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APPLICATION OF THE MAGNETIC FLUX PLASMA TRAP TO GENERATION OF CURRENT SHEETS IN A RAREFIED PLASMA

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One simple experimental device for modelling processes occurring in neutral current sheets is Ω-pinch with reverse field. In such a system for a long confinement of the neutral sheet arises a need at a required moment for sharply increasing the characteristic time of magnetic field change at the plasma boundary. Generally this problem is solved using special dischargers (crowbars). A crowbar must stand great initial strengths in the main charge circuit and be controllable at small potential difference on solenoid ends. To meet these requirements, the presence is necessary of additional electrical devices for crowbar ignition and synchronization circuits. Furthermore, crowbar applications do not exclude magnetic field distortion inside the single-turn solenoid arising due to the slot between current supplies.

This paper presents a description of a device constructed on the basis of the magnetic flux plasma trap, in which field trapping is effected by the formation of a well conducting envelope of cylindrical shape composed entirely out of plasma, and synchronization is effected without electric circuits - by variation of gas pressure in the ignition interspace.

The diagram of the device is given in Fig. 1. Two coaxial dielectrical cylinders (d₁=17 cm, L₁=35 cm; d₂=11 cm, L₂=100 cm) provide working 2 and annular 1 volumes, each having an independent gas out/input system. The annular volume is filled with easily-ionized gas (argon).

Using system 7 of coils, a quasi-stationary initial field \( H_0 \sim 150 - 600 \, \text{G} \), was created inside volumes 1 and 2. When \( H_0 \) reached a maximum value (T/4 = 250 \( \mu \text{sec} \)) with induction coils 4, initial plasma was created (density \( n_0 \sim 10^{12} \, \text{cm}^{-3} \), \( T_0 \sim 0.5 + 1 \, \text{eV} \)). After 30 + 40 \( \mu \text{sec} \) i.e. time required for plasma flowing along volume 2 and temperature leveling, the condenser (C = 0.5 \( \mu \text{F} \), U = 30 + 35 kV) was connected to exciting coil 3 (L=30cm). The \( \tilde{H} \) field increase time up to maximum \( \tilde{H}_{\text{max}} = 1300 \, \text{G} \), T/4 = 500 \( \mu \text{sec} \). When condenser discharges on coil, due to arising electric fields, gas in the annular interspace becomes ionized. Gas conductivity at initial time moments is small (the \( \tilde{H} \) magnetic field penetrates freely into the working volume), however at \( t > t_0 \) (Fig. 2) increases rapidly. The produced plasma forms a closed cylindrical conductor and the current flowing on the plasma, confines the field penetrated into the working volume. \( t_0 \) is controlled by changing pressure in the annular in-
The magnetic flux plasma trap was used for forming current sheets in the configuration of opposite magnetic fields $H_o$ and $\tilde{H}$.

When the piston field is switched on in the working volume, a neutral current sheet is formed, which is moving towards the system axis, stops, then moves away towards the boundary of the internal volume.

On the basis of measurements of the axial magnetic fields in a working volume plasma (system of five magnetic probes located in the central cross-section of the exciting coil), the neutral sheet parameters ($\Delta = \Delta (n_o, H_o)$, $U = U(n_o, H_o)$, etc.) were determined.

The results of measurements of ion distribution functions in dynamical and static states with using eight-channel energy analyzer of charge-exchange atoms are reported.

Fig. 2. Oscillograms from the magnetic probe for different pressures of argon in the annular volume $t_o$ - time moment of the formation of the conducting shell.

- a - $P = 10^{-5}$ torr;
- b - $P = 3 \cdot 10^{-2}$ torr;
- c - $P = 0.7 \cdot 10^{-2}$ torr.

Fig. 1. Diagram of the device.