diffraction pattern are due to the large Faraday rotation, which amounts to 40° over the thickness of the sample. The absence of the first and succeeding even orders is evidence of good periodicity of the structure. It follows from the theory of diffraction gratings that there should be no even orders other than the zeroth for a grating having a period double the width of the gap [5]. The diffraction picture was observed without an analyzer. An analyzer made it possible to vary the intensity of the zeroth order down to zero. The diffraction angles, as well as the period of the stripe structure in the vicinity of the reorientation point, could be varied by applying small magnetic fields. Analogous stripe structures should be observed also in other orthoferrites, particularly in $Sm_xY_{1-x}FeO_3$ orthoferrites, the reorientation point of which can be readily varied and brought close to room temperature.

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GENERATION OF SHOCK WAVES BY "EXPLODING" CURRENT SHEATH

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In strong-current pulsed discharges such as linear, azimuthal, and inverted pinches, the current sheath serves as a piston trapping the gas. The velocity of the ensuing frontal shock waves is determined entirely by the magnetic pressure on the current layer. Velocities up to (2 - 3) × 10^7 cm/sec were obtained at pressures 1 - 3 Torr. At larger pressures, the velocities are much smaller. Usually two factors limit the velocity at specified current parameters: capture of a large mass of gas prior to the onset of the current maximum and the magnetic pressure maximum, and decrease of the current in the frontal layer as a result of current distribution in the traversed acceleration zone.

When a dense plasma is accelerated in strong magnetic fields and in short nozzles of small diameter [1], the second factor has little effect and when the magnetic piston reaches the end of the nozzle a unique explosion-like rapid expansion of the current sheath occurs, and is of undoubted interest for the generation of intense shock waves. As described in [1], outside the nozzle, outgoing currents that are shunted by the plasma move together with the plasma. The internal electrode has as its continuation the current filament, and the external the plasma shell, as in an ordinary gushing pinch, where azimuthal and longitudinal magnetic fields are produced. Since the bulk of the accelerator gas moves in the direction of the electrode axis with velocity larger than thermal, the outer current sheath is shunted through a layer of unperturbed gas of much lower density and mass than the mass and density of the plasma ejected from the nozzle.

The radial expansion of the current sheath occurs at velocities greatly exceeding the velocity of the longitudinal axial motion. In the described experiments, the plasma piston reached the end of the nozzle at a maximum current 460 kA. The circuit parameters were as follows: Capacitor bank voltage 25 kV,

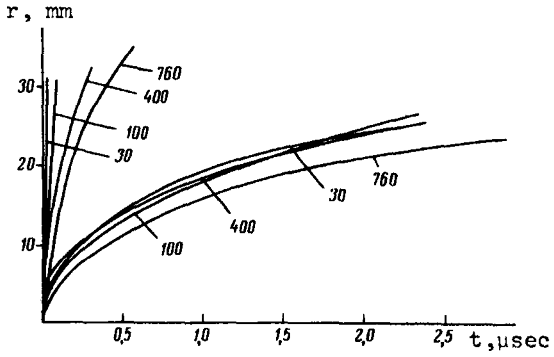

Fig. 1

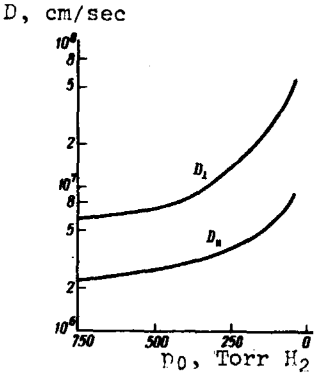

Fig. 2

capacitance 33 μF, inductance 50 nH. The working volume in which the electrodes of the type described in [1] were placed was filled with hydrogen at a pressure 30 - 760 Torr. Streak photographs of the discharge were taken in the longitudinal and transverse directions relative to the jet. In the latter case, the slit was located 5 mm from the end of the jet. Figure 1 shows the limits of the fronts of the current sheaths (lower curves) and of the shock waves (upper curves) obtained from the streak photographs at different gas pressures (each curve is marked with the hydrogen pressure in mm Hg).

The current sheaths move initially at approximately the same velocity as the shock waves, and are then slowed down by mass trapping and by the decrease of the magnetic field on the sheath boundary. The current does not change at this instant, since the inductance of the discharge remains appreciably smaller than the inductance of the external circuit. An increase of the discharge inductance does take place, nevertheless, and has a monotonic character. There are neither inductance breaks nor voltage jumps characteristic of repeated breakdowns. With decreasing pressure, the initial velocity of the current sheaths increases, but not as fast as can be expected by assuming a constant magnetic field when the sheath leaves the nozzle. With increasing pressure, the damping of the shock waves increases. At pressures below 100 Torr the decrease of the velocity at a radius of 3 cm is barely distinguishable, whereas at 400, and 760 Torr it decreases by a factor 2 - 3. The shock waves reach the chamber walls within 0.2 - 0.5 μsec, are reflected from them to the center of the chamber, compress the emerging jet, and thus hinder the expansion of the current sheath. Nonetheless, the expansion process continues to be seen for 2 - 3 μsec on the decreasing discharge current.

Figure 2 shows the absolute values of the velocities $D_\perp$ of the transverse shock waves (vertical curve) and, for comparison, the velocities $D_\parallel$ of the longitudinal shock waves, which vary little over considerable distances (10 - 15 cm).

A sharp increase in the velocity with decreasing pressure in the working volume is noted. At 760 Torr we have $D_\perp = 6.3 \times 10^6$ cm/sec. A pressure of 30 Torr corresponds to a velocity of 6×10^7 cm/sec. This value is apparently underestimated, owing to the insufficient resolution of the streak photographs.

The longitudinal velocities remain smaller than the radial ones in the entire pressure interval. This difference is particularly significant below 100 Torr.

Estimates of the temperature behind the shock-wave front, using well-known relations [2], give values of 4.0, 7.2, 160, and 360 eV for 760, 400, 100 and 30 Torr, respectively.

If we start from the premise that the piston pressure, which determines the shock-wave velocity, is equal to the magnetic pressure of the azimuthal field, then the latter lies in the range $(2.5 - 4) \times 10^5$ Oe for all pressure intervals, in accord with the experimental data. The effect of "explosion" of current sheaths as they emerge to the faces of the electrodes undoubtedly takes place in all types of coaxial accelerators. At low pressures and sufficiently large escape currents this phenomenon leads to production of fast particles and to generation of high-temperature shock waves.

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ELECTRON ACCELERATION IN AN ONDULATOR SYNCHROTRON

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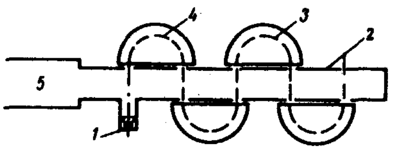
A method of accelerating charged particles in an ondulator synchrotron was proposed in [1]. This method results in intense electron beams with energy up to 5 - 10 MeV, satisfying the same stringent requirements with respect to the geometrical parameters and permissible energy spread as for electron beams accelerated in a microtron [2]. Unlike the microtron, however, in the ondulator synchrotron it is easy to produce high-voltage injection into an accelerating resonator with preliminary bunching of the electrons.

A 2-MeV ondulator synchrotron started operation at our institute. Its schematic diagram is shown in the figure.

The electrons are accelerated in a 10-cm-band resonator in which the H_{014} mode is excited. The resonator is made of a rectangular waveguide and measures 72 × 34 × 340 mm. Four through openings measuring 8 × 16 mm are kept in the resonator walls. This shape of the openings results in vertical focusing of the charged particles. The resonator is excited through a rectangular opening in the end wall by a pulsed 1.5 MW magnetron generator, with a pulsed duration 2 μsec.

The electrons are injected in the accelerating resonator from an electron gun operating at 150 kV and 600 mA. There is no preliminary bunching of the electrons. In each passage through the resonator, the electrons increase their energy by 350 keV at the maximum of the electric field and are then returned to the resonator at the next maximum of the electric field with the aid of "electron-mirror" turning magnets [3] installed in line with the resonator.



Schematic diagram of accelerator: 1 - injector, 2 - resonator, 3 - magnet, 4 - electron trajectory, 5 - exciting waveguide

The accelerator output current is 50 mA. The electron energy spread is 6%. The main electron loss occurs after the first passage through the resonator, after which the current is decreased in each passage because there is no focusing in the turning magnets. The electrons are focused only on going through the resonator.