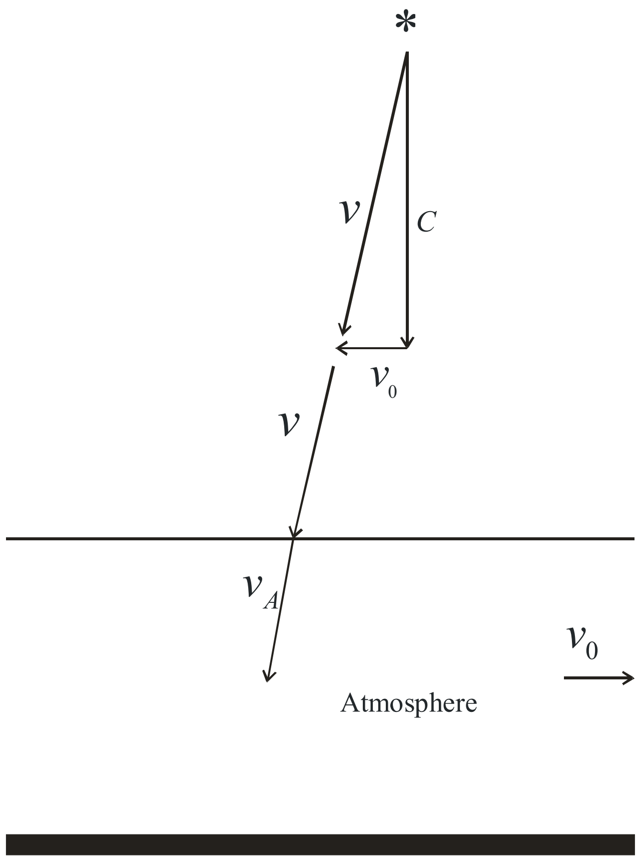


Fig. 1. Diagram of the aberration of light of the star

In this case the summary velocity vector of ray no longer is vertical the earth's surface, but its slope angle is equal to the angle of aberration, whose tangent is defined as to the ratio of the velocity of the Earth to the speed of light. Continuing its motion in the direction indicated, ray reaches the atmosphere (in this case it is considered that the atmosphere has sharp boundary with the vacuum of space). But air of the atmosphere has dielectric constant greater than dielectric constant of vacuum; therefore On the Border with the atmosphere ray experiences refraction in accordance with the law Of sneliusa and changes its speed and direction. Before the entry into the atmosphere the beam velocity was more than the speed of light in air, but with the entry into the atmosphere it changes its speed in such a way that it would correspond to the speed of light in air.

Are known numerous attempts at the measurement of the speed of light, radiated by the moving sources. Most characteristic of them are given in the works [3-11], but all these experiments they gave one and the same result, which confirms the postulate of the theory of relativity about the invariance of the speed of light. But another result and it could not be, since the existing interferometers, utilized in the experiments, for these purposes were not suitable.

Work [2] presents Mende interferometer, free from the deficiencies indicated. This interferometer does not have the re-reflecting and dividing mirrors, but the principle of its operation is based on the mechanical division of laser beam. The experiments, carried out with the aid of this interferometer, STR about the invariance of the speed of light showed the insolvency of the transformation of Lorenz and postulate.

2. Interferometer with the mechanical division of laser beam

The schematic of interferometer with the mechanical division of laser beam is shown in Fig. 2.

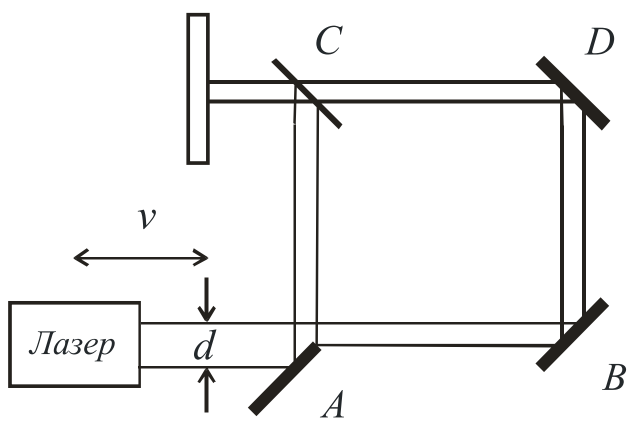


Fig. 2. Schematic of interferometer with the mechanical division of laser beam

Laser beam, whose diameter is equal d, it partially overlaps the reflecting mirror A. This mirror the part of the ray it located so that reflects in the normal direction with respect to the primary direction of the motion of ray. The second part of the ray continues to move in the previous direction with the previous speed and, falling on the reflecting mirror B, it is reflected in the vertical direction with respect to the initial direction of motion. Further rays, after passing the ways, indicated in the diagram, where D - the reflecting mirror, and mirror C - dividing, fall on the screen, where is reproduced the picture of their interference. In the diagram examined the laser, which is radiation source, can be fixed or move with the given speed. On the spot laser also can be located the mirror, which reflects the ray of fixed laser, in this case the mirror also can be fixed or move according to the assigned law. This case is equivalent examined with the only difference that as the ray, emitted by the moving laser, is used the ray, reflected from the moving reflective mirror. The advantage of interferometer with the mechanical division of ray is the fact that in it are not used the dividing mirrors, but the division of ray in the assigned proportion is produced by the method of its mechanical overlap.

The schematic of interferometer with the mechanical division of the ray, in which is used the fixed laser, whose ray is reflected from the fixed or moving mirror, it is depicted in Fig. 3. On this diagram the laser beam has a diameter, which is equal to the distance between the lines, which emerge from the laser.

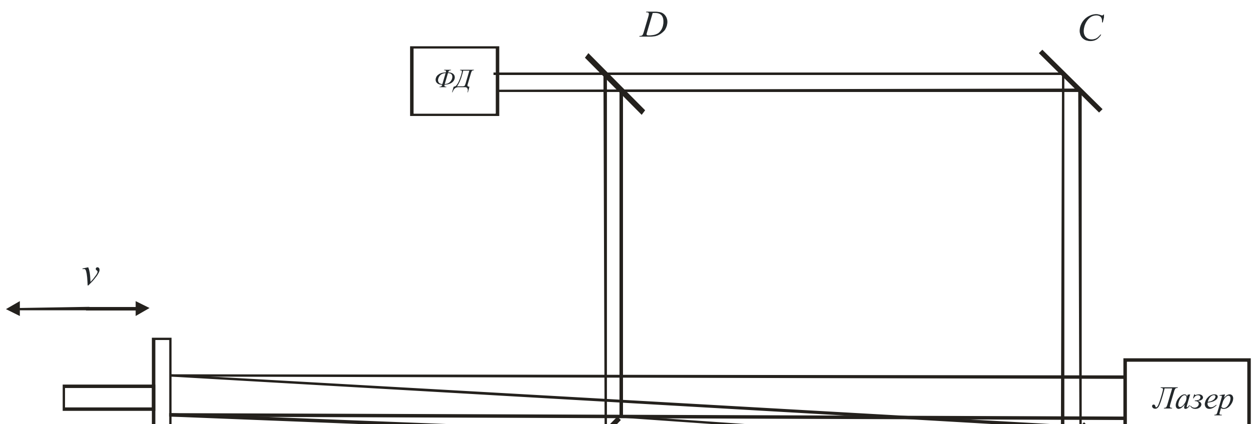


Fig. 3. Schematic of interferometer with the reflective mirror

3. The experimental check of the validity of the transformation of Lorenz and principle of the invariance of the speed of light

That created by Einstein and that rules in physics already more than hundred years STR 13, 14 uses the transformation of Lorenz, based on the postulated in it principle of the invariance of the speed of light, which causes criticism from the side of many scientists.

Let the emission in the transparent medium with the refractive index n have in IRS K, of fixed relative to source, frequency ω and wave number k. Then, if IRS K moves with respect to ISO K', of fixed relative to medium, with speed v, that, according to STR, frequency ω' and wave number k' of emission in IRS K' are determined by the following transformation, which escape from the transformation of Lorenz:

$$\omega' = \frac{\omega\left(1+\frac{nv}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}}, \qquad (3.1)$$

$$k' = \frac{\frac{n\omega}{c}\left(1+\frac{nv}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}}. \qquad (3.2)$$

A simultaneous change in the frequency and the wave number upon transfer from IRS K to IRS K' occurs in such a way that the ratio of frequency to the wave number in both IRS remains equal to the speed of light on medium c/n. Whatever reasons led to a change in the frequency, nevertheless are fulfilled the relationships (3.1), (3.2). These reasons there can be two: a change in the oscillation frequency of fixed generator and the Doppler effect from the moving generator. From the point of view STR cannot be found true reason.

If receiver moves with the speed u relative to medium in the direction of source, then wave velocity relative to receiver is obtained by the relativistic addition of this speed with wave velocity c/n relative to the medium:

$$\frac{c/n+u}{1+u/(nc)} \approx c/n+\alpha u,$$

where $\alpha = 1-1/n^2$ – the entrainment factor. This approximation is carried out in the first order on u. In STR partial enthusiasm of light by medium, approximately described by coefficient α, is the apparent effect, caused by relativistic addition of velocities. However, the real (physical) enthusiasm of light by medium is complete. This is manifested in the fact that the speed of light on medium depends on the speed of receiver relative to medium, but it does not depend on the speed of source relative to medium. This approximate equality is confirmed by Fizeau experiment. But this does not mean that the Fizeau experiment proves STR, since it has the classical explanation (within the framework the transformation of Galileo).

The classical explanation of Fizeau experiment leaves valid this approximate equality only in the case of the source, which is rested relative to receiver, but changes its interpretation. The physical enthusiasm of light by medium is already the partial, accurately described coefficient α. This is manifested in the fact that the speed of light on Wednesday depends not only on the speed of receiver relative to medium, but also on the speed of source relative to medium. If receiver rests relative to medium, and source moves strictly towards the receiver with speed v, that wave velocity relative to them is equal $c/n+v-\alpha v=c/n+v/n^2$. This speed is lower than the result of the corresponding classical addition of velocities $c/n+v$ for the value αv. But if source moves in the direction, strictly opposite to receiver, then value v is substituted to value $-v$, and wave velocity it proves to be equal to the value $c/n-v/n^2$.

Let us begin the examination of the Doppler effect from his classical theory.

Let the radiation source flat transverse EM of wave rest in selected IRS. Then, if wave is propagated along the three-dimensional axis z, and at the origin of coordinates its electric field it changes according to the law

$$E(t)=E_0 \sin \omega_0 t ,$$

the the same value of field will be observed at any observation point z with the delay $t=z/V$, where V - phase wave velocity. In this case the dependence of electric field on coordinate and time of signs the form

$$E(t,z)=E_0 \sin \omega_0 (t-z/V).$$

The instantaneous values of phase at the observation points z_1 and z_2 are respectively equal

$$\varphi_1(t)=\omega_0 t-z_1\omega_0/V , \tag{3.3}$$

$$\varphi_2(t)=\omega_0 t-z_2\omega_0/V . \tag{3.4}$$

A phase difference between the points in this case indicated will comprise

$$\Delta\varphi=(z_2-z_1)\omega_0/V=\Delta z\omega_0/V=\Delta zk ,$$

where $\Delta z=z_2-z_1$ - the distance between the observation points, $k=\omega_0/V$ - wave number.

Let now the generator move in selected IRS. Then, if at the observation point z_1 the phase of wave is again determined by relationship (3.3), that at the observation point z_2 the phase of wave will be as before determined by the relationship (3.4). But if for any reasons the frequency of incident wave will become equal ω_1 , that for the phase of wave will be carried out the same relationships (3.3) , also, (3.4) with the new value of frequency.

If the generator of wave moves with the constant velocity v , that phase waves at points z_1 z_2 will change according to the law

$$\varphi_1(t)=\omega_0 t-\frac{\omega_0}{V}(z_1+vt) \tag{3.5}$$

$$\varphi_2(t)=\omega_0 t-\frac{\omega_0}{V}(z_2+vt) \tag{3.6}$$

A phase difference between the observation points in this case will comprise

$$\Delta\varphi_{1-2}=\omega_0\Delta z/V=2\pi\Delta z/\lambda_0, \tag{3.7}$$

where $\lambda_0=2\pi V/\omega_0$ - the wavelength.

A phase difference (3.7) on the speed of generator does not depend. This connected with the fact that wave velocity in the selected frame of reference is constant. However, the frequency of signal at the points indicated will change according to the law

$$\omega_1=\partial\varphi_1(t)/\partial t=\omega_0(1+v/V), \tag{3.8}$$

$$\omega_2=\partial\varphi_2(t)/\partial t=\omega_0(1+v/V). \tag{3.9}$$

It is evident that at both observation points the frequency obtained the not depending from the distance to the generator, Doppler additive identical,

$$\Delta\omega_D=\omega_0 v/V. \tag{3.10}$$

If a phase difference (3.7) is constant during the motion of generator, then is constant wavelength. In this case a change of the frequency in the observation points can be connected only with a change in phase wave velocity in selected IRS. This change can be determined from the relationship

$$\lambda=\frac{2\pi V}{\omega_0}=\frac{2\pi(V\pm\Delta V)}{\omega_0(1\mp v/V)} \tag{3.11}$$

from where we obtain

$$\Delta V=\mp v.$$

This indicates the classical addition of velocities of light and speed of generator, and it means wave velocity in selected IRS it can be both more and it is less than the standard speed of light on Wednesday, including in the vacuum, which contradicts STR.

Let us further examine the relativistic theory of the Doppler effect.

Accordingly (3.1), (3.2), frequency changes simultaneously with the wave number, and it means also with a phase difference between the observation points. This phase difference depends both on the speed of generator and on the distance between these points. To frequency (3.8) or (3.9) corresponds the wave number

$$k=\omega_0\left(1+v/V\right)/V ,$$

therefore a phase difference between the observation points into STR changes according to the law

$$\Delta\varphi=\Delta z\omega_0\left(1+v/V\right)/V . \qquad (3.12)$$

From the relationship (3.12) it follows that a phase difference between the observation points will depend on the distance between this by points and on the speed of generator. However, in the classical case, as follows from the relationship (3.7), a phase difference between the observation points on the speed of generator it does not depend.

Therefore the measurement of a phase difference between the observation points for the case of the moving generator is the task of the proposed experiment. If it seems that a phase difference does not depend on the speed of the motion of generator, then this will mean that STR, transformation of Lorenz and principle of the invariance of the speed of light are not accurate.

Let us examine within the framework STR case, when generator varies along the axis z according to the harmonic law with the frequency Ω :

$$z=z_1+z_0\sin\Omega t ,$$

where z_1 - the initial position of generator, z_0 - the amplitude of its of fluctuations.

Then the flutter speed of generator will be determined by the relationship

$$v(t)=\partial z/\partial t=z_0\Omega\cos\Omega t=v_0\cos\Omega t ,$$

where $v_0=z\Omega$ - the amplitude of speed.

In this case Doppler additive to the frequency at both observation points will change according to the law

$$\Delta\omega_D=\left(\omega_0 z_0\Omega\cos\Omega t\right)/V ,$$

and additive to the wave number will be determined by the relationship

$$\Delta k(t) = \left(\omega_0 z_0 \Omega \cos \Omega t\right) / V^2 .$$

The phase difference between the observation points, caused by this additive, will comprise

$$\Delta\varphi(t) = \left(\Delta z \omega_0 z_0 \Omega \cos \Omega t\right) / V^2 . \quad (3.13)$$

To this dependence of a phase difference on the time corresponds the frequency modulated signal, whose frequency will change according to the law

$$F(t) = \omega_0 \left(1 - \left(\Delta z x_0 \Omega^2 \sin \Omega t\right) / V^2\right), \quad (3.14)$$

i.e. within the framework STR will be obtained the frequency-modulated signal, whose frequency changes according to the harmonious law and the amplitude of the deviation of frequency of which it is equal

$$M = \Delta z \omega_0 x_0 \Omega^2 / V^2 .$$

Since the last $V = c/n$, equality can be written down in the form into STR

$$M = n^2 \Delta z \omega_0 x_0 \Omega^2 / c^2 .$$

In any material medium the value M is always greater than in the vacuum, n^2 once, but in air this difference can be disregarded.

Let us calculate the expected parameters of the signal, which enters from the photodetector, for the case examined. For this it is utilized the parameters of the interferometer, described above, on which were conducted studies. The distances between the mirrors A also in it was 500 mm, the frequency of the vibrations of vibrator – 50 Hz, the amplitude of the fluctuations of mirror was equal 5 mm. With these parameters (in the case of justifiability STR) the amplitude of the deviation of the frequency of the frequency-modulated signal, which must be isolated on the photodetector, will be about 180 Hz. This signal easily yields to detection and measurement.

However, with conducting of experiment according to the diagram, represented in Fig. 3 interference picture did not change both in the case of the fixed reflecting mirror and in the case of its fluctuations, and interference fringes remained at their places, picture was only extended on the vertical line approximately on 50%. This connected with the fact that the axis of oscillation of the reflecting mirror is slightly inclined with respect to the laser beam reflected. Separately clearly were distinguished the interference fringes, when they were located vertically. With the start of vibrator they only were lengthened. Since the interference fringes with the start of the vibration of mirror did not change their position and did not move, signal on the photodetector was absent. Since in the process of experiment frequency modulated of signal, removed from the photodetector, was not discovered, this means that the connection between the frequency and the wave number, determined by relationships (3.1) and (3.2), they are not carried out, which contradicts STR. Experimental results indicate also that in this case the transformation of Galileo are carried out, and the rate of radiation source is added to the speed of light.

During the motion of generator in air with the speed v to the side of the reflecting mirrors in entire section AB ray moves with the speed $c/n+v/n^2$, while in the remaining arms of interferometer it it moves with the speed c/n. Since in the process of experiment it is discovered, that a phase difference in the section AB does not depend on the speed of generator, in this section the wavelength also does not depend on the speed of generator. But this means that the Doppler frequency, fixed at the observation points, which depends on the speed of generator, is not connected with the wavelength in this section.

This fact contradicts ofthe Lorenz transformation and the principle of the invariance of the speed of light, indicating that the rate of radiation source is added to the speed of light according to the classical rule.

But was achieved in the experiment conducted the faster-than-light (more than the rate constant c of light in the vacuum) wave propagation velocity in IRS of interferometer? No, it was not, since experiment was conducted in atmospheric air. For the exceeding with wave velocity of rate constant c of source (generator or mirror) v towards the interferometer and refractive index n must be connected with the inequality

$$c/n+v/n^2>c.$$

Expressing from this inequality a value v , we have:

$$v > n(n-1)c.$$

For air ($n = 0{,}0003$) we under normal conditions obtain the astronomical speed of source $v > 90$ km/s. But it is possible to attain reduction in this speed due to reduction in the value n, of air achieved by the replacement by vacuum. With the assigned magnitude v the requirement for the value n takes the form:

$$n<\left(1+\sqrt{1+4v/c}\right)/2.$$

At least, mirrors A also in, the space between them and moving mirror, and mirror itself must it is found in vacuum chamber.

Let us assume that the value $(n-1)$ is proportional to the pressure of residual gases in the camera. If we accept the speed of the mirror of the equal 1 to m/s, then it suffices to decrease the pressure in the camera on six orders in order with the tenfold reserve to satisfy the condition presented. This vacuum is considered low, and its reaching is not problem with the contemporary level of vacuum technology.

4. Conclusion

The results of the experimental refutation of the transformation of Lorenz and postulate about the invariance of the speed of light are represented. This became Mende with the mechanical division of laser beam possible because of the use in the experiments of interferometer.

The appreciation

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3. New methods of the solution of the problem of emission and propagation of the electromagnetic waves

1. Concept of emission in the classical electrodynamics

Any field can be revealed with the aid of the meters. If there is a charged parallel-plate capacitor (Fig. 1) consisting of two flat plates, the electric field between them it is easy to reveal, introducing between these plates trial charge. By the force, which acts on this charge, and is revealed the electric field. By the characteristic property of this field is the fact that it presents the continuous homogeneous medium, which possesses specific energy, proportional to the square of electric field. Of this easily it will be convinced with the aid of the simple experiment. If we begin to separate the plates of parallel-plate capacitor, then in this case it will necessary spend the specific work.

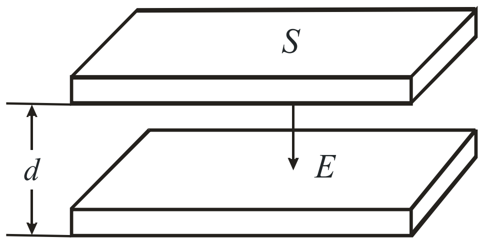

Fig. 1. Capacitor, which consists of the plane-parallel charged plates

If the surface density of charges on its plates is equal σ , that the tension of the electric field between its plates is equal

$$E=\frac{\sigma}{2\varepsilon_0}.$$

Without taking into account edge effects the electric force, which acts on the plates, is determined by the relationship

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

If in this case plates are moved apart up to the distance d , that in this case the mechanical work will be perfected

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

But energy of electrical pour on also it will be equal to the same value. But if plates converge, then, on the contrary, electrical energy will be converted into the mechanical. These examples show, as mechanical energy it can be converted into the electrical and vice versa.

It is well known that near the wires, along which flows alternating electric current, are formed the electrical induction fields, which can be connected with the alternating magnetic field. Magnetic field was introduced by ampere by phenomenological way on the basis of the observation of power interaction between the conductors, along which flows the current.

The Ampere law, expressed in the vector form, determines magnetic field at the point [1]:

$$\vec{H}=\frac{1}{4\pi}\int\frac{I\left[d\vec{l}\ \vec{r}\right]}{r^3}$$

where I - current in the element $d\vec{l}$, $\vec{r}$ - vector, directed from to the point $d\vec{l}$ (Fig. 2)

It is possible to show that

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

and, besides the fact that

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

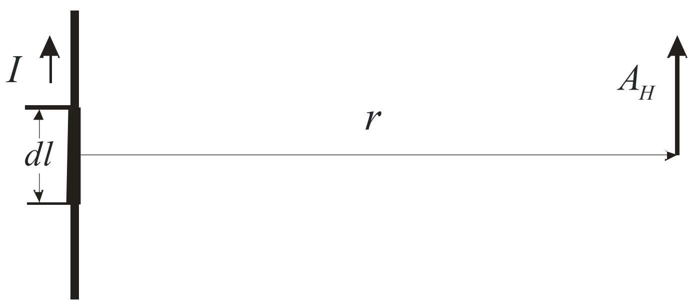

Fig. 2. The formation of vector potential by the element of the conductor dl, along which flows the current I.

But the rotor of $d\vec{l}$ 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

$$\vec{A}_H = \int I\left(\frac{d\vec{l}}{4\pi r}\right). \tag{1.1}$$

The remarkable property of this expression is the fact that the dependence of vector potential is inversely proportional to distance to the observation point, which is characteristic for the emission laws. Specifically, this property makes it possible to obtain emission laws.

Since $I = gv$, where g the quantity of charges, which falls per unit of the length of conductor, from (1.1) we obtain:

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

If the size of element $d\vec{l}$, along which flows current, it is considerably less than distance to the observation point, then this relationship takes the form:

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

From this relationship follows interesting fact. Even on the direct current the dependence of vector potential on the distance corresponds to emission laws. And, it would seem, that, changing by jumps current in the short section of wire, and measuring the vector potential at the remote point, it is possible to transfer information into this point by the emission laws. But this interfere withs the circumstance that the direct-current circuit is always locked to the local power source and therefore always there is both straight and return conductor. This special feature leads to the fact that in this situation the vector potential in the distant zone occurs inversely it is proportional to the square of distance to the observed point. This is easy to show based on the example of two parallel elements of conductor, located at a distance d (Fig. 3) in which flow the opposite currents.

In this case vector potential in the remote zone is defined as the sum of the vector potentials, created in the distant zone individually by each current element. when considerably more than we obtain:

$$\vec{A}_H = \frac{gv\ d\vec{l}}{4\pi r} - \frac{gv\ d\vec{l}}{4\pi(r+d)} \simeq \frac{gv\ d\vec{l}\ d}{4\pi r^2}.$$

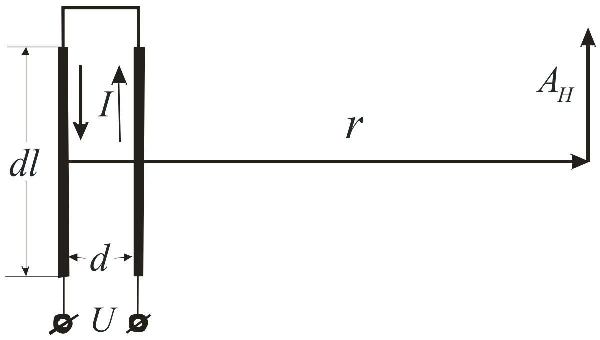

Fig. 3. Two conductor with the opposite currents

To avoid these difficulties is possible by the way of using alternating currents. Since the electric field and vector potential in the free space are connected with the relationship

$$\vec{E}=-\mu_0\frac{\partial\vec{A}}{\partial t},$$

where μ_0 - magnetic permeability of vacuum, the electric field, created in the distant zone by current element $gv\vec{dl}$, will depend on the acceleration of charges in this element

$$\vec{E}=-\frac{\mu_0 ga\ \vec{dl}}{4\pi r}, \tag{1.2}$$

where $a=\frac{dv}{dt}$ - acceleration of charge. It is known from Maxwell's equations that the electric fields are extended in the free space with the speed

$$\text{of } c=\frac{1}{\sqrt{\varepsilon_0\mu_0}}, \tag{1.3}$$

where of - the dielectric constant of vacuum.

Therefore, if current elements are arranged at a distance equal to half of wavelength and are created in them the differently directed currents, then in the distant zone due to the delay electric fields from the separate current elements will be formed, and summary electric field will be doubled:

$$\vec{E}_\Sigma=-\frac{\mu_0 ga\ \vec{dl}}{2\pi r}.$$

If we in the relationship (1.2) consider that the fields are extended with the final speed and to consider delay $\left(t-\frac{r}{c}\right)$, that we will obtain taking into account (1.3) relationship:

$$\text{of } \vec{E}=-\int \frac{ga(t-\frac{r}{c})\ d\vec{l}}{4\pi\varepsilon_0 c^2 r}\ . \tag{1.4}$$

When the acceleration of charges changes according to the harmonic law

$$a=a_0 \sin\omega\left(t-\frac{r}{c}\right),$$

and relationship (1.4) takes the form

$$\text{of } \vec{E}=-\int \frac{ga_0 \sin\omega\left(t-\frac{r}{c}\right)\ d\vec{l}}{4\pi\varepsilon_0 c^2 r}. \tag{1.5}$$

In the case, when the size of current element is considerably lower than the distance to the observation point, we have:

$$\vec{E}=-\frac{ga_0 \sin\omega\left(t-\frac{r}{c}\right)\ d\vec{l}}{4\pi\varepsilon_0 c^2 r}. \tag{1.6}$$

Relationships (1.4-1.6) it shows that the electric fields in the distant zone for the case examined depend on the acceleration of charges. Examining the electric fields of parallel-plate capacitor, we saw that such fields possess the specific energy, which they will transfer with their propagation.

But in this examination metal of the place for the magnetic field, which is located in the electromagnetic wave. This field can be introduced as purely mathematical concept from the second equation of Maxwell

$$rot\vec{H}=\varepsilon_0 \frac{\partial \vec{E}}{\partial t}\ .$$

We have for the case of the smallness of current element in comparison with the distance to the observation point:

$$rot\vec{H}=-\frac{\omega ga_0 \cos\omega\left(t-\frac{r}{c}\right)\ d\vec{l}}{4\pi c^2 r}\ . \tag{1.7}$$

From these relationships it follows that the magnetic field is the gradient of electric field.

If there is a single charge e that relationship (1.6) (1.7) they will be rewritten as follows:

$$\vec{E}=-\frac{ea_0 \sin\omega\left(t-\frac{r}{c}\right)\ \vec{k}}{4\pi\varepsilon_0 c^2 r}, \tag{1.8}$$

$$rot\vec{H}=-\frac{\omega ea_0 \cos\omega\left(t-\frac{r}{c}\right)\ \vec{k}}{4\pi c^2 r}, \tag{1.9}$$

where $\vec{k}$ - unit vector in the direction of the motion of charge.

Let us write down these relationships in the Cartesian coordinate system, by considering that direction of propagation is the axis y, and vector $\vec{E}$ it is directed along the axis z (Fig. 4).

Fig. 4. Diagram of shaping of magnetic field

From relationship (1.9) we obtain

$$\frac{\partial H_x}{\partial y}=-\frac{\omega ea_0 \cos\omega\left(t-\frac{y}{c}\right)}{4\pi c^2 y}, \tag{1.10}$$

One should consider with the integration of this relationship that with the wavelength considerably smaller than distance to the observation point, harmonic derivative on the coordinate is considerably more than derivative of the reverse value of coordinate. Therefore coordinate in the numerator of the right side of the relationship (1.10) can be considered constant. We obtain with this condition from (1.10) the relationship

$$H_x=-\frac{ea_0 \sin\omega\left(t-\frac{y}{c}\right)}{4\pi cy}. \tag{1.11}$$

This value of magnetic field is obtained with the condition for existence z of the component of the electric field

$$E_z = -\frac{ea_0 \sin\omega\left(t-\frac{r}{c}\right)}{4\pi\varepsilon_0 c^2 y} \ . \tag{1.12}$$

From the relationships (1.11) and (1.12) it is evident that electrical and magnetic field they are cophasal.

After dividing (1.12) on (1.11) we obtain

$$\frac{E_z}{H_x} = \sqrt{\frac{\mu_0}{\varepsilon_0}} = Z_0 ,$$

where Z_0 - the wave drag of vacuum.

The carried out examination showed that in the free space can be extended the so-called electromagnetic wave, whose vectors of electrical and magnetic field are cophasal. Let us emphasize again that the introduction of the vector of magnetic field is the purely mathematical formality, which is not the necessary for the construction theory of emission.

Thus, relying on the phenomenological concept of magnetic field, are obtained the laws of the propagation of electromagnetic waves. These laws exclude the need of using Maxwell's equations, since. all laws of propagation can be obtained from them, and Maxwell's equations with respect to these equations are the special case, when distance from the emitter to the observation point is great.

There remains only to ask, why electrodynamics is not banal along this way immediately after the introduction of the concept of magnetic field. Answer lies in the fact that then no one knew about existence of electromagnetic waves and only experiences of Hertz confirmed this.

Thus, the physical the basis of the emission of electromagnetic waves to us is not thus far clear, since it is not understandable that the vector potential represents from a physical point of view and why it is connected with the motion of charges. In connection with the incomprehension of these questions, but vector potential is critical not only for the emission, but also for the power of interaction of the current carrying systems, the classical electrodynamics and it is divided up to now into two those not connected with each other of part. Its one part this of Maxwell's equation, the determining wave processes in the material media. Another part, which determines power interaction of the current carrying systems, is based on the experimental postulate about the Lorentz force.

From the relationships (1.8) and (1.11) it is evident that the electrical and magnetic fields of electromagnetic waves in this posing of the question depend only on the second derivatives of coordinate on the time, and in this case as yet there is no answer apropos of that, can these fields depend on higher derivatives.

This question is examined from a formal phenomenological point of view by the way of the introduction of the concept of magnetic field and vector potential, and the obtained results well soglasuyushchiesya with the experiment. However, basic problem today consists in the fact that physical nature of this potential until is known.

2 Further development of phenomenological approaches to questions of the propagation of electromagnetic waves.

2.1 Laws of the self-induction

To the laws of self-induction should be carried those laws, which describe the reaction of such elements of radio-technical chains as capacity, inductance and resistance with the galvanic connection to them of the sources of current or voltage [2-4]. These laws are the basis of the theory of electrical chains. the motion of charges in any chain, which force them to change their position, is connected with the energy consumption from the power sources. The processes of interaction of the power sources with such structures are regulated by the laws of self-induction.

To the self-induction let us carry also that case, when its parameters can change with the presence of the connected power source or the energy accumulated in the system. This self-induction we will call parametric [2-4]. Subsequently we will use these concepts: as current generator and the voltage generator. By ideal voltage generator we will understand such source, which ensures on any load the lumped voltage, internal resistance in this generator equal to zero. By ideal current generator we will understand such source, which ensures in any load the assigned current, internal resistance in this generator equally to infinity. The ideal current generators and voltage in nature there does not exist, since both the current generators and the voltage generators have their internal resistance, which limits their possibilities.

If we to one or the other network element connect the current generator or voltage, then opposition to a change in its initial state is the response reaction of this element and this opposition is always equal to the applied action, which corresponds to third Newton's law.

If the capacity C is charged to a potential difference U, then the charge Q, accumulated in it, is determined by the relationship

$$Q_{C,U}=CU\ . \tag{2.1.1}$$

The charge $Q_{C,U}$, depending on the capacitance values of capacitor and from a voltage drop across it, we will call still the flow of electrical self-induction.

When speech goes about a change in the charge, determined by relationship (2.1.1), that this value it can change with the method of changing the potential difference with a constant capacity, either with a change in capacity itself with a constant potential difference, or and that and other parameter simultaneously.

If capacitance value or voltage drop across it depend on time, then the current strength is determined by the relationship:

$$I=\frac{dQ_{C,U}}{dt}=C\frac{dU}{dt}+U\frac{dC}{dt}\ .$$

This expression determines the law of electrical self-induction. Thus, current in the circuit, which contains capacitor, can be obtained by two methods, changing voltage across capacitor with its constant capacity either changing capacity itself with constant voltage across capacitor, or to produce change in both parameters simultaneously.

For the case, when the capacity C_1 is constant, we obtain known expression for the current, which flows through the capacity:

$$I=C_1\frac{dU}{dt}\ , \tag{2.1.2}$$

when changes capacity, and at it is supported the constant voltage U_1, we have:

$$I=U_1\frac{dC}{dt}\ . \tag{2.1.3}$$

This case to relate to the parametric electrical self-induction, since the presence of current is connected with a change in this parameter as capacity.

Let us examine the consequences, which escape from relationship (2.1.2).

If we to the capacity connect the direct-current generator I_0, then voltage on it will change according to the law:

$$U=\frac{I_0 t}{C_1}\ . \tag{2.1.4}$$

Thus, the capacity, connected to the source of direct current, presents for it the effective resistance

$$R = \frac{t}{C_1} \tag{2.1.5}$$

linearly depending on the time. The it should be noted that obtained result is completely obvious; however, such properties of capacity, which customary to assume by reactive element they were for the first time noted in the work [1].

This is understandable from a physical point of view, since in order to charge capacity, source must expend energy.

The power, output by current source, is determined in this case by the relationship:

$$P(t) = \frac{I_0^2 t}{C_1}. \tag{2.1.6}$$

The energy, accumulated by capacity in the time t, we will obtain, after integrating relationship (2.1.6) with respect to the time:

$$W_C = \frac{I_0^2 t^2}{2C_1}.$$

Substituting here the value of current from relationship (2.1.4), we obtain the dependence of the value of the accumulated in the capacity energy from the instantaneous value of voltage on it:

$$W_C = \frac{1}{2} C_1 U^2.$$

Using for the case examined a concept of the flow of electrical induction, which is the charge, we obtain

$$\Phi_U = C_1 U = Q(U), \tag{2.1.7}$$

and using relationship (2.1.2), let us write down:

$$I_0 = \frac{d\Phi_U}{dt} = \frac{dQ(U)}{dt}, \tag{2.1.8}$$

i.e., if we to a constant capacity connect the source of direct current, then the current strength will be equal to the derivative of the flow of capacitive induction on the time.

now we will support at the capacity constant voltage U_1, and change capacity itself, then

$$I = U_1 \frac{dC}{dt}. \tag{2.1.9}$$

It is evident that the value

$$R_C = \left(\frac{dC}{dt}\right)^{-1} \tag{2.1.10}$$

plays the role of the effective resistance. This result is also physically intelligible, since. with an increase in the capacitance increases the energy accumulated in it, and thus, capacity extracts in the voltage source energy, presenting for it resistive load. The power, expended in this case by source, is determined by the relationship:

$$P(t) = \frac{dC}{dt} U_1^2 . \tag{2.1.11}$$

From relationship (2.1.11) is evident that depending on the sign of derivative the expendable power can have different signs. When the derived positive, expendable power goes for the accomplishment of external work. If derived negative, then external source accomplishes work, charging capacity.

Again, introducing concept the flow of the capacitive induction

$$\Phi_C = CU_1 = Q(C),$$

we obtain

$$I = \frac{\partial \Phi_C}{\partial t} . \tag{2.1.12}$$

Relationships (2.1.8) and (2.1.12) indicate that regardless of the fact, how changes the flow of electrical self-induction (charge), its time derivative is always equal to current.

Let us examine one additional process, which earlier the laws of induction did not include, however, it it falls under for our extended determination of this concept. From relationship (2.1.7) it is evident that if the charge, left constant (we will call this regime the regime of the frozen electric flux), then voltage on the capacity can be changed by its change. In this case the relationship will be carried out:

$$CU = C_0 U_0 = const,$$

where C , U - instantaneous values, and C_0, U_0 - initial values of these parameters, which occur with turning off from the capacity of the power source.

The voltage on the capacity and the energy, accumulated in it, will be in this case determined by the relationships:

$$U = \frac{C_0 U_0}{C} , \tag{2.1.13}$$

$$W_C = \frac{1}{2}\frac{(C_0 U_0)^2}{C} .$$

It is natural that this process of self-induction can be connected only with a change in capacity itself, and therefore it falls under for the determination of parametric self-induction.

Thus, are located three relationships (2.1.8), (2.1.12) and (2.1.13), which determine the processes of electrical self-induction. We will call their rules of capacitive flow. Relationship (2.1.8) determines the electrical self-induction, during which there are no changes in the capacity, and therefore this self-induction can be named simply electrical self-induction. Relationships (2.1.3) and (2.1.9-2.1.11) assume the presence of changes in the capacity; therefore the processes, which correspond by these relationships, we will call electrical parametric self-induction.

Let us now move on to the examination of the processes, proceeding in the inductance. Let us introduce the concept of the flow of the inductive self-induction

$$\varPhi_{L,I} = LI .$$

If inductance is shortened outed, and made from the material, which does not have effective resistance, for example from the superconductor, then

$$\varPhi_{L,I} = L_1 I_1 = const ,$$

where L_1 and I_1 - initial values of these parameters, which are located at the moment of the short circuit of inductance with the presence in it of current.

This regime we will call the regime of the frozen flow. In this case the relationship is fulfilled:

$$I = \frac{I_1 L_1}{L} , \tag{2.1.14}$$

where I and L - the instantaneous values of the corresponding parameters.

In flow regime examined of current induction remains constant, however, in connection with the fact that current in the inductance it can change with its change, this process falls under for the determination of parametric self-induction. The energy, accumulated in the inductance, in this case will be determined by the relationship of

$$W_L = \frac{1}{2}\frac{(L_1 I_1)^2}{L} = \frac{1}{2}\frac{(const)^2}{L} .$$

Voltage on the inductance is equal to the derivative of the flow of current induction on the time:

$$U = \frac{d\Phi}{dt} = L\frac{dI}{dt} + I\frac{dL}{dt}.$$

let us examine the case, when the inductance of is constant.

$$U = L_1\frac{dI}{dt}. \qquad (2.1.15)$$

Designating $\Phi_I = L_1 I$, we obtain $U = \frac{d\Phi_I}{dt}$.

After integrating expression (2.1.15) on the time, we will obtain:

$$I = \frac{Ut}{L_1}. \qquad (2.1.16)$$

Thus, the capacity, connected to the source of direct current, presents for it the effective resistance

$$R = \frac{L_1}{t}, \qquad (2.1.17)$$

which decreases inversely proportional to time.

The power, expended in this case by source, is determined by the relationship:

$$P(t) = \frac{U^2 t}{L_1}. \qquad (2.1.18)$$

this power linearly depends on time. After integrating relationship (12.18) on the time, we will obtain the energy, accumulated in the inductance of

$$W_L = \frac{1}{2}\frac{U^2 t^2}{L_1}. \qquad (2.1.19)$$

After substituting into expression (2.1.19) the value of voltage from relationship (2.1.16), we obtain:

$$W_L = \frac{1}{2}L_1 I^2.$$

This energy can be returned from the inductance into the external circuit, if we open inductance from the power source and to connect effective resistance to it.

Now let us examine the case, when the current I_1, which flows through the inductance, is constant, and inductance itself can change. In this case we obtain the relationship

$$U = I_1\frac{dL}{dt}. \qquad (2.1.20)$$

Thus, the value

$$R(t) = \frac{dL}{dt} \qquad (2.1.21)$$

plays the role of the effective resistance.

As in the case the electric flux, effective resistance can be (depending on the sign of derivative) both positive and negative. This means that the inductance can how derive energy from without, so also return it into the external circuits.

Introducing the designation $\Phi_L = LI_1$ and, taking into account (2.1.20), we obtain:

$$U = \frac{d\Phi_L}{dt}. \tag{2.1.22}$$

Of relationship (2.1.14), (2.1.19) and (2.1.22) we will call the rules of current self-induction, or the flow rules of current self-induction. From relationships (2.1.19) and (2.1.22) it is evident that, as in the case with the electric flux, the method of changing the flow does not influence eventual result, and its time derivative is always equal to the applied potential difference. Relationship (2.1.19) determines the current self-induction, during which there are no changes in the inductance, and therefore it can be named simply current self-induction. Relationships (2.1.20-2.1.21) assume the presence of changes in the inductance; therefore we will call such processes current parametric self-induction.

2.2. Work presents the new method of obtaining the wave equation for the long lines.

The processes, examined in two previous paragraphs, concern chains with the lumped parameters, when the distribution of potential differences and currents in the elements examined can be considered uniform. However, there are chains, for example the long lines, into which potential differences and currents are not three-dimensional uniform. These processes are described by the wave equations, which can be obtained from Maxwell's equations or with the aid of the telegraphic equations, but physics of phenomenon itself in these processes to us is not clear.

We will use the results, obtained in the previous paragraph, for examining the processes, proceeding in the long lines, in which the capacity and inductance are the distributed parameters. Let us assume that linear (falling per unit of length) capacity and inductance of this line are equal. If we to this line connect the dc power supply U_1, then its front will be extended in the line some by the speed v, and the moving coordinate of this front will be determined by the relationship $z = vt$. In this case the total quantity of the charged capacity and the value of the summary inductance, along which it flows current, calculated from the beginning lines to the location of the front of voltage, will change according to the law:

$$C(t) = zC_0 = vt\ C_0,$$

$$L(t)=zL_0=vt\ L_0 .$$

The source of voltage U_1 will in this case charge the being increased capacity of line, for which from the source to the charged line in accordance with relationship (11.9) must leak the current:

$$I_1=U_1\frac{dC(t)}{dt}=vU_1C_0 . \tag{2.2.1}$$

This current there will be the leak through the conductors of line that possess inductance. But, since the inductance of line in connection with the motion of the front of voltage, also increases, in accordance with relationship (2.1.20), on it will be observed a voltage drop:

$$U=I_1\frac{dL}{dt}=vI_1L_0=v^2U_1C_0L_0 .$$

But a voltage drop across the conductors of line in the absolute value is equal to the voltage, applied to its entrance; therefore in the last expression should be placed $U=U_1$. We immediately find taking this into account that the rate of the motion of the front of voltage with the assigned linear parameters and when, on, the incoming line of constant voltage U_1 is present, must compose

$$v=\frac{1}{\sqrt{L_0C_0}} . \tag{2.2.2}$$

This expression corresponds to the signal velocity in line itself. Consequently, if we to the infinitely long line connect the voltage source, then in it will occur the expansion of electrical pour on and the currents, which fill line with energy, and the speed of the front of constant voltage and current will be equal to the velocity of propagation of electromagnetic vibrations in this line. This wave can be named electrocurent. It is interesting to note that the obtained result does not depend on the form of the function U, i.e. to the line can be connected both the dc power supply and the source, whose voltage changes according to any law. In all these cases the value of the local value of voltage on incoming line will be extended along it with the speed, which follows from relationship (2.2.2). This result could be, until now, obtained only by the method of solution of wave equation, but in this case he indicates the physical cause for this propagation, and it gives the physical picture of process itself. Examination shows that very process of propagation is connected with the energy processes of the filling of line with electrical and current energy. This process occurs in such a way that the wave front, being extended with the speed of v, leaves after itself the line, charged to a potential difference U_1, which corresponds to the filling of line with electrostatic electric field energy. However, in the section of line from the voltage source also to the wave front flows the current I_1, which corresponds to the filling of line in this section with energy, which is connected with the motion of the charges along the conductors of line, which possess inductance.

The current strength in the line can be obtained, after substituting the values of the velocity of propagation of the wave front, determined by relationship (2.2.2), into relationship (2.2.1). After making this substitution, we will obtain

$$I_1 = U_1 \sqrt{\frac{C_0}{L_0}} ,$$

where $Z = \sqrt{\frac{L_0}{C_0}}$ - line characteristic.

In this case

$$U_1 = I \ \frac{dL}{dt} = \frac{d\Phi_L}{dt} .$$

So accurately

$$I_1 = U_1 \frac{dC}{dt} = \frac{d\Phi_C}{dt} .$$

It is evident that the flow rules both for the electrical and for the current self-induction are observed also in this case.

Thus, the processes of the propagation of a potential difference along the conductors of long line and current in it are connected and mutually supplementing each other, and to exist without each other they do not can. This process can be called [electrocurent] spontaneous parametric self-induction. This name connected with the fact that flow expansion they occur arbitrarily and characterizes the rate of the process of the filling of line with energy. From the aforesaid the connection between the energy processes and the velocity of propagation of the wave fronts in the long lines becomes clear. Since with the emission of electromagnetic waves the free space is also transmission line, similar laws must characterize propagation in this space.

That will be, if we in the considered case as one of the conductors of long line take spiral, or to as is customary call, long solenoid. Obviously, in this case the velocity of propagation of the front of voltage in this line will decrease, since the linear inductance of line will increase. This propagation will accompany the process of the propagation not only of external with respect to the solenoid pour on and currents, but both the process of the propagation of magnetic flux inside the solenoid itself and the velocity of propagation of this flow will be equal to the velocity of propagation of electromagnetic wave in line itself.

Knowing current and voltage in the line, it is possible to calculate the specific energy, concluded in the linear capacity and the inductance of line. These energies will be determined by the relationships:

$$W_C=\frac{1}{2}C_0U_1^{\,2}, \tag{2.2.3}$$

$$W_L=\frac{1}{2}L_0I_1^{\,2}. \tag{2.2.4}$$

It is not difficult to see that $W_C=W_L$.

Now let us discuss a question about the duration of the front of electrocurent wave and about which space will occupy this front in line itself. Answer to the first question is determined by the properties of the very voltage source, since local derivative $\frac{\partial U}{\partial t}$ at incoming line depends on transient processes in the source itself and in that device, with the aid of which this source is connected to the line. If the process of establishing the voltage on incoming line will last some time Δt, then in the line it will engage section with the length $v\Delta t$. If we to the line exert the voltage, which is changed with the time according to the law $U(t)$, then the same value of function will be observed at any point of the line at a distance Z rel.un. of beginning with the delay $t=\frac{z}{v}$. Thus, the function

$$U(t,z)=U\left(t-\frac{z}{v}\right) \tag{2.2.5}$$

can be named propagation function, since. it establishes the connection between the local temporary and three-dimensional values of function in the line. Long line is the device, which converts local derivative voltagees on the time on incoming line into the gradients in line itself. On the basis propagation function (2.2.5) it is possible to establish the connection between the local and gradients in the long line. It is obvious that

$$\frac{\partial U(z)}{\partial z}=\frac{1}{v}\,\frac{\partial U(t)}{\partial t}\ .$$

Is important to note that very process of propagation in this case is obliged to the natural expansion of electric field and current in the line, and it is subordinated to the rules of parametric self-induction. In the second place, for solving the wave equations of the long lines

$$\begin{aligned}\frac{\partial^2 U}{\partial z^2}&=\frac{1}{v^2}\,\frac{\partial^2 U}{\partial t^2}\\ \frac{\partial^2 I}{\partial z^2}&=\frac{1}{v^2}\,\frac{\partial^2 I}{\partial t^2}\end{aligned}\ , \tag{2.2.6}$$

obtained from the telegraphic equations

$$\frac{\partial U}{\partial z} = -L \frac{\partial I}{\partial t}$$
$$\frac{\partial I}{\partial z} = -C \frac{\partial U}{\partial t},$$

the knowledge second derivative voltages and currents is required.

But what is to be done, if to incoming line is supplied voltage, whose second derivative is equal to zero (case, when the voltage of source it does change according to the linear law)? Answer to this question equation (2.2.6) they do not give. The utilized method gives answer also to this question.

With the examination of processes in the long line figured such concepts as linear capacity and inductance, and also currents and voltage in the line. However, in the electrodynamics, based on Maxwell's equations, there are no such concepts as capacity and inductance, and there are concepts of the electrical and magnetic permeability of medium. In the carried out examination such concepts as electrical and magnetic fields also was absent. Let us show how to pass from such categories as linear inductance and capacity, current and voltage in the line to such concepts as dielectric and magnetic constant, and also electrical and magnetic field. For this let us take the simplest construction of line, located in the vacuum, as shown in Fig. 5.

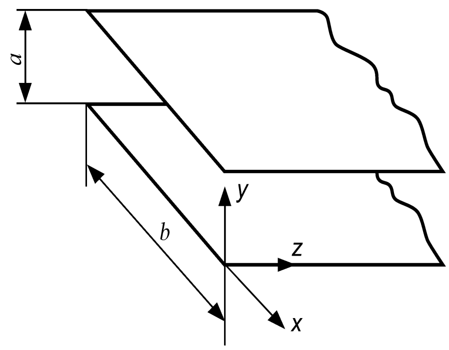

Fig. 5. The two-wire circuit, which consists of two ideally conducting planes.

We will consider that and edge effects it is possible not to consider. Then the following connection will exist between the linear parameters of line and the magnetic and dielectric constants:

$$L_0 = \mu_0 \frac{a}{b}, \tag{2.2.7}$$

$$C_0 = \varepsilon_0 \frac{b}{a}, \tag{2.2.8}$$

where μ_0, ε_0 - dielectric and magnetic constant of vacuum.

The phase speed in this line will be determined by the relationship:

$$v = \frac{1}{\sqrt{L_0 C_0}} = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = c,$$

where c - velocity of propagation of light in the vacuum.

The wave drag of the line examined will be equal

$$Z = \frac{a}{b}\sqrt{\frac{\mu_0}{\varepsilon_0}} = \frac{a}{b} Z_0,$$

where $Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}}$ - wave drag of free space.

Besides this with the observance of the condition $a=b$ we obtain the equality $L_0 = \mu_0$ This means that magnetic permeability μ_0 plays the role of the longitudinal specific inductance of vacuum. In this case is observed also the equality $C_0 = \varepsilon_0$. This means that the dielectric constant ε_0 plays the role of the transverse specific capacity of vacuum. In this interpretation both μ_0 and ε_0 acquire clear physical sense and, just as in the long line, ensure the process of the propagation of electromagnetic wave in the free space.

The examination of electromagnetic wave in the long line can be considered as filling of space, which is been located between its conductors, special form of material, which present the electrical and magnetic fields. Mathematically it is possible to consider that these fields themselves possess specific energy and with their aid it is possible to transfer energy by the transmission lines. But if we examine the processes, which take place with the emission of electromagnetic waves with the aid of any antenna, then it it is possible to examine also as the filling of free space with this form of material. However, pour on geometric form and currents in this case it will be more complexly, since they will always be present both transverse and longitudinal component pour on. This approach excludes the need for application, for describing the propagation of electromagnetic waves, this substance as ether.

If we to the examined line of infinite length, or of line of that loaded with wave drag, connect the dc power supply U, then the field strength in the line will comprise:

$$E_y = \frac{U}{a},$$

and the current, which flows into the line from the power source, will be determined by the relationship:

$$I = \frac{U}{Z} = \frac{aE_y}{Z}. \tag{2.2.9}$$

Magnetic field in the line will be equal to the specific current, flowing in the line

$$H_x = \frac{I}{b} = \frac{aE_y}{bZ}.$$

Substituting here the value Z, we obtain

$$H_x = \frac{E_y}{Z_0}. \tag{2.2.10}$$

The same connection between the electrical and magnetic field exists also for the case of the transverse electromagnetic waves, which are extended in the free space.

Comparing expressions for the energies, it is easy to see that the specific energy can be expressed through the electrical and magnetic fields

$$\frac{1}{2}\mu_0 H_x{}^2 = \frac{1}{2}\varepsilon_0 E_y{}^2. \tag{2.2.11}$$

Thismeans that the specific energy, accumulated in the magnetic and electric field in this line is identical. If the values of these energies are multiplied by the volumes, occupied by fields, then the obtained values coincide with expressions (2.2.3-2.2.4).

Thus, it is possible to make the conclusion that in the line examined are propagated the same transverse plane waves, as in the free space. Moreover this conclusion is obtained not by the method of solution of Maxwell's equations, but by the way of examining the dynamic processes, which are related to the discharge of parametric self-induction. The special feature of this line will be the fact that in it, in contrast to the free space, the stationary magnetic and electric fields can be extended, but this case cannot be examined by the method of solution of Maxwell's equations.

Consequently, conditionally it is possible to consider that the long line is the device, which with the connection to it of dc power supply is filled up with two forms of the energy: electrical and magnetic. The specific densities of these energies are equal, and since and electrical and magnetic energy fill identical volumes, the general energy, accumulated in these fields is identical. The special feature of this line is the fact that with the flow in the line of direct current the distribution of electrical and magnetic pour on in it it is uniform. It is not difficult to show that the force, which acts on the conductors of this line, is equal to zero. This follows from relationship (2.2.11), in which its right and leftist of part present the force gradients, applied to the planes of line. But electrical and magnetic forces have different signs; therefore they compensate each other. This conclusion concerns the transmission lines of any other configuration.

If we to the line exert the voltage, which is changed in the course of time according to any law of $U(t)=aE_y(t)$, the like of analogy (2.2.5) it is possible to write down

$$E_y(z)=E_y\left(t-\frac{z}{c}\right). \tag{2.2.12}$$

Analogous relationship will be also pour on for the magnetic.

Is obvious that the work $I(t)U(t)$ represents the power P, transferred through the cross section of line in the direction z. If in this relationship current and voltage was replaced through the tensions of magnetic and electrical pour on, then we will obtain $P=abE_yH_x$. The work E_yH_x represents the absolute value of Poynting's vector, which represents the specific power, transferred through the cross section of the line of single area. Certainly, all these relationships can be written down also in the vector form.

Thus, all conclusions, obtained on the basis of the examination of processes in the long line by two methods, coincide. Therefore subsequently, without risking to commit the errors of fundamental nature, it is possible for describing the processes in the long lines successfully to use such parameters as the distributed inductance and capacity. Certainly, in this case one should understand that C_0 and this L_0 some integral characteristics, which do not consider structure pour on. It should be noted that from a practical point of view, the application of the parameters C_0 and L_0 has important significance, since can be approximately solved the tasks, which with the aid of Maxwell's equations cannot be solved. This, for example, the case, when spirals are the conductors of transmission line.

3. New approaches to questions of emission and propagation of the electromagnetic waves

3.1. Dynamic potentials and the field of the moving charges

With the propagation of wave in the long line it is filled up with two forms of energy, which can be determined through the currents and the voltages or through the electrical and magnetic fields in the line. And only after wave will fill with electromagnetic energy all space between the generator and the load on it it will begin to be separated energy. I.e. the time, by which stays this process, generator expended its power to the filling with energy of the section of line between the generator and the load.

But if we begin to move away load from incoming line, then a quantity of energy being isolated on it will decrease, since. the part of the energy, expended by source, will leave to the filling with energy of the additional length of line, connected with the motion of load. If load will approach a source, then it will obtain an additional quantity of energy due to the decrease of its length. But if effective resistance is the load of line, then an increase or the decrease of the power expendable in it can be connected only with a change in the voltage on this resistance. Therefore we come to the conclusion that during the motion of the observer of those of relatively already existing in the line pour on must lead to their change.

Being located in assigned IRS, us interest those fields, which are created in it by the fixed and moving charges, and also by the electromagnetic waves, which are generated by the fixed and moving sources of such waves. The fields, which are created in this IRS by moving charges and moving sources of electromagnetic waves, we will call dynamic. Can serve as an example of dynamic field the magnetic field, which appears around the moving charges.

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

in this division will made attempt find the precisely physically substantiated ways of obtaining the transformation pour on upon transfer of one IRS to another, and to also explain what dynamic potentials and fields can generate the moving charges. The first step, demonstrated in the works [11-15], was made in this direction a way of the introduction of the symmetrical laws of magnetoelectric and electromagnetic induction. These laws are written as follows:

$$\oint \vec{E}'dl' = -\int \frac{\partial \vec{B}}{\partial t} d\vec{s} + \oint \left[\vec{v}\times\vec{B}\right] dl' ,$$
$$\oint \vec{H}'dl' = \int \frac{\partial \vec{D}}{\partial t} d\vec{s} - \oint \left[\vec{v}\times\vec{D}\right] dl' \quad (3.1.1)$$

or

$$rot\vec{E}' = -\frac{\partial \vec{B}}{\partial t} + rot\left[\vec{v}\times\vec{B}\right] .$$
$$rot\vec{H}' = \frac{\partial \vec{D}}{dt} - rot\left[\vec{v}\times\vec{D}\right] \quad (3.1.2)$$

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

$$\begin{aligned}\vec{E}' &= \left[\vec{v}\times\vec{B}\right] \\ \vec{H}' &= -\left[\vec{v}\times\vec{D}\right]\end{aligned}. \tag{3.1.3}$$

In relationships (3.1.1-3.1.3), which assume the validity of the transformation of Galiley, marcer and not marcer values present fields and elements in moving and fixed IRS respectively. It must be noted, that transformation (3.1.3) earlier could be obtained only from the transformation of Lorenz.

Of relationships (3.1.1-3.1.3), which present the laws of induction, do not give information about how arose fields in initial fixed IRS. They describe only laws governing the propagation and conversion pour on in the case of motion with respect to the already existing fields.

Of relationship (3.1.3) 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 pour on $\vec{E}$ and vice versa. From these relationships escape the additional consequences, which were for the first time examined in the work [16]. Электрическое поле $E=\frac{g}{2\pi\varepsilon r}$ за пределами заряженного длинного стержня, на единицу длины которого приходится заряд g, убывает по закону $\frac{1}{r}$, где r - расстояние от центральной оси стержня до точки наблюдения.

The electric field $E=\frac{g}{2\pi\varepsilon r}$ outside the charged long rod, per unit length of which there is a charge g, decreases according to the law $\frac{1}{r}$, where r is the 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 IRS, then in it will appear the additional magnetic field $\Delta H = \varepsilon E \Delta v$. If we now with respect to already moving IRS begin to move third frame of reference with the speed Δv, then already due to the motion in the field ΔH will appear additive to the electric field $\Delta E = \mu\varepsilon E(\Delta v)^2$. 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 IRS with reaching of the speed $v=n\Delta v$, when $\Delta v \to 0$, and $n\to\infty$. In the final analysis in moving IRS the value of dynamic electric field will prove to be more than in the initial and to be determined by the relationship:

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

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

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

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

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

$$\varphi'(r,v_\perp)=\frac{ech\frac{v_\perp}{c}}{4\pi\varepsilon r}=\varphi(r)ch\frac{v_\perp}{c}, \tag{3.1.4}$$

where $\varphi(r)$ - scalar potential of fixed charge.

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

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

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

where $v_\perp$ - speed normal to the direction of the magnetic field.

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

$$\begin{aligned}
&\vec{E}'_\uparrow=\vec{E}_\uparrow,\\
&\vec{E}'_\perp=\vec{E}_\perp ch\frac{v}{c} + \frac{Z_0}{v}\left[\vec{v}\times\vec{H}_\perp\right]sh\frac{v}{c},\\
&\vec{H}'_\uparrow=\vec{H}_\uparrow,\\
&\vec{H}'_\perp=\vec{H}_\perp ch\frac{v}{c} - \frac{1}{vZ_0}\left[\vec{v}\times\vec{E}_\perp\right]sh\frac{v}{c},
\end{aligned} \tag{3.1.5}$$

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

Transformation pour on (3.1.5) they were for the first time obtained in the work [16-18] they are called Mende transformation

3.2 Phase aberration and the transverse Doppler effect

Using relation (3.1.5) it is possible to explain the phenomenon of phase aberration, which did not have within the framework existing classical electrodynamics of explanations.

We will consider that there are components of the plane wave of and , which is extended in the direction of , and primed system moves in the direction of the axis of with the speed of . Then components pour on in the [shtrikhovannoy] coordinate system in accordance with relationships (3.1.5) 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'_y.

let us write down the summary field of E' in moving IRS:

$$E' = \left[\left(E'_x\right)^2 + \left(E'_y\right)^2 \right]^{\frac{1}{2}} = E_x ch\frac{v_x}{c}. \tag{3.2.1}$$

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:

$$\alpha \cong sh\frac{v}{c} \cong \frac{v}{c}. \tag{3.2.2}$$

Thisis 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 (3.2.2). However, the relation of the absolute values of the vectors of $\vec{E}'$ and $\vec{H}'$ in both systems they remained identical. However, the absolute value of the very vector of Poynting 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 (3.2.1).

Is not difficult to show that, if we the polarization of electromagnetic wave change ourselves, then result will remain before. Transformation with respect to the vectors $\vec{E}$ and $\vec{H}$ 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 and H of the waves, which are extended in the waveguides. In this case appears the uncommon wave, whose phase front is inclined toward the Poyntnng vector to the angle, determined by relationship (3.2.2). In fact obtained wave is the superposition of plane wave with the phase speed of $c=\sqrt{\frac{1}{\mu\varepsilon}}$ and additional wave of plane wave with the infinite phase speed orthogonal to the direction of propagation.

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 IRS it is necessary to incline telescope on the motion of motion to the angle, determined by relationship (3.2.2). 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 (3.2.2). but this means that this star with respect to the observer has radial it [skorost], 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

$$\omega_{d\perp} = \omega_0 \frac{v^2}{c^2}. \tag{3.2.3}$$

This result numerically coincides with results STR, but it is principally characterized by rel.un. of results fact that it is considered into STR that the transverse Doppler effect, determined by relationship (3.2.3), there is in actuality, while in this case this only apparent effect. If we compare the results of transformation pour on (3.2.5) with transformation STR, 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.

Of conversion STR, 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. Transformation (3.2.4) and (3.2.5) are obtained on the physical basis without the use of postulates and they with the high accuracy coincided with STR. Difference is the fact that in transformation (3.2.5) there are no limitations on the speed for the material particles, and also the fact that the charge is not the invariant of speed. The experimental confirmation of the fact indicated can serve as the confirmation of correctness of the proposed transformation.

3.3. Laws of the electro-electrical induction of

Since pour 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 [19, 20]:

$$\varphi(r,t)=\frac{g\ ch\dfrac{v_{\perp}\left(t-\dfrac{r}{c}\right)}{c}}{4\pi\ \varepsilon_0 r}, \tag{3.3.1}$$

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

But does appear a question, on what bases, if we do not use Maksvell's equation, from whom does follow wave equation, is introduced the being late scalar- vector potential? This question was examined in the thirteenth paragraph, when the velocity of propagation of the front of the wave of the tension of magnetic and electric field in the long line was determined. There, without resorting to to Maxwell's equations, it was shown that electrical and magnetic field they are extended with the final speed, which in the vacuum line is equal to the speed of light. Consequently, such fields be late to the period of (see relationship (13.12)). The same delay we introduce in this case and for the scalar- vector potential, which is the carrier of electrical pour on.

Using a relationship $\vec{E}=-grad\ \varphi(r,t)$, let us find field at point 1 (Fig. 6)

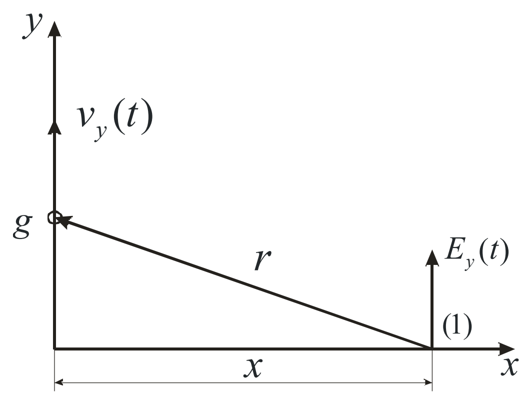

Fig. 6 . Diagram of shaping of the induced electric field

The gradient of the numerical value of a radius of the vector of 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 of 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 is considered as the function of the position of observation point.

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

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:

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

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:

$$E_y(x,t) = -\frac{e}{4\pi\varepsilon_0 cx}\frac{\partial v_y\left(t-\frac{x}{c}\right)}{\partial y} sh\frac{v_y\left(t-\frac{x}{c}\right)}{c}, \tag{3.3.2}$$

where x - 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 (3.3.2):

$$E_y(x,t)=\frac{e}{4\pi\varepsilon_0 cx}\frac{1}{v_y\left(t-\frac{x}{c}\right)}\frac{\partial v_y\left(t-\frac{x}{c}\right)}{\partial t}sh\frac{v_y\left(t-\frac{x}{c}\right)}{c}. \tag{3.3.3}$$

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 (3.3.3):

$$E_y(x,t)=-\frac{ea_y\left(t-\frac{x}{c}\right)}{4\pi\varepsilon_0 c^2 x}, \tag{3.3.4}$$

where $a_y\left(t-\frac{x}{c}\right)$ - 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 (3.3.4) takes the form:

$$E_y(x,t,\alpha)=-\frac{ea_y\left(t-\frac{x}{c}\right)\sin\alpha}{4\pi\varepsilon_0 c^2 x}. \tag{3.3.5}$$

Relationship (3.3.5) 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

$$\frac{ev_z\left(t-\frac{x}{c}\right)}{4\pi x}=A_H\left(t-\frac{x}{c}\right)$$

there is the being late vector potential, the relationship (3.3.5) can be rewritten

$$E_y(x,t,\alpha)=-\frac{ea_y\left(t-\frac{x}{c}\right)\sin\alpha}{4\pi\varepsilon_0 c^2 x},$$

or

$$E_y(x,t,\alpha)=-\mu_0\frac{\partial A_H\left(t-\frac{x}{c}\right)}{\partial t}.$$

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 (3.3.5). 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:

$$\vec{p}=e\vec{d}, \tag{3.3.6}$$

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 (3.3.5), we obtain the emission law of the being varied dipole.

$$\vec{E}=-\frac{1}{4\pi r\varepsilon_0 c^2}\frac{\partial^2 p(t-\frac{r}{c})}{\partial t^2}. \tag{3.3.7}$$

This is also very well known relationship [21].

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 (3.3.4), (3.3.5) and (3.3.6), 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. However, the summary value of field, around this dipole defines as the superposition of those obtained pour on.

Laws (3.3.4), (3.3.5), (3..7) are the laws of the direct action, in which already there is neither magnetic pour 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 (3.3.5) 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 (3.3.5). The superposition of electrical pour on, radiated by all charges, it is electrical wave.

If on the charge acts the electric field of , then the acceleration of charge is determined by the equation

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

Taking into account this relationship (18.5) assumes the form

$$E_y(x,t,\alpha) = \frac{e^2 \sin\alpha}{4\pi\varepsilon_0 c^2 m x} E'_{y0} \sin\omega\left(t - \frac{x}{c}\right) \quad , \qquad (3.3.8)$$

where the coefficient

$$K = \frac{e^2 \sin\alpha}{4\pi\varepsilon_0 c^2 m}$$

where the coefficient of 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:

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

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

$$j_y(x,t)=-\frac{e^2\omega}{4\pi c^2 mx} E'_{y0} \cos \omega\left(t-\frac{x}{c}\right). \tag{3.3.9}$$

The sum wave, which presents the propagation of electrical pour on (3.3.8) and bias currents (3.3.9), can be named [electrocurent]. In this current wave of displacement lags behind the wave of electric field to the angle equal $\frac{\pi}{2}$. For the first time this term and definition of this wave was used in the works [2, 3].

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

$$\vec{j}=\varepsilon_0 \frac{\partial \vec{E}}{\partial t}=rot\vec{H}, \tag{3.3.10}$$

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

introduced thus magnetic field is vortex. Comparing (3.3.9) and (3.3.10) 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

$$H_z(x,t)=\frac{e^2 \ \sin\alpha}{4\pi cmx} E'_{y0} \sin \omega\left(t-\frac{x}{c}\right). \tag{3.3.11}$$

Thus, relationship (3.3.8), (3.3.9) and (3.3.11) 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 reradiation.

The magnetic field, which can be calculated with the aid of relationship (3.3.11), 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

$$Z=\frac{E_y}{H_z}=\frac{1}{\varepsilon_0 c}=\sqrt{\frac{\mu_0}{\varepsilon_0}} \ ,$$

where Z - wave drag of free space.

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

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

Therefore electrocurrent wave, crossing this area, transfers through it the power, determined by the data by relationship, which is located in accordance with 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 electrocurrent 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 of a certain scalar function φ and rotor of a certain vector function $\vec{C}$, whose divergence is equal to zero:

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

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

Consequently, must exist clear separation pour on to the gradient and the vortex. It is evident that in the expressions, obtained for those induced pour 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 pour 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 (3.3.1), 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.

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4. Transformation of Mende in the concept of the scalar- vector potential

1 Introduction

The special theory of relativity (STR) was developed by Albert Einstein in 1905. Its basis are the postulates, one of which (the so-called second postulate) says, that the speed of set is invariant, i.e., it does not depend on observation system. This means that under no circumstances the speed of light cannot exceed its standard value, which in the vacuum is equal 299 792 458 ± 1,2 m / s (it is rounded 300000 km / s). Second postulate STR contradicts the common sense, since the speed is a value relative. Passenger, edushchiy in the railroad car of train, with respect to the railroad car is fixed, whereas according to the relation to the station buildings he moves with the speed of train. In all STR this not thus. If inside the railroad car light beam moves with the standard speed, then with respect to the station buildings it moves with the same speed.

From the moment of creation STR were carried out the numerous experiments, in which the experimenters attempted to prove the inaccuracy of the second postulate. For this they used radiation sources, which moved with respect to the observation system with the given speed, but, values of the speed of light in the observation system obtained in such experiments always proved to be equal to the standard value of the speed of light [1-9].

Such experiments in the diverse variants were carried out and outstanding scientific Michaelson, with the aid of the invented by it interferometer, but also these experiments also ended by failure.

Michelson interferometer was invented by American physicist by Albert Abrakhamom by Michaelson at the beginning of past century. A number of important scientific and applied problems was solved with the aid of this interferometer, the speed of light was in particular with the high accuracy measured. However, in the experiments, carried out by Michaelson, that are concerned checking second postulate STR, were significant errors. It completed these errors, when it attempted to prove that the speed of electromagnetic (EM) wave is added to the speed of its source, which would contradict the second postulate. Michaelson considered to the end of his life that there is an elastic medium (ether), in which are extended EM of wave. Therefore the results of the experiments, which it conducted together with Morley [10] for the detection of this medium, were for it large unexpected contingency, since ether was not discovered. Attempting to improve experiment, it attempted as the radiation source to use light of star, but it it here awaited still large failure. Studies showed that the measured speed of light, does not depend on the speed of star and is equal to the previously measured by it standard value.

In the works [11,12] it is shown that for similar studies the Michelson interferometer is unfit, with which and were connected its errors. And only after the invention of interferometer with the mechanical division of ray became possible the correct checking of the second postulate of the theory of relativity [11]. The results of this checking are represented in the work [12], which they showed that the speed of light is added to the rate of radiation source, which corresponds to the transformation of Galileo, but not to the transformation of Lorenz. But if this then the transformation of Lorenz are erroneous, then should be searched for them replacement. To this question is dedicated the proposed article.

2. Transformation of Mende in the concept of the scalar- vector potential

Let us explain for the solution of the problem presented, what dynamic potentials and fields generate the moving charges. The first step, demonstrated in the works [13-15], was made in this direction a way of the introduction of the symmetrical laws of magnetoelectric and electromagnetic induction. They are written in the following form [16-20]:

$$\oint \mathbf{E}'d\mathbf{l}' = -\int \frac{\partial \mathbf{B}}{\partial t} d\mathbf{s} + \oint [\mathbf{v}\times\mathbf{B}] d\mathbf{l}'; \quad \oint \mathbf{H}'d\mathbf{l}' = \int \frac{\partial \mathbf{D}}{\partial t} d\mathbf{s} - \oint [\mathbf{v}\times\mathbf{D}] d\mathbf{l}', \tag{2.1}$$

or

$$\mathrm{rot}\,\mathbf{E}' = -\frac{\partial \mathbf{B}}{\partial t} + \mathrm{rot}[\mathbf{v}\times\mathbf{B}]; \quad \mathrm{rot}\,\mathbf{H}' = \frac{\partial \mathbf{D}}{dt} - \mathrm{rot}[\mathbf{v}\times\mathbf{D}]. \tag{2.2}$$

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

$$\mathbf{E}' = [\mathbf{v}\times\mathbf{B}]; \quad \mathbf{H}' = -[\mathbf{v}\times\mathbf{D}]. \tag{2.3}$$

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

Of relationships (2.1-123), which present the laws of induction, do not give information about how arose fields in initial fixed IRS. They describe only laws governing the propagation and conversion pour on in the case of motion with respect to the already existing fields.

Of relationship (2.3) attest to the fact that in the case of relative motion of frame of references, between the fields $\mathbf{E}$ and $\mathbf{H}$ there is a cross coupling, i.e. motion in the fields $\mathbf{H}$ leads to the appearance pour on $\mathbf{E}$ and vice versa. From these relationships the additional consequences, for the first time examined in the works escape [13-15,21].

If the charged rod has linear charge g, its electric field $E=g/(2\pi\varepsilon r)$ it diminishes according to the law $1/r$, where r - the distance from the central axis of 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 IRS, then in it will appear the additional magnetic field $\Delta H=\varepsilon E\Delta v$. If we now with respect to already moving IRS begin to move third frame of reference with the speed Δv, then already due to the motion in the field ΔH will appear additive to the electric field $\Delta E=\mu\varepsilon E(\Delta v)^2$. Is obtained the number, which gives the value of electric field $E'_v(r)$ in moving IRS with reaching of speed $v=n\Delta v$, when $\Delta v\to 0$, $n\to\infty$. In the final analysis, in moving IRS the value of dynamic electric field will prove to be more than in the initial, and depending on normal component $v_\perp$ charge rate to the vector, which connects the moving charge and observation point:

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

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

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

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. It is expressed as the scalar potential $\varphi(r)$ of fixed charge by the equality

$$\varphi'(r,v_\perp)=\frac{e\,\mathrm{ch}(v_\perp/c)}{4\pi\varepsilon r}=\varphi(r)\,\mathrm{ch}(v_\perp/c). \tag{2.4}$$

Potential is maximum and normal to the motion of charge direction.

It is analogous, we have for the case of moving the charge in the magnetic field:

$$H'(v_\perp)=H\,\mathrm{ch}(v_\perp/c),$$

where $v_\perp$ - speed normal to the direction of the magnetic field.

We will obtain this result by another method. Let us designate field variables in the fixed frame of reference without the prime, and in the mobile – with the prime. In the differential form let us write down the formulas of the mutual induction of electrical and magnetic pour on in the mobile frame of reference:

$$dH'=\varepsilon E'dv_\perp, \tag{2.5}$$

$$dE'=\mu H'dv_{\perp}\,, \tag{2.6}$$

or, otherwise,

$$dH'/dv_{\perp}=\varepsilon E'\,, \tag{2.7}$$

$$dE'/dv_{\perp}=\mu H'\,, \tag{2.8}$$

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

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

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

$$\frac{d(E'/E)}{dv_{\perp}}=\mu\frac{H'}{H}\,. \tag{2.10}$$

Differentiating both parts (2.10), we have:

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

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

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

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

$$E'/E=C_2\,\mathrm{ch}(v_{\perp}/c)+C_1\,\mathrm{sh}(v_{\perp}/c)\,, \tag{2.13}$$

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

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

$$C_2=1\,, \tag{2.14}$$

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

$$E'/E=\mathrm{ch}(v_{\perp}/c)+C_1\,\mathrm{sh}(v_{\perp}/c)\,.$$

Selecting $C_1=0$, we obtain

$$E'=E\,\mathrm{ch}(v_{\perp}/c)\,.$$

In connection with to electromagnetic wave, introducing the parallel $E_{\uparrow}$, $H_{\uparrow}$ and normal $E_{\perp}$, $H_{\perp}$ speeds IRS of component pour on, we have [9]:

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

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

Let us name transformation pour on (2.15) by the Mende transformation.

Let us derive them in the matrix form [22, 23] and will show that the form of transformation is determined by the law of addition of velocities (classical or relativistic).

Let us examine the totality IRS of such, that IRS K 1 moves with the speed of relative to ISO K, IRS K 2 moves with the same speed of relative to K 1 , etc. If the module Δv the speed of is small (in comparison with the speed of light c), then for the transverse components pour on in IRS K1. K 2 , we have:

$$\mathbf{E}_{1\perp}=\mathbf{E}_{\perp}+\Delta\mathbf{v}\times\mathbf{B}_{\perp} \qquad \mathbf{B}_{1\perp}=\mathbf{B}_{\perp}-\Delta\mathbf{v}\times\mathbf{E}_{\perp}/c^2$$
$$\mathbf{E}_{2\perp}=\mathbf{E}_{1\perp}+\Delta\mathbf{v}\times\mathbf{B}_{1\perp} \qquad \mathbf{B}_{2\perp}=\mathbf{B}_{1\perp}-\Delta\mathbf{v}\times\mathbf{E}_{1\perp}/c^2, \qquad (2.16)$$

and so on. Upon transfer to each following IRS of field are obtained increases in $\Delta\mathbf{E}$ and $\Delta\mathbf{B}$

$$\Delta\mathbf{E}=\Delta\mathbf{v}\times\mathbf{B}_{\perp}, \qquad \Delta\mathbf{B}=-\Delta\mathbf{v}\times\mathbf{E}_{\perp}/c^2, \qquad (2.17)$$

where of the field $\mathbf{E}_{\perp}$ and $\mathbf{B}_{\perp}$ relate to current IRS. Directing the Cartesian axis x along $\Delta\mathbf{v}$, let us rewrite (2.17) in the components of the vector

$$\Delta E_y=-B_z\Delta v, \qquad \Delta E=B_y\Delta v, \qquad \Delta B_y=E_z\Delta v/c^2. \qquad (2.18)$$

Relationship (2.18) can be represented in the matrix form

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

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

$$dU(v)/dv=AU(v), \qquad (2.19)$$

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

$$U'\equiv U(v)=\exp(vA)U, \qquad U=U(0). \qquad (2.20)$$

Here U - matrix column pour on in the system K and U' - matrix column pour on in the system K'. Substituting (2.20) into system (2.19), we are convinced, that U' is actually the solution of system (2.19):

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

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 - unit matrix with the size 4×4. It is convenient to write down for this 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 - 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

$$\exp(vA)=\begin{pmatrix}I\,\mathrm{ch}(v/c) & -c\alpha\,\mathrm{sh}(v/c)\\ (\alpha\,\mathrm{sh}(v/c))/c & I\,\mathrm{ch}(v/c)\end{pmatrix}=\begin{pmatrix}\mathrm{ch}(v/c) & 0 & 0 & -c\,\mathrm{sh}(v/c)\\ 0 & \mathrm{ch}(v/c) & c\,\mathrm{sh}(v/c) & 0\\ 0 & (\mathrm{ch}(v/c))/c & \mathrm{ch}(v/c) & 0\\ -(\mathrm{sh}(v/c))/c & 0 & 0 & \mathrm{ch}(v/c)\end{pmatrix}.$$

Now we return to (2.20) and substituting there $\exp(vA)$, we find

$$E'_y=E_y\,\mathrm{ch}(v/c)-cB_z\,\mathrm{sh}(v/c),\quad E'_z=E_z\,\mathrm{ch}(v/c)+cB_y\,\mathrm{sh}(v/c),$$
$$B'_y=B_y\,\mathrm{ch}(v/c)+(E_z/c)\mathrm{sh}(v/c),\quad B'_z=B_z\,\mathrm{ch}(v/c)-(E_y/c)\mathrm{sh}(v/c).$$

Or in the vector record

$$\mathbf{E}'_\perp = \mathbf{E}_\perp \operatorname{ch}\frac{v}{c} + \frac{v}{c}\mathbf{v}\times\mathbf{B}_\perp \operatorname{sh}\frac{v}{c}, \quad \mathbf{B}'_\perp = \mathbf{B}_\perp \operatorname{ch}\frac{v}{c} - \frac{1}{vc}\mathbf{v}\times\mathbf{E}_\perp \operatorname{sh}\frac{v}{c} \ . \tag{2.21}$$

This is transformation (2.15)

Let us show how the phenomenon of phase aberration is explained with the aid of relations (2.15), which did not have within the framework existing classical electrodynamics of explanations. We will consider that there are components of the plane wave H_z and 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 pour on in the [shtrikhovannoy] coordinate system in accordance with relationships (2.15) they will be written down:

$$E'_x = E_x, \quad E'_y = H_z \operatorname{sh}\frac{v_x}{c}, \quad H'_z = H_z \operatorname{ch}\frac{v_x}{c}.$$

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

let us write down the summary field E' in moving IRS:

$$E' = \sqrt{\left(E'_x\right)^2 + \left(E'_y\right)^2} = E_x \operatorname{ch}\left(v_x/c\right). \tag{2.22}$$

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

$$\alpha \cong sh\left(v/c\right) \cong v/c \ . \tag{2.23}$$

Thisis 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 (2.23). However, the relation of the absolute values of the vectors $\mathbf{E}'$ and $\mathbf{H}'$ in both systems they remained identical. However, the absolute value of Poynting vector increased. Even transverse to the direction of propagation of wave motion IRS increases its energy in this IRS. The physical sense of phenomenon is explained by the following analogy. 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 (2.22).

If the polarization of wave changes, then result will remain before, since transformation with respect to the vectors $\mathbf{E}$, $\mathbf{H}$ are completely symmetrical. Only difference will be the fact that now will come out the wave, in which it will appear in the direction of propagation of 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 and H of the waves, which are extended in the waveguides. In this case appears the uncommon wave, whose phase front is inclined toward the Poyntnng vector to the angle, determined by relationship (2.23). In fact obtained wave is the superposition of plane wave with the phase speed $c=1/\sqrt{\mu\varepsilon}$ and additional wave of plane wave with the infinite phase speed orthogonal to the direction of propagation.

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 IRS it is necessary to incline telescope on the motion of motion to the angle, determined by relationship (2.23). The star, observed in the zenith, is in actuality found somewhat behind through the direction of motion. Its angular displacement from the visible position in this case will be determined by relationship (2.23). But this means that this star with respect to the observer has radial it speed, determined by the relationship

$$v_r = v \sin\alpha \, .$$

Doppler frequency $\sin\alpha \cong \alpha$, $\alpha = v/c$, is equal for small angles

$$\omega_{d\perp} = \omega_0 \, v^2/c^2 \, . \tag{2.24}$$

This result numerically coincides with results STR, but it is principally characterized by rel.un. of results fact that it is considered into STR that the transverse Doppler effect, determined by relationship (2.24), there is in actuality, while in this case this only apparent effect.

3. Conclusion

In the article are obtained the transformation pour on upon transfer of one IRS to another. In contrast to the transformation of Lorenz the basis of such transformation are the transformation of Galileo and the symmetrical laws of induction. In this case the total derivatives, which consider their convective part, are used. This made possible to explain the phenomenon of phase aberration of light and to explain the reasons of the transverse Doppler effect, who is only apparent effect.

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5. From the electrodynamics of Maxwell, Hertz, Heaviside to the trans-coordinate electrodynamics

1. Introduction

Past century is marked by the most great crisis in physics, when for the change to a fundamental understanding of the physical sense of natural phenomena and technical processes arrived new scientific orientators. Physicist P. Dirac proclaimed mathematical beauty by sole criterion for the selection of the way of development in theoretical physics. But mathematician M. Atya, realizing risk to be that lulled by the elegance, which is been based on unsteady soil, warned that the subordination of physics to mathematics conceals danger, since can bring into the region of the fabrications, which personify the mathematical perfection, but too distant from the physical reality or even having with it nothing in common.

The special feature of contemporary physics is its comparatively high financing with the fact that the realization of transparent and effective state and public control of the appropriate financial flows runs into the formidable difficulties. The situation, when physicists control themselves, creates favorable circumstances for all possible abuses of the hypertrophied authorities. Especially complex state of affairs occurs in the sphere of basic physical research. The extremely high level of the mathematization of scientific works in this sphere leads to the fact that even the highly skilled specialists of adjacent regions or altogether only belonging to different scientific schools begin to speak “in the different languages” and they cease to understand each other.

The scientific results of the individual scientists (such, as Einstein Khoking) proclaim immutable truth similarly to religious dogmas. But open and secret prohibitions to the critical analysis of the works of the acknowledged coryphaei are always disastrous for the scientific progress and unavoidably they lead to the stagnation. However, any criticism must be objective and design. At the basis of physics was always it must remain physical experiment, and the correspondence to physical experiment must always be the principal criterion of the truth of physical theories. The mathematical rigor of physical theories is also important, but is not less important that, so that the physical sense of phenomena and processes would not be hidden, obscured by mathematical formalizations.

Finally, one additional brake of the development of science – its excessive popularization in the commercial interests. The science, chained into the shackles of the yellow press, when on the covers of popular periodicals for the larger psychological effect are depicted allegedly the brilliant persons with the limited physical possibilities, tendentiously praised by journalists, who do not absolutely examine science itself on themselves, causes bewilderment. The high mathematization of physical theories only helps yellow press to give to physics the halo of mysticity, taking away the reader from the truth. Is preferable the qualified popularization of physics by scientists themselves, but furthermore, it must rest on the objective information about the results of physical experiments and the comprehensive disclosure of the physical sense of theoretical models.

All this gave birth to the most severe crisis in contemporary physics. But this state of affairs cannot continue eternally. Now situation in physics greatly resembles that, which preceded the fall of the system of Ptolemy. For the change to decrepit dogmas prepare to arrive new progressive ideas and views. So that it is better to understand, what renovation contemporary physics requires, necessary critically to analyze as why arose this deep and prolonged crisis.

Passage from comparatively simple and intuitively intelligible classical ideas about the space and time to the relativistic was critical moment. But after connecting relativity with the quantization of action, complete geometrization of gravity and propagation of the principle of geometrization on other physical interactions the imperfection of the prevailing ideas and views became obvious. The root of this imperfection consists in the fundamental disagreement between physics and mathematics, when the mathematical apparatus for physics increasingly more degenerates into polumisticheskuyu scholasticism, within the framework by which the objective physical sense of phenomena increasingly more slips off, and the role of the subjective consciousness of observer and unknown "magic" force of abstract mathematical formulas becomes of ever of more fundamental. One should recognize that the noted disagreement of physics and mathematics began to increase long before the victorious procession of the theory of relativity. Probably, by historically first especially "solid nut" for mathematical physics proved to be electrodynamics. Passage from the mechanics of material points and their final totalities to the formal description of continuous in the space and the time of electromagnetic field required the attraction of more powerful mathematical apparatus, but the development of mathematics, which goes in many respects according to its own internal laws, it did not chronically answer the demands of vigorously developing physics.

2. Symmetrization of the laws of the induction

In the initial form the system of equations of classical electrodynamics, based on the laws of electromagnetic induction, was recorded by Maxwell in his famous treatise 1 with the use of calculation of the quaternions, which allow the transformation of Galileo upon transfer from to that inertial reference system (IRS) into another IRS. In the treatise the works of ampere and Faraday were generalized and systematized [2,3]. However, it was immediately explained that the apparatus for quaternion calculation in mathematics was developed not so well so that physics they could it successfully apply to the wide circle of the tasks of electrodynamics. In order to draw into the electrodynamics the simpler and more effective means of mathematical physicists, Hertz and Heaviside reformulated Maxwell's equations from the language of quaternion calculation to the language of vector analysis.

At that time it seemed that the formulation of Hertz- Heaviside is equivalent to the initial formulation of Maxwell, but now already it is possible to establish that the equations, obtained by Hertz and Heaviside, are essential simplification in Maxwell's equations in the quaternions, moreover this simplification relates not only to their mathematical form, but also (that most important!) to their physical content, since in this case equations were deprived naturally Galileo- invariance of inherent in them. Nevertheless for the concretely undertaken inertial reference system (but not their totality) the equivalence of formulations occurred, by virtue of which the formulation of Hertz- Heaviside it obtained the deserved acknowledgement of scientific association it extruded in the theoretical and applied research the formulation of Maxwell himself. But this approach during writing of the equations of electrodynamics deprived the possibility of use by the substantional derivative, after rejecting from the examination its convective component.

Further development of Hertz- Heaviside ideas led to the development by Lorenz and Poincare the bases of the mathematical apparatus of the special theory of relativity (STR). This was major step forward in comparison with the nonrelativistic theory of electromagnetic field, since it was possible to reveal the dependence of electromagnetic field on the relative speed of observer. But those leading of physics and mathematics of their time could not propose to the clear physical interpretation of their formulas. This is what writes in regard to this well-known specialist in the region of tensor analysis Rachewsky [2]: “The theory of relativity arose as a result the prolonged accumulation of the experimental material, which led to the deep conversion of our physical ideas about the forms of material and motion. And other physical quantities to the newly open experimental facts it was revealed after the whole series of the attempts to adapt previous ideas about the space, time that for these purposes it is necessary to reconstruct all these concepts radically. This task was executed in basic a. By Einstein in 1905. (special theory of relativity) and in 1915. (general theory of relativity). In other the task was executed was only in the sense that given the ordered formal mathematical description of new state of affairs. The task of the deep, really physical substantiation of this mathematical diagram still stands before physics”.

At this sudbonosnyy moment physics proved to be on rasputi. One of the ways lay at the direction of further searches for the suitable mathematical apparatus for electrodynamics (to what, judging by everything, were inclined they themselves Lorenz and Poincare), but the physicist following Einstein it was banal along another way, who consisted in the decisive and uncompromising failure of the classical ideas about the space and the time with the passage to the relativistic ideas.

By the way of introduction into physics of known postulates, the theory of relativity in Einstein's version explained several important experimental results and in connection with this was obtained the acknowledgement of the wide circles of physicists. Relativistic ideology supported such those leading of mathematics of that time as Minkowski, Gilbert and Born. The principle of geometrization, which reflects secret dreams and expectations of many thinkers, was and remains especially attractive for the mathematicians in this ideology, beginning from the idealistic views of great Ancient Greek philosopher Plato, to reduce all fundamental laws of universe to the geometric properties of the certain idealized mathematical objects.

Thus, mathematics, after yielding to temptation to subordinate to itself physics by means of the principle of geometrization so desired for it, proved to be unable to rise higher than the geometric means of thinking and it is worthy to satisfy the increasing needs of physics. Physics used that apparatus, which mathematics was ready to propose to it, and this unavoidably conducted to the creation of special, and then general theory of relativity and, further, to all to the increasing celebration of the principle of geometrization.

In accordance with them, the dependence of electromagnetic field on the speed of the motion of observer is not caused by the fundamental factors of physical nature of field itself, but it is defined by example through the dependence on it of the intervals of time and spatial distance (conversion of Lorenz) under the assumption of the relativistic invariance of electric charge. However, specialists (first of all, by experimenters) discovered, that the classical electrodynamics and STR, in spite of already the more centenary myth, are located in the contradiction to each other. However, contemporary experiences on the measurement of the speed of light in one direction (but the not averaged speed “back and forth” as, for example, in Fizeau's experiments and to them analogous) 8,9 contradict postulate STR about the constancy of the speed of light and is brought into question the physical validity of the transformation of Lorenz.

Maxwell's ideas about the use during the writing of the laws of the electrodynamics of the substantional derivative lead to the need for the symmetrization of the equations of induction. For the first time this principle was developed in the work 10 and underwent its further development in the works [11-20].

This approach not only opened new direction in physics, but also it made it possible to predict new physical phenomenon by the name transverse plasma resonance in the confined plasma [21].

The symmetrized laws of magnetoelectric and electromagnetic induction are written

$$\oint \mathbf{E}'d\mathbf{l}' = -\int \frac{\partial \mathbf{B}}{\partial t} d\mathbf{s} + \oint [\mathbf{v}\times\mathbf{B}] d\mathbf{l}',$$
$$\oint \mathbf{H}'d\mathbf{l}' = \int \frac{\partial \mathbf{D}}{\partial t} d\mathbf{s} - \oint [\mathbf{v}\times\mathbf{D}] d\mathbf{l}'. \qquad (2.1)$$

or

$$\operatorname{rot}\mathbf{E}' = -\frac{\partial \mathbf{B}}{\partial t} + \operatorname{rot}[\mathbf{v}\times\mathbf{B}],$$
$$\operatorname{rot}\mathbf{H}' = \frac{\partial \mathbf{D}}{dt} - \operatorname{rot}[\mathbf{v}\times\mathbf{D}]. \qquad (2.2)$$

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

$$\mathbf{E}' = [\mathbf{v}\times\mathbf{B}],$$
$$\mathbf{H}' = -[\mathbf{v}\times\mathbf{D}]. \qquad (2.3)$$

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

Of relationships (2.1-2.3), which present the laws of induction, do not give information about how arose fields in initial fixed IRS. They describe only laws governing the propagation and conversion pour on in the case of motion with respect to the already existing fields.

Of relationship (2.3) attest to the fact that in the case of relative motion of frame of references, between the fields $\mathbf{E}$ and $\mathbf{H}$ there is a cross coupling, i.e., motion in the fields of $\mathbf{H}$ leads to the appearance pour on $\mathbf{E}$ and vice versa.

This connection leads to the transformation of Mende, which take the form

$$\mathbf{E}'_{\uparrow} = \mathbf{E}_{\uparrow}; \quad \mathbf{E}'_{\perp} = \mathbf{E}_{\perp}\operatorname{ch}\frac{v}{c} + \frac{Z_0}{v}[\mathbf{v}\times\mathbf{H}_{\perp}]\operatorname{sh}\frac{v}{c},$$
$$\mathbf{H}'_{\uparrow} = \mathbf{H}_{\uparrow}; \quad \mathbf{H}'_{\perp} = \mathbf{H}_{\perp}\operatorname{ch}\frac{v}{c} - \frac{1}{vZ_0}[\mathbf{v}\times\mathbf{E}_{\perp}]\operatorname{sh}\frac{v}{c}. \qquad (2.4)$$

where $E_{\uparrow}$ and $H_{\uparrow}$ parallel, and $E_{\perp}$ also $H_{\perp}$ normal to the speed IRS of component pour on; $Z_0 = \sqrt{\mu_0/\varepsilon_0}$ – the impedance of free space; $c = 1/\sqrt{\mu_0\varepsilon_0}$ – the speed of light.

The transformation of Mende are obtained from the classical symmetrized equations of the induction within the framework of the transformation of Galileo in contrast to the transformation of Lorenz, which are obtained on the basis of known postulates. It should be noted that the transformation examined coincide to the quadratic terms.

Of the aid of relationships (2.4) it is possible to explain the phenomenon of phase aberration, which did not have within the framework existing classical electrodynamics of explanations.

The principle of the symmetrization of the laws of induction opened way to the creation of the concept of scalar- vector potential, which indicates that the fields of charge, its normal to speed motions change according to the law

$$E' = E\,\mathrm{ch}\left(v_{\perp}/c\right).$$

3. From Hertz- Heaviside electrodynamics to the trans-coordinate electrodynamics

The conclusion about the absence in them of the mathematical means of the adequate description of passage from one inertial reference system to another because of the use by them of particular derived field functions on the time, which completely tie electrodynamic process to one concrete frame of reference, is made on the basis of the critical analysis of extraction from the equations of the electrodynamics of ideas about the space and period. Let us examine new approach to the development of the mathematical apparatus for electrodynamics in the direction of the more adequate description of passage from one inertial reference system to another due to the introduction into the examination of the trans-coordinate equations, which use new Galilean and trans-coordinate derivatives of the field functions [22]. This generalization of electrodynamics assumes the dependence of electromagnetic field and electric charge on the speed of the motion of observer, caused not by the geometry of space-time, but by physical nature of the very field within the framework of giperkontinualnykh ideas about the space and the time. The consequence of this approach propose the new trans-coordinate formulation of Maxwell's equations for the case of isotropic homogeneous medium without the dispersion, which generalizes the traditional formulation of Hertz- Heaviside for the same case. Let us give Maxwell's equations in the integral and differential forms in the idea of Hertz- Heaviside and in the trans-coordinate idea.

Despite the fact that Maxwell's equations both in the formulation of Maxwell himself and in the formulation of Hertz- Heaviside, are obtained within the framework classical ideas about the space and of time, who use transformation of Galileo, subsequently precisely of Maxwell's equation they became the theoretical prerequisite of the creation of the special theory of relativity STR. As convincingly shown, for example, in [23], be STR it consists of the identification of the natural geometry of the electromagnetic field, described by Maxwell's equations, with the geometry of world physical space-time. And now already in the contemporary works on the electrodynamics (typical example – the work [24] of Maxwell's equation they are examined in the four-dimensional pseudo-Riemann space-time).

Is it possible to return to Maxwell's equations the original Galileo-invariance within the framework of certain new, its kind of neoclassical ideas about the space and the time, without rejecting the use of an apparatus of vector analysis during writing of equations? In this work we will show that the answer to this question is affirmative.

In the classical mechanics particle dynamics is described by the differential equations for its radius-vector, which use usual derivative of the second order on the time. Specifically, its use ensures the Galileo- invariance of equations. If we connect the set of massive material points by weightless elastic threads into the united string, i.e. fluctuation will be described by the Galileo- invariant system of differential equations. But if we complete passage to the limit, after fixing the number of material points to infinity, and their mass and the length of separate threads – to zero, then we will obtain the one-dimensional wave equation (equation of vibrations of string), not invariant relative to the transformation of Galileo, but invariant relative to the group of pseudo-orthogonal transformation (hyperbolic turnings, which preserve pseudo-Euclidean certificate). The culprit of this strange and unexpected metamorphosis upon transfer from "material- point mechanics to continuous medium – this passage to the limit with the substitution by usual derivative to the quotient, which, generally speaking, is analytically legal [25], but it narrows the region of the physical applicability of equation. The real wave process of mechanical vibrations of string remains Galileo- invariant, but its equation is already deprived of the mathematical means of the description of passage from one inertial reference system to another, and completely ties process to one concrete frame of reference, attaching in it the ends of the string.

The discovery wave equation in the mechanics did not lead to the revision of ideas about the space and the time, but to this led the discovery the same equation in the electrodynamics. In the theory of relativity the corresponding group of pseudo-orthogonal transformation for the electromagnetic waves in the vacuum (conversion of Lorenz) obtained status of the subgroup of the motion of the certificate of united world physical space-time. But appears doubt about the justification of the use of traditional equations of electrodynamics, in particular, wave equation, for the adequate extraction of them of ideas about the space and the time. Easily to assume that these equations, using partial derivatives of field functions on the time, similar to the equation of mechanical fluctuations, are simply deprived of the mathematical means of the adequate description of passage from one inertial reference system to another and so completely they tie process to one concrete frame of reference. The question of the possibility of the suitable refinement or generalizing the equations of electrodynamics so arises, beginning from the equations of the induction of electric field by magnetic and magnetic – electrical. The thorough study of this problem in [10] led to the appearance of an idea about the fact that this improvement of electrodynamics must assume existence of the dependence of electromagnetic field on the speed of the motion of observer, caused not by the geometry of space-time, but by physical nature of field.

In the theory of relativity the electromagnetic field also depends on the speed of the motion of observer, but it is only defined by example through the dependence on it of the intervals of time and spatial distance (conversion of Lorenz), the relativistic invariance of electric charge occurs result of which. However, the more fundamental (direct) dependence of field on the speed is cmbined with the presence of this dependence even absolute value of electric charge. Until recently this not invariance of charge was confirmed only by indirect empirical data, which were being consisted in the appearance of an electric potential on the superconductive windings and the tori during the introduction in them of direct current, or in the observation of the electric pulse of nuclear explosions.

In particular 9 July 1962 of year with the explosion in space above Pacific Ocean H-bomb with the TNT equivalent 1,4 Mt. according to the program of the USA «Starfish » the tension of electrical pour on she exceeded those forecast by Nobel laureate Bethe 1000 once. With the explosion of nuclear charge according to the program "Program K", which was realized into the USSR, the radio communication and the radar installations were also blocked at a distance to 1000 km of. It was discovered, that the registration of the consequences of space nuclear explosion was possible at the large (to 10 thousand kilometers) distances from the point of impact. The electric fields of pulse led to the large focusings to the power cable in the lead shell, buried at the depth about 1 m, which connects power station in Akmola with Alam-Ata. Focusings were so great that the automation opened cable from the power station.

However, 2015 year was marked by the already direct experimental confirmation of this phenomenon as a result of detection and study of the pulse of the electric field, which appears with the warming-up of the plasma as a result of the discharge through the dischargers of the capacitors of great capacity {26]. It turned out that in the process of the warming-up of plasma with an equal quantity in it of electrons and positive ions in it the unitary negative charge of free electrons, not compensated by slower positive ions, is formed.

This fact contradicts not only the classical, but also relativistic transformation of electromagnetic field upon transfer from one inertial reference system to another, testifying about the imperfection not only of classical, but also relativistic ideas about the space and the time. Idea about the fact that the promising electrodynamics must assume existence of the dependence of electromagnetic field on the speed of the motion of observer, caused not by the geometry of space-time, and by physical nature of field, which does not assume the invariance of electric charge, was developed in a number of the work of Mende F.F., beginning [8]. In these works, in particular, in [10, 26] is given the substantiation of introduction into the electrodynamics instead of the classical and relativistic new transformation of electromagnetic field, which was called the transformation of Mende.

However, the sequential development of this radical idea, as not the invariance of charge, requires the deep revision of the mathematical apparatus for electrodynamics, called to the creation of the mathematical means of the more adequate description of passage from one inertial reference system to another. Approach to precisely this development of the mathematical apparatus for electrodynamics was proposed by dubrovinym A.S. in [27]. This approach lies within the framework the sequential revision of ideas about the space and the time with the failure of the relativistic and the passage to the new ideas, which we call giperkontinualnymi.

The concept of time-spatial giperkontinuuma is introduced in [28] as a result the joint study of the algebraic and geometric structures of the commutative algebras with one, elements of which are the functions of sine waves. The hypothesis of giperkontinuuma (about the hierarchical giperkontinualnoy structure of world physical space-time) is starting point of scientific studies, directed toward the generalization of ideas about the structure of space and time in the course of passage from the contemporary quantum scientific paradigm to the new system, that simultaneously structurally connecting up its framework continuity and the discretion, dynamicity and static character, and also globality and the locality .

In [27] is proposed new approach to the development of the mathematical apparatus for electrodynamics in the direction of the more adequate description of passage from one inertial reference system to another on the basis of giperkontinualnykh ideas about the space and in the time due to the improvement of differential calculus of the field functions under the assumption of their dependence on the speed of the motion of observer. Let us accept for the basis this approach.

Two inertial reference systems with the time united for them will examine $t \in \mathbb{R}$. One of them (with the system of rectangular Cartesian space coordinates $OXYZ$) let us name laboratory (not shtrikhovannoy) and we will interpret it as relatively fixed. The second (with the system of rectangular Cartesian space coordinates $O'X'Y'Z'$) let us name substantive (shtrikhovannoy) and we will interpret it as connected with the certain moving real or imaginary medium. Let us assume that with $t = 0$ the system of space coordinates of both frame of references they coincide. Let us introduce the indices $\alpha = \overline{1,3}$, $\beta = \overline{1,3}$. Coordinates along the axes OX, OY, OZ, $O'X'$, $O'Y'$, $O'Z'$ we will assign by variables x^{α} and x'^{α} respectively. Unit vectors along the axes OX and $O'X'$, the axes OY and $O'Y'$, the axes OZ $O'Z'$ let us designate through $\mathbf{e}_{\beta} = \left(e^{\alpha}_{\beta}\right)$, moreover $e^{\alpha}_{\beta} = \delta_{\alpha\beta}$, where $\delta_{\alpha\beta}$ – Kronecker's symbol. Through $\mathbf{v} = \left(v^{\alpha}\right)$ v let us designate the velocity vector of the motion of substantive frame of reference relative to laboratory and the module of this vector. Directing a unit vector $\mathbf{e}_1$ $\mathbf{v}$, we lengthwise have: $\mathbf{v} = v\mathbf{e}_1 = \left(v^{\alpha}\right)$, $v^{\alpha} = v\delta_{\alpha 1}$. Event in the data two frame of references takes the form $\mathbf{x} = (\mathbf{r}, t) = (x^{\alpha}, t)$; $\mathbf{x}' = (\mathbf{r}', t) = (x'^{\alpha}, t)$, where $\mathbf{r} = (x^{\alpha})$, $\mathbf{r}' = (x'^{\alpha})$ – the radius-vectors. We will consider that the physical equivalence of events $\mathbf{x}$ $\mathbf{x}'$ indicates the validity of the conversion of Galileo

$$\mathbf{r} = \mathbf{r}' + t\mathbf{v} \tag{3.1}$$

or, otherwise, substituting vector idea by the component,

$$x^{\alpha} = x'^{\alpha} + tv\delta_{\alpha 1} \tag{3.2}$$

Classical physical field is described in the laboratory and substantive frame of references by its field functions $\Phi(\mathbf{r}, t)$ and $\Phi'(\mathbf{v}, \mathbf{r}', t)$, moreover $\Phi'(\mathbf{0}, \mathbf{r}', t) = \Phi(\mathbf{r}', t)$, and equality $\mathbf{v} = \mathbf{0}$ indicates $v^{\alpha} = 0$. Their values are called field variables. For pour on different physical nature they can be suitable the different mathematical ideas of field functions, so that field variables can be, for example, scalar or vector with the material or complex values of their most variable or vector components. If in the role of this field electric field comes out, then in this role can come out the functions of its tension $\mathbf{E} = \Phi(\mathbf{r}, t)$, $\mathbf{E}' = \Phi'(\mathbf{v}, \mathbf{r}', t)$, and in the case of magnetic field we have functions of the magnetic induction $\mathbf{B} = \Phi(\mathbf{r}, t)$, $\mathbf{B}' = \Phi'(\mathbf{v}, \mathbf{r}', t)$.

In the classical nonrelativistic field theory it is considered that the equality occurs

$$\Phi(\mathbf{r}' + t\mathbf{v}, t) = \Phi'(\mathbf{v}, \mathbf{r}', t) \tag{3.3}$$

mathematically expressing the physical concept of the invariance of field relative to the speed of the motion of observer. In the theory of relativity (3.3) no longer it is carried out, but the transformation of Lorenz are used instead of the transformation of Galileo. But this not invariance of field does not have fundamental, that not connected with the geometry of the space-time of physical nature, but it occurs simply the consequence of the effects of the reduction of lengths and time dilation in the moving frame of references. The proposed by us giperkontinualnye ideas about the space and the time 28 provide for the great possibilities of the invariance of various physical processes relative to various transformation groups of coordinates with the fact that special role in time-spatial giperkontinuume play the transformation of Galileo (3.1), since they in this case they treat as the level transformation of Lorenz of infinitely high level and, thus, they make it possible in a united manner to synchronize all events in all separate continua, hierarchically strukturiruyushchikhsya into united giperkontinuum. Natural to consider that in giperkontinuume the field also not is invariant relative to the speed of the motion of observer, but to explain this by the already fundamental properties of field, not connected with the geometry of separate continua.

Arises the question about the possible versions of complete differentiation concerning the time of field function in the laboratory frame of reference $\Phi(\mathbf{r},t)$, of that produced depending on substantive frame of reference. In fluid mechanics and classical mechanics widely is used the derivative of Lagrange (the substantional derivative), which has the same arguments as the initial field function:

$$\frac{d\,\Phi(\mathbf{r},t)}{dt}=\frac{d\,\Phi(\mathbf{r}'+t\mathbf{v},t)}{dt}=\lim_{\Delta t\to 0}\frac{\Phi(\mathbf{r}'+(t+\Delta t)\mathbf{v},t+\Delta t)-\Phi(\mathbf{r}'+t\mathbf{v},t)}{\Delta t}. \tag{3.4}$$

But it is possible to examine also the derivative (let us name its derivative of Galileo), whose arguments will coincide with the arguments of field function no longer in the laboratory, but in the substantive frame of reference:

$$\frac{\partial'\Phi}{\partial t}(\mathbf{v},\mathbf{r}',t)=\frac{d\,\Phi(\mathbf{r}'+t\mathbf{v},t)}{dt}=\lim_{\Delta t\to 0}\frac{\Phi(\mathbf{r}'+(t+\Delta t)\mathbf{v},t+\Delta t)-\Phi(\mathbf{r}'+t\mathbf{v},t)}{\Delta t}. \tag{3.5}$$

If the arguments of the derivatives of Lagrange and Galileo are connected with equality (3.1), that their corresponding values are equal and are decomposed into one and the same sum of quotient on the time and the convective derivative of field function in the laboratory frame of reference:

$$\frac{\partial'\Phi}{\partial t}(\mathbf{v},\mathbf{r}',t)=\frac{d\,\Phi(\mathbf{r},t)}{dt}=\frac{\partial\Phi(\mathbf{r}'+t\mathbf{v},t)}{\partial t}+(\mathbf{v}\cdot\nabla)\Phi(\mathbf{r}'+t\mathbf{v},t). \tag{3.6}$$

Let us explain a difference in the physical sense of the Lagrange and Galilean derivatives of field function. Lagrange's derivative (3.4) is complete time derivative of the function of field in the laboratory frame of reference, measured at the point of space, which in the laboratory frame of reference at the moment of time t has a radius-vector $\mathbf{r}$, determined by the equality (3.1). But Galileo's derivative (3.5) is complete time derivative of the function of field in the laboratory frame of reference, measured at the point of space, which in the substantive frame of reference has a radius-vector $\mathbf{r}'$. The concepts of Lagrange and Galilean derivatives (3.4)-(3.6) naturally are generalized to the case derivative of higher order ($n=\overline{1,\infty}$):

$$\frac{d^1\,\Phi(\mathbf{r},t)}{dt^1}=\frac{d\,\Phi(\mathbf{r},t)}{dt};\ \frac{d^{n+1}\,\Phi(\mathbf{r},t)}{dt^{n+1}}=\frac{d}{dt}\frac{d^n\,\Phi(\mathbf{r},t)}{dt^n};$$

$$\frac{\partial'^1\Phi}{\partial t^1}(\mathbf{v},\mathbf{r}',t)=\frac{\partial'\Phi}{\partial t}(\mathbf{v},\mathbf{r}',t);\ \frac{\partial'^n\Phi}{\partial t^n}(\mathbf{v},\mathbf{r}',t)=\frac{d^n\,\Phi(\mathbf{r},t)}{dt^n}.$$

Within the framework concepts of the invariance of field relative to the speed of the motion of observer, i.e., with fulfillment condition (3), we have:

$$\frac{\partial'\Phi}{\partial t}(\mathbf{v},\mathbf{r}',t)=\frac{d\,\Phi(\mathbf{r}'+t\mathbf{v},t)}{dt}=\frac{d\,\Phi'(\mathbf{v},\mathbf{r}',t)}{dt}=\frac{\partial\Phi'(\mathbf{v},\mathbf{r}',t)}{\partial t}, \tag{3.7}$$

i.e., Galilean the derivative of field in the laboratory frame of reference is not distinguished from the particular time derivative of the function of field in the substantive frame of reference. Therefore introduction within the framework to this concept of the derivative of Galileo as some new mathematical object with its independent physical sense, is superfluous. However, within the framework relativistic ideas examination by Galileo's derivative is empty because of the emptiness of very transformation of Galileo (in contrast to the transformation of Lorenz). But giperkontinualnye ideas about the space and the time make Galilean derived completely by that claimed, and equality (3.7) – to false.

This view on the space, the period and the electromagnetic field in conjunction with the application of Galileo's derivative leads to the new, trans-coordinate formulation of the electrodynamics [27]. It generalizes the conventional formulation of Hertz- Heaviside, which will be examined below.

Electromagnetic field in the isotropic homogeneous medium without the dispersion is described in the laboratory and substantive frame of references by its variables (tension of electric field $\mathbf{E} = \left(E^{\alpha}\right)$, $\mathbf{E}' = \left(E'^{\alpha}\right)$ and magnetic induction $\mathbf{B} = \left(B^{\alpha}\right)$, $\mathbf{B}' = \left(B'^{\alpha}\right)$), by constants (electrical ε_0 and magnetic μ_0 , and also expressed as them speed of light in the vacuum $c = 1/\sqrt{\varepsilon_0 \mu_0}$), by the parameters (dielectric and magnetic constant ε and μ , and also the density of strange electric charge ρ, ρ', the electric current density of conductivity $\mathbf{j} = \left(j^{\alpha}\right)$, $\mathbf{j}' = \left(j'^{\alpha}\right)$, electric charge Q, Q' , electric current I, I'), by field functions $\mathbf{E} = \mathbf{E}(\mathbf{r},t) = \left(E^{\alpha}(\mathbf{r},t)\right)$, $\mathbf{B} = \mathbf{B}(\mathbf{r},t) = \left(B^{\alpha}(\mathbf{r},t)\right)$, $\mathbf{E}' = \mathbf{E}'(v,\mathbf{r}',t) = \left(E'^{\alpha}(v,\mathbf{r}',t)\right)$, $\mathbf{B}' = \mathbf{B}'(v,\mathbf{r}',t) = \left(B'^{\alpha}(v,\mathbf{r}',t)\right)$, moreover

$$\mathbf{E}'(0,\mathbf{r}',t) = \mathbf{E}(\mathbf{r}',t);\ \mathbf{B}'(0,\mathbf{r}',t) = \mathbf{B}(v,\mathbf{r}',t). \tag{3.8}$$

In the classical nonrelativistic electrodynamics it is relied:

$$\mathbf{E}(\mathbf{r}' + tv\mathbf{e}_1,t) = \mathbf{E}'(v,\mathbf{r}',t);\ \mathbf{B}(\mathbf{r}' + tv\mathbf{e}_1,t) = \mathbf{B}'(v,\mathbf{r}',t), \tag{3.9}$$

what is the application of a general formula (3.3) of the invariance of field relative to the speed of the motion of observer for the case of electromagnetic field. The proposed by us giperkontinualnye ideas about the space and the time 28 exceed the scope of this concept, but is explained nature of this not invariance not by the geometry of united space-time similar to the theory of relativity, but by the fundamental properties of field.

The integral form of Maxwell's equations in the idea of Hertz- Heaviside with the above-indicated conditions (isotropy, the uniformity of medium, the absence in it of dispersion) is the following system of four integral equations of the electrodynamics:

$$\oint_s \mathbf{E}\cdot ds = \mathrm{Q}/(\varepsilon\varepsilon_0);\ \oint_s \mathbf{B}\cdot ds = 0;\ \oint_l \mathbf{E}\cdot dl = -\frac{d}{dt}\int_s \mathbf{B}\cdot ds;\ \frac{c^2}{\varepsilon\mu}\oint_l \mathbf{B}\cdot dl = \frac{\mathrm{I}}{\varepsilon\varepsilon_0} + \frac{d}{dt}\int_s \mathbf{E}\cdot ds, \tag{3.10}$$

where s, l – the arbitrary two-dimensional closed (for the first two equations) or open (for the second two equations) surface and its limiting locked outline, which not not compulsorily coincides with the electric circuit.

If we on Wednesday put the even additional condition of the absence of free charges and currents, then last two equations (3.10) will take the form:

$$\oint_l \mathbf{E}\cdot dl = -\frac{d}{dt}\int_s \mathbf{B}\cdot ds,\ \oint_l \mathbf{B}\cdot dl = \frac{\varepsilon\mu}{c^2}\frac{d}{dt}\int_s \mathbf{E}\cdot ds. \tag{3.11}$$

They are the integral form of the law of the induction of Faraday and circulation theorem of magnetic field in the laboratory frame of reference for this special case of medium.

These two laws take the mutually symmetrical form with an accuracy to of scalar factor, by virtue of which their analysis it is identical. Let us examine the first law in more detail, for example. In Faraday's experiences it is experimentally established that in the outline the identical currents appear regardless of the fact, this outline relative to the current carrying outline does move or it rests, and the current carrying outline moves, provided their relative motion in both cases was identical (Galilean invariance of Farrday law). Therefore the flow through the outline can change as a result of a change of the magnetic field with time, and the position of its boundary also because with the displacement of outline changes [29]. The corresponding generalization of laws (3.11) to the case of the outline, which moves in the laboratory and which is rested in the substantive frame of reference, takes the form:

$$\oint_l \mathbf{E}'\cdot dl = -\frac{d}{dt}\int_s \mathbf{B}\cdot ds \quad \text{of} \quad \oint_l \mathbf{B}'\cdot dl = \frac{\varepsilon\mu}{c^2}\frac{d}{dt}\int_s \mathbf{E}\cdot ds, \tag{3.12}$$

where $\mathbf{E}'$, $\mathbf{B}'$ are described fields in the element dl in the substantive frame of reference, i.e., in such inertial reference system, in which dl it rests; specifically, such electric field causes the appearance of a current in the case of the presence of real electric circuit in this place. Equations (3.12) are completely interesting and uncommon from a mathematical point of view, since they mutually connect field variables in the different inertial reference systems (let us name such equations trans-coordinate). Specifically, the use of trans-coordinate equations makes it possible to adequately describe physical fields in giperkontinuume. At the same time in this case the discussion deals not simply about the trans-coordinateawn of equations (3.12), and with their global trans-coordinateawn, ensured by use by the Galilean derivative (connected by them inertial reference systems they can move relative to each other with the arbitrary speed, and not compulsorily with infinitely small).

Returning to the system of equations (3.10), it is possible to establish that the region of its applicability is limited by the requirement of the state of rest of outline l in the laboratory frame of reference. If we remove this limitation, after requiring only the states of rest of outline l in the substantive frame of reference, then will come out the known idea of Maxwell's equations (we we call his trans-coordinate [27], integral form of which will be in it the system of the generalizing (3.10) four integral equations of the electrodynamics of the moving media:

$$\oint_s \mathbf{E}\cdot ds = \mathrm{Q}/(\varepsilon\varepsilon_0);\ \oint_s \mathbf{B}\cdot ds = 0;\ \oint_l \mathbf{E}'\cdot dl = -\frac{d}{dt}\int_s \mathbf{B}\cdot ds;\ \frac{c^2}{\varepsilon\mu}\oint_l \mathbf{B}'\cdot dl = \frac{\mathrm{I}'}{\varepsilon\varepsilon_0} + \frac{d}{dt}\int_s \mathbf{E}\cdot ds. \tag{3.13}$$

If the trans-coordinate idea of the equations of Maxwell (both in that examined by integral and in that examined lower than the differential forms) to interpret in the context of the description of electromagnetic field in time-spatial giperkontinuume, then it is necessary to consider that the equalities (3.8) are always carried out, but (3.9) – in the general case no.

Equations (3.12) (3.13) are known in the classical electrodynamics [29, 30]. Arises question, as to pass from the equations in the integral form (3.12) and (3.13) to the corresponding to equations in the differential form adequate of physical reality by means.

The differential form of Maxwell's equations in the idea of Hertz- Heaviside is following system of four of those corresponding to the integral equations (10) of the differential equations of electrodynamics, which relate to the laboratory frame of reference:

$$\nabla\cdot\mathbf{E} = \rho/(\varepsilon\varepsilon_0);\ \nabla\cdot\mathbf{B} = 0;\ \nabla\times\mathbf{E} = -\partial\mathbf{B}/\partial t;\ \nabla\times\mathbf{B} = \mu\mu_0\mathbf{j} + \left(\varepsilon\mu/c^2\right)\left(\partial\mathbf{E}/\partial t\right). \tag{3.14}$$

Equations (3.14) traditionally successfully are used in the electrodynamics, but, as it will be shown below, they have essential deficiency – the region of their applicability it is limited by the case of agreeing the laboratory and substantive frame of references $(v = 0)$, i.e. these equations are deprived of the mathematical means of the adequate description of passage from one inertial reference system to another, completely tying process to one (laboratory) frame of reference.

In [29] based on the example of Farrday law is formulated the following approach to the passage from the integral to the differential form of equations electrodynamics: “Farrday law can be written down also in the differential form, if we use ourselves the Stokes' theorem and to consider outline as that being resting in the selected frame of reference (so that $\mathbf{E}$ and $\mathbf{B}$ they would be determined in one and the same frame of reference)”. This approach answers the concept of the invariance of physical field relative to the speed of the motion of observer, assuming simple failure of the trans-coordinateawn of equations by means of the application (9). Но, отвергая данную концепцию, нужно отвергнуть и данный подход. Thus, the differential form of the corresponding equations must be the same trans-coordinate as integral (3.12), (3.13).

In accordance with the given traditional approach, in [30] is introduced the operation of differentiation with respect to time in the moving (substantive) frame of reference, designated there through $\partial'/\partial t$. In this case it is secretly assumed that at the point of space, which in the substantive frame of reference has a radius-vector $\mathbf{r}'$, measurement by field variable in the laboratory frame of reference equivalent to its measurement in the same substantive frame of reference. But these measurements are not equivalent out of the concept of the invariance of physical field relative to the speed of the motion of observer. Therefore measurement must be limited by laboratory frame of reference, not perenosya its results for the substantive. Thus, we come to the derivative of Galileo (3.5), of the electrodynamics in the differential form leaving equations globally trans-coordinate.

Unknown globally trans-coordinate differential equations of electrodynamics, which correspond to integral equations (3.12) and which use the Galilean derivative:

$$\nabla \times \mathbf{E}' = -\frac{\partial'\mathbf{B}}{\partial t}, \ \nabla \times \mathbf{B}' = \frac{\varepsilon\mu}{c^2}\frac{\partial'\mathbf{E}}{\partial t}. \tag{3.15}$$

They are generalization to the case of the noncoincidence of the laboratory and substantive frame of references ($\mathbf{v} \neq \mathbf{0}$) of the known differential equations of Maxwell

$$\nabla \times \mathbf{E} = -\frac{\partial\mathbf{B}}{\partial t}, \ \nabla \times \mathbf{B} = \frac{\varepsilon\mu}{c^2}\frac{\partial\mathbf{E}}{\partial t}. \tag{3.16}$$

The differential form of Maxwell's equations in the trans-coordinate idea for the case of isotropic, homogeneous medium without the dispersion is the following system of four new globally trans-coordinate differential equations of the electrodynamics:

$$\nabla \cdot \mathbf{E}(\mathbf{r},t) = \frac{\rho(\mathbf{r},t)}{\varepsilon\varepsilon_0}; \ \nabla \cdot \mathbf{B}(\mathbf{r},t) = 0, \tag{3.17}$$

$$\nabla \times \mathbf{E}'(v,\mathbf{r}',t) = -\frac{\partial'\mathbf{B}}{\partial t}(v,\mathbf{r}',t); \ \nabla \times \mathbf{B}'(v,\mathbf{r}',t) = \mu\mu_0\mathbf{j}'(v,\mathbf{r}',t) + \frac{\varepsilon\mu}{c^2}\frac{\partial'\mathbf{E}}{\partial t}(v,\mathbf{r}',t), \tag{3.18}$$

where $\partial'\mathbf{E}/\partial t$, $\partial'\mathbf{B}/\partial t$ – the derivatives of Galileo of field functions, expressed as particular time derivatives and convective derivatives of the same field functions in the laboratory frame of reference by the following equalities:

$$\frac{\partial'\mathbf{E}}{\partial t}(v,\mathbf{r}',t) = \frac{\partial\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)}{\partial t} + (v\mathbf{e}_1 \cdot \nabla)\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t), \tag{3.19}$$

$$\frac{\partial' \mathbf{B}}{\partial t}(v,\mathbf{r}',t)=\frac{\partial \mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)}{\partial t}+(v\mathbf{e}_1\cdot\nabla)\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t). \tag{3.20}$$

With $v=0$ (3.17)-(3.18) it passes in (3.14).

In the particular case the absences of free charges and currents of equation (3.17)-(3.18) will take the form:

$$\nabla\cdot\mathbf{E}(\mathbf{r},t)=0;\ \nabla\cdot\mathbf{B}(\mathbf{r},t)=0, \tag{3.21}$$

$$\nabla\times\mathbf{E}'(v,\mathbf{r}',t)=-\frac{\partial'\mathbf{B}}{\partial t}(v,\mathbf{r}',t);\ \nabla\times\mathbf{B}'(v,\mathbf{r}',t)=\frac{\varepsilon\mu}{c^2}\frac{\partial'\mathbf{E}}{\partial t}(v,\mathbf{r}',t). \tag{3.22}$$

With $v=0$ (3.21)-(3.22) it passes into the well-known system of equations of Maxwell:

$$\nabla\cdot\mathbf{E}(\mathbf{r},t)=0;\ \nabla\cdot\mathbf{B}(\mathbf{r},t)=0;\ \nabla\times\mathbf{E}(\mathbf{r},t)=-\frac{\partial\mathbf{B}(\mathbf{r},t)}{\partial t};\ \nabla\times\mathbf{B}(\mathbf{r},t)=\frac{\varepsilon\mu}{c^2}\frac{\partial\mathbf{E}(\mathbf{r},t)}{\partial t}. \tag{3.23}$$

By the vector product of nabla to both parts of the equations (3.16) with their mutual substitution into each other obtains the known wave differential equations

$$c^2\nabla^2\mathbf{E}=\varepsilon\mu\frac{\partial^2\mathbf{E}}{\partial t^2},\ c^2\nabla^2\mathbf{B}=\varepsilon\mu\frac{\partial^2\mathbf{B}}{\partial t^2}. \tag{3.24}$$

The absence of trans-coordinateawn is their drawback, they are valid only in the case of agreeing the laboratory and substantive frame of references ($\mathbf{v}=\mathbf{0}$). It is analogous, i.e., by the vector product of nabla to both parts of the equations (3.15) with their mutual substitution into each other, we will obtain the new equations of electrodynamics – the globally trans-coordinate wave differential equations, which use Galilean derivative of field functions and generalizing equations (24) in the case $\mathbf{v}\neq\mathbf{0}$:

$$c^2\nabla^2\mathbf{E}'=\varepsilon\mu\frac{\partial'^2\mathbf{E}}{\partial t^2},\qquad c^2\nabla^2\mathbf{B}'=\varepsilon\mu\frac{\partial'^2\mathbf{B}}{\partial t^2}. \tag{3.25}$$

We investigate in more detail the equation of form (3.25) in connection with to arbitrary field functions $\Phi(x,t)$, also, $\Phi'(v,x',t)$ for the case of plane wave with the wave vector, collinear to vector $\mathbf{v}=(v,0,0)$ and to axes OX , $O'X'$, coordinates along which are assigned by the variables x , x' . In this case the equation proves to be one-dimensional, and field functions – scalar:

$$c^2\frac{\partial^2}{\partial x'^2}\Phi'(v,x',t)=\varepsilon\mu\frac{\partial'^2\Phi}{\partial t^2}(v,x',t)=\varepsilon\mu\frac{d^2}{dt^2}\Phi(x'+vt,t). \tag{3.26}$$

If we differentiate in the right side (3.26), this equation of signs the form:

$$\frac{c^2}{\varepsilon\mu}\frac{\partial^2}{\partial x'^2}\Phi'(v,x',t)=\left(\frac{\partial^2}{\partial t^2}+2v\frac{\partial^2}{\partial t\partial x}+v^2\frac{\partial^2}{\partial x^2}\right)\Phi(x'+vt,t)=\left(\frac{\partial}{\partial t}+v\frac{\partial}{\partial x}\right)^2\Phi(x'+vt,t). \tag{3.27}$$

With $v=0$ (3.26) (3.27) it degenerates into the one-dimensional version of the wave equation of the form (3.24):

$$c^2\frac{\partial^2}{\partial x^2}\Phi(x,t)=\varepsilon\mu\frac{\partial^2}{\partial t^2}\Phi(x,t). \tag{3.28}$$

Any solution (3.28) is determined by the proper superposition of the simple harmonic waves

$$\Phi(x,t)=A\cos(\omega t-k_x x+\varphi) \tag{3.29}$$

with the approximate values of the parameters $A\geq 0$, $\omega>0$, $k_x\neq 0$, $\varphi\in\mathbb{R}$ – amplitude, angular frequency, the projection of wave vector on the axis OX and the initial phase of wave. In this case all waves (3.29) must have one and the same phase speed $\omega/k=c/\sqrt{\varepsilon\mu}$, where $k=|k_x|$ – wave number. We will search for function $\Phi'(v,x',t)$, satisfying (3.26)-(3.29), also in the form of simple harmonic wave, but with those depending on v by the parameters $A'(v)$, $\omega'(v)$, $k_x'(v)$, $\varphi'(v)$:

$$\Phi'(v,x',t)=A'(v)\cos(\omega'(v)t-k_x'(v)x'+\varphi'(v)), \tag{3.30}$$

$$\Phi'(0,x',t)=\Phi(x',t),\quad A'(0)=A,\quad \omega'(0)=\omega,\quad k_x'(0)=k_x,\quad \varphi'(0)=\varphi.$$

Let us substitute (3.29)-(3.30) in (3.27):

$$c^2k_x'^2(v)A'(v)\cos(\omega'(v)t-k_x'(v)x'+\varphi'(v))=\varepsilon\mu(\omega-k_xv)^2A\cos(\omega t-k_x(x'+vt)+\varphi). \tag{3.31}$$

Equalizing the similar parameters of wave on the left side (3.31) and in the right, we have:

$$A'(v)=\left(\operatorname{sgn}k_x-\frac{\sqrt{\varepsilon\mu}}{c}v\right)^2A,\ \omega'(v)=|\omega-k_xv|=\left|1-\frac{\sqrt{\varepsilon\mu}}{c}v\operatorname{sgn}k_x\right|\omega, \tag{3.32}$$

$$k_x'(v)=k_x\operatorname{sgn}(\omega-k_xv),\ k'(v)=|k_x'(v)|=k,\ \varphi'(v)=\varphi\operatorname{sgn}(\omega-k_xv),\ |\varphi'(v)|=|\varphi|. \tag{3.33}$$

Thus, upon transfer from the laboratory to the substantive frame of reference change amplitude and frequency (3.32) of simple harmonic wave, and its wave number and module of initial phase (3.33) remain constant. In this case the frequency changes in such a way that phase wave velocity in the substantive frame of reference is obtained according to the classical summation rule of speeds from its phase speed in the laboratory frame of reference and speed of substantive frame of reference relative to the laboratory:

$$\omega'(v)/k'_x(v) = \omega'(v)/k_x = \omega/k_x - v, \ \omega'(v)/k'(v) = |\omega/k - v \operatorname{sgn} k_x| = \left|c/\sqrt{\varepsilon\mu} - v \operatorname{sgn} k_x\right|. \quad (3.34)$$

From (3.32)-(3.34) it is evident that if the vector of phase wave velocity in the laboratory frame of reference coincides with the velocity vector of substantive frame of reference in it ($k_x > 0$, $v = \omega/k$), that in the substantive frame of reference wave generally disappears ($A'(v) = 0$). Thus, in contrast to the theory of relativity, in the theory of giperkontinuuma this wave always can be destroyed by the suitable selection of frame of reference. But if relative to laboratory frame of reference substantial frame of reference outdistances wave, then upon transfer from the laboratory frame of reference to the substantive the direction of propagation of wave changes by the opposite. If in the laboratory frame of reference wave is propagated in the positive direction, then upon transfer into the substantive it will satisfy wave equation (3.35), while if in the negative, then to the equation (3.36):

$$\left(c/\sqrt{\varepsilon\mu} - v\right)^2 \partial^2 \Phi'(v, x', t)/\partial x'^2 = \partial^2 \Phi'(v, x', t)/\partial t^2, \quad (3.35)$$

$$\left(c/\sqrt{\varepsilon\mu} + v\right)^2 \partial^2 \Phi'(v, x', t)/\partial x'^2 = \partial^2 \Phi'(v, x', t)/\partial t^2. \quad (3.36)$$

The selection of inertial reference system to the role of laboratory is, generally speaking, conditional. Thus, substantial frame of reference it is possible in turn to accept for the laboratory, and in the role of substantial to examine certain by third (twice shtrikhovannuyu) inertial reference system with that directed to the same side, that also OX, $O'X'$, by attitude reference $O''X''$, the coordinate along which is assigned by the variable x''. Let, for example, the point O'' move in the positive direction of axis $O'X'$ with the speed Δv. Wave in the new laboratory and substantive frame of references will have an identical wave number and a module of initial phase and will be described by field functions $\Phi'(v, x', t)$ and $\Phi'(v + \Delta v, x'', t)$ respectively. The role of equation (3.28) plays (3.35) or (3.36), the role of the function of wave (3.29) – function (3.30), while the role of equations (3.35), (3.36) – the following wave equations:

$$\left(c/\sqrt{\varepsilon\mu} - (v + \Delta v)\right)^2 \partial^2 \Phi'(v + \Delta v, x'', t)/\partial x''^2 = \partial^2 \Phi'(v + \Delta v, x'', t)/\partial t^2, \quad (3.37)$$

$$\left(c/\sqrt{\varepsilon\mu} + (v + \Delta v)\right)^2 \partial^2 \Phi'(v + \Delta v, x'', t)/\partial x''^2 = \partial^2 \Phi'(v + \Delta v, x'', t)/\partial t^2. \quad (3.38)$$

For (3.37) the role of equalities (3.32), (3.33) play the following transformations of the parameters of the wave:

$$A''(v+\Delta v)=\left(\operatorname{sgn}k'_x(v)-\frac{\sqrt{\varepsilon\mu}\cdot\Delta v}{c-\sqrt{\varepsilon\mu}\cdot v}\right)^2 A'(v), \quad \omega''(v+\Delta v)=|\omega'(v)-k'_x(v)|\Delta v, \tag{3.39}$$

$$k''_x(v+\Delta v)=k'_x(v)\operatorname{sgn}(\omega'(v)-k'_x(v)\Delta v), \quad \varphi''(v+\Delta v)=\varphi'(v)\operatorname{sgn}(\omega'(v)-k'_x(v)\Delta v). \tag{3.40}$$

For (3.38) the corresponding (3.39)-(3.40) transformation of the parameters are determined analogously.

Sequential passage from not shtrikhovannoy to shtrikhovannoy and is further to the twice shtrikhovannoy frame of reference equivalent to direct passage from not shtrikhovannoy to twice shtrikhovannoy. For example, with $\operatorname{sgn}k'_x(v)=\operatorname{sgn}k_x=1$ from (3.32), (3.39) it is possible to obtain

$$A''(v+\Delta v)=\left(1-\sqrt{\varepsilon\mu}\,(v+\Delta v)/c\right)^2 A, \tag{3.41}$$

which is obtained also upon direct transfer to the twice shtrikhovannoy frame of reference, since (3.41) it is obtained from (3.32) by replacement v on $v+\Delta v$. In this case the role of equation (3.27) plays

$$\left(\frac{c}{\sqrt{\varepsilon\mu}}-v\right)^2\frac{\partial^2\Phi'(v+\Delta v,x'',t)}{\partial x''^2}=\frac{\partial^2\Phi'(v,x''+\Delta vt,t)}{\partial t^2}+\left(2\Delta v\frac{\partial^2}{\partial t\partial x'}+\Delta v^2\frac{\partial^2}{\partial x'^2}\right)\Phi'(v,x''+\Delta vt,t). \tag{3.42}$$

For the derivatives of arbitrary n- GO of order $\partial^n\Phi'(v+\Delta v,x'',t)/\partial x''^n$ $\partial^n\Phi'(v,x',t)/\partial x'^n$ it is possible to use a united designation $\partial^n\Phi'(v+\Delta v,x,t)/\partial x^n$ and $\partial^n\Phi'(v,x,t)/\partial x^n$ ($n=\overline{1,\infty}$), respectively indicating simply derived on the second argument. In accordance with this, after substitution (3.35) in (3.42) we will obtain:

$$\left(\frac{c}{\sqrt{\varepsilon\mu}}-v\right)^2\frac{\partial^2}{\partial x^2}\left(\frac{\Phi'(v+\Delta v,x,t)-\Phi'(v,x+\Delta vt,t)}{\Delta v}\right)=\left(2\frac{\partial^2}{\partial t\partial x}+\Delta v\frac{\partial^2}{\partial x^2}\right)\Phi'(v,x+\Delta vt,t). \tag{3.43}$$

Let $\Delta v\to 0$. Let us introduce one additional new derivative, which let us name trans-coordinate, and which in the case of the one-dimensional system of space coordinates takes the form:

$$\frac{\partial'\Phi'(v,x,t)}{\partial' v}=\lim_{\Delta v\to 0}\frac{\Phi'(v+\Delta v,x,t)-\Phi'(v,x+\Delta vt,t)}{\Delta v}. \tag{3.44}$$

In the determination (3.44) of value $\Phi'(v,x+\Delta vt,t)$ $\Phi'(v+\Delta v,x,t)$ is described physical field at one and the same point of space, but in the different frame of references (shtrikhovannoy and moving relative to it with speed Δv twice shtrikhovannoy respectively). Within the framework they are equal to the concept of the invariance of field relative to the speed of the motion of observer:

$$\Phi'(v, x+\Delta v t, t) = \Phi'(v+\Delta v, x, t). \tag{3.45}$$

The equalities (3.3) (3.45) making identical physical sense, but in connection with to the different pairs of frame of references. However, out of the framework of the indicated concept upon transfer from shtrikhovannoy to the twice shtrikhovannoy frame of reference the field function at the particular point of space experiences the increase, the limit of relation of which k Δv with $\Delta v \to 0$ gives the trans-coordinate derivative (3.44). It is possible to generalize it to the case of the higher orders ($n = \overline{1,\infty}$):

$$\frac{\partial'^1 \Phi'(v,x,t)}{\partial' v^1} = \frac{\partial' \Phi'(v,x,t)}{\partial' v}; \quad \frac{\partial'^{n+1} \Phi'(v,x,t)}{\partial' v^{n+1}} = \lim_{\Delta v \to 0} \frac{\dfrac{\partial'^n \Phi'(v+\Delta v, x, t)}{\partial' v^n} - \dfrac{\partial'^n \Phi'(v, x+\Delta v t, t)}{\partial' v^n}}{\Delta v}. \tag{3.46}$$

Using trans-coordinate derivatives of the first two orders (3.46), it is possible to represent increase in the field function of in the form corresponding partial summation of series of Taylor:

$$\Phi'(v+\Delta v, x, t) - \Phi'(v, x+\Delta v t, t) \approx \frac{\partial' \Phi'(v,x,t)}{\partial' v}\Delta v + \frac{1}{2}\frac{\partial'^2 \Phi'(v,x,t)}{\partial' v^2}\Delta v^2, \tag{3.47}$$

Substituting (3.47) in (3.43), equalizing between themselves members with the identical degrees Δv in the left and right sides of the received equality, fixing $\Delta v \to 0$, taking into account that the fact that in this case $\Phi'(v, x+\Delta v t, t) \to \Phi'(v,x,t)$ and by adding equality (3.35) in the new form of record (with the use by variable x instead of x', we will obtain the following system of three equations:

$$\begin{cases} \left(\dfrac{c}{\sqrt{\varepsilon\mu}} - v\right)^2 \dfrac{\partial^2 \Phi'(v,x,t)}{\partial x^2} = \dfrac{\partial^2 \Phi'(v,x',t)}{\partial t^2}, \\ \left(\dfrac{c}{\sqrt{\varepsilon\mu}} - v\right)^2 \dfrac{\partial\partial' \Phi'(v,x,t)}{\partial x \partial' v} = 2\dfrac{\partial \Phi'(v,x',t)}{\partial t}, \\ \left(\dfrac{c}{\sqrt{\varepsilon\mu}} - v\right)^2 \dfrac{\partial'^2 \Phi'(v,x,t)}{\partial' v^2} = 2\Phi'(v,x',t). \end{cases} \tag{3.48}$$

System of equations (3.48) can be written down in following that indexed on α the form:

$$\left(\left(\frac{c}{\sqrt{\varepsilon\mu}} - v\right)^2 \frac{\partial^{2-\alpha}\partial'^{\alpha}}{\partial x^{2-\alpha}\partial' v^{\alpha}} - 2^{\operatorname{sgn}\alpha}\frac{\partial^{2-\alpha}}{\partial t^{2-\alpha}}\right)\Phi'(v,x',t) = 0 \qquad \alpha = \overline{0,2}, \tag{3.49}$$

or in the operator form

$$\circledcirc \Phi'\left(v, x', t\right)=0 \ , \tag{3.50}$$

where $\circledcirc=(\circledcirc^{\alpha})$; $\circledcirc^{\alpha}=\left(\left(\frac{c}{\sqrt{\varepsilon\mu}}-v\right)^2 \frac{\partial^{2-\alpha}\partial'^{\alpha}}{\partial x^{2-\alpha}\partial' v^{\alpha}}-2^{\operatorname{sgn}\alpha}\frac{\partial^{2-\alpha}}{\partial t^{2-\alpha}}\right)$ – the suitable version of the one-dimensional (case of one axis of space coordinates) differential operator of Dubrovin, which generalizes d'Alembert's operator □, who occurs one of his three (zero) components for the laboratory frame of reference, i.e., $\alpha=0$, $v=0$. Differential equation (3.49) or (3.50) is the giperkontinualnoe one-dimensional homogeneous wave equation, which generalizes, similar to differential equation (3.26) or (3.27), the known one-dimensional homogeneous wave equation (28). The vital difference between them (3.26)-(3.27) is lies in the fact that the globally trans-coordinate form of giperkontinualnogo wave equation, and (3.49)-(3.50) – by its locally trans-coordinate form. Local trans-coordinateawn means that the equation connects the inertial reference systems, which move relative to each other with the infinitely low speed.

The trans-coordinateawn of giperkontinualnykh wave equations is ensured by the use in them of the suitable derived field functions. Namely, use by Galileo's derivative reports to equation global trans-coordinateawn, and by trans-coordinate derivative – local.

Thus, is proposed the new approach to the development of the mathematical apparatus for electrodynamics in the direction of the more adequate description of passage from one inertial reference system to another on the basis of giperkontinualnykh ideas about the space and in the time due to the introduction into the examination of the globally and locally trans-coordinate equations, which use new Galilean and trans-coordinate derivatives of field functions, and also the new differential operator of Dubrovin, which generalizes d'Alembert's operator. This approach leads to the reformulation of electrodynamics with the passage from the traditional formulation of Hertz-Heaviside to the new trans-coordinate. In this case immediately arise the question about what form they have transformation of electromagnetic field upon transfer from one inertial reference system to another, and will be these transformation the Mende transformation [31].

The convective derivatives of field functions in (19)-(20) can be written down in the form:

$$(v\mathbf{e}_1\cdot\nabla)\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)=v(\nabla\cdot\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t))\mathbf{e}_1-\nabla\times(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)), \tag{3.51}$$

$$(v\mathbf{e}_1\cdot\nabla)\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)=v(\nabla\cdot\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t))\mathbf{e}_1-\nabla\times(v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)). \tag{3.52}$$

We have in view of the first two (3.22) equations taking into account (3.1)-(3.2) :

$$\nabla\cdot\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)=0, \quad \nabla\cdot\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)=0. \tag{3.53}$$

After substituting (3.53) in (3.51)-(3.52), we will obtain equalities for the convective derivatives:

$$(v\mathbf{e}_1\cdot\nabla)\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)=-\nabla\times(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)). \tag{3.54}$$

$$(v\mathbf{e}_1\cdot\nabla)\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)=-\nabla\times(v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)), \tag{3.55}$$

After substitution (3.54)-(3.55) in (3.19)-(3.20) we take another form of the Galilean derivatives:

$$\frac{\partial'\mathbf{E}}{\partial t}(v,\mathbf{r}',t)=\frac{\partial\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)}{\partial t}-\nabla\times(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)), \tag{3.56}$$

$$\frac{\partial'\mathbf{B}}{\partial t}(v,\mathbf{r}',t)=\frac{\partial\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)}{\partial t}-\nabla\times(v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)). \tag{3.57}$$

The substitution of Galilean derivatives (3.56)-(3.57) into the last two equalities (3.22) gives:

$$\nabla\times\mathbf{E}'(v,\mathbf{r}',t)=-\partial\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)/\partial t+\nabla\times(v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)), \tag{3.58}$$

$$\nabla\times\mathbf{B}'(v,\mathbf{r}',t)=(\varepsilon\mu/c^2)(\partial\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)/\partial t-\nabla\times(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t))). \tag{3.59}$$

After substituting last two equations (3.23) in (3.58)-(3.59), we will obtain:

$$\nabla\times\mathbf{E}'(v,\mathbf{r}',t)=\nabla\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)+\nabla\times(v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)), \tag{3.60}$$

$$\nabla\times\mathbf{B}'(v,\mathbf{r}',t)=\nabla\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)-(\varepsilon\mu/c^2)\nabla\times(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)). \tag{3.61}$$

Let us omit the operation of rotor both parts of the equalities (3.60)-(3.61):

$$\mathbf{E}'(v,\mathbf{r}',t)=\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)+v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t), \tag{3.62}$$

$$\mathbf{B}'(v,\mathbf{r}',t)=\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)-(\varepsilon\mu/c^2)(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)). \tag{3.63}$$

Besides the shtrikhovannoy frame of reference, which moves relative to laboratory with speed v let us introduce also relatively mobile frame of reference – twice shtrikhovannuyu, that moves in the same direction with another speed $v+\Delta v$ relative to laboratory. Thus, the twice shtrikhovannaya frame of reference moves with relatively shtrikhovannoy with speed Δv , the so that shtrikhovannuyu frame of reference can be accepted for the new laboratory (relatively fixed), and twice shtrikhovannuyu – for the new substantive.

Equalities (62)-(63) for them let us write down taking into account the replacement of radius-vector $\mathbf{r}'$ on $\mathbf{r}''$:

$$\mathbf{E}'(v+\Delta v,\mathbf{r}'',t)=\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)+\Delta v\mathbf{e}_1\times\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t), \tag{3.64}$$

$$\mathbf{B}'(v+\Delta v,\mathbf{r}'',t)=\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)-(\varepsilon\mu/c^2)\Delta v\mathbf{e}_1\times\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t). \tag{3.65}$$

Let us write down equalities (3.64)-(3.65) in the following form:

$$\frac{\mathbf{E}'(v+\Delta v,\mathbf{r}'',t)-\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)}{\Delta v}=\mathbf{e}_1\times\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t), \tag{3.66}$$

$$\frac{\mathbf{B}'(v+\Delta v,\mathbf{r}'',t)-\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)}{\Delta v}=-\frac{\varepsilon\mu}{c^2}\mathbf{e}_1\times\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t). \tag{3.67}$$

In (3.66)-(3.67) the values $\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)$, $\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)$, $\mathbf{E}'(v+\Delta v,\mathbf{r}'',t)$, $\mathbf{B}'(v+\Delta v,\mathbf{r}'',t)$ is described the electromagnetic field at one and the same point of space (medium), but in the different frame of references (shtrikhovannoy and by twice shtrikhovannoy). Within the framework they are equal to the concept of the invariance of field relative to the speed of the motion of observer:

$$\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)=\mathbf{E}'(v+\Delta v,\mathbf{r}'',t),\quad \mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)=\mathbf{B}'(v+\Delta v,\mathbf{r}'',t), \tag{3.68}$$

the equalities (9) (68) making identical physical sense, but in connection with to the different pairs of frame of references. However, out of the framework of the indicated concept upon transfer from shtrikhovannoy to the twice shtrikhovannoy frame of reference the field function at the particular point of space experiences the increase, the limit of relation of which k Δv with $\Delta v\to 0$ gives that for the first time introduced into 27 the trans-coordinate derivative of the field function:

$$\frac{\partial'\mathbf{E}'(v,\mathbf{r}'',t)}{\partial' v}=\lim_{\Delta v\to 0}\frac{\mathbf{E}'(v+\Delta v,\mathbf{r}'',t)-\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)}{\Delta v}, \tag{3.69}$$

$$\frac{\partial'\mathbf{B}'(v,\mathbf{r}'',t)}{\partial' v}=\lim_{\Delta v\to 0}\frac{\mathbf{B}'(v+\Delta v,\mathbf{r}'',t)-\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)}{\Delta v}. \tag{3.70}$$

Equalities (3.66)-(3.67) with $\Delta v\to 0$ taking into account (3.69)-(3.70) after replacement $\mathbf{r}''$ on $\mathbf{r}$ take the form:

$$\frac{\partial'\mathbf{E}'(v,\mathbf{r}',t)}{\partial' v}=\mathbf{e}_1\times\mathbf{B}'(v,\mathbf{r}',t)\ ;\quad \frac{\partial'\mathbf{B}'(v,\mathbf{r}',t)}{\partial' v}=-\frac{\varepsilon\mu}{c^2}\mathbf{e}_1\times\mathbf{E}'(v,\mathbf{r}',t). \tag{3.71}$$

If equations (3.22) are the globally trans-coordinate differential equations of electrodynamics for the case of isotropic homogeneous medium without the dispersion in the absence of free charges and currents, then equations (3.71) are the locally trans-coordinate differential equations of electrodynamics for the same case. The locality of trans-coordinateawn, ensured by use by trans-coordinate derivative, means that the connected by differential equations inertial reference systems (conditionally speaking, shtrikhovannaya and twice shtrikhovannaya) they move relative to each other with the infinitely low speed Δv . Equations (3.71) form the system, by solving which, it is possible to obtain the transformation of electromagnetic field upon transfer of one inertial reference system into another.

Let us use system of equations (3.71) for obtaining the transformation of electromagnetic field upon transfer from the laboratory frame of reference to the substantive.

Lowering the arguments of functions, let us write down vector products in (3.71) in the form:

$$\mathbf{e}_1 \times \mathbf{B}' = \mathbf{e}_1 \times \left(B'^1\mathbf{e}_1 + B'^2\mathbf{e}_2 + B'^3\mathbf{e}_3\right) = B'^2\mathbf{e}_3 - B'^3\mathbf{e}_2\,, \tag{3.72}$$

$$\mathbf{e}_1 \times \mathbf{E}' = \mathbf{e}_1 \times \left(E'^1\mathbf{e}_1 + E'^2\mathbf{e}_2 + E'^3\mathbf{e}_3\right) = E'^2\mathbf{e}_3 - E'^3\mathbf{e}_2\,. \tag{3.73}$$

Taking into account (3.72)-(3.73) the system of equations (3.71) is divided off into two independent systems of two equations each and two additional independent equations:

$$\begin{cases} \dfrac{\partial' E'^2}{\partial' v} = -B'^3, \\ \dfrac{\partial' B'^3}{\partial' v} = -\dfrac{\varepsilon\mu}{c^2}E'^2; \end{cases} \quad \begin{cases} \dfrac{\partial' E'^3}{\partial' v} = B'^2, \\ \dfrac{\partial' B'^2}{\partial' v} = \dfrac{\varepsilon\mu}{c^2}E'^3; \end{cases} \quad \frac{\partial' E'^1}{\partial' v} = 0 \; \frac{\partial' B'^1}{\partial' v} = 0\,. \tag{3.74}$$

We differentiate the first equations of systems (3.74) and will substitute them the secondly:

$$\frac{\partial'^2 E'^2}{\partial' v^2} = \frac{\varepsilon\mu}{c^2}E'^2, \quad \frac{\partial'^2 E'^3}{\partial' v^2} = \frac{\varepsilon\mu}{c^2}E'^3, \quad \frac{\partial'^2 B'^2}{\partial' v^2} = \frac{\varepsilon\mu}{c^2}B'^2, \quad \frac{\partial'^2 B'^3}{\partial' v^2} = \frac{\varepsilon\mu}{c^2}B'^3\,. \tag{3.75}$$

The general solution of equations (3.75) is expressed as the arbitrary constants $C_1,\ldots,C_{10}$:

$$E'^1 = C_1, \; E'^2 = C_2\cosh\frac{\sqrt{\varepsilon\mu}v}{c} + C_3\sinh\frac{\sqrt{\varepsilon\mu}v}{c}, \; E'^3 = C_4\cosh\frac{\sqrt{\varepsilon\mu}v}{c} + C_5\sinh\frac{\sqrt{\varepsilon\mu}v}{c}, \tag{3.76}$$

$$B'^1 = C_6, \; B'^2 = C_7\cosh\frac{\sqrt{\varepsilon\mu}v}{c} + C_8\sinh\frac{\sqrt{\varepsilon\mu}v}{c}, \; B'^3 = C_9\cosh\frac{\sqrt{\varepsilon\mu}v}{c} + C_{10}\sinh\frac{\sqrt{\varepsilon\mu}v}{c}. \tag{3.77}$$

Since we search for the transformation of electromagnetic field upon transfer from the laboratory frame of reference, then the desired particular solutions of equations (3.75) must with $v=0$ describe electromagnetic field in the laboratory frame of reference, i.e., satisfy equalities (8) and (74), and the, which means, following totality of the equalities:

$$E'^1(0,\mathbf{r}',t) = E^1(\mathbf{r}',t), \quad E'^2(0,\mathbf{r}',t) = E^2(\mathbf{r}',t), \quad E'^3(0,\mathbf{r}',t) = E^3(\mathbf{r}',t), \tag{3.78}$$

$$B'^1(0,\mathbf{r}',t) = B^1(\mathbf{r}',t), \quad B'^2(0,\mathbf{r}',t) = B^2(\mathbf{r}',t), \quad B'^3(0,\mathbf{r}',t) = B^3(\mathbf{r}',t), \tag{3.79}$$

$$\frac{\partial' E'^2(0,\mathbf{r}',t)}{\partial' v} = -B^3(\mathbf{r}',t), \quad \frac{\partial' E'^3(0,\mathbf{r}',t)}{\partial' v} = B^2(\mathbf{r}',t), \tag{3.80}$$

$$\frac{\partial' B'^2(0,\mathbf{r}',t)}{\partial' v}=\frac{\varepsilon\mu}{c^2}E^3(\mathbf{r}',t),\quad \frac{\partial' B'^3(0,\mathbf{r}',t)}{\partial' v}=-\frac{\varepsilon\mu}{c^2}E^2(\mathbf{r}',t). \tag{3.81}$$

By substitution (3.76)-(3.77) in (3.78)-(3.81) let us find the values of constants $C_1,\dots,C_{10}$, as a result what after the substitution of these constants in (3.76)-(3.77) we will obtain the resultant expression in the component form for the desired transformation of electromagnetic field upon transfer from the laboratory frame of reference to the substantive:

$$E'^1(v,\mathbf{r}',t)=E^1(\mathbf{r}',t);\ B'^1(v,\mathbf{r}',t)=B^1(\mathbf{r}',t); \tag{3.82}$$

$$E'^2(v,\mathbf{r}',t)=E^2(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c}-\frac{c}{\sqrt{\varepsilon\mu}}B^3(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}; \tag{3.83}$$

$$E'^3(v,\mathbf{r}',t)=E^3(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c}+\frac{c}{\sqrt{\varepsilon\mu}}B^2(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}; \tag{3.84}$$

$$B'^2(v,\mathbf{r}',t)=B^2(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c}+\frac{\sqrt{\varepsilon\mu}}{c}E^3(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}; \tag{3.85}$$

$$B'^3(v,\mathbf{r}',t)=B^3(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c}-\frac{\sqrt{\varepsilon\mu}}{c}E^2(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}. \tag{3.86}$$

In the vector form the same transformation take the following form:

$$\mathbf{E}'(v,\mathbf{r}',t)=\mathbf{E}(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c}+\frac{c}{\sqrt{\varepsilon\mu}}\mathbf{e}_1\times\mathbf{B}(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}; \tag{3.87}$$

$$\mathbf{B}'(v,\mathbf{r}',t)=\mathbf{B}(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c}-\frac{\sqrt{\varepsilon\mu}}{c}\mathbf{e}_1\times\mathbf{E}(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}. \tag{3.88}$$

It is easy to see that the transformation (3.82)-(3.88) are known Mende transformation [31, 32].

Conclusion

Thus, the transformation of Mende obtain a sufficient theoretical substantiation within the framework of the trans-coordinate formulation of electrodynamics, connected with the giperkontinualnymi ideas about the space and the time, and also with the concept not of the invariance of electric charge relative to the speed of the motion of observer. Together with that been in [26] direct experimental confirmation of the concept not of the invariance of electric charge, this is convincing evidence of their larger adequacy of physical reality on the comparison not only with the classical, but also with the relativistic transformation of electromagnetic field, or the convincing evidence of the justification of the transfer of electrodynamics from the traditional formulation of Hertz- Heaviside to the the trans-coordinate. The sequential development of trans-coordinate electrodynamics is capable of not only deriving on the new qualitative level of idea about the space and the time, but also of opening the fundamentally new horizons of the development engineering and technologies due to the discovery and the mastery of new physical phenomena and effects.

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6. Is there a dispersion of the dielectric constant of material media

1. Preliminary observations

The presence of dispersion in the dielectric and magnetic constant of the material media is the conventional point of view [1-4]. However, this point of view is incorrect.

Before switching over to the explanation of this assertion, for the best physical understanding of the essence of a question let us give a simple example according to the description of electrical chains with the lumped parameters. As we will see, this example will subsequently refer direct to matter under discussion and it will help to easily understand the physical picture of electrodynamic processes in the material media.

By that taking place through this chain, will be written down for the parallel C resonant circuit L, which is U, the capacity and the connection inductance between the voltage applied I_Σ, to the outline, and summed current

$$I_\Sigma = I_C + I_L = C\frac{dU}{dt} + \frac{1}{L}\int U dt\,, \tag{1.1}$$

where $I_C = C\frac{dU}{dt}$ - current, which flows through the capacity, and $I_L = \frac{1}{L}\int U dt$ - current, which flows through the inductance.

We obtain for the case of harmonic $U = U_0 \sin \omega t$ voltage

$$I_\Sigma = \left(\omega C - \frac{1}{\omega L}\right) U_0 \cos \omega t\,. \tag{1.2}$$

In relationship (1.2) the value, which stands in the brackets, presents summary susceptance of this medium σ_x and it consists it, in turn, of the the capacitive σ_c and by the inductive σ_L the conductivity.

$$\sigma_x = \sigma_c + \sigma_L = \omega C - \frac{1}{\omega L}\,. \tag{1.3}$$

In this case relationship (1.2) can be rewritten as follows:

$$I_\Sigma = \omega C\left(1 - \frac{\omega_0^2}{\omega^2}\right) U_0 \cos \omega t\,, \tag{1.4}$$

where $\omega_0^2 = \frac{1}{LC}$ - the resonance frequency of parallel circuit.

We can consider from a mathematical (we emphasize, with the mathematical, but not with the physical) point of view that the chain in question not at all has inductances, but it consists only of the capacity, which depends on the frequency

$$C^*(\omega) = C\left(1 - \frac{\omega_0^2}{\omega^2}\right) \tag{1.5}$$

is accurate another point of view.

Relationship (1.2) can be rewritten and differently:

$$I_\Sigma = \frac{\left(\frac{\omega^2}{\omega_0^2} - 1\right)}{\omega L} U_0 \cos\omega t\ , \tag{1.6}$$

and to consider that the chain in question not at all has capacities, and consists only of the inductance depending on the frequency

$$L^*(\omega) = \frac{L}{\left(\frac{\omega^2}{\omega_0^2} - 1\right)}\ . \tag{1.7}$$

Using designations (1.5) (1.7) let us write down

$$I_\Sigma = \omega C^*(\omega) U_0 \cos\omega t\ , \tag{1.8}$$

or

$$I_\Sigma = \frac{1}{\omega L^*(\omega)} U_0 \cos\omega t\ . \tag{1.9}$$

Of relationship (1.8) and (1.9) are equivalent, and separately mathematically completely is characterized the chain examined. But view neither $C^*(\omega)$ nor $L^*(\omega)$ by capacity and inductance are from a physical point, although they have the same dimensionality. The physical sense of their names consists of the following:

$$C^*(\omega) = \frac{\sigma_X}{\omega}\ . \tag{1.10}$$

i.e. $C^*(\omega)$ presents summary susceptance of medium, divided into the frequency, and

$$L^*(\omega) = \frac{1}{\omega \sigma_X}\ , \tag{1.11}$$

it represents the reciprocal value of the work of frequency and susceptance of medium.

Value $C^*(\omega)$ is mathematically designed in such a way that into it simultaneously enters and C and L . The same relates and in $L^*(\omega)$.

We will not examine other examples, for example, series circuit or more compound circuits. Let us note only that, using the method examined any chain, which consists of the reactive elements C and L , can be represented as the frequency-dependent inductance or capacity. However, this there will be only the method of the mathematical description of the actually existing chains with the constant quantities of reactive elements.

It is well known that the energy, stocked in the capacity and the inductance, is determined from the relationships

$$W_C=\frac{1}{2}CU^2 , \tag{1.12}$$

$$W_L=\frac{1}{2}LI^2 . \tag{1.13}$$

But what is to be done, if at our disposal there are $C^*(\omega)$ and $L^*(\omega)$? Certainly, to put these relationships in the formulas (1.12) (1.13) is impossible already at least because they can be both the positive and negative. However, it is not difficult to show that the summary energy, accumulated in the outline, is determined by the expressions:

$$W_\Sigma=\frac{1}{2}\cdot\frac{d\sigma_X}{d\omega}U^2 , \tag{1.14}$$

or

$$W_\Sigma=\frac{1}{2}\cdot\frac{d[\omega C^*(\omega)]}{d\omega}U^2 , \tag{1.15}$$

or

$$W_\Sigma=\frac{1}{2}\cdot\frac{d\left(\dfrac{1}{\omega L^*(\omega)}\right)}{d\omega}U^2 . \tag{1.16}$$

If we paint equations (1.14) or (1.15) and (1.16), then we will obtain identical result, namely:

$$W_\Sigma=\frac{1}{2}CU^2+\frac{1}{2}LI^2, \tag{1.17}$$

where U - is a value of voltage on the capacity, and I - the current, which flows through the inductance. Now let us pass to the account of a question about the physical sense of values ε (ω) and μ (ω) for the material media.

2. Case of the plasma media

Superconductor is the ideal plasma medium, in which the charge carriers – electrons can move without the friction. In this case the equation of motion of electron takes the form:

$$m\frac{d\vec{V}}{dt}=e\vec{E}, \tag{2.1}$$

where m - mass electro, e - the electron charge, $\vec{E}$ - the tension of electric field, $\vec{V}$ - speed of the motion of charge.

Taking into account that current density

$$\vec{j}=ne\vec{V}, \tag{2.2}$$

we obtain from (2.1):

$$\vec{j}_L=\frac{ne^2}{m}\int\vec{E}dt. \tag{2.3}$$

In relationship (2.2) and (2.3) the value n determines the charge density. After introducing the designation of

$$L_k=\frac{m}{ne^2}, \tag{2.4}$$

let us write down

$$\vec{j}_L=\frac{1}{L_k}\int\vec{E}dt. \tag{2.5}$$

In this case the value L_k presents the specific kinetic inductance of plasmo-like medium. Its existence connected with the fact that charge, having a mass, possesses inertia properties.

Pour on relationship (2.5) it will be written down for the case of harmonics field $\vec{E}=\vec{E}\sin\omega t$:

$$\vec{j}_L=-\frac{1}{\omega L_k}E_0\cos\omega t, \tag{2.6}$$

Relationships (2.5), (2.6) show that the current $\vec{j}_L$ represents inductive current.

Maxwell's equations for this case take the form:

$$rot\vec{E} = -\mu_0 \frac{\partial \vec{H}}{\partial t},$$
$$rot\vec{H} = \vec{j}_C + \vec{j}_L = \varepsilon_0 \frac{\partial \vec{E}}{\partial t} + \frac{1}{L_k}\int \vec{E}dt, \qquad (2.7)$$

where ε_0 , μ_o - dielectric and magnetic constant of vacuum, and the values $\vec{j}_C$ and $\vec{j}_L$ present respectively the bias current and conductivity. As we already showed, conduction current bears inductive nature.

We obtain from (2.7):

$$rotrot\vec{H} + \mu_0\varepsilon_0 \frac{\partial^2 \vec{H}}{\partial t^2} + \frac{\mu_0}{L_k}\vec{H} = 0. \qquad (2.8)$$

For the case pour on, time-independent, equation (2.8) passes into the equation of London

$$rotrot\vec{H} + \frac{\mu_0}{L_k}\vec{H} = 0, \qquad (2.9)$$

where $\lambda_L^2 = \frac{L_k}{\mu_0}$ - London depth of penetration.

Relationship (2.7) indicates that neither dielectric nor magnetic of the permeability of the nonmagnetized plasma on frequency depend, but they are equal to the dielectric and magnetic constant of vacuum. Furthermore, this plasma characterizes one additional fundamental material parameter - specific kinetic inductance.

Of relationship (2.7) are accurate both for the constants and for the variables pour on. For the case of harmonics pour on $\vec{E} = \vec{E}_0 \sin\omega t$ from (2.24) we obtain

$$rot\vec{H} = \left(\varepsilon_0\omega - \frac{1}{L_k\omega}\right)\vec{E}_0 \cos\omega t. \qquad (2.10)$$

After designating value as specific reactive plasma conductivity confronting in the brackets σ_x , let us write down

$$rot\vec{H} = \sigma_X \vec{E}_0 \cos\omega t, \qquad (2.11)$$

where

$$\sigma_X = \varepsilon_0 \omega - \frac{1}{\omega L_k} = \varepsilon_0 \omega \left(1 - \frac{\omega_\rho^2}{\omega^2}\right) = \omega \varepsilon^*(\omega), \tag{2.12}$$

and

$$\varepsilon^*(\omega) = \varepsilon_0 \left(1 - \frac{\omega_\rho^2}{\omega}\right),$$

where $\omega_\rho^2 = \frac{1}{\varepsilon_0 L_k}$ - plasma frequency.

Now relationship (2.1) can be rewritten as

$$rot \vec{H} = \omega \varepsilon_0 \left(1 - \frac{\omega_\rho^2}{\omega^2}\right) \vec{E}_0 \cos \omega t, \tag{2.13}$$

or

$$rot\ \vec{H} = \omega \varepsilon^*(\omega) \vec{E}_0 \cos \omega t\,. \tag{2.14}$$

It is accepted to call the dielectric constant of dielectric depending on the frequency. In actuality the value $\varepsilon^*(\omega)$ includes simultaneously the dielectric constant of vacuum and the specific kinetic inductance of plasma and it is determined by the relationship

$$\varepsilon^*(\omega) = \frac{\sigma_X}{\omega}, \tag{2.15}$$

is obvious that σ_X can be recorded, also, on other:

$$\sigma_X = \varepsilon_0 \omega - \frac{1}{\omega L_k} = \frac{1}{\omega L_k}\left(\frac{\omega^2}{\omega_\rho^2} - 1\right) = \frac{1}{\omega L_k^*}, \tag{2.16}$$

where

$$L_k^*(\omega) = \frac{L_k}{\left(\frac{\omega^2}{\omega_\rho^2} - 1\right)} = \frac{1}{\sigma_X \omega}\,. \tag{2.17}$$

That recorded thus $L_k{}^*(\omega)$ also includes and ε_0 and L_k.

Relationship (2.12) and (2.16) are equivalent and we with the identical success can assert that the plasma is characterized by the not frequency-dependent dielectric constant $\varepsilon^*(\omega)$, but by the frequency-dependent kinetic inductance $L^*(\omega)$.

With the use of the parameters $\varepsilon^*(\omega)$ and $L^*(\omega)$ equation (2.10) it is possible to rewrite

$$rot\vec{H}=\omega\varepsilon^*(\omega)\vec{E}_0\cos\omega t\ , \tag{2.18}$$

or

$$rot\vec{H}=\frac{1}{\omega L_k{}^*(\omega)}\vec{E}_0\cos\omega t\ . \tag{2.19}$$

Records (2.18) (2.19) are also equivalent.

Thus, the parameter ε* *(ω)* is not dielectric constant, although has its dimensionality. The same relates also to *L* (ω)*.

It is easy to see that

$$\varepsilon^*(\omega)=\frac{\sigma_X}{\omega}\ , \tag{2.20}$$

$$L_k{}^*(\omega)=\frac{1}{\sigma_X\omega}\ . \tag{2.21}$$

These relationships determine physical sense and designation of the parameters ε* *(ω)* and *L* (ω)*.

To use ε* *(ω)* and *L* (ω)* for finding the energy according to the formulas

$$W_E=\frac{1}{2}\varepsilon E_0^2 \tag{2.22}$$

and

$$W_j=\frac{1}{2}L_k j_0^2 \tag{2.23}$$

is cannot. Therefore was obtained a formula of the type of relationship (1.15), namely [1]:

$$W=\frac{1}{2}\cdot\frac{d\left[\omega\varepsilon^*(\omega)\right]}{d\omega}E_0^2\ . \tag{2.24}$$

From relationship (2.24) we obtain

$$W_\Sigma=\frac{1}{2}\varepsilon_0 E_0^2+\frac{1}{2}\cdot\frac{1}{\omega^2 L_k}E_0^2=\frac{1}{2}\varepsilon_0 E_0^2+\frac{1}{2}L_k j_0^2\ . \tag{2.25}$$

We will obtain the same result, after using the formula

$$W=\frac{1}{2}\cdot\frac{d\left[\dfrac{1}{\omega L_k{}^*(\omega)}\right]}{d\omega}E_0^2\ . \tag{2.26}$$

As in the case parallel circuit, it is analogous $C^*(\omega)$ and $L^*(\omega)$ values $\varepsilon^*(\omega)$ $L_k^*(\omega)$ separately completely characterize the electrodynamic properties of plasma. Case

$$\varepsilon^*(\omega) = 0,$$

$$L_k^*(\omega) = \infty \, . \tag{2.27}$$

It corresponds to the resonance of current densities, namely the bias current and conduction current.

Let us show that under specific conditions in the nonmagnetized plasma can exist transverse the resonance with respect to the direction of propagation of electromagnetic waves.

Is known that the plasma resonance is longitudinal. There were no other resonances of any kind, except plasma, earlier known on existence in the nonmagnetic plasma. But it occurs that in the confined plasma the transverse resonance can exist, and the frequency of this resonance coincides with the frequency of plasma resonance, i.e. these resonance are degenerate. For explaining the conditions for the excitation of this resonance let us examine the long line, which consists of two ideally conducting planes, as shown in Fig. 1. Let us examine the case, when this line is located in the vacuum.

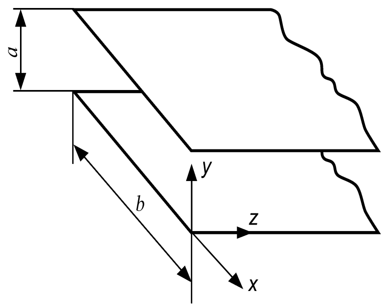

Fig. 1. The two-wire circuit, which consists of two ideally conducting planes

If we to the extended line connect dc power supply U, then the energy, stored up in the electric field of line, will be written down

$$W_{E\Sigma} = \frac{1}{2}\varepsilon_0 E^2 abz = \frac{1}{2} C_{E\Sigma} U^2, \tag{2.28}$$

where $E = \dfrac{U}{a}$ - tension of electric field in the line.

$$C_{E\Sigma} = \varepsilon_0 \frac{bz}{a} \tag{2.29}$$

it represents the total capacitance of line. Value $C_E=\varepsilon_0\frac{b}{a}$ corresponds to the linear capacity of line, whereas value ε_0 is the specific capacity of medium, in this case of vacuum.

Specific potential electric field energy is written as

$$W_E=\frac{1}{2}\varepsilon_0 E^2. \tag{2.30}$$

If we line short out at a distance *z of* rel.un. of beginning and to connect to it the source of the direct current of *I*, then the energy, stored up in the magnetic field of line, will be written down

$$W_{H\Sigma}=\frac{1}{2}\mu_0 H^2 abz=\frac{1}{2}L_{H\Sigma}I^2. \tag{2.31}$$

Since $H=\frac{I}{b}$, immediately let us write down

$$L_{H\Sigma}=\mu_0\frac{az}{b}, \tag{2.32}$$

where $L_H=\mu_0\frac{a}{b}$ the summary inductance of line.

The value $L_H=\mu_0\frac{a}{b}$ is the linear inductance of line, and μ_o corresponds to the specific inductance of medium, in this case of vacuum.

The specific energy of magnetic field in this case will be written down

$$W_H=\frac{1}{2}\mu_0 H^2. \tag{2.33}$$

Subsequently for the larger clarity of the obtained results, together with their mathematical idea, we will use the method of equivalent diagrams. It is evident that with an increase z. $C_{E\Sigma}$, $L_{H\Sigma}$ they increase; therefore the section of the line of the long of dz of can be represented in the form the equivalent diagram, shown to Fig.2.a.

If we into the extended line place the plasma, charge carriers in which can move without the losses, and in the transverse direction pass through the plasma the current, then charges, moving with the definite speed, will accumulate kinetic energy. Since the transverse current density in this line is determined by the relationship

$$j=\frac{I}{bz}=neV, \tag{2.34}$$

that summary kinetic energy of all moving charges will be written down

$$W_{k\Sigma}=\frac{1}{2}\cdot\frac{m}{ne^2}abzj^2=\frac{1}{2}\cdot\frac{m}{ne^2}\frac{a}{bz}I^2 \,. \qquad (2.35)$$

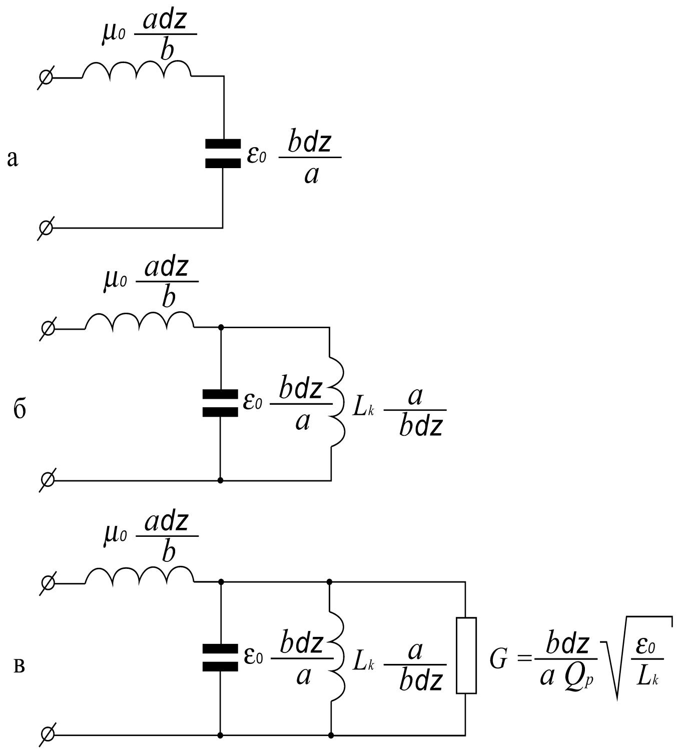

Fig. 2. а - the equivalent the schematic of the section of two-wire circuit; б - the equivalent the schematic of the section of the two-wire circuit, filled with plasma without the losses; в - the equivalent the schematic of the section of the two-wire circuit, filled with the plasma, in which there are ohmic losses

But from other side

$$W_{k\Sigma}=\frac{1}{2}L_{k\Sigma}I^2 \,, \qquad (2.36)$$

where $L_{k\Sigma}$ - complete kinetic inductance of line. Consequently

$$L_{k\Sigma}=\frac{m}{ne^2}\cdot\frac{a}{bz} \,. \qquad (2.37)$$

Thus, the value

$$L_k=\frac{m}{ne^2} \qquad (2.38)$$

the role of the specific kinetic inductance of this medium plays.

We already previously introduced this value in another manner (see relationship (2.4)). Relationship (2.38) is obtained for the case of the direct current, when current distribution is uniform. From relationship (2.37) is evident that in contrast to and of the value of with an increase in does not increase, but it decreases. This is understandable from a physical point of view, connected this with the fact that with an increase in a quantity of parallel-connected inductive elements grows. the equivalent the schematic of the section of the line, filled with the plasma, in which there are no losses, it is shown in Fig. 2. б. Line itself in this case will be equivalent to parallel circuit with the lumped parameters:

$$C=\frac{\varepsilon_0 bz}{a} \text{ и } L=\frac{L_k a}{bz}. \tag{2.39}$$

But if we calculate the resonance frequency of this outline, then it will seem that this frequency generally not on what sizes depends, actually:

$$\omega_\rho^2=\frac{1}{CL}=\frac{1}{\varepsilon_0 L_k}=\frac{ne^2}{\varepsilon_0 m}. \tag{2.40}$$

Is obtained the very interesting result, which speaks, that the resonance frequency macroscopic of the resonator examined does not depend on its sizes. Impression can be created, that this is plasma resonance, since. the obtained value of resonance frequency exactly corresponds to the value of this resonance. But it is known that the plasma resonance characterizes longitudinal waves in the long line they, while occur transverse waves. In the case examined the value of the phase speed in the direction of is equal to infinity and the wave vector $\vec{k}_z=0$. This result corresponds to the solution of system of equations (2.7) for the line with the assigned configuration (Fig. 2). From relationships (2.8) known result. In this case the wave number is determined by the relationship:

$$k_z^2=\frac{\omega^2}{c^2}\left(1-\frac{\omega_\rho^2}{\omega^2}\right), \tag{2.41}$$

and the group and phase speeds

$$V_g^2=c^2\left(1-\frac{\omega_\rho^2}{\omega^2}\right), \tag{2.42}$$

$$V_F^2=\frac{c^2}{\left(1-\frac{\omega_\rho^2}{\omega^2}\right)}, \tag{2.43}$$

where $c=\left(\frac{1}{\mu_0\varepsilon_0}\right)^{1/2}$ - speed of light in the vacuum.

In this plasma the phase speed of electromagnetic wave is equal to infinity. Consequently, at each moment of time pour on distribution and currents in this line uniform and it does not depend on the coordinate z , but current in the planes of line in the direction of is absent. Consequently, current in the planes of line in the direction z is absent. This, from one side, it means that the inductance $L_{H\Sigma}$ will not have effects on electrodynamic processes in this line, but instead of the conducting planes can be used any planes or devices, which limit plasma on top and from below.

From the relationships (2.41-2.43) it is not difficult to see that at the point of ω=ωρ we deal concerning the transverse resonance with the infinite quality. The fact that in contrast to the plasma, this resonance is transverse, will be one can see well for the case, when the quality of this resonance does not be equal to infinity. In this case , and in the line will be extended the transverse wave, the direction of propagation of which will be perpendicular to the direction of the motion of charges. The examination of this task was begun from the examination of the plasma, limited from two sides by the planes of long line. But in the process of this examination it is possible to draw the conclusion that the frequency of this resonance generally on the dimensions of line does not depend. It means, resonance will be observed, also, in the unbounded medium. Thus, in the limitless plasma besides the Langmuir resonance, which characterizes longitudinal waves, can exist transverse resonance. Since the frequencies of these resonances coincide, they are degenerate. It should be noted that the fact of existence of this resonance previously was not realized and in the literature it was not described. Before to pass to the more detailed study of this problem, let us pause at the energy processes, which occur in the line in the case of the absence of losses examined.

Pour on the characteristic impedance of plasma, which gives the relation of the transverse components of electrical and magnetic, let us determine from the relationship

$$Z=\frac{E_y}{H_x}=\frac{\mu_0\omega}{k_z}=Z_0\left(1-\frac{\omega_\rho^2}{\omega^2}\right)^{-1/2}, \tag{2.44}$$

where $Z_0=\sqrt{\frac{\mu_0}{\varepsilon_0}}$ - characteristic (wave) resistance of vacuum.

The obtained value Z is characteristic for the transverse electrical waves in the waveguides. It is evident that when $\omega \to \omega_0$, $Z \to \infty$, $H \to 0$. When $\omega > \omega_\rho$ in the plasma there is electrical and magnetic component of field. The specific energy of these pour on it will be written down:

$$W_{E,H}=\frac{1}{2}\varepsilon_0 E_{0y}^2+\frac{1}{2}\mu_0 H_{0x}^2 . \tag{2.45}$$

Thus, the energy, concluded in the magnetic field, in $\left(1-\frac{\omega_\rho^2}{\omega^2}\right)$ of times is less than the energy, concluded in the electric field. Let us note that this examination, which is traditional in the electrodynamics, is not complete, since. in this case is not taken into account one additional form of energy, namely kinetic energy of charge carriers. Occurs that pour on besides the waves of electrical and magnetic, that carry electrical and magnetic energy, in the plasma there exists even and the third - kinetic wave, which carries kinetic energy of current carriers. The specific energy of this wave is written:

$$W_k=\frac{1}{2}L_k j_0^2=\frac{1}{2}\cdot\frac{1}{\omega^2 L_k}E_0^2=\frac{1}{2}\varepsilon_0\frac{\omega_\rho^2}{\omega^2}E_0^2 . \tag{2.46}$$

Thus, total specific energy is written as

$$W_{E,H,j}=\frac{1}{2}\varepsilon_0 E_{0y}^2+\frac{1}{2}\mu_0 H_{0x}^2+\frac{1}{2}L_k j_0^2 . \tag{2.47}$$

Thus, for finding the total energy, by the prisoner per unit of volume of plasma, calculation only pour on and it is insufficient.

$$\omega = \omega_\rho$$

$$W_H = 0 \tag{2.48}$$

$$W_E = W_k,$$

i.e. magnetic field in the plasma is absent, and plasma presents macroscopic electromechanical resonator with the infinite quality, ωρresounding at the frequency.

Since with the frequencies $\omega > \omega_\rho$ the wave, which is extended in the plasma, it bears on itself three forms of the energy: electrical, magnetic and kinetic, then this wave can be named [elektromagnitokineticheskoy]. Kinetic wave represents the wave of the current density $\vec{j}=\frac{1}{L_k}\int\vec{E}dt$. This wave is moved with respect to the electrical wave the angle π/2.

Until now, a physically unrealizable case has been considered where there are no losses in the plasma, which corresponds to an infinite Q-factor of the plasma resonator. If losses are located, moreover completely it does not have value, by what physical processes such losses are caused, then the quality of plasma resonator will be finite quantity. For this case of Maxwell's equation they will take the form:

$$rot\vec{E} = -\mu_0 \frac{\partial \vec{H}}{\partial t},$$

$$rot\vec{H} = \sigma_{p.ef} \vec{E} + \varepsilon_0 \frac{\partial \vec{E}}{\partial t} + \frac{1}{L_k} \int \vec{E} dt. \qquad (2.49)$$

The presence of losses is considered by the term $\sigma_{p.ef}\vec{E}$, , and, using near the conductivity of the index *ef*, , it is thus emphasized that us does not interest very mechanism of losses, but only very fact of their existence interests. But in this case, if we even do not make the attempt to examine the physical mechanism of the appearance of losses, we must at least know how to measure $\sigma_{r.ef}$.

For measuring should be selected the section of line by the length of , whose value is considerably lower than the wavelength in the plasma. This section will be equivalent to outline with the lumped parameters:

$$C = \varepsilon_0 \frac{bz_0}{a}, \qquad (2.50)$$

$$L = L_k \frac{a}{bz_0}, \qquad (2.51)$$

$$G = \sigma_{\rho.ef} \frac{bz_0}{a}, \qquad (2.52)$$

where G - conductivity, connected in parallel C and L .

Conductivity and quality in this outline enter into the relationship:

$$G = \frac{1}{Q_\rho} \sqrt{\frac{C}{L}}. \qquad (2.53)$$

Taking into account (2.50-2.52), we obtain

$$\sigma_{\rho.ef} = \frac{1}{Q_\rho} \sqrt{\frac{\varepsilon_0}{L_k}}. \qquad (2.54)$$

Thus, measuring its own quality plasma of the resonator examined, it is possible to determine .

Using (2.54) and (2.49) we will obtain:

$$rot\vec{E} = -\mu_0 \frac{\partial \vec{H}}{\partial t},$$

$$rot\vec{H} = \frac{1}{Q_\rho} \sqrt{\frac{\varepsilon_0}{L_k}} \vec{E} + \varepsilon_0 \frac{\partial \vec{E}}{\partial t} + \frac{1}{L_k} \int \vec{E} dt. \qquad (2.55)$$

The equivalent the schematic of this line, filled with dissipative plasma, is represented in Fig. 2.2в.

Let us examine the solution of system of equations (2.55) at the point of , in this case, since of $\varepsilon_0 \frac{\partial \vec{E}}{\partial t} + \frac{1}{L_k} \int \vec{E} dt = 0$, (2.56)

we obtain

$$rot\vec{E} = -\mu_0 \frac{\partial \vec{H}}{\partial t},$$
$$rot\vec{H} = \frac{1}{Q_P} \sqrt{\frac{\varepsilon_0}{L_k}} \vec{E}. \qquad (2.57)$$

The solution of this system of equations is well known. If there is an interface between the vacuum and the medium, whose parameters are determined by equations (2.57), then the surface impedance of this credy is written

$$Z = \frac{E_{tg}}{H_{tg}} = \sqrt{\frac{\omega_p \mu_0}{2\sigma_{p.ef.}}} (1+i), \qquad (2.58)$$

where $\sigma_{p.ef} = \frac{1}{Q_p} \sqrt{\frac{\varepsilon_0}{L_k}}$.

Certainly, in this approach there is a certain inaccuracy, since. surface impedance depends on which connection (local or nonlocal) between the field and the current. However, in spite of this simplification of approach, the qualitative picture of the obtained results will be accurate. The it is another matter that this task can be solved more strictly.

3. Dielectric medium.

The presence in dielectric of bound charges leads to their polarization during the imposition on the dielectric of electrical pour on. On the polarization is spent additional energy, which is selected in the source of field and thus in the dielectric additional electrostatic energy is accumulated.

For the dielectrics the amount of the displacement of the polarizable charges from the position of equilibrium is determined by the value of electric field and by the coefficient of elasticity β , of that characterizing the elasticity of the binding forces of charges. These values are connected with the relationship [2-4]

$$-\omega^2 \vec{r}_m + \frac{\beta}{m} \vec{r}_m = \frac{e}{m} \vec{E}, \qquad (3.1)$$

where $\vec{r}_m$ - the deviation of charges from the position of equilibrium.

Designating the resonance frequency of the bound charges through ω_0, and taking into account that $\omega_0 = \beta / m$, from (3.1) we obtain

$$r_m = -\frac{e^2}{m(\omega^2 - \omega_o^2)}. \tag{3.2}$$

Thus, polarization vector takes the form:

$$\vec{P}_m{}^* = -\frac{ne^2}{m} \cdot \frac{1}{(\omega^2 - \omega_0^2)} \vec{E}. \tag{3.3}$$

Since

$$\vec{P} = \varepsilon_0 (\varepsilon - 1) \vec{E}, \tag{3.4}$$

immediately we obtain

$$\varepsilon'_\partial{}^*(\omega) = 1 - \frac{ne^2}{\varepsilon_0 \ m} \cdot \frac{1}{\omega^2 - \omega_0^2}. \tag{3.5}$$

It is accepted to call the dielectric constant of dielectric depending on the frequency. The absolute value of the dielectric constant of dielectric is determined from the relationship

$$\varepsilon^*(\omega) = \varepsilon_0 (1 - \frac{ne^2}{\varepsilon_0 m} \frac{1}{\omega^2 - \omega_0^2}). \tag{3.6}$$

Again we obtained the dielectric constant depending on the frequency. Let us look, however, that in reality represents the value $\varepsilon_\partial^{©}{}^*(\omega)$. As earlier, let us designate $L_{k\partial} = \frac{m}{ne^2}$ and $\omega_{p.\partial} = \frac{1}{L_{k\partial}\varepsilon_0}$. even when these designations, we immediately focus attention on the fact that the being varied charges of dielectric also have a mass, and it means they possess inertia properties; therefore with the examination of these processes will appear their kinetic inductance. Let us rewrite relationship (4)

$$\varepsilon_\partial{}^*(\omega) = \varepsilon_0 (1 - \frac{\omega_{p\partial}^2}{\omega^2 - \omega_0^2}). \tag{3.7}$$

Let us examine two limiting cases: $\omega >> \omega_0$ and $\omega << \omega_0$.

In the first case, when $\omega >> \omega_0$,

$$\varepsilon_\partial{}^*(\omega) = \varepsilon_0 (1 - \frac{\omega_{p\partial}^2}{\omega^2}), \tag{3.8}$$

and the behavior of dielectric is differed in no way from the behavior of plasma. This passage to the limit led to the thought about the fact that between the dielectrics and the plasma at the high frequencies there is no difference whatever, that also served as base for the introduction in the conductors of polarization vector [1]. In actuality fundamental difference in the behavior of dielectrics and conductors at the high frequencies nevertheless remains. It is simple in the dielectrics at the very high frequencies, in connection with the presence of inertia, the amplitude of the fluctuations of charges is very small; therefore polarization vector is small, while in the conductors it is always equal to zero.

For the case $\omega << \omega_0$

$$\varepsilon_{\partial}{}^{*}(\omega)=\varepsilon_0\left(1+\frac{\omega_{p\partial}^2}{\omega_0^2}\right), \tag{3.9}$$

and the dielectric constant of dielectric on frequency does not depend, and it is greater than the dielectric constant of vacuum $(1+\frac{\omega_{p\partial}^2}{\omega_0^2})$ once. This result is also clear. The frequencies in question simply no longer affect the inertia properties of charges and dielectric constant approaches its value with the permanent fields

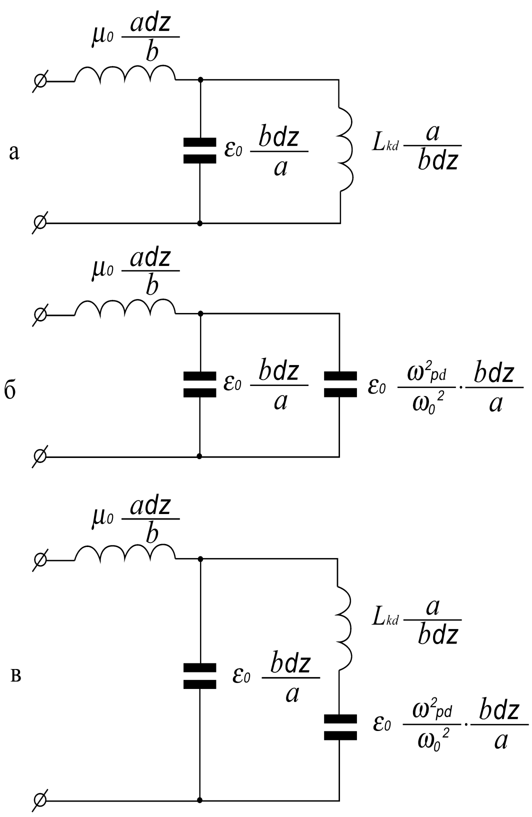

Fig. 3. a - the equivalent the schematic of the section of the two-wire circuit, filled with dielectric, for the case $\omega >> \omega_0$; б - the equivalent the schematic of the section of the two-wire circuit, filled with dielectric, for the case $\omega << \omega_0$; в - the equivalent the schematic of the section of the two-wire circuit, filled with dielectric, for entire frequency spectrum.

Equivalent diagrams for these two cases are represented in Fig. 3a and 3б. It is not difficult to show that for entire frequency spectrum the equivalent the schematic of dielectric presents the sequential oscillatory circuit, connected in parallel to the capacity, formed due to the presence in the vacuum of the dielectric constant ε_0. This equivalent diagram is represented in Fig. 3в. It is obvious that the resonance frequency of such series circuit is determined by the relationship

$$\omega_0^2 = \frac{1}{L_k \varepsilon_0 \left(\frac{\omega_{p\partial}^2}{\omega_0^2} \right)}, \tag{3.10}$$

and, as in the case of plasma, it does not depend on the dimensions of line, i.e. we have the macroscopic resonator, which resounds at the same frequency, at which resounds the separately undertaken connected pair of charges. This conclusion is valid only when the connection between the separately undertaken pairs of bound charges it is absent.

However, the parameter $\varepsilon_\partial{}^*(\omega)$, as in the case of plasma, presents specific reactive dielectric conductance, divided into the frequency. However, in contrast to the plasma it includes already three independent variables from the frequency of the parameter: ε_0 , $L_{k\partial}$ and the static dielectric constant of the dielectric $\varepsilon_0 \frac{\omega_{p\partial}^2}{\omega_0^2}$. Resonance in the dielectric begins when $\varepsilon_\partial{}^*(\omega) \to -\infty$.

In the dielectric three waves also are propagated: magnetic, electrical and kinetic, each of which transfers their form of energy. It is easy to calculate the dependence of these energies on the frequency; however, we do this will not for the purpose of the reduction of computations.

4. Magnetic medium

Resonance processes in the plasma and the dielectrics are characterized by the fact that in the process of fluctuations occurs the alternating conversion of electrostatic energy into the kinetic kinetic energy of charges and vice versa. This process can be named electrokinetic and all devices: lasers, masers, filters, etc, which use this process, can be named electrokinetic.

However, there is another type of resonance – magnetic. If we use ourselves the existing ideas about the dependence of magnetic permeability on the frequency, then it is not difficult to show that this dependence is connected with the presence of magnetic resonance. In order to show this, let us examine the concrete example of ferromagnetic resonance. If we magnetize ferrite, after applying the stationary field of in parallel to the axis of , the like to relation to the external variable field medium will come out as anisotropic magnetic material with the complex permeability in the form of tensor [5]

$$\mu = \begin{pmatrix} \mu_T*(\omega) & -i\,\alpha & 0 \\ i\,\alpha & \mu_T*(\omega) & 0 \\ 0 & 0 & \mu_L \end{pmatrix}, \quad (4.1)$$

where

$$\mu_T*(\omega) = 1 - \frac{\Omega|\gamma|M_0}{\mu_0(\omega^2-\Omega^2)}, \;\; \alpha = \frac{\omega|\gamma|M_0}{\mu_0(\omega^2-\Omega^2)}, \;\; \mu_L = 1, \quad (4.2)$$

moreover

$$\Omega = |\gamma|\, H_0 \quad (4.3)$$

is natural frequency of precession, and

$$M_0 = \mu_0(\mu-1)H_0 \quad (4.4)$$

is a magnetization of medium.

Taking into account (4.4) and (4.5) for $\mu_T*(\omega)$, it is possible to write down

$$\mu_T*(\omega) = 1 - \frac{\Omega^2(\mu-1)}{\omega^2-\Omega^2}. \quad (4.5)$$

If we consider that the electromagnetic wave is propagated along the axis of of and there are components pour on of and , then in this case the first equation Of [maksvella] will be written down:

$$rot\vec{E} = \frac{\partial \vec{E}_Z}{\partial x} = \mu_0\mu_T \frac{\partial \vec{H}_y}{\partial t}. \quad (4.6)$$

Taking into account (4.5), we will obtain

$$rot\vec{E} = \mu_0\left[1 - \frac{\Omega^2(\mu-1)}{\omega^2-\Omega^2}\right]\frac{\partial \vec{H}_y}{\partial t}. \quad (4.7)$$

For the case of $\omega >> \Omega$ we have

$$rot\vec{E}=\mu_0\left[1-\frac{\Omega^2(\mu-1)}{\omega^2}\right]\frac{\partial \vec{H}_y}{\partial t}. \tag{4.8}$$

Assuming $\vec{H}_y = \vec{H}_{y0}\, sin\ \omega t$ and taking into account that in this case

$$\frac{\partial \vec{H}_y}{\partial t}=-\omega^2\int \vec{H}_y dt, \tag{4.9}$$

we obtain from (4.1)

$$rot\vec{E} = \mu_0 \frac{\partial \vec{H}_y}{\partial t} + \mu_0 \Omega^2(\mu-1)\int \vec{H}_y dt, \tag{4.10}$$

or

$$rot\vec{E}=\mu_0\frac{\partial \vec{H}_y}{\partial t}+\frac{1}{C_k}\int \vec{H}_y dt. \tag{4.11}$$

For the case $\omega << \Omega$

$$rot\vec{E}=\mu_0\mu\frac{\partial \vec{H}_y}{\partial t}, \tag{4.12}$$

Value

$$C_k=\frac{1}{\mu_0\ \Omega^2(\mu-1)} \tag{4.13}$$

let us name the kinetic capacity [6]. with which is connected existence of this parameter, and its what physical sense? If the direction of magnetic moment does not coincide with the direction of external magnetic field, then the vector of this moment begins to precess around the vector of magnetic field with the frequency Ω. The magnetic moment $\vec{m}$ possesses in this case potential energy $U_m=-\vec{m}\cdot\vec{B}$. This energy similar to energy of the charged capacitor is potential, because precessional motion, although is mechanical, however, it not inertia and instantly it does cease during the removal of magnetic field. However, with the presence of magnetic field precessional motion continues until the accumulated potential energy is spent, and the vector of magnetic moment will not become parallel to the vector of magnetic field $\vec{H}_0$.

The equivalent diagram of the case examined is given in Fig. 4. At the point $\omega=\Omega$ occurs magnetic resonance, in this case $\mu_t(\omega) \rightarrow -\infty$. The resonance frequency of macroscopic magnetic resonator, as can easily be seen of the equivalent diagram, also does not depend on the dimensions of line and is equal Ω.

Thus, the parameter

$$\mu_H{}^*(\omega)=\mu_0\left[1-\frac{\Omega^2(\mu-1)}{\omega^2-\Omega^2}\right] \tag{4.14}$$

is not the frequency dependent magnetic permeability, but it is the combined parameter, including μ_{of} $_0$, μ and from$_{k\ of}$, which are included on in accordance with the equivalent diagram, depicted in Fig 4.

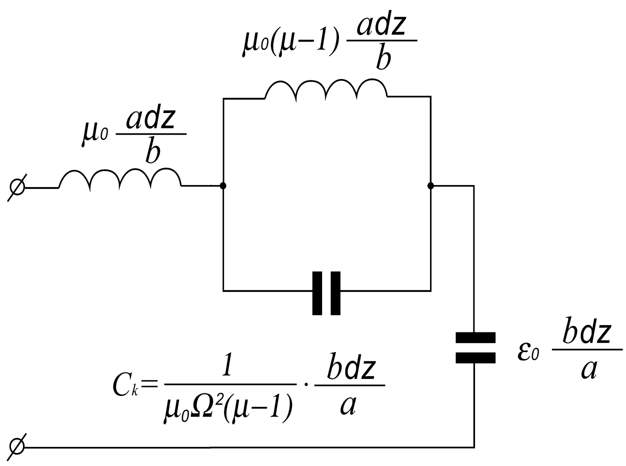

Fig. 4. Equivalent the schematic of the two-wire circuit of that filled with magnetic material.

Is not difficult to show that in this case there are three waves: electrical, magnetic and the wave, which carries potential energy, which is connected with the precession of magnetic moments around the vector $\vec{H}_0$. For this reason such waves can be named electromagnticpotentsial. All devices, in which are used such waves, also can be named electromagnticpotentsial.

4. Conclusions

Thus, we established that together with the fundamental parameters $\varepsilon\varepsilon_0$ and $\mu\mu_0$, which characterize the specific forms of energy, stocked or transferred on medium, namely, electrical and magnetic energy, there are two additional fundamental material parameters L_k and C_k. With these parameters are connected two forms of energy, namely: kinetic and potential, which can be accumulated or be transferred in the material media. If the parameter L_k sometimes and was used with the description of some physical phenomena, for example, in the superconductors [7], that we earlier C_k did not know about existence. Use of all four fundamental parameters $\varepsilon\varepsilon_0$, $\mu\mu_0$, L_k and C_k gives the clear physical picture of the wave and resonance processes, which occur in the material media with the presence in them of electromagnetic pour on. Earlier it was always considered that in the material media the electromagnetic waves are propagated and only these waves transfer energy. However, as we see now, this terminology incomplete. In actuality in the material media magnetic-electrokinetic or electro -magnitopotentsialnye waves are propagated. Resonances in the material media also bear their specific character. In contrast to the electromagnetic resonances in the locked planes, when the energy exchange occurs between the magnetic and electric fields, in the material media there are two forms of resonances. The first - electrokinetic, when electric field energy is converted into the kinetic energy of charge carriers and vice versa, but magnetic pour on no generally. The second resonance it is possible to name magnetopotensial, when the potential energy, accumulated in the precessional motion of magnetic moments, can return into the external space at the frequency of precession.

Thus, such concepts as the dispersion of the dielectric and magnetic constants physically of neobosnovanny, although the parameters $\varepsilon*(\omega)$ and $\mu*(\omega)$ are convenient for the mathematical description of the processes, which occur in the material media. However, we always must remember that they represent. Especially importantly clear explanation of their physical sense in the educational process.

7. Operating principle of Van de Graaff generator, collectorless generators and the multipliers of constant voltage

The physical principle of the work of Van de Graaff generator, until now, is not explained, but there is only a technical oscillator circuit. There are no calculated relationships, which give the possibility to calculate this generator. In the article physical oscillator circuit and its mathematical model is represented, and it is also shown that the principle of its operation is based on the use of a law of parametric self-induction. Are obtained the calculated relationships, which make it possible to calculate the parameters of generator. Collectorless generators and multipliers of constant voltage are examined.

1. Introduction

Van de Graaff generator (Fig. 1) long time it was the basic source of high voltages and widely it was used in the static accelerators. It and, until now, successfully is used in different laboratories in the entire world.

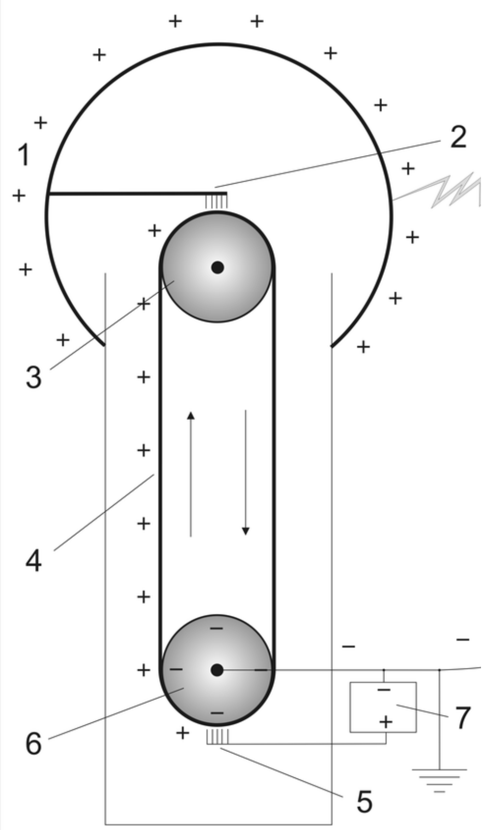

Fig. 1. Van de Graaff generator

The first generator was developed by American physicist by Robert by Van de Graaff in 1929 the year and made it possible to obtain a potential difference to 80 the kilovolts . In 1931, 1933 they built the more powerful generators, which made it possible to reach voltage in 1 million and 7 millions of volts. But, without looking the almost centenary history of this generator, the principle of its operation is not known up to now.

Van de Graaff generator consists of dielectric (silk or rubber) tape 4, which it moves. With the aid of the revolving rollers 3 and 6, moreover upper roller dielectric, and lower metallic and is connected with the earth . The upper part of the tape is located in the metallic hemisphere 1. Two electrodes 2 and 5 in the form brushes are located at small distance from the tape and serve for the electrization of tape and removal from it of charges. The brush 5 serves for the ionization of air, high voltage on which will be given from the source 7. Resultant positive ions under the action of Coulomb force move to the grounded roller 6 and they settle on the tape. The moving tape transfers charge inside the sphere 1, where it it is removed by brush 2, under the action of Coulomb force charges they are pushed out to the surface of sphere and the field inside the sphere it is created only by booster charge on the tape. Thus, on the external surface of sphere is accumulated electric charge. The possibility of obtaining the high voltage is limited by the corona discharge , appearing with the ionization of air around the sphere.

Contemporary Van de Graaff generators instead of the tapes use the chains, which consist of the alternating metallic and plastic it is sectional, which are called the pelletrons .

Unfortunately, the given oscillator circuit is only technical diagram, but the physical principle of its action, until now, is not explained. It is not understandable, what reasons cause an increase in the potential of the charges, located on the tape, with its motion from bottom to top. Generator will unclearly also function, if the moving tape was arranged the horizontally earth's surface. Not clearly also, how can be changed the polarity of generator. But since neither the physical nor mathematical model of generator is thus far developed, its improvement can be carried out only by the trial-and-error method. With this is connected the circumstance that his construction practically did not change from the times of the invention of Van de Graaff generator.

2. Mathematical model of Van de Graaff generator

If there is a capacitor, whose capacity C , and this capacitor it is charged to a potential difference U_0 , that the energy, accumulated in it, is determined by the relationship

$$W_C = \frac{1}{2} C U_0^2 . \qquad (2.1)$$

Charge Q - accumulated in the capacity, is equal

$$Q_{C,U_0} = C U_0 . \qquad (2.2)$$

From relationship (2.1) it is evident that if the charge, accumulated in the capacity, remains constant, then voltage on it can be changed by changing the capacity. In this case is fulfilled the relationship

$$Q_{C,U} = CU = C_0 U_0 = const ,$$

where C, U - instantaneous values, and C_0, U_0 - initial values of these parameters.

This relationship presents the law of parametric self-induction [2-5].

The voltage on the capacity and the energy, accumulated in it, will be in this case determined by the relationships:

$$U = \frac{C_0 U_0}{C} = K U_0 \qquad (2.3)$$

and the energy, accumulated in the capacitor, will be equal

$$W_C = \frac{1}{2} \frac{(C_0 U_0)^2}{C} = K \frac{C_0 U_0^2}{2} . \qquad (2.4)$$

Coefficient

$$K = \frac{C_0}{C} \qquad (2.5)$$

let us name the transformation ratio of constant voltage. It is easy this coefficient by the passing track of changing the relation of capacities.

The incremental voltage, which can ensure this transformation, is determined from the relationship

$$\Delta U_C = \left(\frac{C_0}{C} - 1 \right) U_0 . \qquad (2.6)$$

As follows from the relationships (2.3) and (2.4) with the decrease of capacitance of capacitor on it increases not only voltage, but also the energy, stored up in the Ger. This energy is selected in the mechanical source, which ensures a change in the capacity. Therefore the transformer in question can be considered, and as the converter of mechanical energy into the electrical.

An increase in the energy, accumulated in the capacitor, with a change in its capacity is determined from the relationship

$$\Delta W_C = \frac{1}{2}(C_0 U_0)^2 \left(\frac{1}{C} - \frac{1}{C_0}\right). \tag{2.7}$$

Relationships (2.3-2.7) determine physics of the work of Van de Graaff generator. The moving metallic pelletrons or the sections of tape have relative to the earth a capacity, which during the motion of these sections relative to the earth changes according to the specific law. In the base of generator these sections should be loaded to the assigned potential of the specific sign. If the capacity of these sections will change relative to the earth, then will change the potential of the charges, located on them. In the upper part of the generator these sections betray charges with the high potential to sphere, charging it to the high voltage.

For calculating the generator it is necessary to know the initial potential of pelletrons and the law of variation in their capacity with respect to the earth during the motion of tape. Should be also known the distance of their displacement from the lower part of the generator, where they are charged, to its upper part, where they return their charge to sphere. Therefore in this case the main mathematical problem of calculating the generator is the presence of the dependence of the capacity of pelletrons from the distance to the earth. With the vertical position of generator this there will be one dependence, with the horizontal position - another. If tape moves in parallel to the earth, then this dependence will be absent, and generator work will not be. The precise calculation of the capacity of pelletrons relative to the earth to carry out difficultly, but a good approximation is assumption about the fact that the pelletrons present the conducting spheres, whose diameter is equal to their size. In this case it is necessary to calculate the capacity of the sphere of the intended size relative to the flat conducting surface, which is the earth. This dependence is known and is determined by formula [6]

$$\begin{aligned} C &= 4\pi\varepsilon a \sum_{n=1}^{\infty} \frac{\sinh\left[\ln\left(D+\sqrt{D^2-1}\right)\right]}{\sinh\left[n\ln\left(D+\sqrt{D^2-1}\right)\right]} = \\ &= 4\pi\varepsilon a\left(1+\frac{1}{2D}+\frac{1}{4D^2}+\frac{1}{8D^3}+\frac{1}{32D^5}+\ \ldots\ldots\right) \end{aligned}, \tag{2.8}$$

where $D=\frac{d}{2a}$, a - a radius of sphere, d - distance from the lower part of the generator to its upper part.

But during calculations should be considered also the capacity between the pelletrons, which it is easy to measure. In this case the capacity of pelletron with the number n with respect to the first pelletron can be calculated as $n-1$ the series-connected capacitors. In this case the total capacitance between the first pelletron and the pelletron with the number n will be determined by the relationship

$$\frac{1}{C_\Sigma}=\frac{1}{C_{1-2}}+\frac{1}{C_{2-3}}+.....+\frac{1}{C_{(n-1)-n}}.$$

The first term in the decomposition (2.8) represents the capacity of the secluded sphere and does not depend from the distance to the earth. Us they will interest only that capacity, which depends on distance.

In the case, when d it is considerably more than a in the relationship (2.8) it suffices to take only second term of expansion. In this case the dependence of the capacity of pelletron on the distance to be determined by the relationship

$$C=4\pi\varepsilon\frac{a^2}{d}. \qquad (2.9)$$

In the lower position of pelletron its capacity relative to the earth comprises

$$C_0=4\pi\varepsilon\frac{a^2}{d_0}, \qquad (2.10)$$

where d_0 the distance of pelletron to the earth in the lower position.

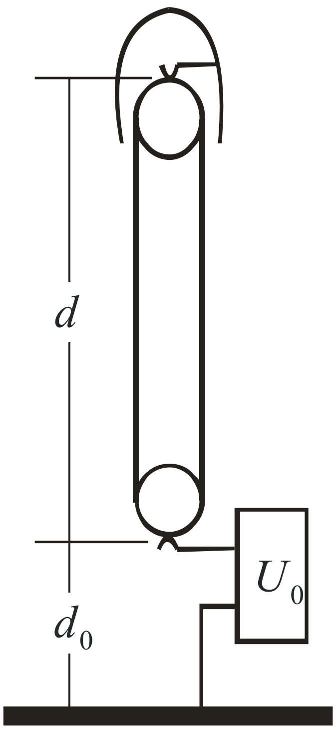

Fig. 2 Oscillator circuit

The transformation ratio of potential can be found from the relationship (2.5)

$$K=\frac{d}{d_0}.$$

Thus, are acquired all necessary data for calculating the generator. The practical oscillator circuit, in which are taken into account the principles examined, is represented in Fig. 2

In contrast to the construction, given in Fig. 1, both upper and lower roller they are made from dielectric, and lower and upper brushes slide on peletronam. Each peletron, moving around the lower roller, by means of the brush is charged from the voltage source U_0. On the polarity of this source depends the polarity of the voltage, manufactured by generator.

In order to increase transformation ratio, one should decrease d_0. With this purpose lower roller can be made composite. Its internal part should be carried out from the metal and grounded, and outside dressed collar from rubber or cylinder from the dielectric. In this case the thickness of collar or cylinder will be the size d_0. It is possible to enter and differently. Roller to make completely from the metal and to ground, and on the rubber tape of peletrony to apply the way of metallization. Then the thickness d_0 of belt will serve as size.

Earlier us lacked the possibility to calculate voltage and power of Van de Graaff generator, now this possibility is located. For this it follows to use relationships (2.3) and (2.7).

Let us give concrete example with the following parameters of the elements of the generator: rubber tape d_0 has a thickness 1 cm and a width 10 cm, which corresponds to a radius a of equivalent sphere 0.05 m. On this tape there are metallized square sections (pelletrons), which alternate with the same not metallized sections. The speed of belt 50 m/s, the distance between the lower and upper brushes d are 5 m, the voltage of the voltage source U_0 is equal 10 kV.

The voltage, generated by generator, will comprise with the parameters indicated

$$U=\frac{d}{d_0}U_0=5 \quad MV .$$

With the speed of belt 50 m/s the charge to sphere in second will return 250 pelletrons. Each peletron will return energy in accordance with the relationship (2.4). After using relationships (2.9) (2.10) we obtain the generatable power

$$P=500\pi\varepsilon\frac{a^2d}{d_0^2}U_0^2$$

Calculation according to this formula taking into account the given parameters gives power 174 W. This power considerably less than that power, which is necessary for the mechanical motion of tape.

Using relationships (2.1) and (2.4) it is possible to calculate the electrical efficiency of the generator, which is equal to the ratio of the manufactured energy to the energy, expended by the voltage source. In this case efficiency it will be equal

$$EFF = \frac{d^2}{d_0^2}.$$

With the parameters efficiency indicated it composes the value of $2.5\text{x}10^{4}$. This high efficiency means that practically entire mechanical energy (if we do not consider energy consumption for the drive of the motion of tape) it is expended on the production of electrical energy. By this high efficiency possesses none of the existing generators. Let us give the alternative oscillator circuit of van de Graff generator which it is represented in Fig. 3

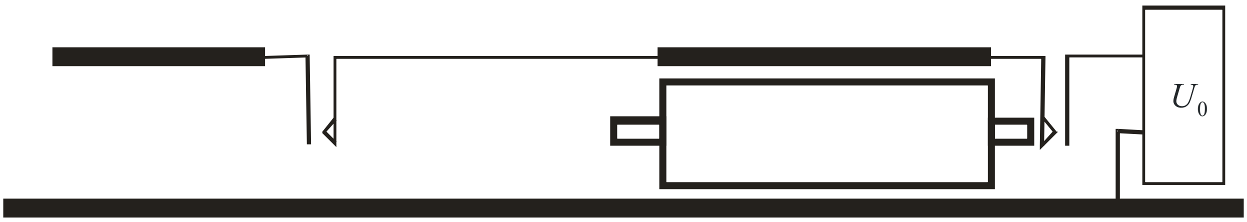

Fig. 3 Alternative oscillator circuit of van de Graff

In the diagram thick lines designated the facings of two parallel-plate capacitors. Solid line designated the lower facing, which is general for both capacitors. Between the facings of left capacitor is located the metallic plate, at ends of which are protrusions, with the aid of which can be locked and be opened contact pairs. When plate is located in the extreme by right position, it locks the contact pair, which connects the voltage source with the upper plate of right capacitor, charging it to the potential U_0 . In this position of plate the capacitance of right capacitor is maximum. When plate begins to be moved to the left, right contact pair is opened, disconnecting capacitor from the voltage source. During further motion of plate the capacitance of right capacitor begins to decrease according to the linear law and potential on it grows. In the end left situation, when plate exceeds the limits of right of capacitor, and potential on it reaches maximum value, occurs closing left contact pair and part from the left capacitor passes charge into the right capacitor, and their potentials are equalized. Further cycle is repeated with the return of plate to the end right position. Thus, the transformation of potential in this case occurs according to the already examined above diagram.

3. Collectorless generators and the multipliers of constant voltage

Collectorless constant-potential generators are not thus far created. Be absent also the transformers of constant voltage.

The schematic of the transformer of constant voltage , realizing the principle examined, is represented in Fig. 4.

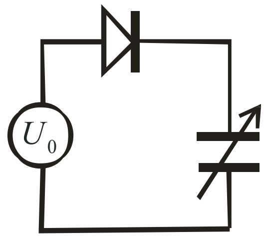

Fig. 4. Schematic of the transformer of constant voltage

In this diagram to the variable capacitor by means of the diode the dc power supply is connected U_0 The incremental voltage, which can ensure this transformer, is determined from the relationship (2.6).

It should be noted that this transformer can work only in the regime of an increase in the voltage, since. with the attempt to obtain the decrease of voltage across capacitor this cannot be made for that reason, that the diode ensures the straight connection of the voltage source to the capacitor and therefore voltage across capacitor decrease cannot. Properties of the transformer of constant voltage can be used for creating the dc power supply, whose diagram is given in Fig. 5.

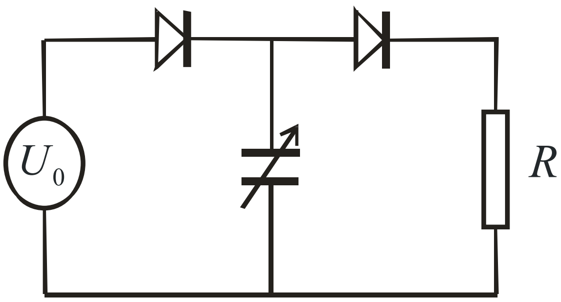

Fig. 5. Diagram of dc power supply.

In this diagram is present still one diode and load resistance R. In the initial state the capacitance of capacitor is equal C_0 , and voltage on it equally U_0 . At this time through the load resistance the current flows

$$I_0 = \frac{U_0}{R}.$$

In this case the energy, obtained by capacitor from the voltage source, is determined by the relationship (2.1)

As soon as capacitance of capacitor will begin to decrease, secondary voltage will appear on it. Secondary voltage through the right diode enters the resistances R.

In the following cycle proceeds an increase in the capacitance of capacitor from the values C to the values C_0. But voltage on it cannot be less than U_0, therefore the voltage source begins to charge the being increased capacity. And up to the moment, when capacitance value reaches value C_0, voltage on it will be equal U_0. During this cycle the left voltage source will repeatedly consume the energy, determined by the relationship, (2.1). In this case complete cycle to be completed and the system returns to the initial state.

The operating principle of the generator examined is such to the operating principle of the valve water pump, whose schematic is represented in Fig. 3 .

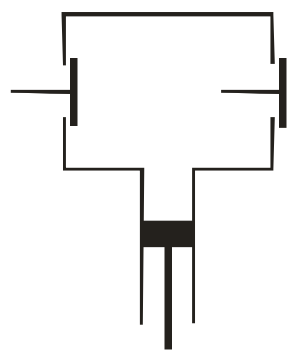

Fig. 3 Schematic of the valve water pump

With the displacement of piston downward left admission valve is opened, and water is sucked in into the cavity of pump. With the displacement of piston upward the water through the right release valve is ejected outside.

The role of valves in the schematic of the described generator diodes play, while the role of cylinder with the being moved piston performs variable capacitor.

Hence it follows that the basic problem of the creation of the proposed generator is the development of the capacitor, whose capacity changes with mechanical method. In this case the capacitor must have the great significances of initial and final capacity, also, with the large relation of these values.

Conclusion

The physical principle of the work of Van de Graaff generator, until now, was not finally described, but there is only a technical oscillator circuit. There are no calculated relationships, which give the possibility to calculate this generator. In the article physical oscillator circuit is represented and it is shown that the principle of its operation is based on the use of a law of parametric self-induction. Are obtained also the calculated relationships, which make it possible to calculate the parameters of generator. The calculation, carried out employing the proposed procedure, shows that the generator in question possesses the very high electrical efficiency, which is not accessible in the existing generators. Is examined the operating principle of the multiplier of constant voltage, and also the schematic of collectorless constant-potential generator.

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8. Parametric electric generator of Mende

1. Introduction

Energy electrical systems include the generator of electrical energy (further generator) and electric power line (LEP). Since the electric transmission up to the great distances is accomplished with the aid of high-voltage LEP, and generators have low output voltage, the intermediate component between the generator and LEP is the high-voltage step-up transformer. All elements indicated have energy losses, and their calculation shows that into these losses they can reach 10% the percentages. Consequently, a question of reduction in these losses is very important.

In essence, LEP are used for the transfer of alternating current; however, the lines of direct current have smaller losses to capacitive and inductive components. Therefore LEP on the direct current build when necessary to betray the separately large volumes of electric power. IN the USSR were built several electric power lines of the direct current: High-voltage line of direct current Moscow- Kashira- project “elba” ; High-voltage line of direct current Volgograd- Donbass ; High-voltage line of direct current Ekibastuz- center and other

The absence of the high-voltage generators, which directly generate constant voltage of the assigned magnitude with the necessary level of power, is the essential problem of the creation of power systems on the direct current. Therefore it is necessary to at first manufacture electric power on alternating current with the low voltages, then, using high-voltage transformers, to increase voltage and with the aid of the high-voltage rectifiers to further manufacture direct current. All these intermediate components have energy losses, what is the basic problem of such systems. Moreover they are very complex from a design point of view.

From the aforesaid it follows that the creation of the high-voltage direct-current generators, which immediately can generate the voltage of the assigned magnitude with the necessary levels of power, is the key problem of contemporary electro-energetics. Up to now such generators are not created.

2. Operating principle of parametric direct-current generator

If there is a capacitor, whose capacity C , and this capacitor it is charged to a potential difference U , that the energy, accumulated in it, is determined by the relationship

$$W_C = \frac{1}{2} C U^2 . \tag{2.1}$$

But charge Q , accumulated in the capacity, is equal

$$Q_{C,U} = CU . \tag{2.2}$$

From relationship (2.1) it is evident that if the charge, accumulated in the capacity, remains constant, then voltage on it can be changed by changing the capacity. In this case is fulfilled the relationship of

$$Q_{C,U}=CU=C_0U_0=const,$$

where of C and U - instantaneous values, and C_0 and U_0 - initial values of these parameters.

The voltage on the capacity and the energy, accumulated in it, will be in this case determined by the relationships:

$$U=\frac{C_0U_0}{C}=KU_0, \tag{2.3}$$

$$W_C=\frac{1}{2}\frac{(C_0U_0)^2}{C}. \tag{2.4}$$

Coefficient

$$K=\frac{C_0}{C}. \tag{2.5}$$

It can be named the multiplication factor (transformation) of constant voltage.

The schematic of voltage transformer , realizing the principle examined, is represented in Fig. 1.

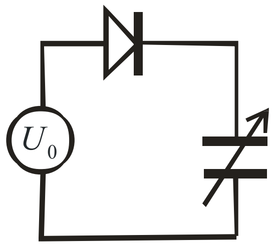

Fig. 1. Schematic of the transformer of constant voltage

In this diagram to the variable capacitor by means of the diode the dc power supply is connected U_0

The incremental voltage, which can ensure this transformer, is determined from the relationship

$$\Delta U_C=\left(\frac{C_0}{C}-1\right)U_0. \tag{2.6}$$

As follows from the relationships (2.3) and (2.4) with the decrease of capacitance of capacitor on it increases not only voltage, but also the energy, accumulated in the Ger.

It should be noted that this transformer can work only in the regime of an increase in the voltage, since. with the attempt to obtain the decrease of voltage across capacitor this cannot be made for that reason, that the diode ensures the straight connection of the voltage source to the capacitor and therefore voltage across capacitor decrease cannot.

An increase in the energy, accumulated in the capacitor, with a change in its capacity is determined from the relationship

$$\Delta W_C = \frac{1}{2}\left(C_0 U_0\right)^2 \left(\frac{1}{C} - \frac{1}{C_0}\right). \tag{2.7}$$

With a mechanical change in the capacitance of capacitor, the increase in the energy indicated ensures the spring mechanical energy source,

Properties of the transformer of constant voltage can be used for creating the high-voltage source of the direct current, whose diagram is given in Fig. 2

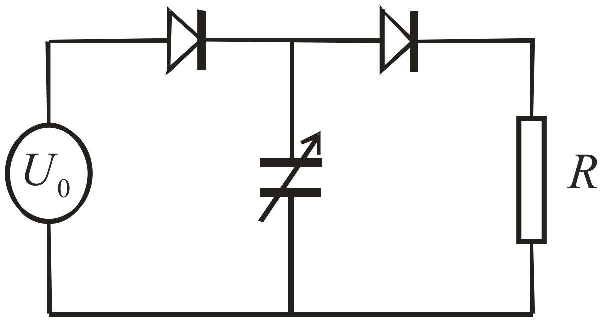

Fig. 2. Diagram of the high-voltage source of direct current

In this diagram is present still one diode and load resistance R .

In the initial state the capacitance of capacitor is equal C_0 , and voltage on it equally U_0 . At this time through the load resistance the current flows

$$I_0 = \frac{U_0}{R}.$$

In this case the energy, obtained by capacitor from the voltage source, comprises

$$W_0 = \frac{1}{2} C_0 U_0^2. \tag{2.8}$$

As soon as capacitance of capacitor will begin to decrease, the secondary voltage, assigned by the relationship will appear on it (2.5). This secondary voltage through the right diode enters on the load resistance R. The additional energy, isolated in this case during the load resistance, is determined by the relationship (2.7). For computed efficiencys of this process, it is necessary to compare the energy, spent by the right voltage source on the charging of capacitor and the energy, isolated during the load resistance. In this case efficiency it is defined as the relation of relationships (2.8) and (2.7).

$$КПД=\frac{\Delta W_C}{W_0}=\left(\frac{C_0}{C}-1\right)100\% . \tag{2.9}$$

In the following cycle proceeds an increase in the capacitance of capacitor from the values C to the values C_0. But voltage on it cannot be less than U_0 , therefore the left voltage source begins to charge the being increased capacity. And up to the moment, when capacitance value reaches value C_0, voltage on it will be equal U_0. During this cycle the left voltage source will repeatedly consume the energy, determined by the relationship (2.8). In this case complete cycle to be completed and the system will return to the initial state.

The operating principle of the generator examined is such to the operating principle of the valve water pump, whose schematic is represented in Fig. 3

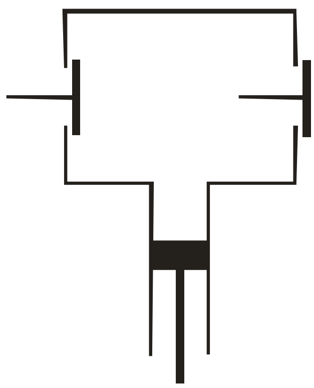

Fig. 3 Schematic of the valve water pump

With the displacement of piston downward left release valve is opened, and water is sucked in into the cavity of pump. With the displacement of piston upward the water through the right release valve is ejected outside.

The role of valves in the schematic of the described generator diodes play, while the role of cylinder with the being moved piston performs variable capacitor.

Hence it follows that the basic problem of the creation of the proposed generator is the development of the capacitor, whose capacity changes with mechanical method. In this case the capacitor must have the great significances of initial and final capacity, also, with the large relation of these values. This question can be solved by the way of using the technology of the creation of the ceramic capacitors, when titanate of barium, which has very large dielectric constant, is used as the dielectric between the capacitor plates. The construction of the generator, in which is used the principle indicated, it is shown in Fig. 4.

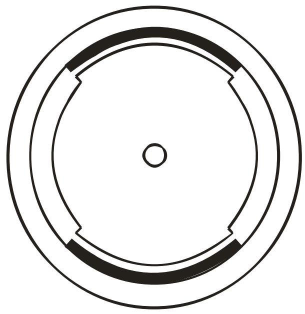

Fig. 4. The mechanical oscillator circuit, in which the inserts from titanate of barium are located on the internal surface of stator

In the given construction there is a figured rotor, and inserts from titanate of barium are located on the internal surface of cylindrical stator.

Let us calculate the practical construction of generator with the following parameters: the voltage of the voltage source $U_0 = 200\ V$; the diameter of the rotor $D = 0.5\ m$; clearance between the inserts of titanate of barium and the stator $d = 10\,\mu m$; the thickness of the inserts $25\ mm$; the depth of turnings on the rotor $25\ mm$; the speed of rotation of the rotor $n = 500\ \frac{1}{s}$ (this rotational speed it is characteristic for the gas turbines); the length of the generator $L = 1m$.
The power, manufactured by generator will comprise

$$P = \frac{\pi \varepsilon n K D L U_0^2}{2d}. \tag{2.10}$$

During the record of this formula are taken into account the fact that in one revolution of rotor it occurs two cycles of a change in the capacity between the rotor and the stator.

The substitution of the assigned parameters into the formula (2.10) gives the power $34\ kW$.

Efficiency generator, calculated according to the formula (2.9), comprises 50000%. This means that practically entire mechanical energy, spent on the rotation of the rotor of generator, is converted into the electrical energy.

The output voltage, which manufactures generator, calculated according to the formula (3.3) it will comprise $1\ MV$. This voltage will be developed between the stator-rotor unit, when the capacity between them is minimum. In order in this case to avoid electrical breakdown, the internal cavity of generator must be filled with air or another gas under the high pressure.

The optimum regime of the work of this generator is the case, when the time constant RC of chain, which it composes the load resistance and the maximum capacity between the rotor and the stator, will be less than half of the period of the rotation of rotor. Then in the time indicated capacity has time to be discharged through the resistance, after returning entire its energy to load.

None of the existing generators can ensure this high efficiency such high voltage without the use of the step-up transformers and rectifiers. Large simplicity of construction is the very great advantage of this generator.

The type of generator in the section is shown in Fig. 5.

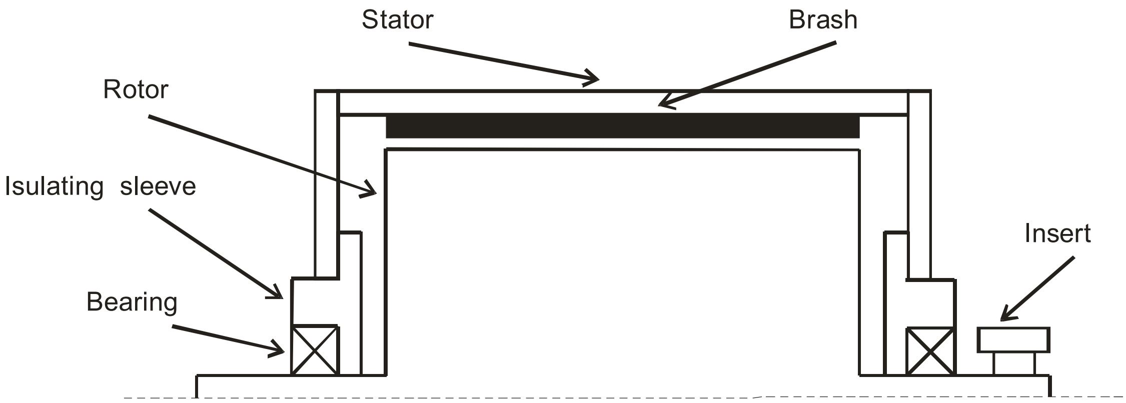

Fig. 5. Type of generator in the section

The insulating bush is located between the axis of rotor and the housing of stator. In this bushing the bearing is located. By lower its edge bushing slides along the axis of shaft, ensuring the vacuum seal between the internal cavity of generator and the atmosphere. The insert from titanate of barium is located on the internal part of the stator. The electrical contact between the axis of rotor and the external circuits brushes ensure.

3. Conclusion

In the article the operating principle is examined and is given the construction of the parametric electric generator, which gives the possibility to generate high constant voltage with the high level of power. The name of generator the production of constant voltage is connected with the fact that produced by the way of a mechanical change in the capacitance value of capacitor. The generator examined possesses large simplicity in comparison with the existing generators.

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9. Electrization of plasma with its warming-up

1. Introduction

The concept of scalar- vector potential provides for the dependence of electrical pour on the moving charge from its speed [1-6]. In this concept the charge is not the invariant of speed. Up to now only indirect experiments, connected with the appearance of electric pulse with the space thermonuclear explosions testified in favor indicated concept [7]. In the proposed article are carried out the straight experiments, which attest to the fact that in the process of the warming-up of plasma it acquires unitary charge. These experiments were carried out by the way of the micro-burst of the thin metallic wires, through which was passed the current from the capacitor bank of great capacity.

2 Examination of the electrization of plasma with its rapid warming-up

In the experiments for the warming-up of plasma the micro-bursts with the discharge of the chemical capacitors of the great capacity through the discharger or with the discharge of such capacitors through the lamp of photoflash were used. In the discharger was used the copper wire, with the connection to which the charged capacitors it was melted and evaporated, being converted into the plasma.

In Faraday's cell, which serves the continuous metal screen (on the figures it is depicted as dotted line) are placed the chemical capacitors of great capacity, the discharger and the key, which makes it possible to connect to the discharger the charged capacitors. The chains of outline, which include capacitor, key and discharger did not have galvanic contact with the screen of Faraday's cell. Faraday's cell surrounds one (Fig. 1) or two (Fig. 2) metallic of screen. Characteristic measurement of electric pulse it was achieved with the aid of the digital memory oscillograph SIGLENT SDS 1072CNL.

In the first case (Fig. 1) oscillograph was connected between the screen of the cell of Faraday and the external screen. In the second case (Fig. 3) the oscillograph was connected between the external screen and the intershield, located between the screen of the cell of Faraday and the external screen.

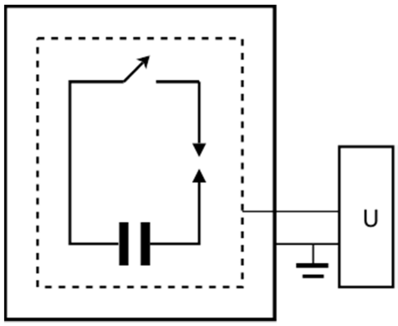

Fig. 1. Diagram of experiment with one external screen

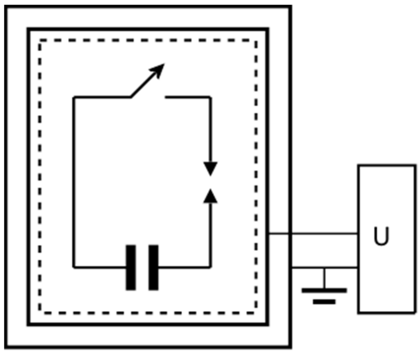

Fig. 2. Diagram of experiment with the intershield

The schematic of experimental installation is shown in Fig. 3 Composite stock consists of two parts. Brass stock is fastened to the upper textolite bushing with the aid of the pins. Between the lower part of the stock and the brass plate there is a spring, which ensures the electrical contact between the brass part of the stock and the brass plate. To the partition inside the screen of Faraday's cell is fastened the insulating plate with the contact washer to it. The unit of capacitors is connected between the brass plate and the contact washer. To the lower part of the stock are attached thin copper wire, gauge 0.2 mm, its length, which comes out from the stock – 5 mm. During lowering of stock the wire concerns contact washer, and the charged capacitors are connected to it: wire is melted and evaporates, being converted into the plasma. The collection of the chemical capacitors with a total capacity 6000 mkF was charged up to the voltage 300 V. Fastening bolts and pins are shown by the fatty sections of lines. Are not shown joints for the connection of the oscillograph between the screen of the cell of Faraday and the external screen, between the external and intershield and joints for the charging of capacitors. The charging cable of capacitors from Faraday's cell was disconnected with the measurements.

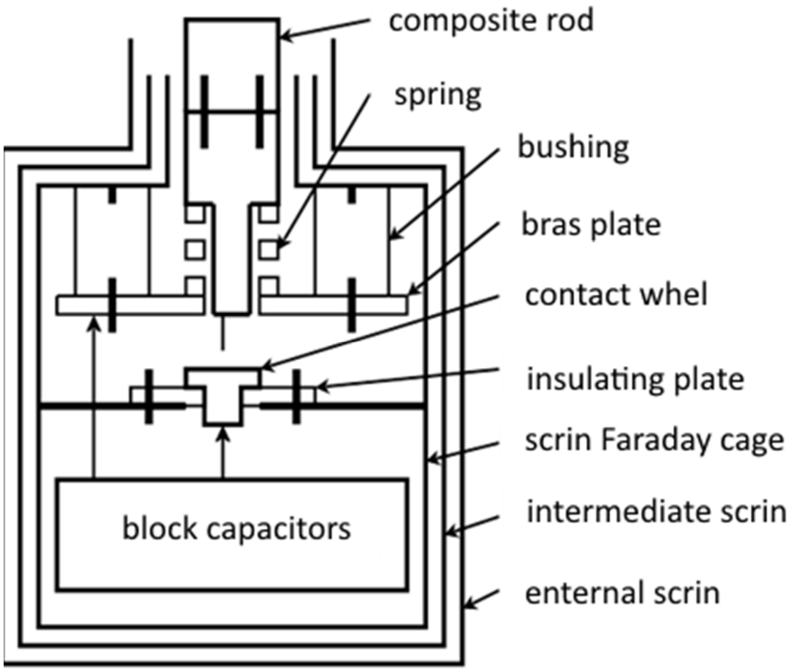

Fig. 3 The schematic of experimental installation

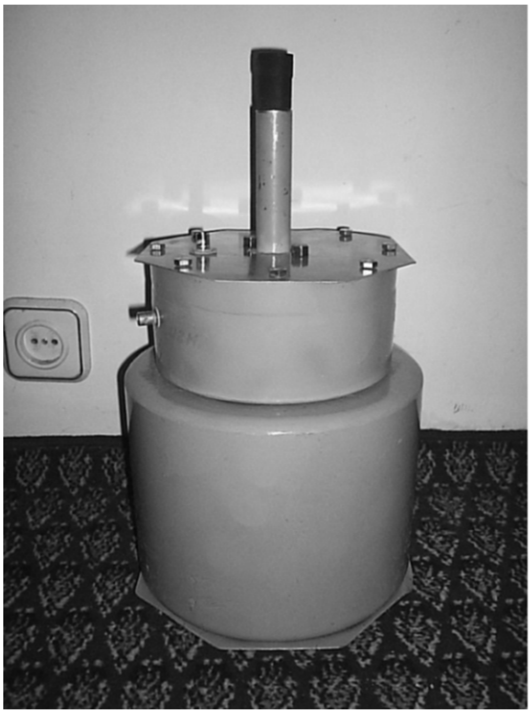

Fig. 4. Photograph of the cell Faraday in the collection form

Fig. 5. Photograph of the experimental installation in the dismantled

The photograph of the screen of Faraday's cell it is shown in Fig. 4. Diameter of the upper and lower part of the screen of the cell of Faraday 180 mm and 220 mm respectively. Height of the upper part 80 mm, and lower – 220 mm. The upper part of the screen is capped, to which is attached the tube, into which is put composite stock. The screen of Faraday's cell is covered with three layers of acrylic auto-enamel. Above can stick copper foil – intershield. In Fig. 5 the separate parts of installation are depicted. The lower part of the photograph presents external screen. Its diameter 300 mm, and a height 600 mm. On top on the external screen, closed with cover, stands Faraday's cell. In the installation in the assembled form Faraday's cell is located inside the external screen on the insulating table.

In the process of experiments it was established that the surge voltage appears with the capacitor discharge through the discharger between the screen of the cell of Faraday and the external screen. In order to be certified in the fact that with the warming-up of plasma in Faraday's cell actually is formed the unitary charge, was carried out the following experiment. After rubbing by the fur of model from the amber (in this case on it it is formed negative charge), it through the tube in the upper lid was rapidly introduced into Faraday's cell. On the oscillograph, connected between the screen of Faraday's cell and the external, is registered the pulse (Fig. 6). Shape of pulse with the rapid withdrawal of the model of the charged amber from Faraday's cell [7]. If we the charged model from the amber rapidly introduce into the cell and to immediately just as rapidly tzyat it from there, then is observed pulse shown in Fig. 8. Between the negative and positive parts of pulse there is a region of the reduction of the derived amplitude of pulse on the time, since. with introduction and withdrawal of the model of amber from Faraday's cell it is not possible to instantly change the speed of stock, at which is fixed the model, to the reverse.

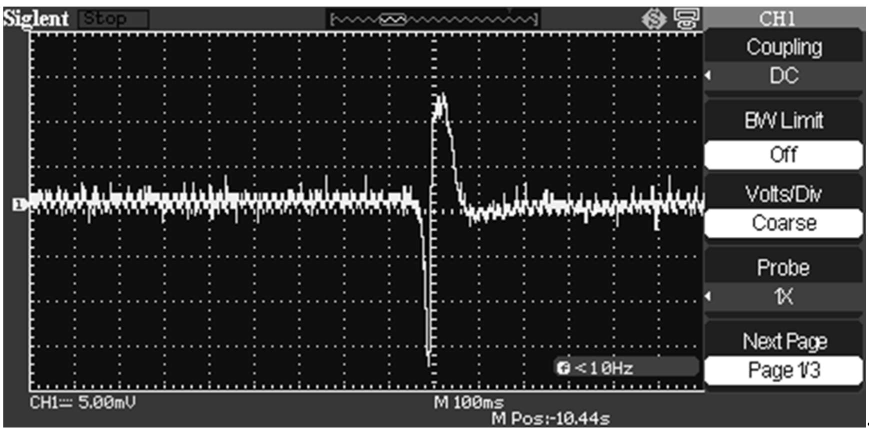

Fig. 6 . Shape of pulse with the rapid withdrawal of the model of the charged amber from Faraday's cell

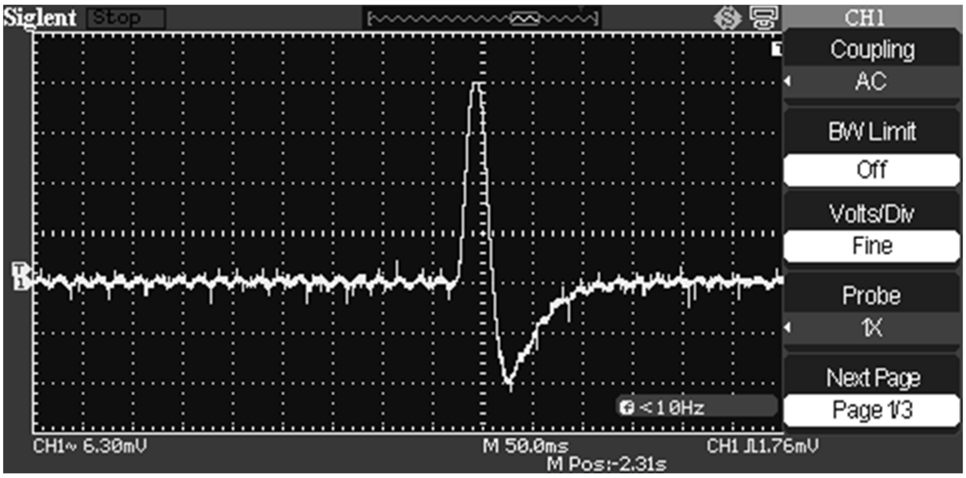

Fig. 7. Shape of pulse with the rapid withdrawal of the model of the amber

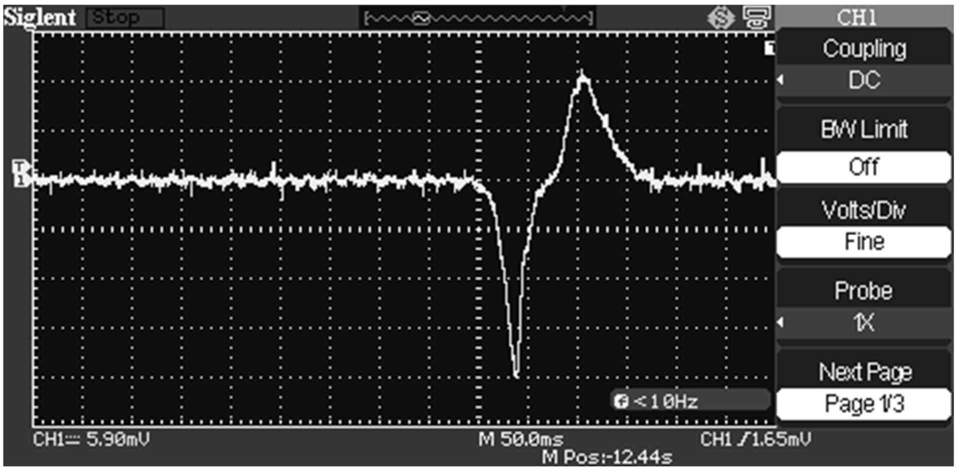

Fig. 8. Voltage pulse, obtained with the rapid introduction and the subsequent withdrawal from the cell of Faraday of the charged model of amber

In Fig. 9 the oscillogram of transient process with the capacitor discharge through the discharger is represented. In discharge time approximately one 600 s voltage across capacitors falls 300 V to 50 V, and the energy of capacitors – on 162 George; therefore the average power of micro-burst 270 kW. The form of the voltage pulse between the external screen and the screen of Faraday's cell, obtained with the discharge through the discharger of the capacitors with a capacity 6000 mkF, charged to the voltage 300 V, it is shown in Fig. 10 (scale value according to axis x 2.5 ms) and Fig. 11 (scale value 1 ms). Formation of the negative part of the pulse (Fig. 11) approximately it coincides with the capacitor discharge time (Fig. 9). This is the time of the greatest warming-up of plasma, since. with the high current the warming-up is connected not only with its effective resistance, but also with the pinch effect. Shapes of pulses in Fig. 6 and Fig. 10 it is very similar. The difference only in the fact that with the mechanical introduction and the withdrawal of amber from the cell it is not possible to ensure this pulse time and the steepness of its fronts as with the electrical discharge. In Fig. 10 the stages of warming-up and cooling of plasma are well visible, evident also that its heating occurs much faster than cooling.

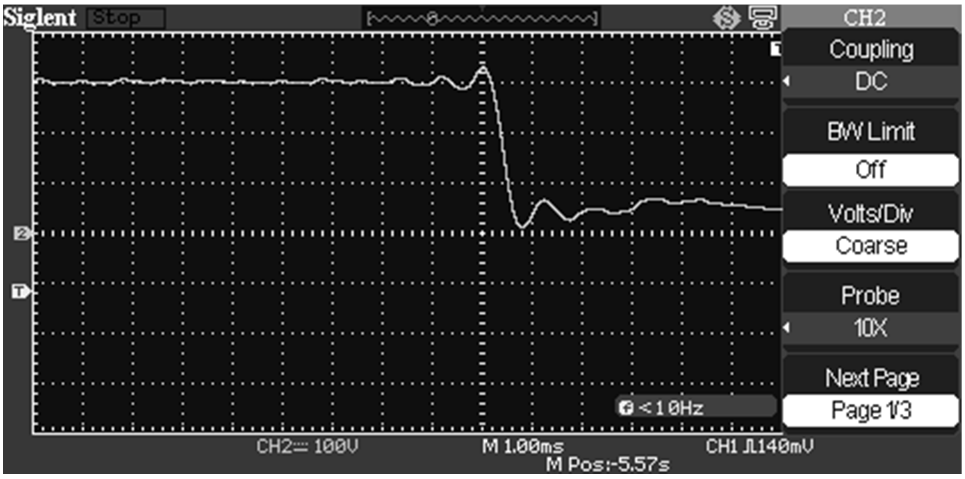

Fig. 9. Oscillogram of the transient process

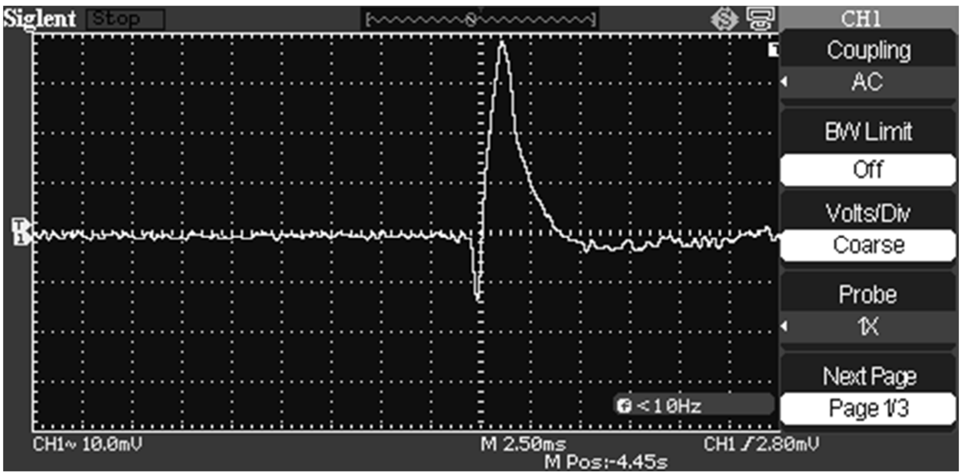

Fig. 10. Form of the voltage pulse

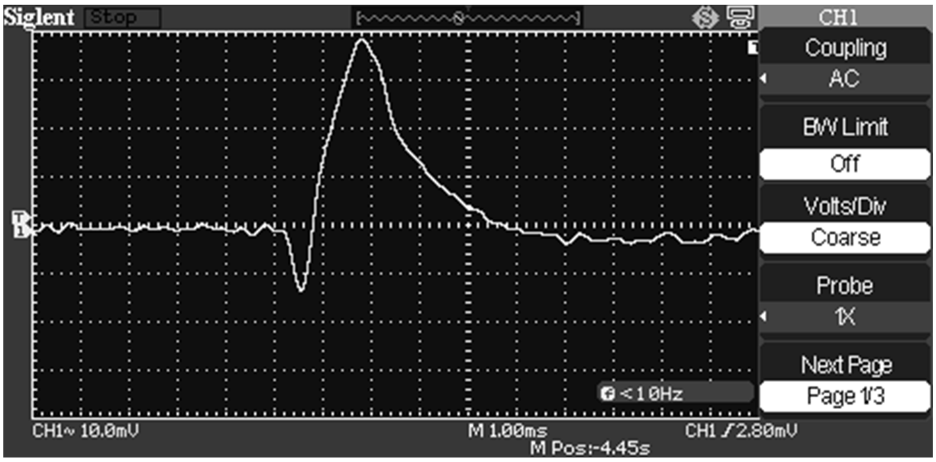

Fig. 11. Form of the voltage pulse

The total capacitance of the input circuit of oscillograph and capacity between the screen of the cell of Faraday and the external screen is 204 pF, and the resistance of the input circuit of oscillograph equally by 1 MOm, therefore, the input circuit of oscillograph is differentiating.

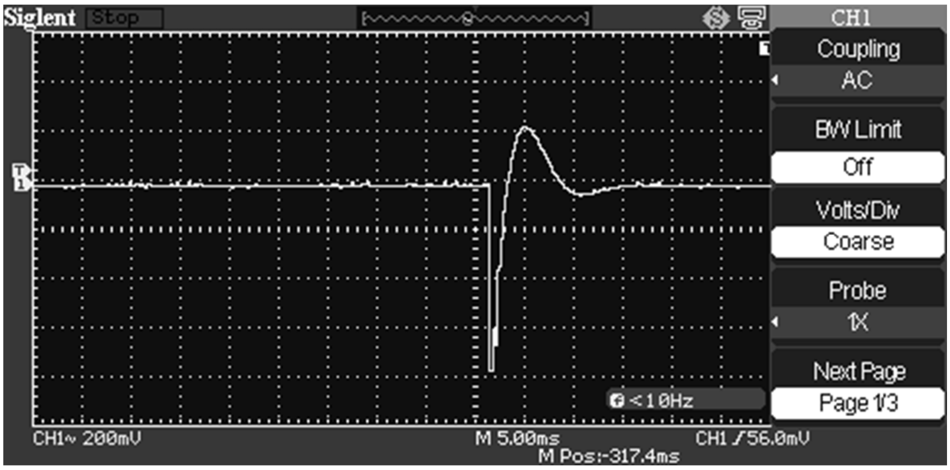

Fig. 12. Derivative of the current, which flows through the plasma

Therefore oscillogram in Fig. 10 and Fig. 12 they present the derivative of the voltage pulse, which appears between the screen of the cell of Faraday and the external screen. Naturally to assume that the temperature of plasma, since it has effective resistance, it is proportional to the current, which flows through it. Derivative of the current

The derivative of the current, which flows through the plasma was removed with the aid of the chain, inductively connected with the conductors of the outline, along which flows the current of discharge. Pulses in Fig. 10 and Fig. 12 they are identical. This means that in the case in question we deal concerning the generation and the disappearance in the cell of Faraday of the unitary charge, connected with the electron motion. In the formed plasma the number of electrons and positive ions is equal, but electrons have high speed, than ions.

Given experimental data are the proof of the fact that in the process of the warming-up of plasma with an equal quantity in it of electrons and ions in the plasma is formed the not compensated by positive ions unitary negative charge, but this means that the charge is not the invariant of speed. Experiment directly confirms that the fact that the invariant of speed is only the polarity of the moving electric charge, and its absolute value depends on speed.

3. Conclusion

Experiments on the rapid warming-up of plasma by the way of the transmission of the high currents through the thin copper wire, that leads to its micro-burst, they showed the presence of unitary charge in the composition of the plasma, obtained thus. These results testify in favor the concept of scalar- vector potential, from which follows this behavior of plasma with its warming-up.

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10. Electrodynamics and the earthquake

1. Introduction

Earthquakes are accompanied by the appearance of electrical phenomena which they did not up to now find its explanation. In 1847 before the earthquake into Sinsyu (Japan) against the background of dark sky arose the revolving fiery cloud. It moved to the side of mountain it was ide and, its reach it disappeared. In 1911 on the eve of the earthquake in Germany in the cloudless sky appeared the fireball. 26 November 1930 before the earthquake in before the earthquake in peninsula Idzu (Japan) of the aurora borealis. Survived Ashkhabad tragedy 1948 they say, that on the eve of the earthquake they saw the arc from the electrical discharges flying on the sky, then immediately after wind gust, it was heard the first underground push. During the Tashkent earthquake 1966 from under the earth was pulled out the gigantic luminous torch, it swiftly rose upward and it was dissolved in air. In 1976 occurred super-power Tien-Shan earthquake , during which light flashes they were controlled hundreds of kilometers from the epicentre of earthquake. Earthquake begins from break and displacement of the rocks in the depth of the Earth [1-4]. This place is called seismic center or hypocenter . Its depth usually is not more than 100 km, but sometimes it reaches also 700 km. In some cases the layers of the earth, situated along the sides of breaking, are moved to each other. In others the earth on one side of breaking descends, forming discharges. Underwater earthquakes are the reason for the tsunami , of the long waves, generated by powerful action on entire thickness of water in the ocean, during which occurs the sharp shift (raising or lowering) of the section of the sea bottom. Tsunami are formed with the earthquake of any force, but large forces those, which appear as a result of the strong earthquakes, reach. The sharp displacement of the large masses of the earth in the seismic center is accompanied by the mechanical impact of colossal force. The energy, isolated with such impacts, can repeatedly exceed energy of the nuclear explosions [5]. It is natural that such processes are accompanied by colossal mechanical voltagees and powerful gaps of the layers of species. From the seismic center the seismic waves, which are also characterized by periodic mechanical compression and tension of layers and rocks, are propagated. Sometimes earthquakes are accompanied by the appearance of lightning.

From the aforesaid follows the consequence about the fact that the electrical phenomena, which accompany earthquakes, can be connected with the mechanical processes in the layers of species.

2. Experimental study of the appearance of electric potential during the metallic models and the dielectrics with their deformation and the destruction

A study of the influence of mechanical voltagees and kinetics of dislocations on the electrostatic potential of models was conducted employing the following procedure. For this copper flask with the thickness of the walls ~ 3 mm and by volume near of 5 liters of it was placed into vacuum chamber, from which could be pumped out air. The end walls of flask were executed in the form hemispheres. The internal cavity of flask in conducting the experiments was found under the atmospheric pressure. Pumping out or filling into vacuum chamber air, it was possible to mechanically load its walls. Flask itself was isolated from vacuum chamber bushing from fluoroplastic resin and thus it had high resistance relative to the housing of unit. One of the typical dependences, obtained with such experiments, is represented in Fig. 1. It is evident that the amplitude of effect reaches 100 mV, dependence has strong hysteresis, moreover an increase in the negative potential corresponds to the tension of the walls of flask. In the figure the circuit on the hysteresis loop was accomplished clockwise. It follows from the obtained results that mechanical voltagees of model lead to the appearance on it of electrostatic potential. The presence of hysteresis indicates that the formation of dislocations bears the irreversible nature. In this case the irreversibility of the influence of dislocations on the electrization is connected with the fact that dislocation they can, falling into potential wells, to be attached on the heterogeneities of crystal structure.

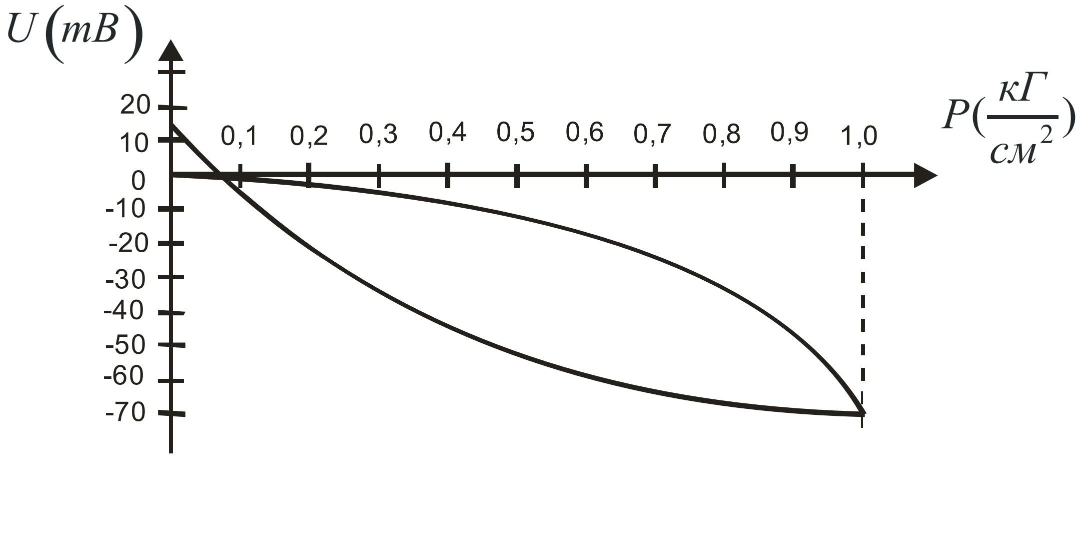

Fig. 1. Dependence of the potential of copper flask on the external pressure.

It follows from the carried out examination that also the appearance of rapid (impact) mechanical loads also must lead to the appearance in the isolated metallic model of pulse potential. This question was investigated on the installation, whose schematic was given in Fig. 2.

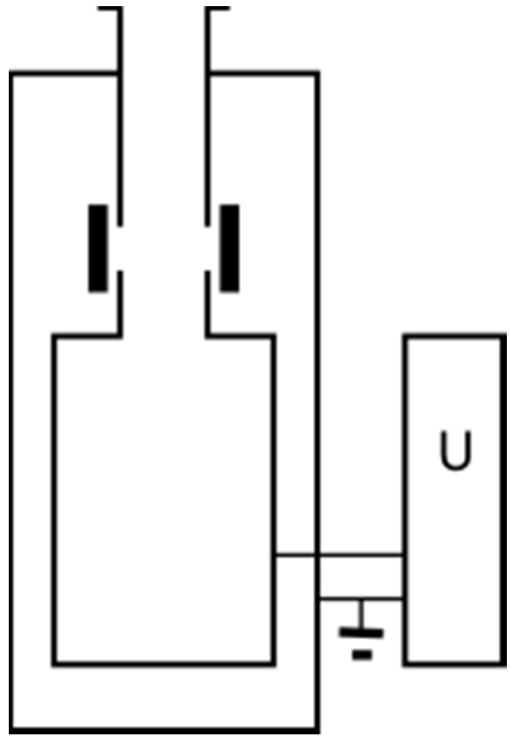

Fig. 2. Installation diagram for investigating the appearance of the pulses of electric field with the impact loads.

Internal capacity is suspended to the external screen with the aid of wide neck. For eliminating the galvanic contact between the external screen and the internal capacity the neck has a section. Odd parts of the neck are connected by the insulating plates, which in the figure are designated by the short black sections of lines. Internal capacity is prepared from aluminum in the form of flask, its end walls are executed in the form hemispheres. This construction of end walls is necessary in order to avoid their severe strain with the realization of the explosions of explosive in the internal capacity. Common form installations for investigating the dynamic loads on the aluminum flask and the component parts of the installation are shown in Fig. 3 and Fig. 4.

Fig. 3. The common form of installation for investigating the dynamic loads

Fig. 4. Type of installation in the dismantled form

During the inclusion into neck from a height 1 m of the bottom of the internal capacity of the rod with a weight 200 g between the external screen and the internal capacity is observed the voltage pulse, shown in Fig. 5. In order to avoid to the appearance of additional pulses with a lateral drop in the rod after the impact of its end about the bottom of flask, the side of rod is wound by soft tissue. Data of this experiment correspond to the experimental data, obtained with the copper flask, the code its tension led to the appearance on the flask of negative potential. With the impact of the end of the rod about the bottom of flask also occurs the local deformation of its bottom, with which in the point of impact occurs the tension.

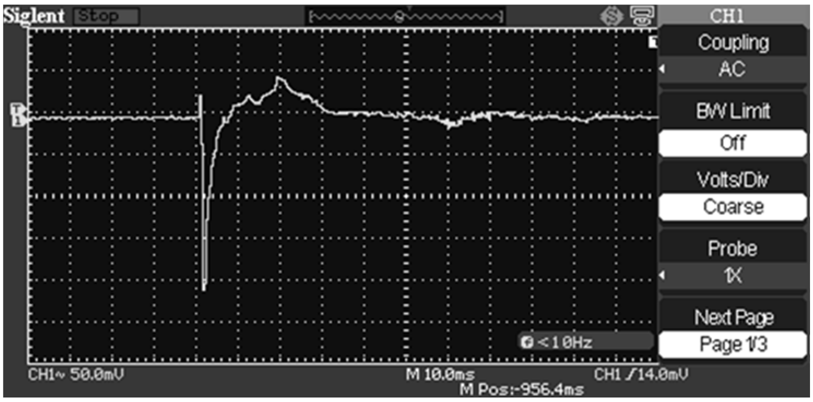

Fig. 5. Shape of pulse after a drop in the rod on the bottom of internal capacity

If we inside the aluminum flask explode the charge of small value, then is observed the voltage pulse, shown in Fig. 6 .

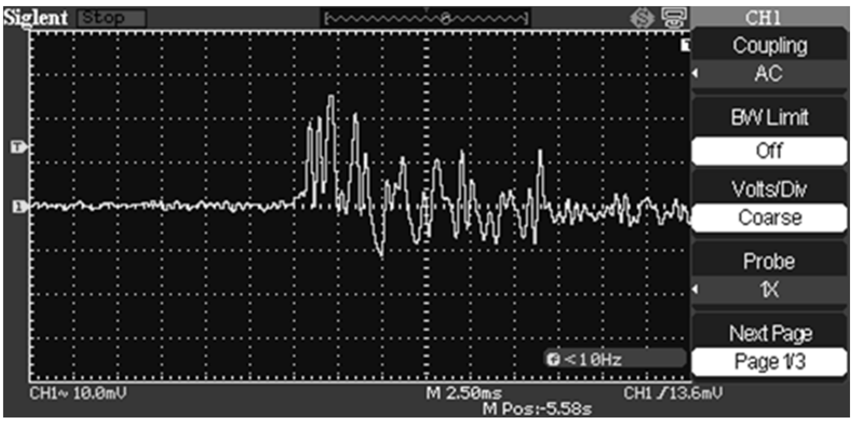

Fig. 6 . Form of the voltage pulses, obtained with the explosion of explosive in the aluminum flask

The heteropolar repetitive pulses, which are been the consequence of the multiple reflection of shock wave from the walls of the flasks, which lead to its deformation, are observed in the oscillogram, in this case there are pulses corresponding to both the tension of the walls of flask and to their compression.

If we into the aluminum flask place the spring, isolated from the flask, and to force it periodically to be compressed, then potential on the flask also bears periodic nature. The experiment indicated was conducted according to the diagram, depicted in Fig. 7.

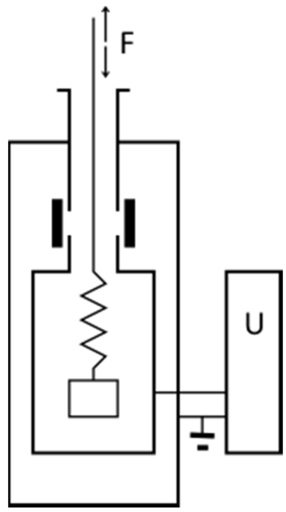

Fig. 7. Diagram of experiment with the spring

To the cotton cord, which emerges outside flask, is fastened the spring, from which is suspended the load. This system is had the mechanical resonance, whose resonance frequency, determined by spring constant and by cargo weight. If we toward the end thread exert periodic force at the frequency of resonance, then it is possible to attain the periodic deformation of spring at this frequency with in effect constant position of load.

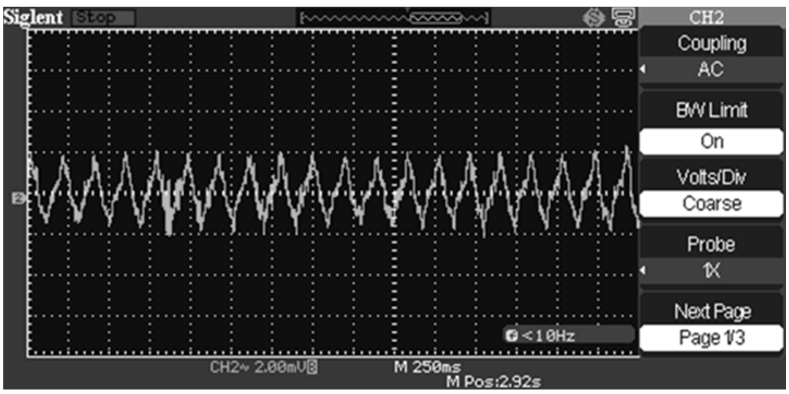

Fig. 8. An alternation in the potential on the flask with the periodic compression of spring

The dependence of electric potential on the flask, obtained in this experiment, it is shown in Fig. 8.

Obtained data attest to the fact that in the process of the deformation of spring, in the flask the alternating unitary charge is formed.

If we inside the flask tear thin copper wire, then the voltage pulse also is observed between the flask and the external screen. This experiment was conducted according to the diagram, shown in Fig. 9.

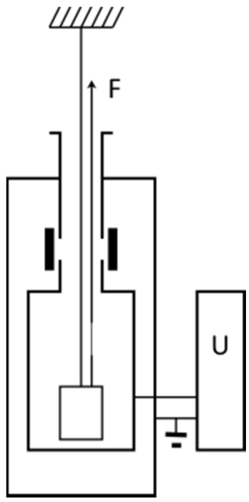

Fig. 9. Experiment on the break inside the flask of copper wire

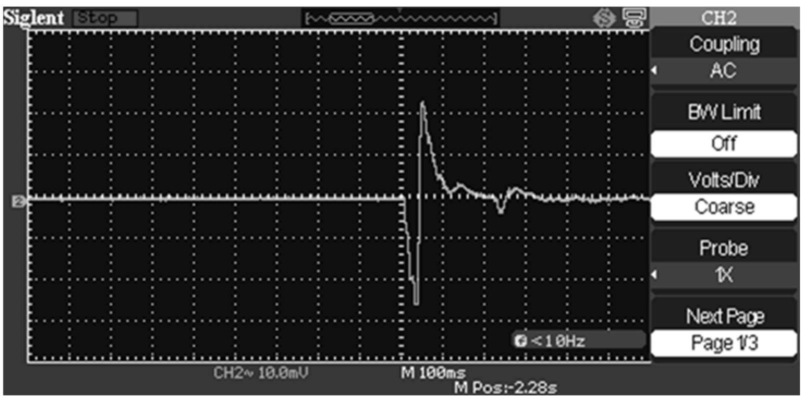

Fig. 10. Pulse, obtained with the break of wire

The load is suspended inside the flask from the cotton cord. In parallel with the thread, from which is suspended the load, is located another kapron thread, in break of which is fixed the section of the copper wire with a diameter 0.3 mm. At the moment of the break of the wire between the flask and the external screen is observed the pulse, depicted in Fig. 10.

The negative part of the pulse corresponds to the tension of wire, which precedes its break. The positive part of the pulse corresponds to relaxation of deformation voltage two parts of the torn wire.

In such a manner both the mechanical deformation of wire and its break it is accompanied by the appearance of unitary charge inside the flask.

Electrization appears also with the mechanical dielectric strains. If we conduct experiment with the dielectrics employing the procedure, depicted in Fig. 10, on it is possible to obtain the following results. With the break of silk thread is observed the oscillogram, given in Fig. 11.

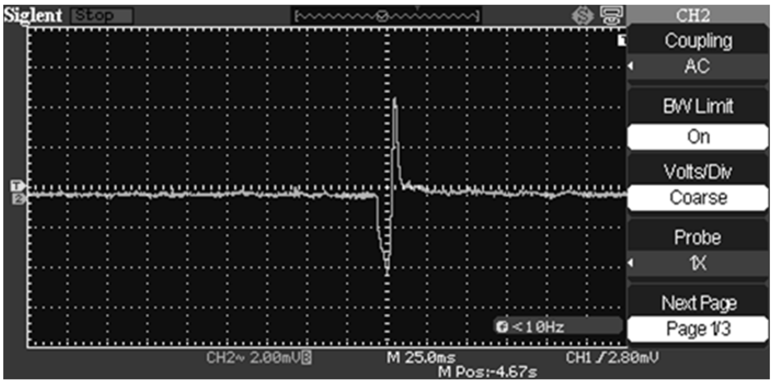

Fig. 11. With the break of silk thread is observed the oscillogram

In Fig. 15 is depicted the oscillogram, observed with the break of thread from vinyl chloride.

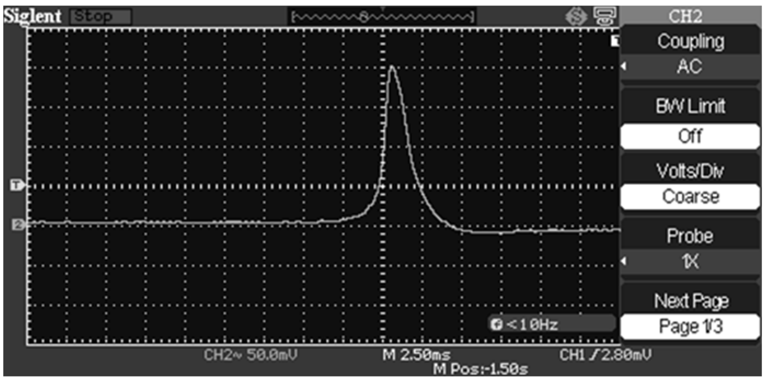

Fig. 15. Is depicted the oscillogram, observed with the break of thread from vinyl chloride

If we as the thread use the lace, interlaced from the synthetic fibers, and to subject to its periodic mechanical loads, then will be obtained the oscillogram, given in Fig. 16.

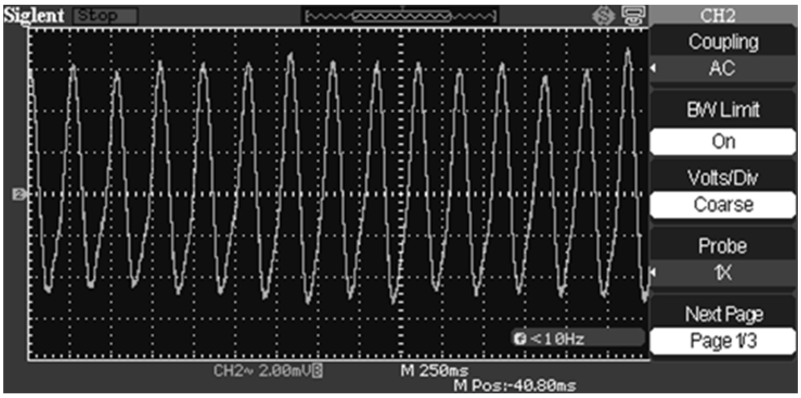

Fig. 16. Oscillogram, observed during application to the lace of periodic mechanical loads

Such properties of dielectrics earlier in the scientific publications are not described. Obtained experimental data speak, that by the way of compression, tension or destruction of conductors and dielectrics, placed in Faraday's cell, it is possible to obtain in it the unitary charge of different signs, whose fields without difficulty penetrate through the metal screen of Faraday's cell. Friction between the separate threads of dielectric generates the same effect, about than testify the experiments with the lace, made from such threads.

3. Physical interpretation of the experimental results

If in any structure coexists several thermodynamic subsystems, then their chemical potential must be equal. In general form chemical potential for any subsystem can be found from the following expressions

$$\mu=\left(\frac{\partial U}{\partial N}\right)_{S,V}=\left(\frac{\partial F}{\partial N}\right)_{T,V}=\left(\frac{\partial W}{\partial N}\right)_{S,P}=\left(\frac{\partial \Phi}{\partial N}\right)_{T,P},$$

where N- number of particles, and the thermodynamic potentials U, F, W, Φ represent internal energy, free energy, enthalpy and Gibbs potential respectively.

In the conductor there are two subsystems: lattice and electron gas, electron gas in the conductors at usual temperatures is degenerate and is subordinated the statistician Fermi-Dirac, his chemical potential is determined from the relationship

$$\mu = W_F\left(1 - \frac{\pi^2 (kT)^2}{12 W_F^{\ 2}}\right),$$

where

$$W_F = \frac{h^2}{2m}\left(\frac{3n}{8\pi}\right)^{\frac{2}{3}}$$

is Fermi energy, h - Planck's constant, and n , m - electron density and their mass.

Consequently, at an assigned temperature chemical potential of electron gas depends on its density.

Chemical potential of lattice depends on mechanical voltagees and number of dislocations. And if lattice was subjected to mechanical voltagees, then for retaining the electroneutrality of models should be changed the density of electron gas that it can be achieved by the way of addition or withdrawal of electrons from the model. This is observed in the experiment.

4. Conclusion

The conducted experimental investigations showed that mechanical voltagees or destruction of conductors and dielectrics lead to the appearance of unitary charge in such models. Friction between the separate threads or the dielectric layers they lead to the same effect. With the earthquakes, which are the consequence of the accumulation of voltagees in the layers of species and their subsequent break or relative shift, also must appear the electric potentials, which present the unitary of charge, whose fields can without difficulty penetrate through the rocks, falling into the atmosphere and into the ionosphere. The shift processes, which associate earthquakes, which lead to the friction between the shifting layers, also can lead to the appearance of electrical pour on. These fields can ionize the atmosphere and the ionosphere, causing its glow. If tension pour on, that appear with such processes, exceeds breakdown voltage for the atmosphere, then lightning can appear. The seismic waves, which are extended during the earthquakes, also lead to the periodic mechanical deformations of the layers of species. These deformations also can cause the appearance of electrical pour on out of the zone of the propagation of such waves.

In the article the physical substantiation of the obtained experimental results is given. Conducted investigations give the physical and theoretical substantiation of the electrical phenomena, which associate earthquakes.

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