APPARATUS FOR INVESTIGATING THE MECHANICAL QUALITIES OF METALS UNDER HIGH HYDROSTATIC PRESSURE*

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Described here is the design of a new apparatus for studying the plastic qualities of metals by elongation tests of specimens under hydrostatic pressure up to 10,000 kg/cm², with automatic recording of a test-diagram.

A very limited number of experimental works have been devoted to the study of the mechanical qualities of metals extended under conditions of high hydrostatic pressure, and this is connected with the serious difficulties which arise in the measurement of the various strength characteristics of metals under pressure.

The first trials in the study of the action of high pressure on the mechanical qualities of various steels were made by P. Bridgman between 1942-1944, but a description of his apparatus and trial results were not published until 1952 [1].

The apparatus devised by Bridgman permitted the testing of specimens under pressures of up to 30,000 kg/cm², but unfortunately did not succeed in obtaining consistent hydrostatic pressure at the time of the trials.

In 1949 Ratner [2] carried out extension tests on various non-ferrous alloys under external hydrostatic pressure up to 4,000 kg/cm², Ratner's apparatus enabled pressure to be maintained at one level for the whole duration of the tests. Furthermore, the force acting on the test-piece was applied not inside a chamber, as was the case with Bridgman, but from the outside, and this, seemingly, cannot but affect the accuracy of the results of experiments.

In the types of apparatus described above, load was applied by degrees with the idea of making it possible for readings to be taken. Then a strain diagram was built up from experimental points. Naturally, for the widest scope in testing the mechanical qualities of metals under high pressure the apparatus should embody automatic recording of the diagrams of extension. Such as apparatus would first of all reveal certain general laws of behaviour of metals and alloys under load in conditions of high hydrostatic compression: for example, the effect of the rate of deformation of test-pieces etc.

Apparatus intended for work under high pressure must satisfy the following requirements: (1) guarantee the attainment of high hydrostatic pressure; (2) guarantee adequate accuracy in plotting curves with force-strain co-ordinates; (3) make it possible to carry out extension tests of specimens in a chamber not only under pressure, but for comparison, under atmospheric pressure.

The Metals Physics Institute of the Urals branch of the Academy of Sciences of the U.S.S.R. built and prepared an apparatus which permits tests to be made on metals under pressures of up to 10,000 kg/mm². The apparatus consists of a high pressure chamber, a small hydraulic press, a high pressure compressor and electrical gear. Fig. 1 shows a schematic drawing of the general arrangement of the apparatus. The high pressure chamber 6 has the form of a thick-walled steel cylinder with external diameter of 200 mm, and internal diameter of 20 mm and a length of 230 mm. The test-piece under study 8, in diameter 5 mm, is inserted in the channel of the pressure chamber and connected by one end to the fixed obturator 9, and by the other end to the spindle 11, which must move freely in anaxial direction. The spindle protrudes outside the chamber and rests with its end against the piston of the hydraulic press 1. Sealing of the spindle is achieved by using a set of Babbit-metal rings, which can be tightened up as they wear.

The pressure developed by the high-pressure compressor of L.F. Bereshchagin's system is supplied to the chamber through the fixed obturator, which has holes to admit liquid. The operation of the compressor is controlled in such a manner that within the chamber hydrostatic pressure is kept at one level for the duration of the tests. As a pressure-giving medium a mixture of transformer oil and kerosene is used, which has sufficiently good dielectric qualities.

Under the action of pressure the spindle 11 tries to move out of the chamber channel. However, this movement can take place only if the supporting

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