system (see [1]). Additional important information can be obtained from the dependence of the intensity ratio of the shifted and fundamental MS lines (which is equal to the ratio of the populations of the excited and the ground state electronic levels) on the illumination power. Knowing this dependence, we can determine on the basis of the kinetic equation, for example, the probability of nonradiative transition between the electronic states.

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OBSERVATION OF DYNAMIC INTERMEDIATE STATE OF SUPERCONDUCTORS WITH THE AID OF MICROCONTACTS

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In 1957 Gorter [1] proposed a model for the intermediate state of a superconductor in which current flows from an external source. According to this model, alternating layers of superconducting and normal phases should arrange themselves in the sample in the direction of the current and move continuously in the perpendicular direction. This interesting idea, however, received no experimental confirmation so far. A. I. Shal'nikov [2] investigated the structure of the intermediate state of a cylindrical sample in a transverse external field, with direct current flowing along its axis, and observed that the layers are immobile and are perpendicular to the current direction, in accordance with the model proposed earlier by F. London [3]. Observations by other authors (see [4,5]) also lead to the conclusion that the current induced when the sample goes over into the intermediate state orients the layers in a perpendicular direction. The experiments described below show, however, that Gorter's model is nonetheless realized in some cases.

Figure 1 shows the diagram of an experiment in which we succeeded in observing continuous motion of superconducting and normal layers under stationary external conditions. A single-crystal disc of thickness $L = 0.4$ mm and of 18 mm diameter, made of tin containing about $10^{-4}\%$ impurities, was placed at $T < T_c$ in a magnetic field H oriented at an angle β to the surface of the disc, and went over into the intermediate state. The direct current I, whose magnetic field at the sample was much smaller than H, was made to flow through the sample in the direction of the projection of H on the sample surface.

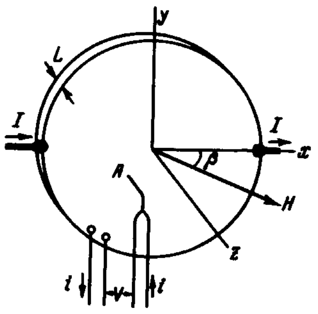

Fig. 1

According to [6], the structure of the intermediate state, produced in the plate under the influence of the inclined field, has in the case of sufficiently small β the form of layers which are elongated along the projection of the field on the surface of the plate. Such an arrangement is stable, corresponding to the minimum system energy [7].

The motion of the layers was observed with the aid of a wire A welded to the sample and carrying a measuring current $i = 3$ mA. The voltage V was measured with the aid of a galvanometric amplifier and an automatic recorder. The resistance $R = V/i$ depended on the state of the material of the sample near the contact with the wire, increasing by $\sim 10^{-3}$ ohm when superconductivity was destroyed. (It follows therefore, in accordance with formula (2) of [8], that the diameter of the contact was of the order of 10^{-4} cm. The same estimate was obtained for the diameter from the critical value of the current i necessary to destroy superconductivity near the contact.)

Figure 2 shows plots of R against the time at $T = 2.75°K$, $\beta = 8 - 9°$, and the different values of I and H listed in the Table together with the tentative characteristics of the corresponding structures, calculated in accordance with [6] neglecting the magnetic field of the current I. The curves are shifted in the Figure arbitrarily. The resistance varied periodically with the time; the maximum value of R corresponded to the normal state of the sample near the contact, and the minimum to the superconducting state. With increasing I (see curves 1 and 2) the oscillations became more frequent, but the relative widths of the maxima and the minima remained unchanged. The oscillations stopped when I dropped to several tenths of an ampere. A change in H sufficient to produce an appreciable change in the relative content η of the normal phase in the sample changed also the relative width of the maxima.

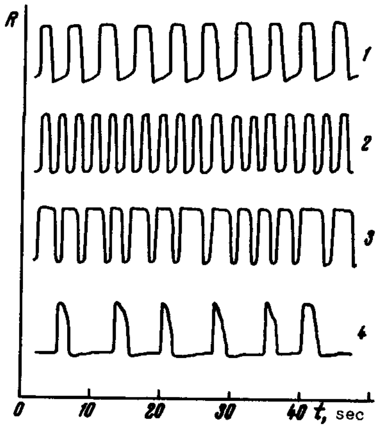

Fig. 2

Curve #	I, A	H/H_c	η	$a \cdot 10^2$,cm	$v \cdot 10^3$, cm/sec
1	1	0.95	0.5	3.5	8
2	1.45	0.95	0.5	3.5	155
3	1,45	0,99	0,7	6	17
4	1,45	0,89	0,3	2,3	3

These observations indicate, obviously, the existence of continuous motion of the layers in the sample in the direction of the y axis. Knowing the spatial period a of the structures, we can calculate the velocity v of the layers, as listed in the last column of the Table.

Comparing the obtained results with earlier investigations, we conclude that the motion of the layers arises only when some additional factors prevent the layers from becoming oriented perpendicular to the current direction. Such factors may probably be, besides the inclination of the field to the surface of the sample, the crystalline anisotropy of the surface energy on the boundaries of the layers. When the current is sufficiently strong the layers should apparently turn perpendicular to the current and stop.

The motion of the normal layers is connected with the transport of entropy in the y direction, and a temperature difference should arise in this direction, especially at low temperatures when the superconducting layers provide good thermal insulation between the normal regions. Such an arrangement is in principle a continuously operating refrigerator, although the motion of the layers is connected also with dissipation of energy and produces resistance to the current I.

The resolution of the method, determined by the diameter of the microcontacts, can be improved to at least 10^{-5} cm, which may make this method suitable for investigations of the motion of vortices in superconductors of type II.

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IONIZATION AND SCATTERING WITH CHARACTERISTIC ENERGY LOSSES IN ATOMIC COLLISIONS

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Investigations of the elementary acts of atomic collisions were first reported in [1]. We studied collisions between ions and argon atoms having keV energies at impact parameters smaller than the atomic dimensions. Analysis of the inelastic energy losses in the collisions has shown that in addition to energy lost to ionization of the colliding particles, a so-called excess inelastic energy loss R^*, consisting of the kinetic energy of the removed electrons and of the radiation energy, is also observed. It turned out that the spectrum of the excess inelastic loss is not continuous, but consists of relatively narrow discrete lines. For the $Ar^+ + Ar$ pair we found three characteristic lines, the energies of which (53, 263, and 475 eV) did not depend on the shortest distance between the nuclei, on the relative velocity of the particles, and on the scheme of the elementary process by which the charge states are changed.

To determine the extent to which the observed phenomenon is general, we investigated collisions between ions and atoms of different noble gases.