The interaction of a straight plasma pinch (current up to 4 kA) with a high-frequency (~1.3 Mc/sec) quadrupolar magnetic field (~100 Oe) is studied by very simple methods.

Long-wave perturbations of a straight or toroidal self-constricted discharge may be stabilized, as first shown by S. M. Osovets [1] (see also [2]), by means of a high-frequency transverse magnetic field. This field may be created by a system of currents flowing through two, four, or more straight rods, and may thus have a dipole, quadrupole, or more complex configuration. The action of such a field on a plasma pinch held in a compressed state by the field of a current flowing through it is to a certain extent analogous to that of a magnetic field with a fall-off index varying in space on a beam of particles in a strong-focusing accelerator.

The aim of the present paper is a qualitative explanation of the main features in the flow of a straight discharge in a hf magnetic field of quadrupolar configuration. For this we used the simplest diagnostic means, photographing the discharge, measuring the magnetic field, and recording the longitudinal magnetic flux.

A pulse discharge in deuterium was created in a glass tube 8 cm in diameter and 80 cm in length. The distance between the cylindrical molybdenum electrodes of diameter 1.4 cm was 60 cm. The discharge was fed from an artificial line giving a rectangular current pulse 120 μsec long with a growth time of 4 μsec through the gas. The return conductor was made in the form of six rods situated symmetrically around the axis of the discharge chamber. Thus the discharge tube remained open for photography. The majority of the experiments were made for an initial voltage of \( U_0 = 10 \) to 30 kV between the electrodes (the current through the gas being 1.2 to 3.6 kA) and initial deuterium pressure \( P_0 = 0.02 \) to 0.15 mm Hg.

For the creation of the hf field we used a system consisting of four rods connected into an oscillatory circuit in such a way that at any moment of time the current in diametrically opposite rods was in the same direction. Together with series capacitors and connecting elements, the system formed a circuit with a resonance frequency of 1465 kc/sec and selectivity \( Q = 200 \). The circuit formed part of the resonance system of a pushpull autogenerator operating at 1278 kc/sec. With development of the hf discharge in the discharge chamber, the frequency rose to 1292 kc/sec and the selectivity fell to \( Q = 50 \) to 70. The pulse power fed into the circuit at \( P_0 = 0.06 \) mm Hg was 200 kW.

The configuration of the magnetic field created by the system of four rods in principle facilitates the stabilization of the plasma pinch on the discharge-tube axis. The conditions for the stabilization of the harmonic component of perturbation with wavelength \( \lambda \) in this case have the form [1]:

\[
\omega > \frac{2I_0}{e} \frac{2\pi}{\lambda} \sqrt{\frac{\ln \frac{\lambda}{\nu_0}}{2MN}}, \tag{1'}
\]

\[
\frac{\partial \vec{H}}{\partial r} > \frac{2I_0}{e} \left( \frac{2\pi}{\lambda} \right)^2 \ln \frac{\lambda}{\nu_0}, \tag{1''}
\]

where \( M \) is the mass of an ion, \( N \) the number of ions in the pinch cross section per unit length, \( r_0 \) the radius of the plasma pinch, \( \vec{H} \) the hf-field strength, and \( I_0 \) the current through the gas.
Fig. 1. Photograph of discharge without hf field for $p_0 = 0.07$ mm Hg, $U_0 = 15$ kV ($I_0 \text{max} = 1.6$ kA).

Fig. 2. Photograph of discharge. High-frequency breakdown takes place simultaneously with start of current pulse through gas: $p_0 = 0.07$ mm Hg, $U_0 = 15$ kV ($I_0 \text{max} = 1.6$ kA).