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STRUCTURE OF THE CURRENT AT ELECTRIC EXPLOSION OF THIN CONDUCTORS *)

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The results of experiments on measuring the magnetic field from the azimuthal component of the current during the explosion of thin wires in high-current generators are presented. An explanation is given for the appearance of striations in such discharges by the appearance of a helical component of the current in the discharge, which in turn leads to the division of the plasma column of the discharge into striations under the action of Ampere forces between the resulting turns with current. Conductors (wires, foils) exploding under the influence of electric current have long been studied both experimentally and theoretically. One of the properties of such explosions is the formation of striations - alternating bands both when illuminated by laser radiation and when using shadow radiography. During an electric explosion, the diameter of the wire increases tens of times, which should lead to a decrease in its inductance, since it decreases logarithmically with an increase in the diameter of the conductor. It is assumed that the opposite occurs - in the formed plasma, the charge carriers begin to twist spirals, creating a helical "solenoidal" shape, increasing the inductance of the discharge circuit. Thus, the discharge current should consist of two main components - a rectilinear current at the location of the original wire creating a circular magnetic field, and a helical current created by electrons moving along the lines of force of this magnetic field. Fig. 1 shows a schematic image of the emerging structure of current channels.

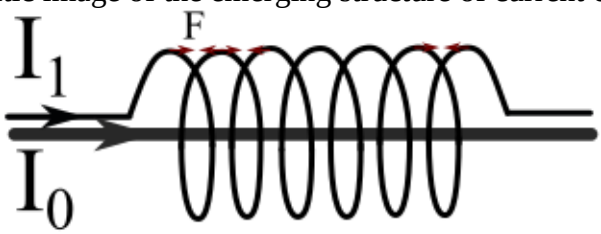

Fig.1. Characteristic current channels in the case of rectilinear current flow (I_0) and helically (I_1). F — the direction of the force arising between the turns of current.

As is known, unidirectional currents attract, then attractive forces marked with the letter F arise between the turns. This leads to the division of the formed plasma into so-called "striations". Thus, filamentation of the current in the longitudinal direction in an axisymmetric geometry occurs, which leads to the formation of a micro-solenoid, which is capable of storing magnetic energy. At the moment of the total current drop to zero, part of this energy can remain in the solenoid in the short-circuiting mode of the beginning and end of the winding. Experiments were carried out to measure the magnetic field in the immediate vicinity of the exploding conductor on the GVP generator with a maximum voltage of up to 20 kV, a current of up to 8 kA and a current rise time of 350 ns. The presence of an azimuthal component of the current is shown even after the cessation of the total current in the circuit. This effect limits the possibilities of using Z-pinches for linear current pinching in order to obtain high-temperature plasma.

*) abstracts of this report in Russian