REACTION OF CONTRACTED GLOW DISCHARGE TO UNIFORM ROTATION

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1. A contracted glow discharge in the form of a plasma pinch 5 is produced in a cylindrical tube 4, filled with air at $\sim 10^{-1}$ atm, between cathode 3 and flat differential anodes 1 and 2, separated by a gap $l \approx 10\ \mu$ and located at a distance $L \approx 5$ mm from the cathode (Fig. 1). The anodes are rigidly fixed in the tube, symmetrically about the axis, while the cathode position can be varied with the aid of membrane 6, and then secured by a system of locking screws not shown in the figure.

If an asymmetry is introduced in the system in such a way that the pinch is displaced along the gap between the anodes (along the z axis) and inclined to the y axis, then the system is sensitive to uniform rotation of the tube about this axis, i.e., to the component ω_y of the angular-velocity vector.

In this case, a current i_g appears in the initially balanced bridge of the external circuit.

2. The asymmetrical discharge may be produced spontaneously in a practically-symmetrical tube as a result of edge distortions of the pinch shape. Thus, at a current $i_c \sim 10^{-4}$ A, the positive end of the pinch shifts spontaneously away from the symmetry axis y to one of the ends of the gap and settles on the side walls of the anodes, bending into a droplike form (Fig. 2) which becomes more noticeably pronounced when the width d of the

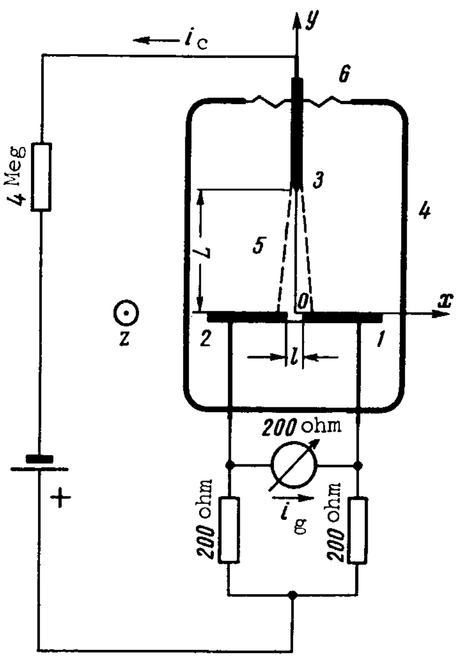

Fig. 1. Schematic diagram of setup.

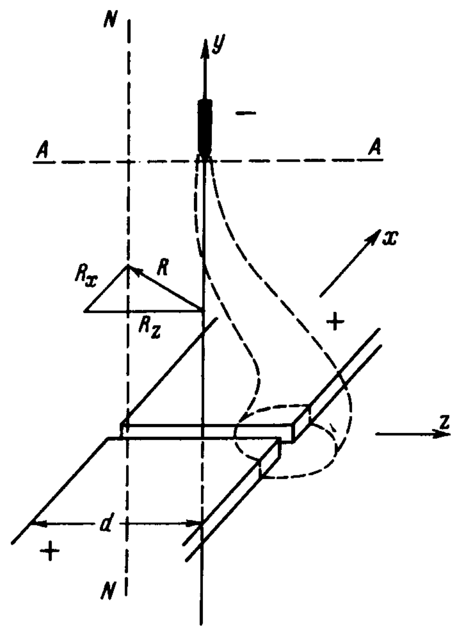

Fig. 2. Illustrating the formation of edge distortion of the plasma pinch.

anodes is increased to 2 - 3 mm. Such a shift of the pinch to the side wall results from the smallest asymmetry in the position of the cathode relative to the center of the gap. When the cathode is brought closer to one of the ends of the gap, the discharge is ignited from this end when the tube is turned on again. On the other hand, if the tube is already on and the cathode is displaced (using the compliance of the membrane), then the pinch continues to glow quite stably from the same end of the gap, even when the cathode is strongly deflected in the opposite direction.

To investigate the dependence of the edge distortion on the resistivity of the anode material, we constructed two identical tubes with anodes having d = 1.80 mm made of platinum and of iron-chromium alloy (resistivity 10 times larger than platinum). When the tubes were filled with air, no noticeable difference was observed in either the discharge configuration or in the current i_g, at a fixed value of ω_y.

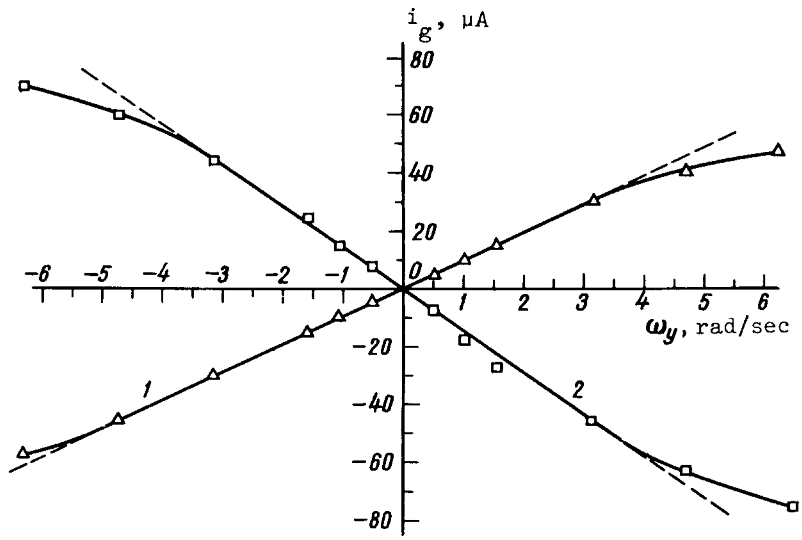

Fig 3. Current in bridge circuit vs. speed of rotation. Tube filled with air at 140 mm Hg, L = 4 mm, i_c = 0.3 mA. Curves 1 and 2 were obtained with the discharge struck alternately from opposite ends of the gap.

3. The most characteristic case is that of relatively broad anodes (d = 2 - 3 mm), when the aforementioned unilateral droplike thickening of the pinch takes place. In the case of uniform rotation around the NN axis with $\omega_y \sim (1 - 10)\ \mathrm{sec}^{-1}$, the resultant current $i_g \sim (10^{-5} - 10^{-4})$ A is proportional to ω_y over a rather wide range (Fig. 3). The sign of i_g depends on the direction of rotation and on the end of the gap at which the droplike thickening took place, but when $R_x = 0$ neither the sign nor practically the value of i_g depends on the arm R (in particular, we can have R = 0).

This independence of R and the odd character of the function $i_g(\omega_y)$ exclude the possibility of explaining the electric reaction to the rotation as being due to the action of a centrifugal force on the pinch particles. The disparity in the sign of i_g also excludes the possibility that the pinch particles are made to drift by those layers of gas which are not set in rotation.*

The reason for the appearance of the current i_g when the tube is rotated is apparently the displacement of the pinch particles by the component of the Coriolis inertia force

$$F_x = -2m\omega_y v_z,$$

where m is the particle mass and v_z the component of its velocity along the gap. The sign of i_g corresponds to a predominant action of this force on the negative particles which move near the gap in a direction away from the droplike formation, thus causing redistribution of the currents between the anodes.

When the anode width is decreased to $d \approx 0.5$ mm, the effect first vanishes, and then a weak effect reappears but with opposite sign. This may correspond either to an intensification of the action of the Coriolis force on the positive particles or to an increase in the role of the drift.

The influence of the central force becomes pronounced if the arm R is increased at the expense of R_x. Then the symmetry of the plots in Fig. 3 first becomes distorted, and with further increase of R_x the current i_g ceases to reverse sign when the direction of rotation is reversed.

A noticeable drift effect can be attained by displacing the entire electrode block (the anodes together with the cathode) along z inside the tube away from its symmetry axis. The sign turns out to be dependent on the direction of rotation (opposite to the plot of Fig. 3), but does not depend on which end of the gap the discharge starts from.

4. The actions of the centrifugal force and of the drift become particularly noticeable when the tube is filled under the same conditions with argon, which does not produce, at a pressure $\sim 10^{-1}$ atm, as strong a contraction of the discharge as air. The droplike thickening of the positive end of the pinch is in this case practically unnoticeable and the action of the Coriolis force is insignificant.

* At the indicated angular velocities, the gas layers in the central regions of the tube remain stationary even after very prolonged rotation.

CONNECTION BETWEEN DYNAMIC POLARIZATION OF NUCLEI AND ELECTRON SPIN-SPIN RESERVOIR TEMPERATURE

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Recent theoretical papers [1,2] mention the possibility of a new mechanism of dynamic polarization of nuclei in paramagnetic crystals, by direct transfer of temperature from the reservoir of the electron spin-spin interactions of the paramagnetic impurity (S-S system) to the Zeeman system of the lattice nuclei (Z_N system); indirect evidence of the existence of a direct contact between the S-S and Z_N systems is provided also by certain experimental data [3]. The purpose of the present paper is to obtain convincing proof of a direct