Is charge the invariant of speed?

F. F. Mende

B. Verkin Institute for Low Temperature Physics and Engineering NAS Ukraine. Kharkov, Ukraine.

Abstract

According to the program «*Starfish*» July 9, 1962 the United States detonated in space over the Pacific Ocean H-bomb with a TNT equivalent of 1.4 Mt. The explosion was followed by the appearance of an electric pulse with a high electric field intensity and short duration. In the experiments on the detection and study of the electrical pulse that occurs when the capacitor discharges through the gaps large capacity. It is shown that when such discharges occur electric field pulses, which indicates the occurrence of a plasma heated to a unitary charge. This fact contradicts not only classic but also relativistic transformations of the electromagnetic field in the transition from one inertial reference system to another, and indicates that the absolute value of the electric charge, unlike its polarity is not an invariant speed.

Keywords: charge, plasma, H-bomb, electric pulse of nuclear explosion.

1. Introduction

According to the program «*Starfish*» July 9, 1962 the United States detonated in space over the Pacific Ocean H-bomb with a TNT equivalent of 1.4 Mt. This event placed before the scientific community many questions [20,21]. Earlier into 1957 Nobel laureate Hans Albrecht Bethe predicted that with a similar explosion will be observed the electromagnetic pulse (EMP), the strength electric fields which on the earth's surface will comprise not more than 100 V/m. But with the explosion of bomb discomfiture occurred, fields on the tension of electrical, beginning from the epicentre of explosion, and further for the elongation of more than 1000 km of it reached $(3-5)10^4$ V/m. Electric pulse had not only very large amplitude, but also very short duration on the order 50 ns (Fig. 1).
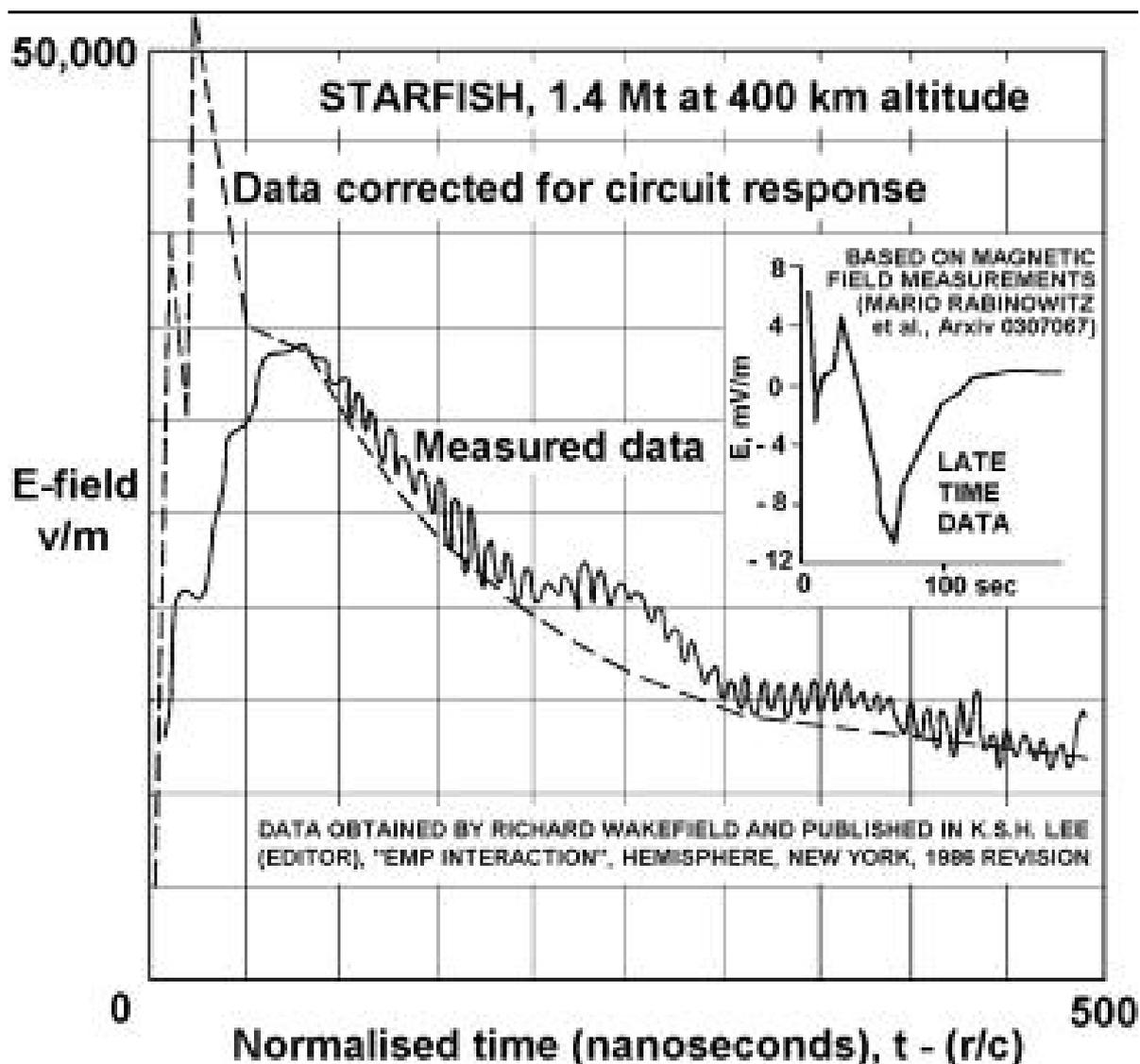
Fig. 1. Experimental dependence of amplitude EMP on the time, obtained with the tests according to the program *"Starfish"*.

Thus, after explosion in the course of several ten minutes there is no radio communication with Japan and Australia, and even at a distance into 3200 km from the epicentre of explosion were fixed ionospheric disturbances, which several times exceeded those, which are caused by the most powerful solar flares. Explosion influenced also the automatic spacecraft. Three satellites were immediately disabled. The charged particles, which were appeared as a result explosion, were seized by the magnetosphere of the Earth, as a result of which their concentration in the artificial Earth radiation belt it increased by 2-3 orders. The action of radiation belts led to the very rapid degradation of solar batteries and electronics in seven more

satellites, including in the first commercial telecommunication satellite Telestar 1. On the whole explosion derived from system third of the automatic spacecraft, which were being found in low orbits at the moment of explosion.

With the explosion of nuclear charge according to the program *"Program K",* which was realized into the USSR, the radio communication and the radar research facilitys were also blocked at a distance to 1000 km. 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 Alma-Ata. The electrical pickup were so great that the automation opened cable from the power station.

Is known that the problem of this phenomenon attempted together with his students to solve and academician Zeldovich [22]. However, in the existing sources there is no information about the fact that this problem was solved by it. Exponential is the fact that more than fifty years in the official scientific journals there are no publications on the explanation of the phenomenon indicated, which attests to the fact that the scientists lacks the substantiated point of view on the explanation of the physical causes for this phenomenon.

The first article with the explanation this of phenomenon appeared in the periodical Engineering physics only in 2013 the year [4]. In the article the attempt to explain this phenomenon within the framework is made of the concept of scalar- vector potential, represented in the works [5-9]. This concept assumes the dependence of the scalar potential of charge on its relative speed. Moreover this dependence is obtained not within the framework SR, that uses conversions of Lorenz, but within the framework the conversions of Galileo from the use of laws of induction and substantional derivative. Subsequently the concept of scalar- vector potential and its practical results were published in a number of the foreign periodicals, where shown that the concept of scalar- vector potential is the basis of all dynamic laws of electrodynamics, charges connected with the motion. [10-19].

Up to now there are only indirect experimental data, which confirm the validity of the concept of scalar vector potential, which consisted in the observation of the electric pulse of nuclear explosions [1,7,4,16,19] and also in the appearance of an electric potential on the superconductive windings and the tori during the introduction in them of the direct current, [20-23]. Proposed article gives experimental results on the detection of the pulse of the external

electric field, which appears with the warming-up of plasma. Is given also one of the possible explanations of this phenomenon within the framework of the concept of scalar- vector potential.

2. Experimental detection and a study of the pulse of the electric field, caused by the warming-up of the plasma

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. the diagram of experiment is shown in Fig. 2 and Fig. 3. In Faraday's cage, 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 cage. Faraday's cage surrounds one (Fig. 2) or two (Fig. 3) metallic of screen. Characteristic measurement of electric pulse it was achieved with the aid of the digital memory oscilloscope SIGLENT SDS 1072CNL. In the first case (Fig. 2) oscilloscope was connected between the screen of the Faraday's cage and the external screen.
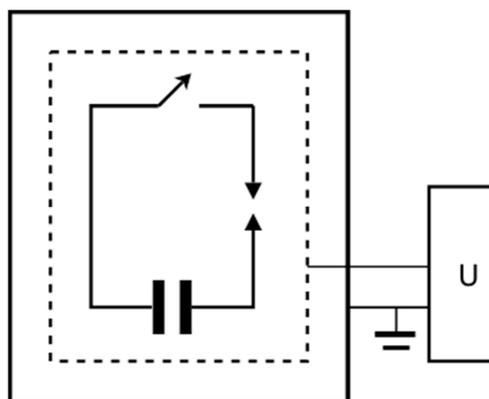

Fig. 2 Diagram of experiment with one external screen.

In the second case (Fig.3) the oscilloscope was connected between the external screen and the intermediate screen, located between the screen of the Faraday's cage and the external screen.
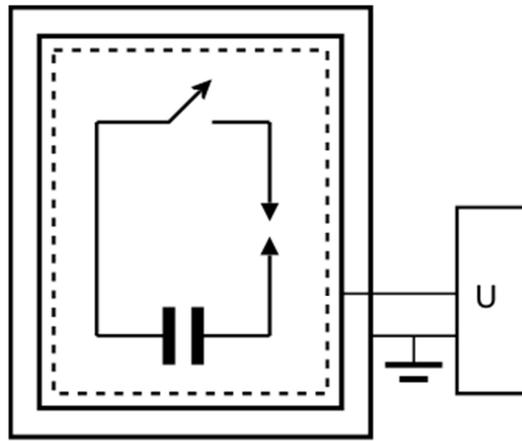
Fig. 3. Diagram of experiment with the intermediate screen.

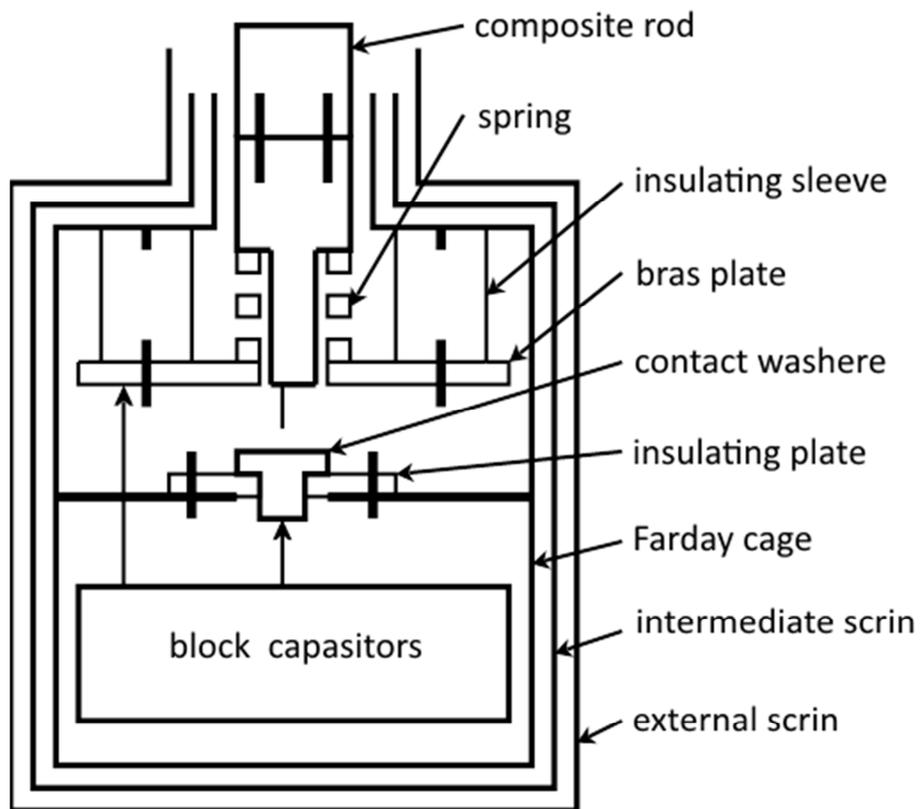The schematic of experimental installation is shown in Fig. 4.

Fig. 4. The schematic of experimental installation.

The composite stock, which forms part of installation, consists of two parts. Its upper part is made from ebonite, the lower part, made from brass, is fastened to it with the aid of the fastening pin. 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. Inside the screen of

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Faraday's cage is a partition, to which is attached the insulating plate. Contact washer is located on this plate. 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 is 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. In the installation they were used the collection of the chemical capacitors with a total capacity 3000 μF, which were charged up to the stress 300 V.

Fastening bolts and pins are shown in the figure by the fatty sections of lines. The joints, which make it possible to connect the oscilloscope between the screen of the Faraday's cage and the external screen, and also between the external and intermediate screen in the diagram are not shown. Are not shown also the joints, through which is achieved the charge of capacitor With the measurements the cable, through which is achieved the charge of capacitor, from Faraday's cage is disconnected.

The photograph of the screen of the Faraday's cage it is shown in Fig. 5.

Fig. 5. The photograph of the Faraday's cage.

Diameter of the upper and lower part of the screen of the Faraday's cage 180 mm and 220 mm respectively. Height of the upper part 80 mm, and lower is 220 mm. The upper part of the screen is capped, to which is attached the tube, into which is put composite stock. Length of tube 100

mm. The screen of the Faraday's cage is covered with three layers of acrylic auto-enamel. This layer presents the insulator, above which stuck the aluminum foil, which presents intermediate screen.

In Fig. 6 the separate parts of installation are depicted.

Fig. 6 . Photograph is installation in the dismantled form.

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 the Faraday's cage. In the installation in the assembled form Faraday's cage 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 Faraday's cage and the external screen.

In order to be certified in the fact that with the warming-up of plasma in Faraday's cage actually is formed the unitary charge, was carried out the following experiment. It is known that with the rubbing by the fur of amber on it is formed the negative charge. After rubbing by the fur of model from the amber it with the aid of the stock, prepared from the ebonite, through the tube in the upper lid of camera was introduced into the Faraday's cage, and then rapidly was pulled out from it. When oscilloscope was connected between the screen of the Faraday's cage and the external screen, was registered the pulse, whose oscillogram was shown in Fig. 7.
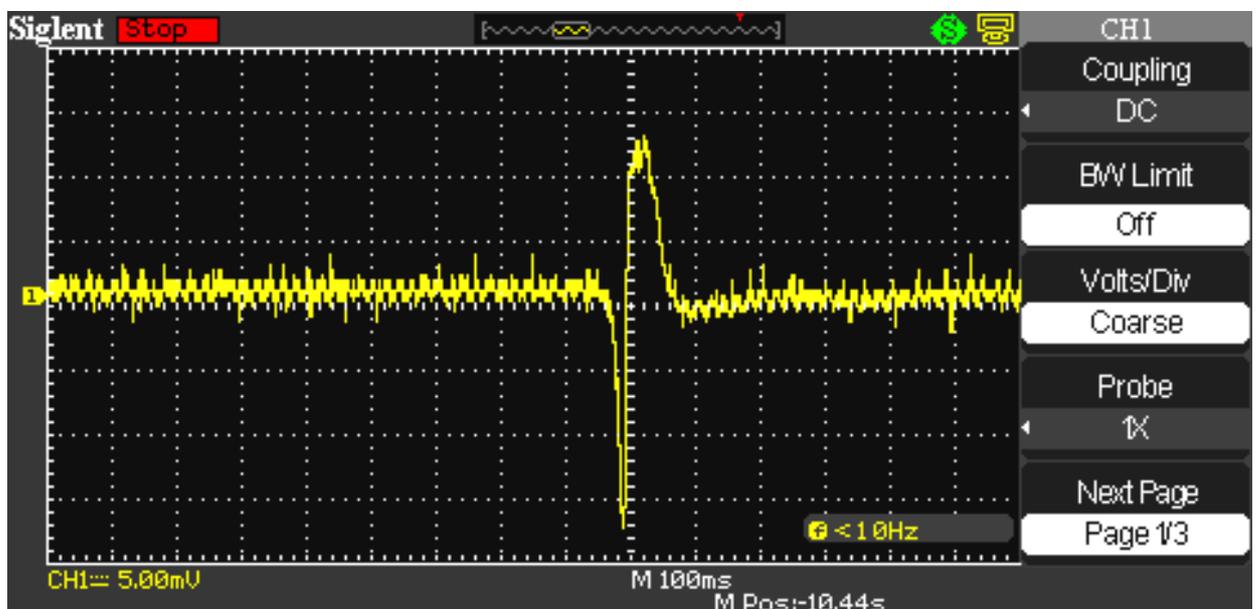

Fig. 7. Shape of pulse with the rapid withdrawal of the model of the charged amber from the Faraday's cage.

If we model from the amber slowly introduce into the cell, to and then rapidly withdraw it from there, then is observed the pulse, shown in Fig. 8.
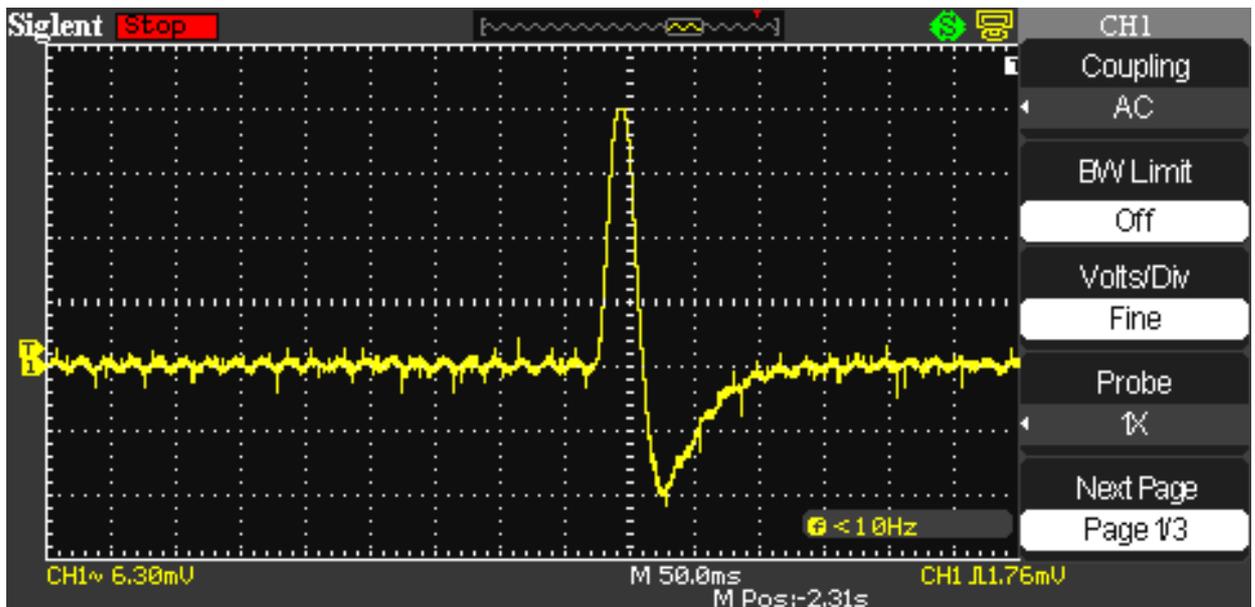
Fig. 8. Shape of pulse with the rapid withdrawal of the model of the charged amber from Faraday's cage.

If we the charged model from the amber rapidly introduce into the cell and to immediately just as rapidly remove it from there, then is observed pulse shown in Fig. 9.
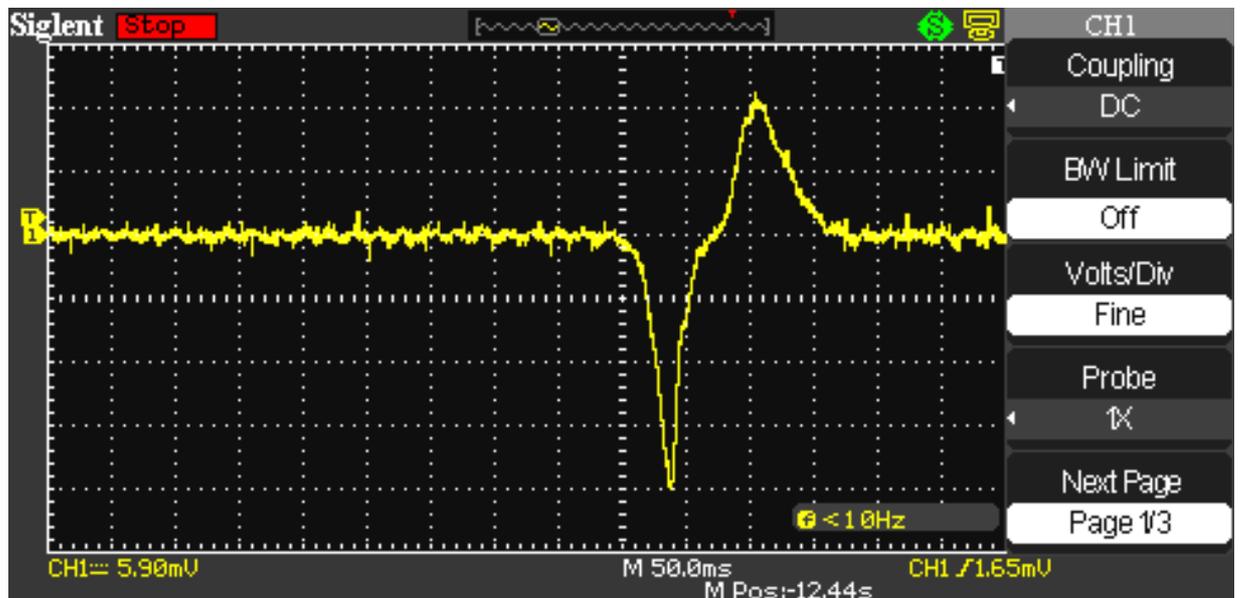

Fig. 9. Voltage pulse, obtained with the rapid introduction and the subsequent withdrawal from the Faraday's cage of the charged model of amber.

The process examined can be considered as appearance and subsequent disappearance in the Faraday's cage of negative charge. It is evident that between the negative and positive part of the pulse is a region, where the derivative of the pulse amplitude on the time decreases. This is connected with the fact that with the mechanical introduction and the withdrawal of the model of amber from Faraday's cage it is not possible to instantly change the speed of stock for the reverse.

In the following stage of studies it was explained, in what time the charged capacitors are discharged through the discharger, and also was written the signal, proportional to current, current in the discharge circuit. Total capacitance of capacitors was 6000 μF, they were charged to the stress 300 V.

The oscillogram of transient process with the capacitor discharge through the discharger with different scanning speeds along the axis X, and also signal of proportional to current in the circuit discharge, they are shown in Fig. 10 and Fig. 11.
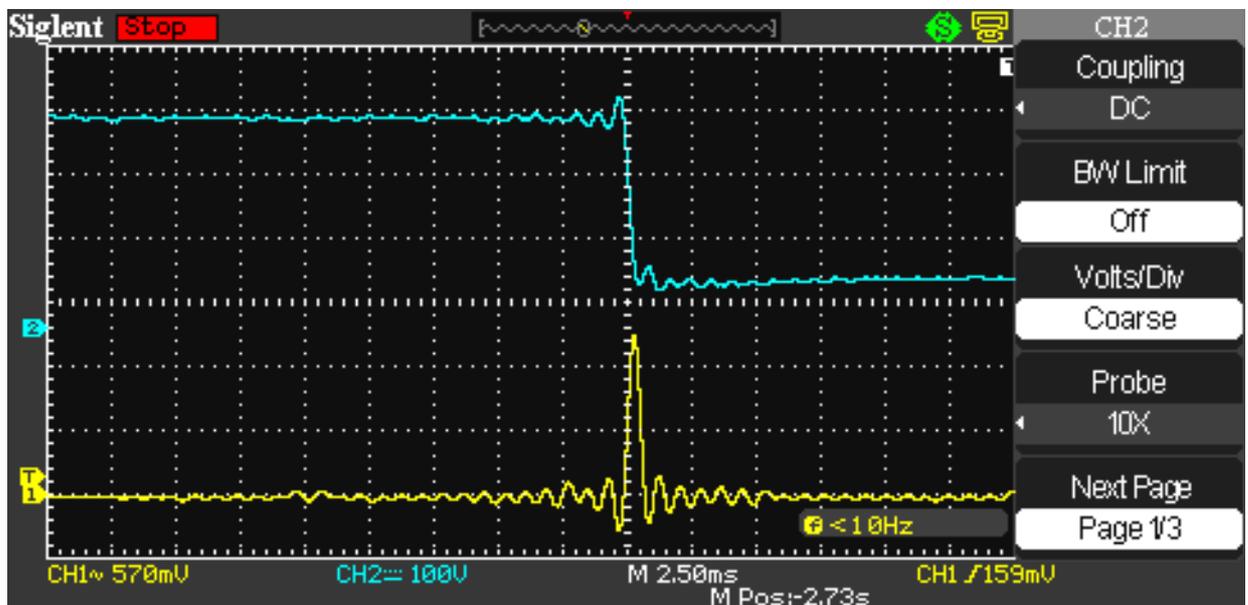

Fig. 10. The oscillogram of transient process with the capacitor discharge through the discharger is represented. Scale value along the axis X is 2.5 ms.
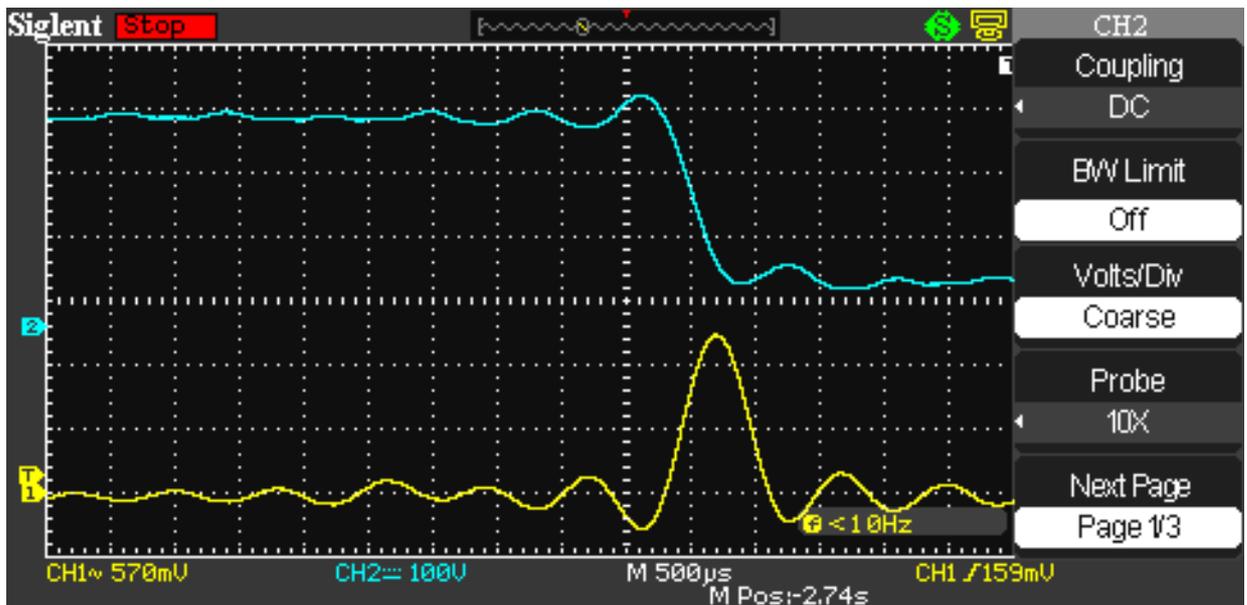
Fig. 11. The oscillogram of transient process with the capacitor discharge through the discharger is represented. Scale value along the axis X is 2.5 ms.

The measurement of a voltage drop across capacitors during their the discharge through the discharger, and also the signal, proportional to the current of discharge, was made according to the diagram of that represented in Fig. 12.

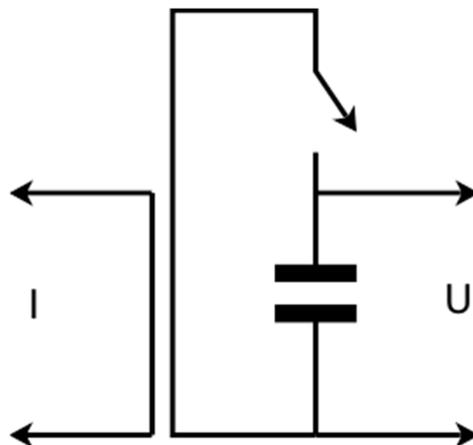Fig. 12. The measurement of a voltage drop across capacitors during their the discharge through the discharger, and also the signal, proportional to the current of discharge.

The chain, with the aid of which was measured the signal, proportional to the current of discharge, was inductively connected with the conductors of outline. The conductor, fixed in parallel to one of the conductors of outline, was used for this.

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The dependence on the time of voltage across capacitors during the discharge is represented in the upper oscillogram. It is evident that in the time ~ 500 μs the stress falls s 300 V to 50 V. Lower oscillogram presents the current pulse, registered by the method examined.

It is evident that in discharge time voltage across capacitors falls a 300 V to 50 V. In this case the discharge time is approximately ~ 500. The difference between the energy of the capacitors, charged to 300 V in those charged to 50 V composes 162 J; therefore the average power of micro-burst is 270 kW. If one considers that for the heating, the melting and evaporating the wire of discharger it is necessary to spend energy ~10 J, then the remained energy ~ 150 J goes to the warming-up of the formed plasma.

It is evident from the given oscillogram that the current, which flows through the plasma reaches its maximum value toward the end of capacitor discharge.

The form of the voltage pulse between the external screen and the screen of the Faraday's cage, obtained with the discharge through the discharger of the capacitors with a capacity 6000 μF, charged to the stress 300 V, it is shown in Fig. 14.

Fig. 14. Form of the voltage pulse between the external screen and the screen of Faraday's cage, obtained with capacitor discharge with a capacity 6000 μF, charged to the stress 300 V. Scale along the X-axis is 5 ms.

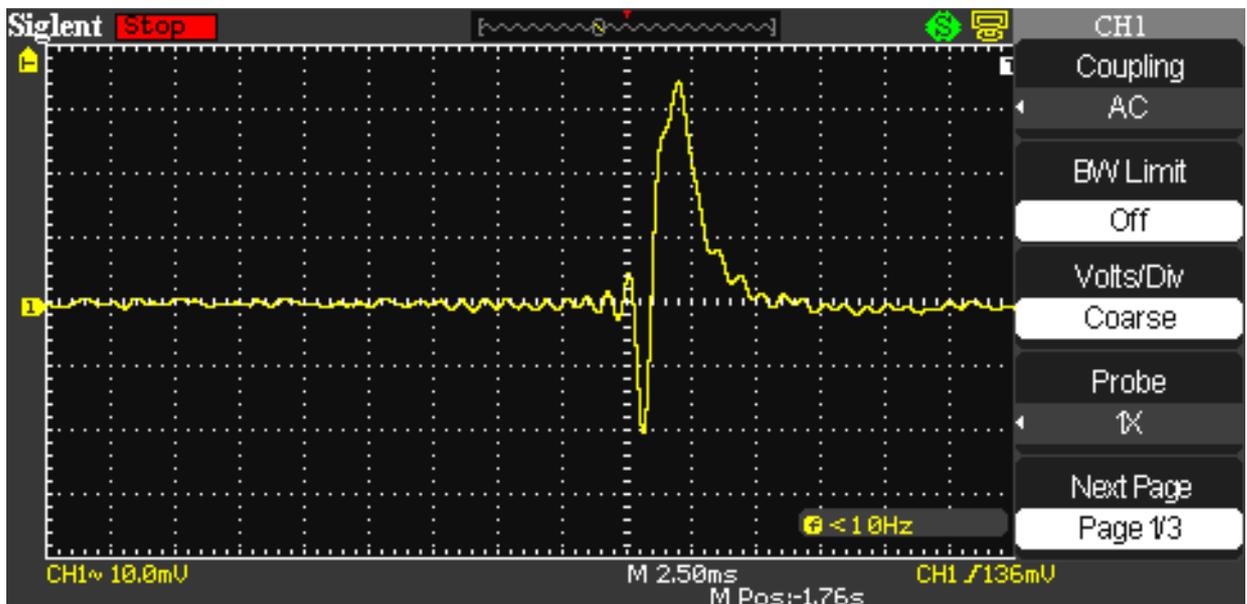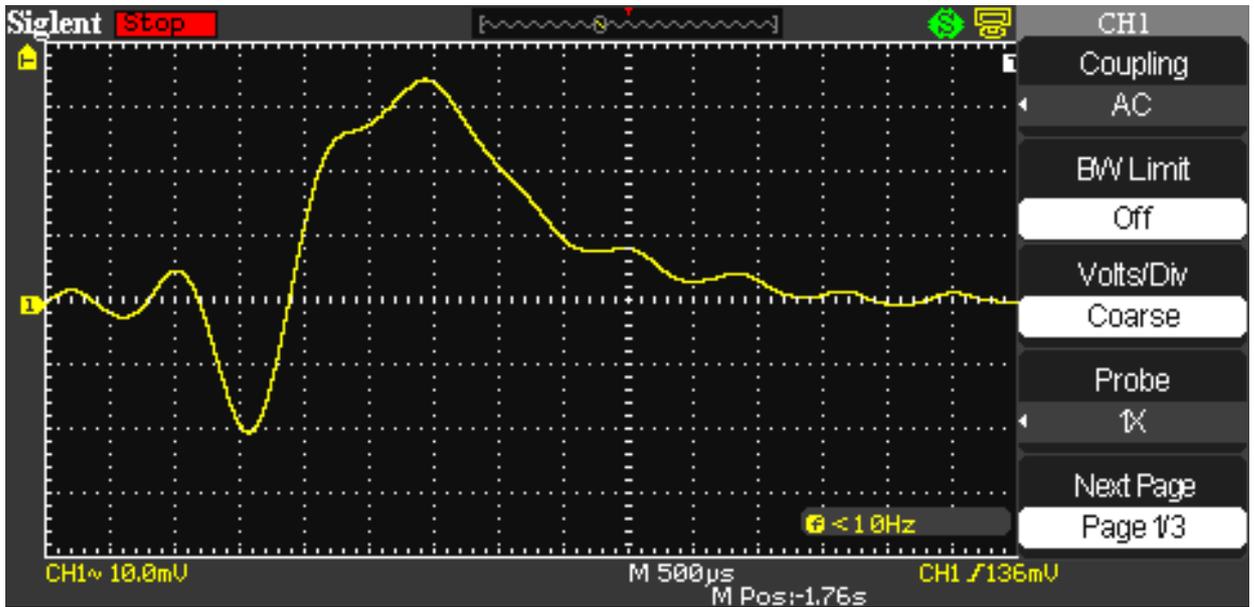The same pulse with the scale value the axis X 500 s is shown in Fig. 15.

Fig. 15. Form of the voltage pulse between the external screen and the screen of Faraday's cage, obtained with capacitor discharge with a capacity 6000 μF, charged to the stress 300 V. Scale along the X-axis is 5 ms.

Should be focused attention on the fact that the formation of the negative part of the pulse (Fig. 14) practically it coincides with the capacitor discharge time (Fig. 11), when through the plasma maximum current flows precisely in this time and the maximum warming-up of plasma occurs, since with the flow through it of high currents the warming-up is connected not only with its effective resistance, but also with the pinch effect.

If we compare Fig. 9, where is shown the shape of pulse with introduction into Faraday's cage of the charged amber and Fig. 14, that it is possible to see that the shapes of pulses 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. 14 and Fig. 15 the stages of warming-up and cooling of plasma are well visible, evident also that its heating occurs much faster than cooling.

The results of the conducted investigations attest to the fact that in the process of formation and warming-up of plasma in it the unitary negative charge is formed. In the formed plasma the number of electrons and positive ions is equal, but electrons have high speed, than ions; therefore naturally to assume that the formation of unitary charge is connected with the fact that the speed of electron motion more than in ions.

The total capacitance of the input circuit of oscilloscope and capacity between the screen of the Faraday's cage and the external screen is 204 pF, and the resistance of the input circuit of oscilloscope equally by 1 Mom, therefore, the input circuit of oscilloscope is differentiating. Consequently, the input circuit of oscilloscope together with the capacity between the screen of the Faraday's cage and the external screen, between which appears the voltage pulse, is differentiating. Therefore the oscillogram, represented in Fig. 14 and Fig. 15 they present the derivative of the voltage pulse, which appears between the screen of the Faraday's cage and the external screen.

With the explosion in space of H-bomb was discovered the pulse, shown in Fig. 1. When his record was used analog oscilloscope, but did not say what was used in this dish. Standard parameters of the input circuits is oscilloscope input capacitance of ~ 50 pF and the input resistance of ~ 1 *MΩ*. If we assume that a dipole antenna is used, together with the capacitance of the feeder its capacity is several hundred picofarad, and it means that the input circuit of oscilloscopes in this method of measurement are differentiating circuit. Therefore with the registration of the electric pulse of space explosion, as in our case, was recorded the derivative of the pulse, accepted by antenna. Comparison of the shape of pulse, obtained with the space explosion of the H-bomb and shape of the pulse, depicted in Fig. 13 it shows that in Fig. 1 the very short negative part of the pulse is absent. The subsequent positive parts of the pulse are very similar. This can be connected with the fact that with the explosion of H-bomb the short part of the pulse was so short, that the utilized oscilloscope had insufficient passband for the reproduction of so short a pulse.

Tests, carried out according to the diagram, depicted in Fig. 2 they showed that the shape of pulse with the identical values of the capacity of the discharged capacitor and stress on it, remains the same, as in the case of the connection of oscilloscope to the screen of the Faraday's cage. If we above the enamel as the second screen stick the copper foil, which repeats the outlines of the screen of the Faraday's cage, and to connect to the oscilloscope face, then the pulse amplitude and the shape of pulse does not change. But if we inside the external screen put the same metal intermediate screen of smaller sizes, which coincides in the form with the

external screen, but with the ample clearance between it and screen of the Faraday's cage, then the shape of pulse remains, but its amplitude decreases. This fact means that in the process of the warming-up of plasma in it is formed the unitary electric charge, whose electric fields freely penetrate both through the screen of the Faraday's cage and through the intermediate screen, reaching external screen. These fields penetrate through the outer screen and they can be found outside of the screen using a dipole antenna, the axis of which is directed towards the external screen, but it is very difficult to make, so how. there are large external interference. Such an experiment can be done only in a shielded room.

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 positive ions in it is formed the unitary negative charge, not compensated by positive ions the experiment examined it directly confirms that the fact that the invariant of speed is only the polarity of the moving electric charge, but its absolute value depends on speed.

3. Concepts of scalar-vector potential and its use for explaining the obtained results

Maxwell's equations do not give the possibility to write down fields in the moving coordinate systems, if fields in the fixed system are known. This problem is solved with the aid of the conversions of Lorenz, however, these conversions from the classical electrodynamics they do not follow. In the unipolar generator the electric fields appear in the elements, which revolve with respect to the fixed frame of reference, but the revolving frame of reference is not inertial. For this reason for explaining the operating principle of unipolar generator it is not possible to use either the principles of classical electrodynamics, or Lorentz conversion. Question arises can the principles of classical electrodynamics give correct results regarding fields on in the moving coordinate systems at least in some approximation, and if yes, then as the equations of electromagnetic induction must appear in this case.

The indication of how can be recorded fields in the moving coordinate system, if they are known in the fixed, there are already in the Faraday law, if we use ourselves the substantional derivative [24]. For the study of this problem let us rewrite Faraday law in the precise form:

$$\oint \vec{E}' d\,\vec{l}' = -\frac{d\,\Phi_B}{d\,t} \qquad (3.1)$$

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The refinement of law, is more accurate than its record, it concerns only that circumstance that if we determine contour integral in the moving (prime) coordinate system, then near $\vec{E}$ and $\vec{dl}$ must stand primes. But if circulation is determined in the fixed coordinate system, then primes near $\vec{E}$ and $\vec{dl}$ be absent, but in this case to the right in expression (3.1) must stand particular time derivative. Usually this circumstance in the literature on this question is not specified.

The substantional derivative in relationship (3.1) indicates the independence of the eventual result of appearance emf in the outline from the method of changing the flow, i.e. flow can change both due to the local time derivative of the induction of and because the system, in which is measured , it moves in the three-dimensional changing field of . In relationship (3.1) the value

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

(3.2)

where the magnetic induction $\vec{B} = \mu\, \vec{H}$ is determined in the fixed coordinate system, and the element $d\, \vec{S}'$ is determined in the moving system. Taking into account (3.2), we obtain from (3.1)

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

(3.3)

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

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

(3.4)

In this case contour integral is taken on the outline $d\, \vec{l}'$, which covers the area $d\, \vec{S}'$. Let us immediately note that entire following presentation will be conducted under the assumption the validity of the Galileo conversions, i.e., $d\, \vec{l}' = d\, \vec{l}$ and $d\, \vec{S}' = d\, \vec{S}$. From (3.4) follows the result

$$\vec{E}' = \vec{E} + \left[\vec{V} \times \vec{B}\right]$$

(3.5)

from which it follows that during the motion of charge in the magnetic field to it the additional electric field, determined by second term of the right side of the relationship acts (3.5). Let us note that this relationship we obtained not of the Lorentz conversions, but altogether having only refined Faraday law. Thus, Lorentz force

$$\vec{F}_L = e\vec{E} + e\left[\vec{V} \times \vec{B}\right]$$

it is the direct consequence of this precise law.

From relationship (3.5) it follows that during the motion in the magnetic field to the charge acts the force perpendicular to direction of motion. However, physical nature of this force is not clear and from the times of Lorenz and Poincare this force introduced as experimental postulate. But one cannot fail to note that are not known to us such laws of the mechanics, when with the uniform rectilinear motion of body on it the force, which depends on the speed of body and normal to the direction of its motion, acts.

For explaining physical nature of the appearance of this force let us write down $\vec{B}$ also $\vec{E}$ in the terms the magnetic vector potential $\vec{A}_B$:

$$\vec{B} = rot\ \vec{A}_B, \qquad \vec{E} = -\frac{\partial\ \vec{A}_B}{\partial\ t} \tag{3.6}$$

Then relationship (3.5) can be rewritten

$$\vec{E}' = -\frac{\partial\ \vec{A}_B}{\partial\ t} + \left[\vec{V} \times rot\ \vec{A}_B\right] \tag{3.7}$$

and further

$$\vec{E}' = -\frac{\partial\ \vec{A}_B}{\partial\ t} - \left(\vec{V}\ \nabla\right)\vec{A}_B + grad\left(\vec{V}\ \vec{A}_B\right) \tag{3.8}$$

The first two members of the right side of equality (3.8) can be gathered into the total derivative of vector- potential on the time, namely:

$$\vec{E}' = -\frac{d\,\vec{A}_B}{d\,t} + grad\left(\vec{V}\,\vec{A}_B\right) \qquad (3.9)$$

From relationship (3.8) it is evident that the field strength, and consequently also the force, which acts on the charge, consists of three parts.

The first of them is obliged by the local derivative of magnetic vector potential on the time. The sense of second term of the right side of relationship (3.8) is also intelligible. It is connected with a change in the vector potential, but already because charge moves in the three-dimensional changing field of this potential. Other nature of last term of the right side of relationship (3.8). It is connected with the presence of potential forces, since potential energy of the charge, which moves in the potential field of $\vec{A}_B$ with the speed $\vec{V}$, is equal $-e\left(\vec{V}\,\vec{A}_B\right)$. However, value $e\ grad\left(\vec{V}\,\vec{A}_B\right)$ determines the force of potential nature, exactly as determines force the gradient of scalar potential.

The relationship (3.8) gives the possibility to physically explain all composing tensions electric fields, which appears in the fixed and that moving the coordinate systems. In the case of unipolar generator in the formation of the force, which acts on the charge, two last addend right sides of equality (3.8) participate, introducing identical contributions.

Thus, to speak about the unipolar generator as about "an exception to the flow rule" is impossible, since flow rule this is the totality of all three components. Taking rotor from both parts of equality (3.9) and taking into account that $rot\ grad \equiv 0$, we obtain

$$rot\ \vec{E}' = -\frac{d\,\vec{B}}{d\,t} \qquad (3.10)$$

If there is no motion, then relationship (3.10) is converted into the Maxwell first equation. Certainly, on its informational content relationship (3.10) strongly is inferior to relationship (3.1), since in connection with the fact that $rot grad \equiv 0$, in it there is no information about the potential forces, designated $e\ grad\left(\vec{V}\,\vec{A}_B\right)$. Therefore, if us interest all components of electrical fields on, that act on the charge both in the fixed and in that moving the coordinate systems, we must use relationship (3.1).

Summing up the preliminary sum, it is possible to say that with the more careful examination Faraday law (3.1) it is possible to sufficient clearly understand all special features of the work of unipolar generator, it is possible to also assert that the operating principle of unipolar generator is not an exception to the rule flow (3.1), but it is its consequence. The assertion that the rule $\left[\vec{V} \times \vec{B}\right]$ for "moving outline" and $\nabla \times \vec{E} = -\dfrac{\partial \vec{B}}{\partial t}$ for "changing field" they are two completely different laws it does not correspond to reality. Exactly that united basic principle, absence of which indicates Feynman [26] and is Faraday law.

Consequently, we must conclude that the moving or fixed charge interacts not with the magnetic field, but with the field of magnetic vector potential, and only knowledge of this potential and its evolution they give the possibility to calculate all force components, which act on the charges. However, magnetic field appears altogether only of the gradient of such vectorial field.

But one cannot fail to note that to us is not thus far clear physical nature of quite vector potential.

From the aforesaid it follows that the record of the Lorentz force in the terms of the magnetic vector potential:

$$\vec{F}^{\,'} = e\,\vec{E} + e\,[\vec{V} \times rot\,\vec{A}_B] = e\,\vec{E} - e(\vec{V}\,\nabla)\vec{A}_B + egrad\,(\vec{V}\,\vec{A}_B) \qquad (3.11)$$

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

The Faraday law (3.1) should be called the law of magnetoelectric induction in connection with the fact that it it shows how a change in the magnetic fields on it leads to the appearance of electrical fields on. However, in the classical electrodynamics there is no law of electromagnetic induction, which would show, how a change in the electrical fields on, or motion in them, it leads to the appearance of magnetic fields on. The development of classical electrodynamics followed along another way. Was first known the Ampere law

$$\oint \vec{H}\,d\,\vec{l} = I \qquad (3.12)$$

where I is current, which crosses the area, included by the outline of integration. In the differential form relationship (3.12) takes the form:

$$\text{rot } \vec{H} = \vec{j}_\sigma \qquad (3.13)$$

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

Maxwell supplemented relationship (3.12) with bias current

$$\text{rot } \vec{H} = \vec{j}_\sigma + \frac{\partial \vec{D}}{\partial t} \qquad (3.14)$$

However, the law of the induction was not established in the times of Ampere and Maxwell

$$\oint \vec{H'} d \vec{l}' = \frac{d \Phi_D}{d t} \qquad (3.15)$$

where $\Phi_D = \int \vec{D} d \vec{S}'$ is the flow of electrical induction, since then sensitivity of meters did not be sufficient for establishing this law.

Is already later in 1878 H. Rowland it experimentally proved that the convection current of free charges on the moving conductor on its magnetic action was identical with the conduction current in the quiescent conductor.

In this case relationship (3.15) can be rewritten as follows:

$$\oint \vec{H'} d \vec{l}' = \int \frac{\partial \vec{D}}{\partial t} d \vec{S} + \oint [\vec{D} \times \vec{V}] d \vec{l}' + \int \vec{V} \text{ div } \vec{D} d \vec{S}' \qquad (3.16)$$

In contrast to the magnetic fields, when $\text{div}\vec{B} = 0$, for the electrical fields $\text{div}\vec{D} = \rho$ and last term in the right side of relationship (3.16) it gives the conduction current of and from relationship (3.15) the Ampere law immediately follows. From relationship (3.16) follows also the equality:

$$\vec{H} = [\vec{D} \times \vec{V}] \qquad (3.17)$$

which earlier could be obtained only from the Lorenz conversions.

As shown in the work [26], from relationship (3.17) follows and Bio-Savara law, if for enumerating the magnetic fields on to take the electric fields of the moving charges. In this case

the last member of the right side of relationship (3.16) can be simply omitted, and the laws of induction acquire the completely symmetrical form

$$\oint \vec{E}' d\,\vec{l}\,' = -\int \frac{\partial \vec{B}}{\partial t} d\,S - \oint [\vec{B} \times \vec{V}] d\,\vec{l}\,' \quad,$$

$$\oint \vec{H}' d\,\vec{l}\,' = \int \frac{\partial \vec{D}}{\partial t} d\,S + \oint [\vec{D} \times \vec{V}] d\,\vec{l}\,' \quad.$$

(3.18)

$$E' = \vec{E} + [\vec{V} \times \vec{B}] \quad,$$
$$H' = \vec{H} - [\vec{V} \times \vec{D}] \quad.$$

(3.19)

Let us note that previously relationships (3.19) could be obtained only from the covariant Lorentz conversions, i.e. within the framework the special theory of relativity (SR). Thus, with an accuracy down to the terms $\sim \dfrac{V}{c}$ results SR follow from the laws of the induction within the framework of the Galileo conversions. Further we will show that they follow from laws of induction (3.18) and results SR with an accuracy $\sim \dfrac{V^2}{c^2}$. However, before this we will introduce one additional vector potential, which in the classical electrodynamics was not introduced. For the vortex fields on let us accept [5]

$$\vec{D} = rot\,\vec{A}_D$$

(3.20)

where $\vec{A}_D$ is electrical vector potential. Then from (3.16) follows

$$\vec{H}' = \frac{\partial \vec{A}_D}{\partial t} + [\vec{V}\,\nabla]\vec{A}_D - grad\,[\vec{V}\,\vec{A}_D]$$

(3.21)

or

$$\vec{H}' = \frac{\partial \vec{A}_D}{\partial t} - [\vec{V} \times rot\,\vec{A}_D]$$

(3.22)

or

$$\vec{H}' = \frac{d\vec{A}_D}{dt} - grad\,[\vec{V}\,\vec{A}_D] \qquad (3.23)$$

.

These relationships are the writing of the law of electromagnetic induction in the terms of electrical vector potential.

The relationship (3.19) attest to the fact that in the case of relative motion the inertial reference system (RS), between the fields $\vec{E}$ and $\vec{H}$ there is a cross coupling, i.e., motion in the fields $\vec{H}$ leads to the appearance fields $\vec{E}$ and vice versa. From these relationships escape the additional consequences, which were for the first time examined in the work [5].

The electric field $E = \dfrac{g}{2\pi\varepsilon r}$ outside the charged rod with a long chase charge g decreases according to the law $\dfrac{1}{r}$, where r is distance from the central axis of the rod to the observation point.

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

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

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

$$E'\left(r, v_{\perp}\right) = \frac{ech\dfrac{v_{\perp}}{c}}{4\pi\varepsilon r^2}, \qquad (3.24)$$

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

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

$$\varphi'(r, v_{\perp}) = \frac{ech\dfrac{v_{\perp}}{c}}{4\pi\varepsilon r} = \varphi(r)ch\frac{v_{\perp}}{c}, \qquad (3.25)$$

where $\varphi(r)$ is scalar potential of fixed charge. The potential $\varphi'(r, v_{\perp})$ can be named scalar-vector potential, 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 not difficult to see that the obtained relationship with an accuracy to of the quadratic members of the expansion of the corresponding functions in series coincides with results SR, in which scalar potential is determined by the relationship [27]:

$$\varphi'(r, v) = \frac{\varphi(r)}{\sqrt{1 - \dfrac{v^2}{c^2}}}$$

Using for enumerating the conversion of magnetic fields on the same method, we obtain:

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

where $v_{\perp}$ is speed normal to the direction of the magnetic field.

If we apply the obtained results to the electromagnetic wave and to designate components fields on parallel speeds RS as $E_{\uparrow}, H_{\uparrow}$, and $E_{\perp}, H_{\perp}$ as components normal to it, then with

the conversion fields on components, parallel to speed will not change, but components, normal to the direction of speed are converted according to the rule

$$\vec{E}'_\perp = \vec{E}_\perp ch \ \frac{v}{c} + \frac{v}{c}\vec{v}\times\vec{B}_\perp sh\frac{v}{c},$$

$$\vec{B}'_\perp = \vec{B}_\perp ch \ \frac{v}{c} - \frac{1}{vc}\vec{v}\times\vec{E}_\perp sh\frac{v}{c},$$

(3.26)

where $c = \sqrt{\dfrac{1}{\mu_0\varepsilon_0}}$ is speed of light.

Conversions fields (3.26) they were for the first time obtained in the work [5]. However, the iteration technique, utilized for obtaining the given relationships, it is not possible to consider strict, since its convergence is not explained

A more rigorous derivation proposed by N. A. Drobyshev [15] can be obtained in a matrix form.

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

$$\vec{E}_{1\perp} = \vec{E}_\perp + \Delta\vec{v}\times\vec{B}_\perp \qquad \vec{B}_{1\perp} = \vec{B}_\perp - \Delta\vec{v}\times\vec{E}_\perp / c^2$$

$$\vec{E}_{2\perp} = \vec{E}_{1\perp} + \Delta\vec{v}\times\vec{B}_{1\perp} \qquad \vec{B}_{2\perp} = \vec{B}_{1\perp} - \Delta\vec{v}\times\vec{E}_{1\perp} / c^2$$

(3.27)

and etc. Upon transfer to each following RS fields are obtained increases $\Delta\vec{E}$ and $\Delta\vec{B}$

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

(3.28)

where the fields $\vec{E}_\perp$ and $\vec{B}_\perp$ relate to current RS. Directing the Cartesian axis x along $\Delta\vec{v}$, let us rewrite (3.28) in the components of the vector

$$\Delta E_y = -B_z\Delta v, \qquad \Delta E = B_y\Delta v, \qquad \Delta B_y = E_z\Delta v / c^2 \qquad (3.29)$$

Relationship (3.29) 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 the target RS $K' = K_N$ relative to the initial K is $v = N\Delta v$, then we will obtain the matrix system of the differential equations

$$\frac{dU(v)}{dv} = AU(v) \qquad (3.30)$$

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

$$U' \equiv U(v) = \exp(vA)U, \qquad U = U(0) \qquad (3.31)$$

here U is matrix column fields on in the system K, and U' is matrix column fields on in the system of K'. Substituting (3.31) in the system (3.30), we are convinced, what U' is actually the solution of the system (3.30):

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

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

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

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

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

then

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

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

And the elements of matrix exponential curve take the form

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

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

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

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

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

Now we return to (3.31) and substituting there $\exp(vA)$, we find

$$E'_y = E_y ch\,v/c - cB_z sh\,v/c, \qquad E'_z = E_z ch\,v/c + cB_y sh\,v/c,$$

$$B'_y = B_y ch\,v/c + (E_z/c) sh\,v/c, \qquad B'_z = B_z ch\,v/c - (E_y/c) sh\,v/c,$$

Or in the vector record

$$\vec{E}'_\perp = \vec{E}_\perp ch\,\frac{v}{c} + \frac{v}{c}\vec{v} \times \vec{B}_\perp sh\,\frac{v}{c},$$

$$\vec{B}'_\perp = \vec{B}_\perp ch\,\frac{v}{c} - \frac{1}{vc}\vec{v} \times \vec{E}_\perp sh\,\frac{v}{c},$$

(3.32)

This is conversions (3.26)

The carried out experiments showed that in the process of the warming-up of plasma inside Faraday cage appears the unitary charge, whose fields penetrate through the metal screen

Faraday cage. This confirms the fact that even when entrance of oscilloscope it does not have galvanic contact with the screen Faraday cage, but it is connected to the intermediate screen, with the warming-up of plasma is fixed the pulse of the same form as with the connection of the entrance of oscilloscope to the screen of Faraday cage.

If we calculate the energy, necessary for the warming-up, melting and the evaporation of the copper wire with a diameter 0.2 mm and with a length 5 mm that it will be near 8 J. In this case the temperature of vapors of copper will already be approximately 2800 K. However, energy of the capacitor with a capacity 3000 microfarad, charged to the voltage 300 V composes 134 J. Consequently, energy of order 125 J will leave to the warming-up of vapors of copper and ambient air, to their ionization and the light and other forms of emission, which accompanies heating gas and plasma.

We have no way to calculate the temperature of the electron gas and the number of electrons in the plasma, but the concept of using a scalar-vector potential, we can calculate the equivalent charge arises within a Faraday cage during discharge. We will consider that the plasma is heated to such temperature, that the velocity of particles in it is subordinated to the distribution of Boltzmann. The most probable electron velocity in this case is determined by the relationship

$$v = \sqrt{\frac{2k_B T}{m}} .$$

(3.33)

Now, using relationship (3.25) for compute the increase scalar–vector potential

and taking into account only terms of the expansion $\sim \dfrac{v^2}{c^2}$, we obtain

$$\Delta\varphi \cong \frac{Nek_B T}{4\pi\varepsilon_0 rmc^2} .$$

(3.34)

To solve stated problem for the concrete configuration of the screen of the Faraday cage and external screen task is not simple. Therefore let us examine solution of problem for the case of the spherical configuration of these elements, when the heated plasma is located in the cent of spheres. We will also consider that the dimensions of plasmoid are considerably less than the sizes of screens, i.e., we will examine the case of point charge. We will consider that a radius Faraday cage is equal r_1 and a radius of external screen it is equal r_2 .

Integrating relationship (3.34) on the coordinate, we obtain the pulse amplitude.

$$U = \frac{Nek_{Б}T}{4\pi\varepsilon_0 mc^2}\left(\frac{1}{r_1^2} - \frac{1}{r_2^2}\right)$$

(3.35)

In relationship (3.35) the value

$$\Delta q = \frac{Nek_{Б}T}{mc^2}$$

(3.36)

the equivalent charge of discharge represents. This value is equal to exceeding the charge of the moving electrons above their equilibrium value in the metal.

To us is known neither quantity of electrons, which participate in the formed plasma its nor temperature, but according to the data of experiment we can determine the equivalent charge of discharge.

From relationships (3.35) and (3.36) we find

$$\Delta q = \frac{4\pi\varepsilon_0 U}{\left(\dfrac{1}{r_1^2} - \dfrac{1}{r_2^2}\right)}$$

In the research facility in question a maximum radius of the lower part of the screen Faraday cage is 0.11 m, and a radius of external screen is equal 0.15 m. Let us accept these sizes for the spherical surfaces, examined in the task, for tentative the calculated value of equivalent charge. For this case, the maximum value equivalent to the charge explosion formed during heating of the plasma is equal to 3.4×10^{-14} Q.

4. Conclusion

In the article are given the experimental proofs of the fact that the charge is not the invariant of speed. This fact contradicts not only classical electrodynamics, in which the charge and its fields on speed do not depend, but also the special theory of relativity . In SR electric fields of charge they depend on speed, but component, its normal and parallel to direction motions change in such a way that the flow of the electric field through the surface, which surrounds charge, remains constant, i.e., charge is the invariant of speed.

The obtained results not only have large value for physics, but also are opened new technical capabilities for diagnostics of the kinetics of the warming-up of plasma. This is first of all important for the realization of the controlled thermonuclear fusion.

From the conducted investigations it follows that the fact of the appearance of unitary charge does not depend on the method of the warming-up of plasma, but is important only the fact of its warming-up. Therefore electric pulse must appear, also, with the usual explosions, when the formation of plasma occurs, but studies on this question are still in front. In the publishing house Palmarium academic publishing was recently published monograph [28], where they were examined questions of electrodynamics and thermodynamics of nuclear and trotyl explosions.

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