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Simple Apparatus for the Generation of Pressures above 100 000 Atmospheres Simultaneously with Temperatures above 3000°C

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Equipment has been constructed for experimentation at very high pressures and temperatures. With the modified Bridgman anvil device described, it has proven possible to maintain pressures in excess of 100 000 atm simultaneously with temperatures above 3000°C for periods greater than one hour. [The fixed points used to infer this pressure are taken to be the pressure values established by Bridgman for discontinuities of the electrical resistance of bismuth and barium, 25 650 kg cm^{-2} and 80 000 kg cm^{-2}, respectively, and called the bismuth and barium points. Recent unpublished work indicates that the barium point pressure will probably have to be revised downward materially, reducing our pressure estimates in the upper range.] The use of an extrudable plastic compressible gasket is described. Several considerations are presented concerning the support of high pressure components constructed of cemented tungsten carbide. Coesite, almandite, and diamond have been synthesized in the apparatus.

INTRODUCTION

A SIMPLE modified Bridgman anvil device has been constructed using a radially composite compressible gasket geometry. The equipment resembles the Hall "Belt" apparatus described in a recent article[1] but large relative compression of the gasket is achieved in a different manner. The high pressure core of the apparatus which is shown in Figs. 1 and 2, consists of two frusto-conical cemented tungsten carbide rams and a cemented carbide core vessel supported radially by pressed-on alloy steel cylinders. Cemented tungsten carbide with 6% cobalt has been used throughout this work. Pressure is generated by advancing the rams with a hydraulic press, compressing the contents of the core vessel while compressing and extruding the gasket seal. The pressure transmitting medium has been pyrophyllite. Internal heating is provided by passing an electric current via the rams, through a conduction heating tube along the axis of the core vessel.[1,2] The sample to be investigated lies within the heating tube. Pressure calibration of this system has been made by the standard procedure of observing sharp changes in electrical resistances during polymorphic transitions at fixed pressures with wires of Bi and Ba inside a silver chloride sleeve replacing the testing tube. For the $\frac{1}{2}$-in. bore system, the loads required to reach the Bi I→II transition, taken to be 25 650 kg/cm^2,[3] and the transition in barium, taken to be 80 000 kg/cm^2,[3] were 56 tons and 165 tons, respectively, yielding 100 000 kg/cm^2 at about 205 tons. Temperatures

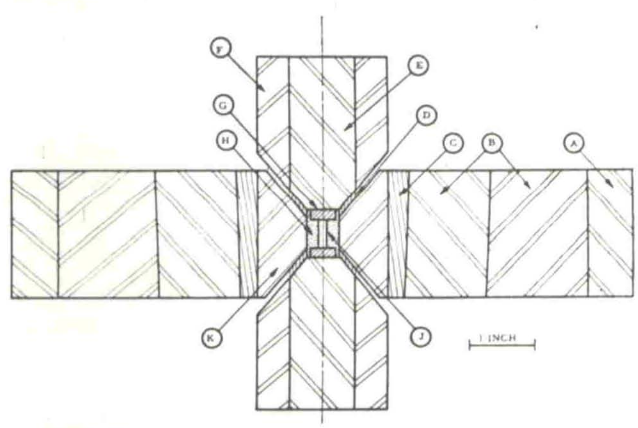

FIG. 1. Cross section of modified Bridgman anvil device. (A) safety ring, (B) binding rings, (C) shim, (D) Teflon compressible gasket, (E) cemented tungsten carbide ram, (F) ram support, (G) steel decompression cap, (H) pyrophyllite pressure transmitting cylinder, (K) cemented tungsten carbide die, and (J) sample container and heating tube.

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[2] R. Roy and O. F. Tuttle, J. Phys. Chem. Earth 1, 138 (1956). Describes Loring Coe's internally heated apparatus.
[3] P. W. Bridgman, Proc. Am. Acad. Arts Sci. 81, 165 (1952).