

- A. CEMENTED CARBIDE PISTON (MOVABLE)
- B. SOLAR STEEL INSERT
- C. CEMENTED CARBIDE PISTON (STATIONARY)
- D. BRASS GUIDE
- E. BAKELITE INSULATING RING
- F. S. A. E. 6150 STEEL JACKET
- G. SOLAR STEEL BINDING RINGS

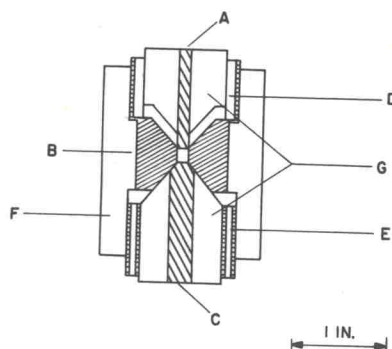


Fig. 2 Cross-section of high-pressure cell

- A. AND B. SOLAR STEEL RINGS
- C. MICA
- D. Ag Cl
- E. GOLD CONTACTS

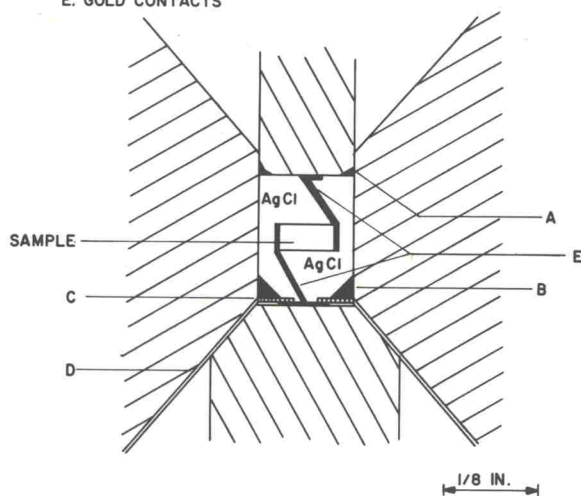


Fig. 3 Detailed drawing of sample chamber

The method of measurement is quite straightforward. An X-Y recorder is used, with pressure plotted on the X-axis and resistance on the Y-axis. The pressure is converted to an electrical signal by a strain-gage transducer mounted in the oil reservoir supplying the ram. In a typical run, the change of resistance at some fixed temperature is plotted as the pressure is first increased to a point above the bismuth I - II - III transitions, and then decreased until the transitions reappear in reverse order. The resulting curve is thus a loop, and the assumption is made that the transition pressures observed on the "up" and "down" curves may be averaged to yield the true transition pressure. At room temperature

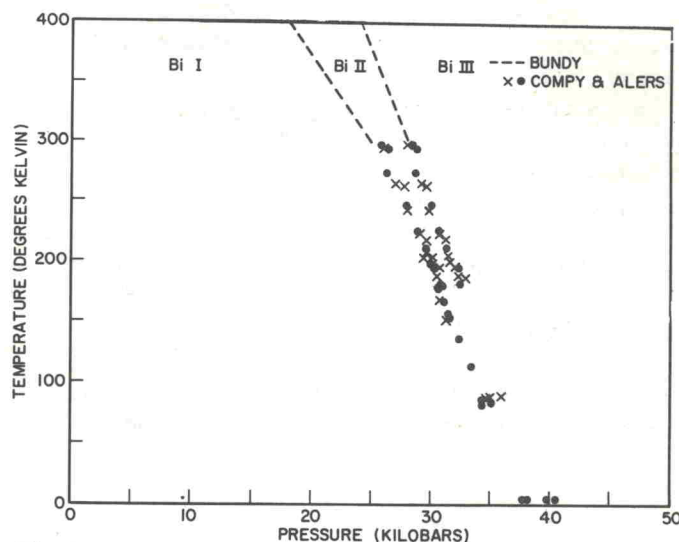


Fig. 4 Data on phase changes of bismuth taking place from zero to 40 kilobars in the 4.2 K to 300 K temperature range

such a procedure yields a Bi I - II transition which runs 2 - 5 percent high, and a Bi II - III transition about 6 - 8 percent high, when compared with the results of Kennedy and La Mori (7). A thermocouple, attached to the tension member as near as possible to the pressure cell, is used to monitor temperatures down to the boiling point of liquid nitrogen, and a carbon resistor is used to measure temperature in the liquid-helium range.

Because of the massive construction of the cell, some 15 liters of liquid helium are required to cool the apparatus from 77 to 4.2K, but the rate of helium boiloff is quite moderate: about 500 cc of liquid per hr.

PRELIMINARY RESULTS

To demonstrate the operation of this equipment, we have accumulated data on the bismuth transitions below room temperature. We are thus in a position to suggest the form of the phase diagram of bismuth from 300 to 4.2K and zero to 40 kilobars, complementing the work of Bundy (8) at higher temperatures and pressures. The data are shown in Fig. 4. The point at which Bi II disappears seems to be in the neighborhood of 180K, but our measurements are not refined enough to show the shape of the phase boundaries at this point.

REFERENCES

- 1 "Measurements at Low Temperatures and High Pressures," by B. G. Lasarev and L. S. Kan, Journal of Physics (USSR), vol. 8, 1944, p. 193.

- 2 "Superconductivity at Very High Pressures," by P. F. Chester and G. O. Jones, Philosophical Magazine, vol. 44, 1953, p. 1281.
- 3 Described in Modern High Pressure Techniques, R. H. Wentorf, editor, "High Pressure at Low Temperatures," by J. W. Stewart, Butterworths, Washington, D. C., 1962, p. 181.
- 4 Described in "Investigation of the Crystal-line Modifications of Bismuth," by N. V. Brandt and N. I. Ginzburg, Soviet Physics-Solid State, vol. 3, 1961, p. 2510.
- 5 "Effect of High Pressure on the Electrical Resistance of Bi, Yb, and Dy," by P. C. Souers, Lawrence Radiation Laboratory Report No. UCRL 11220, University of California, 1964.
- 6 "Apparatus for Optical Studies to Very High Pressures," by R. A. Fitch, T. E. Slykhouse, and H. G. Drickamer, Journal of the Optical Society of America, vol. 47, 1957, p. 1015.
- 7 Progress in Very High Pressure Research, by F. P. Bundy, W. R. Hibbard, Jr., and H. M. Strong, editors, "Some Fixed Points on the High Pressure Scale," by G. C. Kennedy and P. N. La Mori, John Wiley and Sons, Inc., New York, 1961, p. 304.
- 8 "Phase Diagram of Bismuth to 130,000 kg/cm², 500°C," by F. P. Bundy, Physical Review, vol. 110, 1958, p. 314.