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HIGH-CURRENT ELECTRON GUN WITH RADIALLY CONVERGING BEAM[i]

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Low-energy (10–30 keV), high-current (up to 25 kA) electron beams (LHEB) are widely used for surface treatment of materials for several decades [1]. As a rule, such beams are produced in the guns with plasma anode and explosive-emission cathode. High energy density (up to 15 J/cm^2) and short pulse duration (2–4 μs) allow one to release beam energy in a thin (sub-micron or micron in thickness) surface layer providing its melting and even partial evaporation. Such effects provide the development of different promising technologies including surface alloying of sub-micron or micron range in thickness. Due to this, our LHEB-sources found wide applications both in physical experiment and in practice [2].

The present LHEB sources have a planar-axial geometry of electron gun and produce cylindrical beams transported along the guide magnetic field lines [1]. Plasma anode in such guns is formed with the use of high-current electron discharge in the space between the explosive-emission cathode and collector. At the same time, there are many tasks on irradiation of longitudinal cylindrical parts and it is better to use radially converging beams for these purposes [3]. For example, formation of protective coatings on the nuclear fuel elements made of Zr alloys or alloyed steels for prevention/deceleration from corrosion and high-temperature oxidation; increasing the lifetime of different cutting tools and dies. However, an essential defect of the «GESA» facilities described in [3] is relatively high accelerating voltage (up to 250 kV), that results in high cost of the equipment, decreases its reliability, pulse repetition rate (for «GESA» facilities it makes up 2 pulses/min). The absence of the sources of radially converging LHEB operating at voltages of tens of kV as well as good understanding of the physical processes in them determines an actuality of the proposed electron gun.

We proposed our recently developed new cathode assembly with multi-gap initiation of explosive emission by dielectric surface flashover [4] for the production of a radially converging beam (see Fig. 1). The present work is devoted to the research of electron gun with this new cathode assembly.

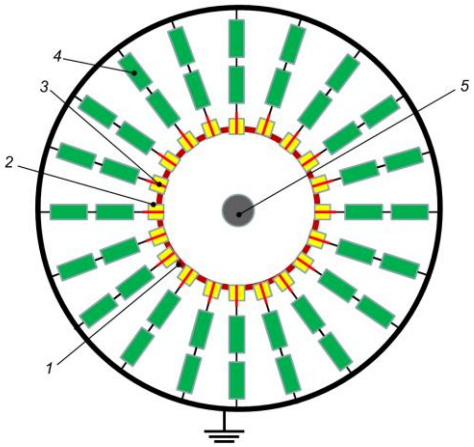

Fig. 1. Principal design of the gun with radially converging electron beam. *1* – explosive-emission cathode; *2* – ceramic tube; *3* – electrode (69 pcs); *4* – resistor TBO-2; *5* – anode (target).

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