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Electromagnetic Energy Flow in the Wire and Milroy Engine

Abstract

It is shown show that the current in the wire has a complex structure, and inside the wire a flow of electromagnetic energy is spreading. The functioning of Milroy engine can be explained by the existence of circular current and energy flow in the conductor. Based on this fact perform the calculation of Milroy engine can be performed.

Contents

Introduction

The engine presented by English physicist R. Milroy in the year 1967 is known as the Milroy engine – see Fig. 1 from [1]. Conductive shaft with flywheels can rotate in two bearings. Through the outer rings of the bearing and through the shaft an electric current is passed. The shift begins to spin up to any side after the first jot. In [2] the functioning of this engine is explained by the action of non-potential lateral Lorentz forces. In [3] the functioning of this engine is explained by the interaction of magnetic flow created by current spiral *I* in the shaft and modulated variable reluctance of the gap between the holders of the bearing with the currents inducted in the inner holder of the bearing.

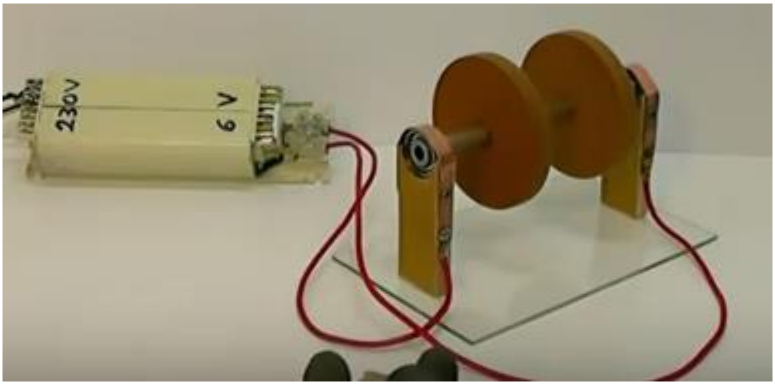

Fig. 1.

V.V. Kosyrev, V.D. Ryabkov and N.N. Velman before Milroy in 1963 presented an engine of different construction [4]. Their engine differs fundamentally from the Milroy engine by the absence of one of bearings. The conductive shaft is pressed into the inner ring of the horizontal bearing. So the shaft is hanging on the bearing. The electrical circuit is closed through the outer ring of the bearing and the brush touching the lower face of the shaft. The authors see the cause of rotation in the fact that the shaft "rotates as a result of elastic deformation of the engine's parts when they are heated by electric current flowing through them".

Finally, often the functioning of this engine is explained by the Hoover's effect [9].

Below we are giving another explanation of this engine's operating principle. We show that **inside** the conductor with current there appears a torque. It seems to the author that the Kosyrev's engine cannot be explained in another way.

1. About Energy Transfer through Wires

The existing idea of energy transfer through the wires is that the energy in a certain way is spreading outside the wire [5]: "*So our "crazy" theory says that the electrons are getting their energy to generate heat because of the energy flowing into the wire from the field outside. Intuition would seem to tell us that the electrons get their energy from being pushed along the wire, so the energy should be flowing down (or up) along the wire. But the theory says that the electrons are really being pushed by an electric field, which has come from some charges very far away, and that the electrons get their energy for generating heat from these fields. The energy somehow flows from the distant charges into a wide area of space and then inward to the wire.*"

Such theory contradicts the Law of energy conservation. Indeed, the energy flow, travelling in the space must lose some part of the energy. But this fact was found neither experimentally, nor theoretically. But, most important, this theory contradicts the following experiment. Let us assume that through the central wire of coaxial cable runs DC. This wire is isolated from the external energy flow. Then whence the energy flow compensating the heat losses in the wire comes?

So, the existing theory claims that the incoming (perpendicularly to the wire) electromagnetic flow permits the current to overcome the resistance to movement and performs work that turns into heat. This known conclusion veils the natural question: how can the current attract the flow, if the current appears due to the flow? It is natural to assume that the flow creates a certain emf which "moves the current".

2. Direct Current in a Conductor

In [6-8] based on the Law of impulse conservation it is shown that DC in a conductor must have a complex structure. Let us consider first a conductor with DC. The current J in the wire creates in the body magnetic induction B, which acts on the electrons with charge q_e, moving with average speed v in the direction opposite the current J, with Lorentz force F, making them move to the center of the wire – see Fig. 1.

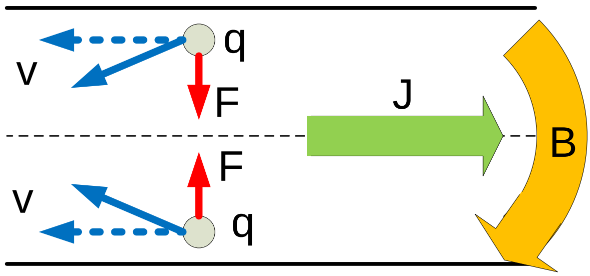

Fig. 1.

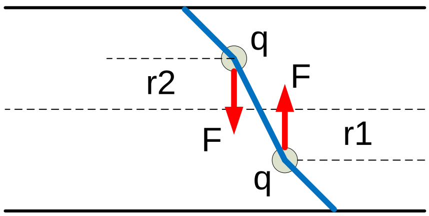

Fig. 2.

Due to the known distribution of induction B on the wire's cross section the force F decreases from the wire surface to its center – see Fig. 2, showing the change of F depending on radius r, on which the electron is located.

Thus, it may be assumed that in the wire's body there exist elementary currents I, beginning on the axis and directed by certain angle α to the wire axis – see Fig. 3.

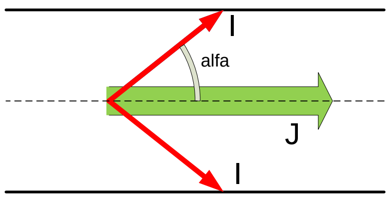

Fig. 3.

The current in the wire is usually regarded as an average flow of electrons. The mechanical interactions of electrons with atoms are regarded as equivalent to electrical resistance. For stricter analysis of the current's structure we should consider Maxwell equations for magnetic intensities and currents in the wire body. Here it is convenient to use cylindrical coordinates $r,\ \varphi,\ z$. It may be shown that the solution of these equations I as follows:

$$H_r. = \frac{\alpha}{2} h_\varphi r \sin(\alpha\varphi), \tag{1}$$

$$H_\varphi. = h_\varphi r \cos(\alpha\varphi) + \frac{J_o r}{2}, \tag{2}$$

$$H_z = -\frac{1}{2} j_\varphi r^2 \sin(\alpha\varphi), \tag{3}$$

$$J_r. = -\frac{\alpha}{2} j_\varphi r \cos(\alpha\varphi), \tag{4}$$

$$J_\varphi. = j_\varphi r \sin(\alpha\varphi), \tag{5}$$

$$J_z = J_o + h_\varphi \left(1 - \alpha^2/2\right) \cos(\alpha\varphi), \tag{6}$$

where

J_o - the density of main current,

$J_r,\ J_\varphi,\ J_z$ - the densities of additional currents,

$H_r,\ H_\varphi,\ H_z$ - magnetic fields intensities,

$j_\varphi,\ h_\varphi,\ \alpha$ - constants.

Thus, there exists uneven distribution of currents J_r, J_φ, J_z and intensities H_r, H_φ, H_z along the wire section. Fig. 4 shows the vector field of currents J_r, J_φ on the section plane $(r,\ \varphi)$ for $\alpha = 1$. It can be seen that there exist circular currents along the wire section. So there exists a torque acting on the wire as a whole. This phenomenon is similar to the fact that the currents appearing in the wire section under the action of Ampere forces can displace the wire as a whole.

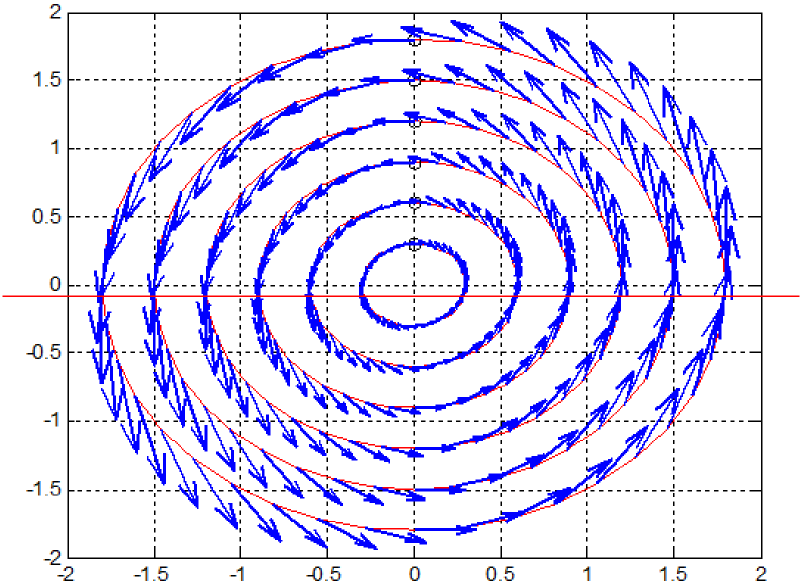

Fig. 4.

3. The Electromagnetic Energy Flow in a Conductor

The currents and intensities indicated above create flows of energy. In cylindrical coordinates the densities of these flows by coordinates can be expressed by the following formula:

$$\begin{bmatrix} S_r \\ S_\varphi \\ S_z \end{bmatrix} = \rho \begin{bmatrix} J_\varphi H_z - J_z H_\varphi \\ J_z H_r - J_r H_z \\ J_r H_\varphi - J_\varphi H_r \end{bmatrix}, \tag{1}$$

where ρ is specific resistivity. It can be shown that average for every circle density f electromagnetic energy flow is expressed by the following formula (here the upper dash denotes the average value for a circle):

$$\overline{S} = \begin{bmatrix} \overline{S_r} = -\frac{J_o^2 r}{2} - \frac{1}{2\sqrt{2}} j_\varphi^2 r^3 - \frac{h_\varphi^2 r}{\sqrt{2}}\left(1 - \frac{\alpha^2}{2}\right) \\ \overline{S_\varphi} = -\frac{\alpha^2}{2\sqrt{2}} h_\varphi^2 r \\ \overline{S_z} = -j_\varphi h_\varphi r^2 \frac{\alpha}{2} \end{bmatrix} \tag{2}$$

It can be seen that inside the wire the flows of energy are circulating along the coordinates. This energy is being spent on the heat losses of circulating current if the wire is fixed. In particular, the flow $\overline{S_\varphi}$ is circulating along the circle. Its energy is spent on the heat losses if the wire is fixed. If the wire can rotate, as it happens in the Milroy engine, then this energy is transformed into mechanical energy of rotation.

These formulas permit to realize the mechanical calculation of Milroy engine.

4. The Start of Milroy Engine

For starting Milroy engine it is necessary to give it a starting impulse. Nevertheless, Nikolaev [2] has shown that the engine is started by itself if the current to the outer rings of the bearing is supplied through contact brushes placed in different planes (passing through the shaft's axis). This fact can be explained as follows.

The solution (2.1-2.6) actually integrated two solutions: for $\alpha > 0$ and for $\alpha < 0$.To each solution corresponds its own direction of rotation – see Fig. 2.4. Usually these two opposite directed torques compensate each other. However the may be cases when one of the directions of rotation gain an advantage. Apparently this occurs on the appearance of a staring torque of on asymmetrical distribution of current in the wire (caused by asymmetrical location of contacts in Nikolaev's experiments). At present the author cannot give a strict justification of these cases.

5. An Additional Experiment

We may propose an experiment in which the previously suggested explanations of the reasons for the rotation of Milroy engine are not acceptable (in the author's view). We should give the opportunity to a rod with current to rotate freely. This can be realized in the following way – see Fig. 1. A copper roll with pointed ends is clamped between two carbon brushes so that it could rotate. The carbon brushes are needed in order that the contacts would not be welded at strong currents. In accordance with the theory contained in this paper, in such a structure the shaft must rotate. This will permit to refrain from the consideration of several hypothesis for the explanation of Milroy engine functioning.

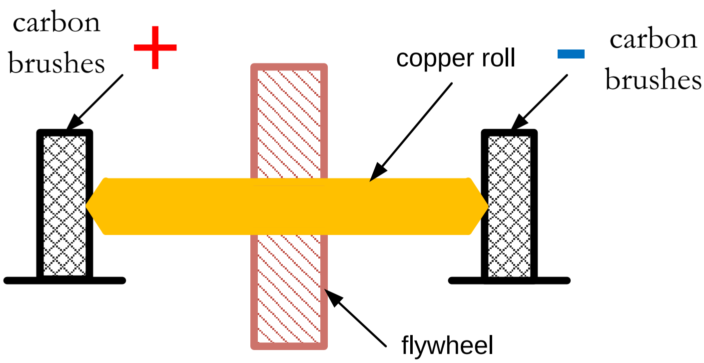

Fig. 1.

6. About the Law of Impulse Conservation

We need to pay attention to the fact that in the Milroy engine the Law of mechanical impulse conservation is clearly violated. This is due to the fact that in the rod there exist an electromagnetic impulse with a flow of electromagnetic energy. And this once more confirms that the torque exists **inside** the wire.

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