In single crystals of CdS with indium electrodes an asymmetry in the volt—ampere characteristic has been discovered which develops after the passage of large currents at elevated temperatures. A change in the resistivity of the specimen in a direction from the cathode to the anode is simultaneously observed, associated with the high-temperature drift of charged vacancies.

It has been discovered experimentally [1, 2] that the passage of an electric current through a single crystal of CdS provided with two metal contacts may lead to a irreversible change in the shape of the volt—ampere characteristic and other electric properties of the system. Sometimes the passage of a current through the contact is used to impart to it requisite properties ("contact forming"). In this case, the change in contact properties is facilitated at elevated temperatures. In a MSM system such a process is usually accompanied by the release in the semiconductor of Joule heat and its uncontrollable warming up.

It was shown that the passage of considerable currents through high-resistivity single crystals of CdS is accompanied by not only a change in the dark resistivity of these crystals, but also in their photo-electric properties [3, 4]. At the same time, changes take place both in regions adjacent to the contacts and in the bulk of the specimen.

Fig. 1. a) Relaxation of the dark current being observed after applying to a In—CdS—In system a voltage of 200 V at the temperatures: 1) 80, 2) 100, 3) 135, 4) 150°C; b) volt—ampere characteristic measured at room temperature after a 30-min passage through the system of dark current at the same temperatures.

Fig. 2. Potential distribution in the interelectrode space of the crystal in the initial state (1) and after the passage through it of an electric current at an elevated temperature (2).
We have investigated the causes for the appearance of an asymmetry in the volt—ampere characteristic of single crystals of cadmium sulfide with two indium electrodes after the passage through them of large currents at elevated temperatures. The crystals used were grown by the method of recrystallization of the powder in an atmosphere of hydrogen sulfide. Their dark resistivity was $10^{10}$ to $10^{11} \Omega \cdot \text{cm}$. In the initial state the volt—ampere characteristic of the In—CdS—In system was linear and symmetric at both polarities of the applied voltage.

The temperature of the crystal, placed in a vacuum in the dark, was raised to $30^\circ \text{C}$ and a voltage of 200 V was applied to the electrodes. The current thereby flowing through the specimen did not remain constant but increased slowly, as shown by curve 1, Fig. 1a. The volt—ampere characteristic measured after a 30-min passage of current and cooling to room temperature is presented in Fig. 1b (curve 1). The experiment was then repeated at 100, 135, 150°C (curves 2-4 in Fig. 1a). With the increase of temperature and, consequently, also of the current passing through the crystal, its volt—ampere characteristic became increasingly nonlinear (curves 2-4 in Fig. 1b). A sharp change in slope occurs only in the branch of the volt—ampere characteristic corresponding to the same polarity of the applied voltage as used during the forming of the In—CdS—In system by an electric current. The reverse branch of the volt—ampere characteristic remains linear, though it indicates some lowering of the conductivity of the specimen at this polarity of the voltage. In crystals subjected to the current "treatment" described above, the ratio of "direct" and "reverse" current at a voltage of some hundreds of volts could reach a value of $10^4$ to $10^5$.

The asymmetry in the volt—ampere characteristic can be eliminated by annealing the specimen in the absence of an electric field at high temperatures (150 to 180°C) for 20 to 30 min. The process is considerably speeded up if during annealing a current is passed through the specimen in the "blocking" direction. The volt—ampere characteristic measured after completing the annealing and cooling of the specimen is again linear and is practically the same at both polarities of the applied voltage.

Noticeable changes in the shape of the volt—ampere characteristic were accompanied by additional heating of the crystal by the electrical current passing through it.

The potential distribution measured in the interelectrode space of the crystal in the initial state and after the passage through it of an electric current at an elevated temperature indicates the emergence of a section of high electric field intensity in the region adjacent to the anode (see Fig. 2). This means that in the section of the crystal adjacent to the anode the resistivity becomes considerably higher than in the rest of the crystal.