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By F. F. Mende

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I. Introduction

At present classical electrodynamics consists of two not connected together parts. This of Maxwell's equation the determining wave properties [1], pour on from one side, from other side these are Lorentz force [2], is determining ponderomotive (power) interactions of the current carrying systems. As is known, this force is introduced in the form separate postulate. And as yet there is no that connecting link, which would unite these odd parts. in the electrodynamics the fundamental law of induction is Farrday law. But also here matters be not in the best way. Homopolar induction is exception from this law, whiches indicate its incompleteness. Specifically, this induction, until now, causes among the scientists many disputes, it was opened by Faraday more than 200 years ago, but also up to now the physical principles of the operation of some constructions of unipolar generators remain obscure. There were the attempts to explain the work of such generators by action on the moving charges of Lorentz force, but it turned out that there are such constructions, in which to explain their operating principle thus is impossible. Here one example. If we to the conducting disk, fasten on the insulating plate end magnet, and to begin I utter its mating-call construction to revolve, then between the brushes, which slide through the periphery of disk and by its axis, will arise a potential difference. Since in the case indicated the magnet revolves together with the disk, there is no motion of the charges of disk in the magnetic field of magnet, and to explain the appearance of a voltage drop across brushes on the basis of Lorentz force is impossible.

In the separate publications it is indicated that for explaining the work of unipolar generators should be drawn the special theory of relativity (SR), but no one showed, as this to make. It will be in this work shown that attraction of the concept of scalar- vector potential for explaining the work of all known constructions of unipolar generators gives answers to all presented questions.

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II. Homopolar Induction In The Concept Of Scalar- Vector Potential

Beginning the study of the problem about the homopolar induction, it is necessary to clearly demarcate the concepts of a potential difference and electromotive force (EMF). The scalar potential of fixed charge is determined by the relationship

$$\varphi_0(r)=\frac{Q}{4\pi\varepsilon r},$$

where Q - magnitude of the charge, and ε - dielectric constant of medium.

Electric field is the gradient of the scalar potential

$$\mathbf{E}=-grad\ \varphi_0(r).$$

This field is potential, while this means that the work is not accomplished with the transfer of trial charge in this field along any locked trajectory, i.e. the condition is satisfied

The electromotive force is the scalar quantity, which characterizes the work of strange (nonpotential) forces in the locked conducting outline and is determined the work of these forces on the displacement of unit charge along the outline. EMF determines the work of these forces on the displacement of single positive charge along the outline. This work is determined by work EMF to the magnitude of the charge. Both potential difference and EMF are measured in volts.

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In the usual electric generators EMF is generated in the locked fixed or moving outline, partly which appears the load, in which is separated the energy. A difference in the unipolar generator from such generators is the fact that in it the locked outline is composite: one part of this outline is fixed, and the second moves relative to the first. Galvanic contact between these parts is ensured with the aid of the feeder brushes. Both parts of the outline of unipolar generator their EMF, which have different value, are excited. EMF in this composite outline is the bag EMF of its component parts. Let us note that component parts it can be and more than two.

The concept of scalar- vector potential, developed in the works [3-6], the dependence of the scalar potential of charge on its relative speed is assumed

$$\varphi(v)=\varphi_0 ch\frac{v_\perp}{c}, \qquad (1)$$

where $v_\perp$ - normal component of charge rate to the vector, which connects the moving charge and observation point, c - speed of light Let us examine the case, when there is a section of the conductor, along which flows the current (Fig.1). We will consider that in the conductor are two subsystems of the mutually inserted charges of positive lattice g^+ and free electrons g^-, absolute values of which they are equal in magnitude they compensate each other, leaving conductor neutral. For convenience in the examination in the figure these two subsystems are moved apart along the coordinate r.

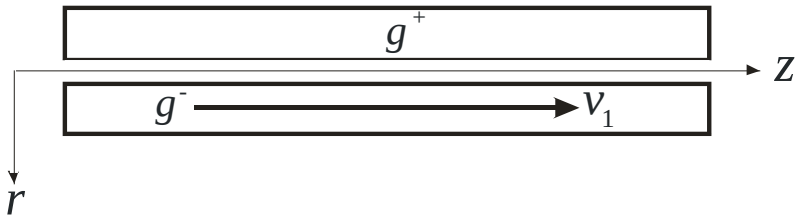

Fig. 1: Section is the conductor, along which flows the current

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

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

where g - the absolute value of a quantity of positive chargex, which fall per unit of the length of conductor.

As in relationship (2), with the further consideration we will introduce only absolute values of the densities both of positive and negative charges, counting the absolute values of electrical pour on, which coincide in the direction from r by positive, and opposite to this direction - negative.

Using relationship (2), we obtain the values of electrical pour on, created by the electrons, which move in the conductor with the speed v_1

$$E^- = -\frac{g}{2\pi\varepsilon r} ch\frac{v_1}{c} \cong -\frac{g}{2\pi\varepsilon r}\left(1+\frac{1}{2}\frac{v_1^2}{c^2}\right). \qquad (3)$$

In this relationship only two first members of expansion in the series of hyperbolic cosine are undertaken.

Adding (2) and (3), we obtain the summary value of the electric field at a distance of from the axis of the conductor:

$$E=-\frac{gv_1^2}{4\pi\varepsilon c^2 r}.$$

This relationship indicates that around the conductor, along which move the electrons, is created the electric field, which corresponds to the negative charge of conductor. However, this field with those current densities, which can be provide ford in the normal conductors, has insignificant value, and discovered be it cannot with the aid of the existing measuring means. It can be discovered only with the use of the superconductors, where the current density can on many orders exceed currents in the normal metals [4].

Let us examine the case, when very section of the conductor, on which with the speed v_1 flow the electrons, moves in the opposite direction with speed v (Fig. 2).

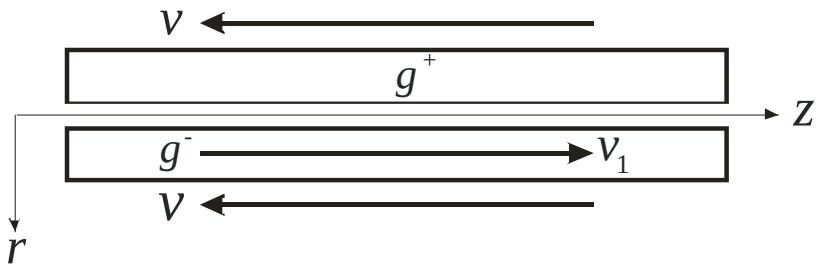

Fig. 2: Section of conductor with the current, which moves with the speed v

In this case relationships (2) and (3) will take the form

$$E^{+}=\frac{g}{2\pi\varepsilon r}\left(1+\frac{1}{2}\frac{v^2}{c^2}\right), \tag{4}$$

$$E^{-}=-\frac{g}{2\pi\varepsilon r}\left(1+\frac{1}{2}\frac{(v_1-v)^2}{c^2}\right). \tag{5}$$

Adding (4) and (5), we obtain the summary field

$$E_{\Sigma}=\frac{g}{2\pi\varepsilon r}\left(\frac{v_1 v}{c^2}-\frac{v_1^2}{c^2}\right). \tag{6}$$

We will consider that the speed of the mechanical motion of conductor is considerably more than the drift velocity of electrons. Then in relationship (6) the second term in the brackets can be disregarded, and finally we obtain:

$$E\cong\frac{gv_1 v}{2\pi\varepsilon c^2 r}. \tag{7}$$

The obtained result means that around the moving conductor, along which flows the current, with respect to the fixed observer is formed the electric field, determined by relationship (7), which is equivalent to appearance on this conductor of the specific positive charge of the equal This field not is potential, since it is created with strange sources, and it is equivalent to appearance on this conductor of the specific positive charge of the equal

$$g^{+}=\frac{gv_1 v}{c^2}. \tag{8}$$

If in parallel with the conductor with the same speed moves the plate (it is shown in the lower part of Fig. 3), whose width is equal r_2-r_1, then between its edges will be observed electromotive force

$$U_1=-\int_{r_1}^{r_2}\frac{gv_1^2 dr}{2\pi\varepsilon c^2 r}=-\frac{gv_1^2}{2\pi\varepsilon c^2}\ln\frac{r_2}{r_1}. \tag{9}$$

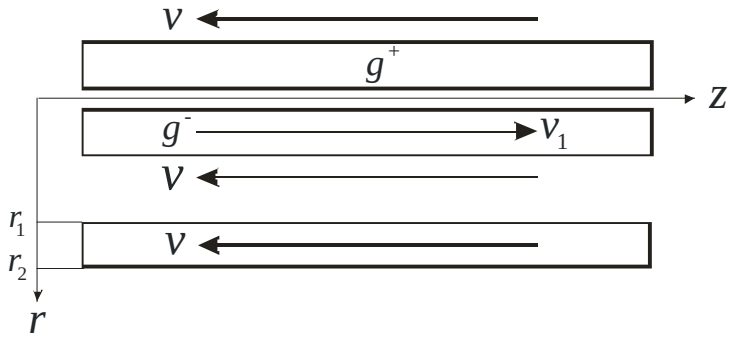

Fig. 3: The conducting plate moves with the same speed, as conductor

But if along the moving plate slide the contacts, which are fixed in the reference system (Fig.4), then EMF between such contacts will comprise

$$U_2=\frac{g}{2\pi\varepsilon}\left(\frac{v_1 v}{c^2}-\frac{1}{2}\frac{v_1^2}{c^2}\right)\ln\frac{r_2}{r_1}. \tag{10}$$

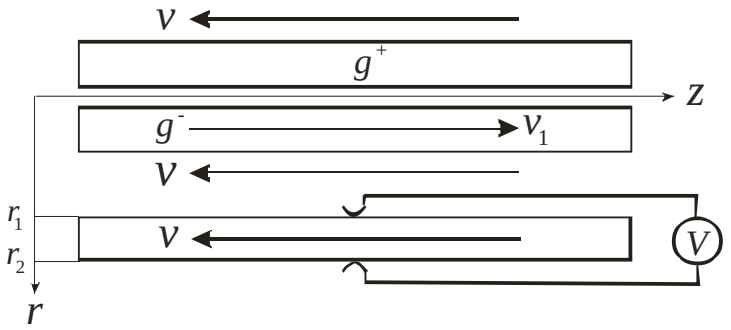

Fig. 4: To the conducting plate, which is moved together with the conductor, with the aid of the brushes the voltmeter is connected

The conducting plate, which is moved together with the conductor, presents together with the circuit of voltmeter the composite locked outline, in which will act EMF, which is been the sum of electromotive force, which is located on the component parts of the outline. We will obtain its value, summing up expressions (9) and (10):

$$U_{\Sigma}=U_2-U_1=\frac{gv_1v}{2\pi\varepsilon c^2}\ln\frac{r_1}{r_2}. \qquad (11)$$

If the conductor, along which flows the current, to roll up into the ring, after making from it a turn with the current, and to revolve this turn then, so that the speed of its parts would be equal v, that the electric field, which corresponds to the presence on the conductor of the specific charge, determined by the relationship will appear around this turn, (8). Let us roll up into the ring the conducting plate, after making from it a disk with the opening, and let us join to its generatrix feeder brushes, as shown in Fig. 5. If we with the identical speed revolve ring and disk, then on the condition that that the diameter of ring is considerably more than its width, on the brushes we will obtain EMF, determined by relationship (11).

Ring of wire can consist not of one, but of several turns. Such turns are the analog of the end magnet, which revolves together with the conducting disk.

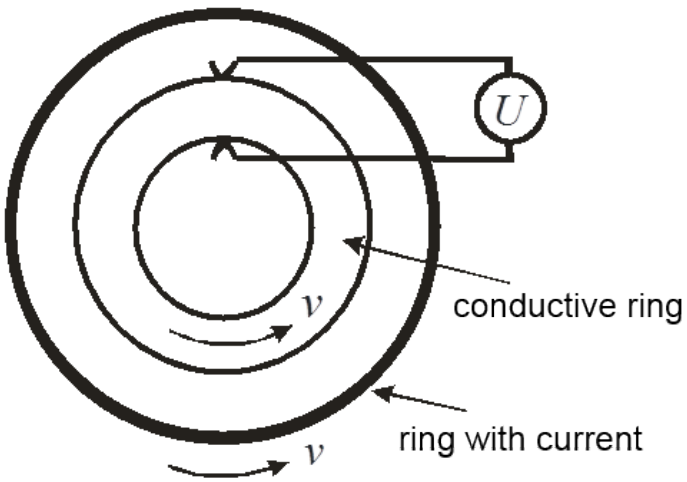

Fig. 5: Schematic of unipolar generator with the revolving turn with the current and the revolving conducting ring

Is examined the most contradictory version of the unipolar generator, the explanation of the operating principle of which in the literary sources previously was absent. With its examination it is not possible to use a concept of Lorentz force, since. and magnet and conducting ring revolve together with the identical speed.

The conducting ring and the revolving together with it magnet it is possible to combine in the united construction. For this should be taken the conducting disk from the magnetic material and magnetized it in the axial direction, after joining feeder brushes to its generatrix. The continuous magnetized disk is the limiting case of this construction. With this EMF it is removed with the aid of the feeder brushes between the generatrix of disk and its axis. This construction presents the unipolar generator, which was proposed still by Faraday.

III. Conclusion

The homopolar induction was discovered by Faraday more than 200 years ago, but also up to now the physical principles of the operation of some constructions of unipolar generators remain obscure. There were the attempts to explain the work of such generators by action on the moving charges of Lorentz force, but it turned out that there are such constructions, in which to explain their operating principle thus is impossible. It is in the present work shown that the concept of the scalar- vector potential, which assumes the dependence of the scalar potential of charge on its relative speed, makes it possible to explain the work of all existing types of unipolar generators. from the day of discovery by Faradayhomopolar induction this article appears first and thus far of only, where the true reasons for this phenomenon are reflected.

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