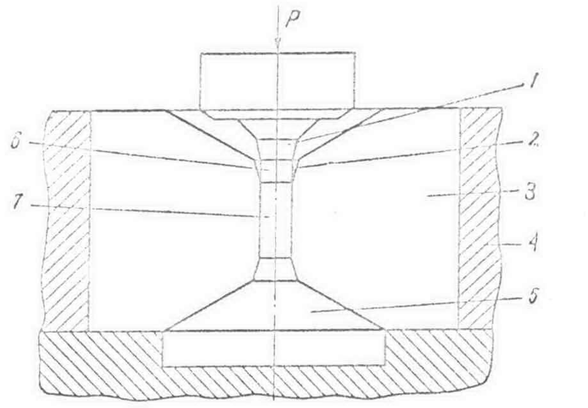

Fig. 2. Diagram of the construction of an apparatus with a wedge vessel.

However, the two indicated problems can also be solved separately with the use of the same principle which is used in the basic tetrahedral anvil. Without dwelling on the support of the piston, let us examine the problem of making a high-strength pressure vessel. Let us recall how thick-walled vessels act at pressures exceeding the ultimate strength of the material. A plastic layer, in which the equivalent stresses have a constant value independent of the pressure, is formed on the inner fibers of the vessel. The thickness of the plastic layer increases with increasing internal pressure. It turns out that the cylinder can be divided into two layers — plastic and elastic. The latter keeps the plastic layer from breaking. At some pressure, the elastic layer ruptures, having become thinner and thinner as a consequence of the thickening of the plastic layer over more and more of the wall thickness; this marks the onset of rupture of the entire apparatus. Experiment shows that high-pressure vessels do indeed crack on the outside.

Let us now represent the high-pressure vessel as made of two layers: an outer elastic band 1, and an inner layer consisting of several hard wedges 2 (Fig. 1). It is easy to see that the material of the wedges operates not in tension, but in compression, as a consequence of which the wedges can sustain a substantially higher pressure than the walls of an ordinary vessel. The pressure at the inner surface of the wedge cylinder (i.e., the cylinder formed from the wedges ground in to one another), is transmitted through the body of wedges to its outer surface. The value of the stress thereby is decreased (in the limiting case of no friction between the wedges) by the ratio R/r, where R and r are the outer and inner radii of the wedges.*

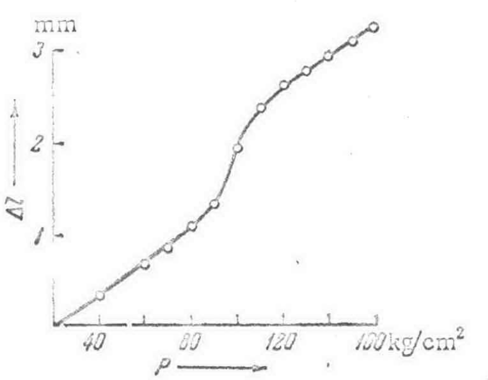

Fig. 3. Polymorphic transition of bismuth in coordinates of piston displacement versus pressure at the press multiplier.

On the basis of this principle, we designed and constructed the apparatus with a high-pressure vessel, a diagram of which is shown in Fig. 2. Four wedges 3 with spherical surfaces are carefully ground to one another and placed in a steel band to form the high-pressure vessel. The apparatus is closed at the bottom by the plug 5. A small steel cylindrical piston 6 is placed at the top in the bore formed by the wedges. The pressure on this piston is created by the conical piston 1. The shape of this piston was selected from the follow-considerations. It is known that the geometrically most-favorable form for specimens subjected to axial loading is a truncated cone. It withstands a larger pressure than a cylinder of the same area of cross section because the atoms on the truncated surface have mechanical bonds fanning outward, to the extent that the area increases in the direction of the base of the cone. For the same reason, we used wedges whose shape is nearly that of a truncated cone.

The specimen under investigation is placed inside of a pyrophyllite cylinder 7, which is situated in the bore. During motion of the piston, the pressure inside the bore increases rapidly, attaining a maximum at the end of the piston stroke. At this instant, the cone of the piston closes the wedge vessel, forming a compact assembly capable of withstanding a pressure higher than 50,000 atmos in conjunction with a high temperature in the given design.

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*It should be noted that the idea of the application of similar wedges in high-pressure apparatus was first expressed by P. V. Mil'vitskii, but it was not realized practically in his time.