formING DENSE PLASMA BY THE METHOD OF ELECTRIC EXPLOSION OF toroidal installed COPPER spiralS AND CREATING SUBMILLISECOND GENERATOR WITH A PEAK CURRENT OF 400 KA

A.N. Vlasov, M.V. Dubkov, M.A. Byrobin, and A.B. Manoshkin

Ryazan state radio engineering University, Ryazan, Russia, anv@fulcra.ryazan.ru

Forming dense plasma by the method of electrical explosion of toroidal installed copper spirals has a feature that, when the electrical explosion occurs, inside spirals is created a strong pulsed toroidal magnetic field, which can excite the induction discharge in the decay products of the spirals. There is formed a plasma clot, which has a lifetime much longer than the lifetime of plasma clots when electrically exploding linear wires.

In the experiments we used the experimental setup of INGIR-Mega-15" [1] which represents the generator of single submillisecond pulses (less than 0.5 milliseconds) with a peak current of 35 kA. When the electrical explosion 4 spirals with 16 turns each, installed toroidal (size 2 cm, Fig. 1, a), was formed plasma clot (Fig. 1, b, c, d) with a diameter of about 6 cm (Fig. 1, d). The typical lifetimes of such clots were 0.5 s, the best result was 1.6 s [2].



 a b c d

Fig. 1. Spirals (a), and frames of electrical explosion (b, c, d) with the sequence of 1/15 s

If we assume that the plasma clot is a plasmoid [3], his lifetime on the basis of the theory of plasmoid [4] can be estimated by the formula: , where  is the projected lifetime of the plasmoid, expressed in seconds,  is the peak current of the spirals (ampere-turns), expressed in kilo amperes. If , than .

In experiments were used multiturn spiral, peak current (ampere-turns) rarely reached 200 kA due to premature breakage of the coils, thereby limiting the lifetime of clots. Therefore, it was decided to use single-turn spiral, less critical to breakage. To get the clots to the time of life at the level of 8 seconds, the required peak current of 400 kA, which has been the aim of the ongoing upgrade of INGIR-Mega-15. For this purpose, the condenser capacity of the battery was increased to 1.12 F at a voltage of 450 V and strengthened the switch current: 112 used thyristors type TB-160-12 with peak currents up to 4 kA in each of them.

This work was supported by the Ministry of education and science of the Russian Federation, state contract № 14.518.11.7002 from July 19, 2012.

References

1. Vlasov A.N., Dubkov M.V., Burobin M.A., and at. al., Vestnik RGRTU, Ryazan, 2013, No. 1 (43), p. 90-94 [in Russian].
2. Vlasov A.N., Zhimoloskin S.V., Manoshkin A.B., and at. al., Vestnik RGRTU, Ryazan, 2013, No. 1 (39), p. 101-106 [in Russian].
3. Shafranov V.D., Zh. Eksp. Teor. Fiz., 1957, V. 33, p. 710-722 [in Russian].
4. Vlasov A.N., Vestnik RGRTU, Ryazan, 2012, No. 1 (39), part 2, p. 108-121 [in Russian].