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A new mathematical model of electrodynamic processes in spiral high-voltage pulse generators

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When a wave propagates in the active line of a spiral high-voltage pulse generator, the electric energy is converted into the energy of the magnetic field, and the electric energy of the coaxial capacitors connected in series. After reflection from the open ends of the line, the energy of the magnetic field in it begins to transform into electric energy, and the wave in the active line changes polarity. When the reflected wave reaches the point where the switch is installed, the voltage between the beginning and the end of the spiral reaches its maximum value.
This paper presents a numerical solution to the problem of the dependence of the voltage at the generator output on time. The process of electromagnetic wave propagation in active and passive lines is described by telegraph equations, and the process of charge draining is described by the model of a classical oscillatory circuit. The solution to wave propagation was found using Godunov's method, and explicit first-order difference schemes were used to calculate the boundary conditions for the spiral generator. The paper also presents experimental results of the distribution of magnetic field induction inside the spiral line in time, obtained by numerical integration of the voltage on the inductive sensor placed inside the generator.
The results of numerical modeling of the spatial distribution of magnetic and electric fields inside and outside the spiral generator are presented. The dependences of the influence of the magnetic circuit on the stabilization of the magnetic field distribution inside the spiral line and on the generator efficiency, respectively, are revealed.
The results obtained in the work allow us to predict and model with sufficient accuracy the physical parameters of spiral generators, which can be used, for example, to manufacture a portable X-ray machine with explosive electron emission.

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