A MULTIPLE CRYSTAL HOLDER FOR ULTRASONIC MEASUREMENT

Y.C. Chen, R.H. Martinson*, and Arthur L. Ruoff

Thurston High Pressure Laboratory, Cornell University

Ithaca, New York 14850

ABSTRACT

A multiple crystal holder for simultaneous ultrasonic measurement on several crystals is presented. Four figures are included to show clearly how it is assembled and how each component works.

*present address: Lockheed Palo Alto Research Center
Palo Alto, California 94303

I. Introduction

In ultrasonic measurement, one usually measures a single mode velocity in one crystal as a function of pressure and/or temperature, then removes the crystal from the holder which is inside a pressure vessel or temperature control unit, changes specimen or changes modes (e.g., from longitudinal to shear mode) by changing transducers and then repeats the experiment.[1] It is thus very time consuming. Moreover, when a measurement is made at a pressure P (or temperature T), the pressure (or temperature) is not exactly identical with the data point obtained on the other crystals or modes. It is therefore necessary to analyze each run and interpolate at a specific temperature or pressure for all crystals or modes. It is, hence, desirable to have a holder which can hold several crystals so that all the necessary measurements (and possibly redundant measurements) can be carried out on all the crystals at the same T and P conditions. For cubic crystals, three elastic constants are needed to describe completely the elastic behavior of the crystal. Hence, in theory, three independent measurements are sufficient. However, the fourth one can be used for checking internal consistency. This paper describes a simple four crystal holder which can be easily constructed. This could readily be extended to six or so crystals for studying hexagonal, tetragonal and trigonal systems.

II. Description of the crystal holder

The schematic arrangement is shown in Fig. 1 which reveals the cross-sectional view. The holder consists of:

(1) a cylindrical shell made of brass which has a dimension of 2 cm I.D., 2.2 cm O.D., and 21.5 cm long partially open on two sides to make handling and alignment of the specimen easy (see side view in Fig. 2),

(2) an amphenol socket,

(3) four identical electrode complexes (A,B,C,D) which on one side (top) houses the specimen base and provides an electrode on the bottom side, and

(4) the holder base (E) which is simply half of A, namely, the top half of A.

In between each complex is the specimen chamber where the specimen with the transducer bonded on top of it can be manipulated by pushing against the specimen base which is supported by three identical base springs of equal length. The total stress exerted on the specimen by the base springs is less than 0.05 bars (0.7 psi) so that no damage results to the specimen.

The electrode is connected through an insulating material, high purity boron nitride. The electrode lead is shielded inside the electrode complex and is led through the lead slot of the complex up to the pin on the amphenol socket. This socket is matched to the feedthrough connected to a Bridgman seal and eventually out of the pressure vessel (or through a feedthrough in a temperature box). The electrode is pushed against the transducer by an electrode spring carefully chosen to give a good contact yet not to exert too much stress on the transducer. The ground ring sits on top of the outer ring of the transducer. The diameter of this ring has to match the size of the transducer. Fig. 3 shows the top view of piece B. Fig. 4 gives the bottom view of B where the relative configuration of the electrode and the ground ring is clear.

The above jig is designed for reflection type measurement, i.e., one transducer only which serves both for signal transmitting and receiving. It is easy to convert to transmission type measurement (two transducers) by modifying the complex so that both top and bottom of the new complex are identical to the bottom of the present complex. Such systems are also used in our laboratory.

III. Performance

The specimen holder described above has been used for various elastic constant measurements as a function of temperature and pressure. The specimens include from less stiff materials such as sodium to stiff ones such as silicon. In the range of liquid helium temperature (4° K) to 350° K and atmospheric pressure to 10 kbars, the performance is excellent.

ACKNOWLEDGMENT

We wish to thank R.E. Terry for help in constructing these devices. We wish to thank R.C. Lincoln, R.E. Larsen, and J.P. Day (all of whom used similar devices or modifications thereof in this laboratory) for numerous discussions.

We acknowledge the support of the United States Atomic Energy Commission under Contract AT (11-1) - 3153.

REFERENCE

1. Koliwad, K.M., Ghate, P.B., and Ruoff, A.L., Phys. Stat. Sol., 21, 507 (1967).

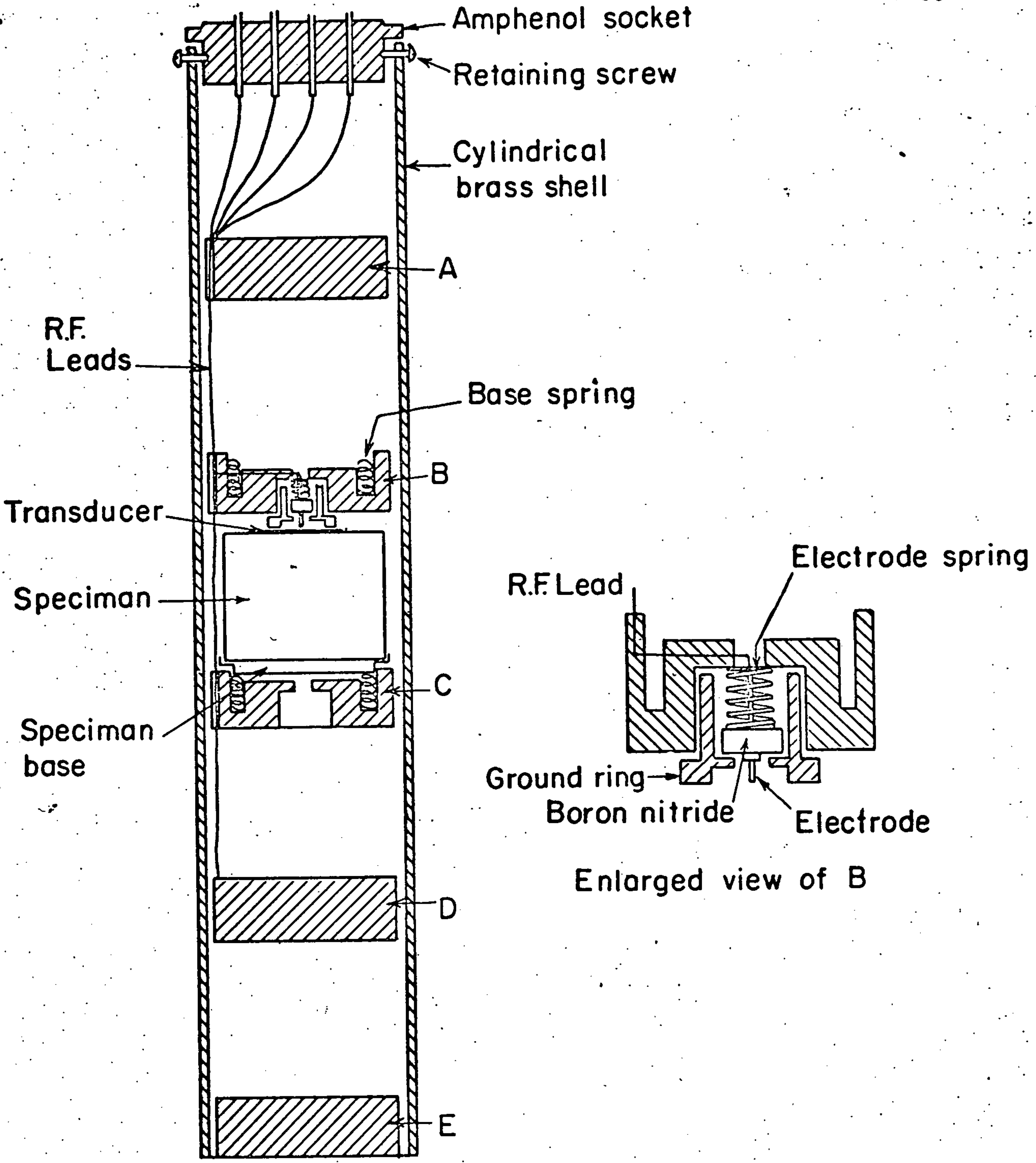
FIGURE CAPTIONS

Fig. 1. Cross-sectional view of four crystal holder (only B and part of C are shown in detail).

Fig. 2. Sketch of side view of four crystal holder.

Fig. 3. Top view of electrode complex (B in Fig. 1).

Fig. 4. Bottom view of electrode complex (B in Fig. 1).



Amphenol socket
Retaining screw
Cylindrical brass shell
A
R.F. Leads
Base spring
B
Transducer
Speciman
C
Speciman base
D
E
Electrode spring
R.F. Lead
Ground ring
Boron nitride
Electrode
Enlarged view of B

FIG. 1

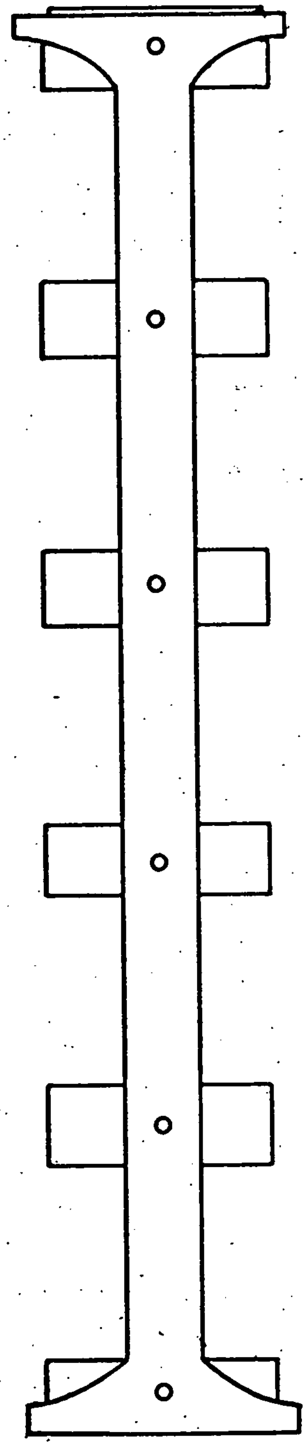


FIG. 2

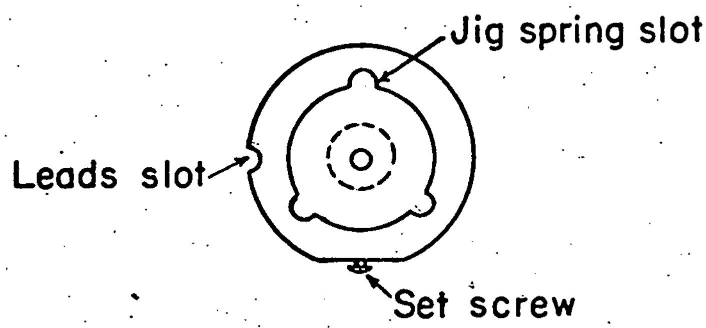

Jig spring slot
Leads slot
Set screw

FIG. 3

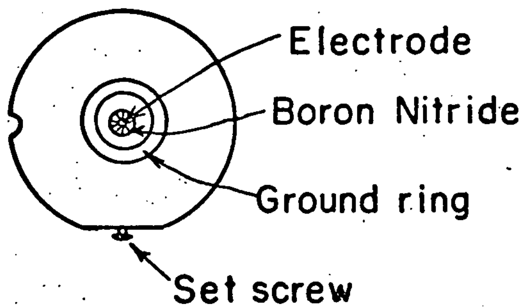

Electrode
Boron Nitride
Ground ring
Set screw

FIG. 4