137. *A New Device for Pressure Vessels*

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Since several years ago, various methods^{1),2)} to split a sphere have been studied with aims to make up high pressure vessels. Using these we investigated phase equilibrium relations,^{3),4)} mineral syntheses,^{5),6)} x-ray analyses⁷⁾ and insulator-metal transitions in oxides.^{8),9)} Although the sphere has a large pressure magnifying ratio, the experiments involve such cumbersome treatments as that the assembly should be covered with a rubber shell and soaked into an oil reservoir, that the attachment for measuring physical properties should be replaced at each time of loading, and furthermore that both handling and arranging the sphere become progressively difficult as the diameter is to be enlarged, and so on. An improved and simplified version of apparatus to increase the maneuverability had long been required till the following vessel was completed.

The vessel in question is composed of cube, sphere and cylinder all split up and assembled in a layered structure. A sphere made of sintered tungsten carbide containing 5.0 % cobalt is equally divided into six wedge shaped anvils whose each apex is so truncated that a square surface is formed in the front. Three anvils out of the six, after being put tightly together at the lateral side surfaces, are placed conformably in a semi-spherical space on the upper part of a cylinder of hardened steel.

When one corner of each anvil that exposes above the equator of the semi-sphere is so cut off as shown in Fig. 1, the assemblage becomes to possess three inclining roofs, a, and one cradle, b, surrounded by three mutually perpendicular square surfaces as shown in Fig. 2. Another assemblage the same as this can be constructed using the remaining three anvils. The two assemblages are set opposed and join so that all roof planes may make respective contacts via six faceted blocks, c, of steel as shown in the diagram. A cubic hollow space whose (111) direction is standing upright remains in the center of the joint. A specimen with shape similar to, but with volume larger than that of the hollow space can be charged to be compressed. This space can also contain the innermost assemblage, d, composed of eight cubic anvils whose each corner is truncated. In

Fig. 1. One of the anvils obtained when a sphere is equally split into six pieces. The apex and one corner are truncated.

d

c

Fig. 2. A view looking down three anvils set in a cylinder.
a: inclining roof, b: cradle, c: faceted block, d: innermost assemblage made up of eight cubes.

the very center of the entire system is charged a pyrophyllite octahedron together with the specimen to be compressed. Crushable spacer made of cardboard sheets is sandwiched between the quasi-

equatorial contact planes as well as the gaps equally made within the inner cubic assemblage.

The two cylinders involving split sphere and cube are finally compressed in a uniaxial press. As thickness of each spacer decreases with increasing load, all anvils in each stage move forward uniformly, and a notably high pressure can be generated in the specimen.

A curve shown in Fig. 3 is a typical relation we obtained between the applied load and elevated pressure calibrated by using several fixed points at which various materials undergo the phase transformations. The calculation is based on the Drickamer's new pressure scale.¹⁰⁾ This curve indicates that pressure beyond 400 kb is easily producible under the load less than 150 ton. The total load was increased to much higher range up to 700 ton with neither the destruction nor perceptible deformation in the segmented sphere as well as in the cubic central anvil. The elastic limit in each constituent materials must have been increased to a great extent.

Fig. 3. Elevated pressure vs. applied load relation.

Beside the room temperature compressions, the vessel enables us to carry out a prolonged heating over 1000°C for a desired length of time in which any sluggish phase change can be completed under pressure.

A relatively wide separation remains in the equatorial gap in the entire course of the experiment. Through this gap not only x-ray but also light beam can be sent to the compressed specimen. The electrodes and heater terminals are more easily dealt with.

The load pressure necessary to induce each transition in Fig. 3 in the present vessel is about one third of the value at which it was attained with our former vessel carrying rubber shell and more cardboard spacers in and around the sphere. This implies that much load had been consumed in the compression of necessary means to build up the sphere other than the sphere itself.

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