to be due to a faulty specimen. The σ_z versus σ_r curve for this material is similar to that for the tungsten carbide with 13 percent cobalt binder both in shape and the onset of yielding with higher pressures. The chrome-carbide specimen exhibited brittle failure at all pressures and the σ_z versus σ_r curve for this material is similar in shape to the curve for the tungsten carbide with 3 percent cobalt binder.

Oxide Ceramics, Fig.5

The specimens for these tests were cut from commercial stock in this laboratory. The Diamonite material was an aluminum-oxide ceramic with low percentage additives of chromium, magnesium, and silicon produced by the Diamonite Corporation. The Al_2O_3 material was a polycrystalline ceramic produced by Wesgo and reported to be 99.5 percent Al_2O_3. The Mullite material was a 3 $Al_2O_3.2\ SiO_2$ ceramic produced by McDaniel, grade MY-30. The MgO material was a high-density ceramic, 99.5 percent MgO, produced by Minneapolis Honeywell. The Pyrex material was taken from the laboratory stock of unknown origin. Several other materials including $BaTiO_3$, Zircoa, sapphire, PZT, quartz, fired lava, and Corning Pyroceram were also tested. During the initial testing, these latter materials were observed to fail at pressures too low to justify further testing. As a group the oxide ceramics displayed very similar characteristics, all exhibiting essentially the same slope for the σ_z versus σ_r curves.

Overall, the most interesting feature of the data is the high ultimate compressive strength exhibited by the tungsten-carbide compounds with 13 percent cobalt binder when supported by only 3 kbar fluid pressure. Although we presently do not have a physical explanation for the anomalous characteristics of the 6 and 13 percent cobalt samples, these characteristics may be immediately employed in the design of high-pressure apparatus. With only 3 to 6 kbar fluid support pressure needed (instead of the usual 25 kbar), a double-piston arrangement similar to the Kennedy (3) apparatus could be constructed with considerable sample volume.

Fig.6 is a schematic representation of an alternate apparatus employing the fluid-enhancement scheme. This apparatus would operate within the pressure chamber of an autoclave, yielding a true "two stage" apparatus. The merit of the apparatus shown in Fig.6 lies in the economy of expanding the pressure range of relatively common autoclaves, rather than constructing a new press unit. The present technology of fluid-pressure-vessel design permits the manufacture of large internal diameter (125 cm) vessels (7) capable of containing pressures as high as 6 kbar. Employing the ultimate compressive strength enhancement exhibited by the carbides with around 13 percent cobalt binder, a piston-cylinder apparatus of considerable volume (on the order of thousands of cubic centimeters) and capable of pressures greater than 60 kbar could be constructed within such an autoclave.

REFERENCES

1 P. W. Bridgman, Proceedings, American Academy of Arts and Sciences, vol. 81, 1952, pp. 167-251.

2 H. T. Hall, Review of Scientific Instruments, vol. 29, 1958, p. 267.

3 P. N. La Mori, "High Pressure Measurement," Butterworths, London, England, 1963, p. 332.

4 P. W. Bridgman, "The Physics of High Pressure," G. Bell and Sons, 1958, p. 401.

5 P. W. Bridgman, "Studies in Large Plastic Flow and Fracture," Chapter 5, Harvard University Press, Boston, Mass., 1964.

6 Harwood Engineering, Walpole, Mass.

7 ASEA, (Allmanna Svenska Elektriska Aktiebolaget), Sweden, Bulletin 8146E.