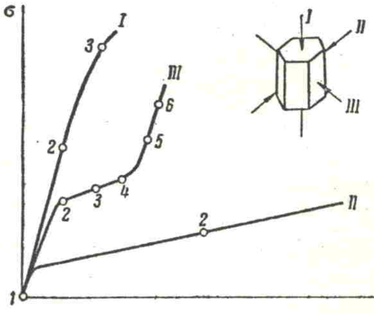

Fig. 2. Deformation curves (schematic) and the orientation scheme of the crystals in this investigation. 1-6) Points corresponding to x-ray photographs in Fig. 1a-c.

faces of the sample are the $(11\bar{2}0)$ and (0001) planes.

The choice of the orientations indicated above is based on the following considerations.

In the case of type I orientation, the well-known elements of plastic deformation of beryllium do not occur; twinning along $(10\bar{1}2)$ planes cannot occur since this would require dilation in a direction opposite to that of the applied load, and slipping along the (0001) and $(10\bar{1}0)$ planes is eliminated because there is no component of the force in the slip direction $[11\bar{2}0]$. This orientation is convenient for observation and investigation of pyramidal slip, which, according to [2, 3], has been observed in the metal when its purity was 99.9% at a temperature of about 200°C. The deformation of single crystals of beryllium of such an orientation was studied in [2-7]. It was shown that in all cases when the crystals were compressed at room temperature only plastic deformation was observable and failure occurred at high stresses, which, according to data of various authors, varied in the range 140 [6] to 210 kg/mm^2 [2].

Orientation of type II was most convenient for slipping along the basal plane. This kind of deformation of beryllium has been studied in great detail [6, 8-10]. Here our main interest will be in comparing results involving the comparison of critical shear stress data from x-ray and microscopic data and also the investigation of the character of structural changes at high deformations.

The compression of beryllium single crystals in the III orientation has been studied in [4, 11]. It was shown that when the samples are compressed along directions perpendicular to the $(10\bar{1}0)$ or $(11\bar{2}0)$ planes, crystal twinning along $(10\bar{1}2)$ planes occurs such that the crystal gradually passes over into a completely twinned situation. It is of interest to study the kinetics of this process of the subsequent deformation of the twinned crystal.

Sample with orientation I. The photographs were taken with the x-ray beam directed perpendicular to the $(10\bar{1}0)$ or $(11\bar{2}0)$ planes of the single crystal. Four samples of the same type were studied. The x-ray photograph of one of these crystals in the initial state is shown in (1) of Fig. 1a. For compressive stresses less than 60 kg/mm^2 no changes were detected in x-ray photographs. Beyond this point the reflections began to separate, which corresponded to a weak fragmentation and the formation of blocks. This process intensified with increasing compression: Fig. 1a (2 and 3) shows illustrative data for the x-ray process, taken at loads of 70 and 150 kg/mm^2. No plastic deformation effects were detected, even up to failure of the crystals. The deformation curve for this case is shown in Fig. 2 (curve I), corresponding to the elastic region. The reflection photographs exhibited a small shift in the position of the reflections, but because these shifts were small, it was not possible to make a quantitative evaluation of the magnitude of the elastic compression of the lattice.

When the crystals of this orientation were compressed in the standard testing machine, the measured values of deformation before failure amounted to 1.5%. For loads less than 60 kg/mm^2 the deformation curve was characterized by a completely elastic region while at higher loads some plasticity was detectable (0.3 to 0.7%); based on the data given above, it is clear that this plasticity is completely determined by the block-formation processes.

Failure of the crystals which we studied occurred at loads of 130, 155, 162, and 170.3 kg/mm^2. One sample failed as a result of static aging after being subjected to the load for 1.5 h, rather than failing during the process of application of successively higher loads. The x-ray photographs of samples prior to failure did not exhibit any peculiarities and were characterized by the growth of the block-formation process. When the samples failed, they crumbled into small particles, just as observed in [2, 4].

On the basis of these results, it is possible to draw the following picture of the deformation of beryllium crystals of basal orientation. The crystal lattice experiences only plastic deformation up to loads between 50 and 60 kg/mm^2. Afterwards, because of existing imperfections in the crystal lattice, a gradual redistribution of dislocations takes place with the formation of defective regions with small-angle boundaries. The source for motion of