FIG. 2. The sample holder for liquid Hg (dimensions in inches).

uncertainty of the 1-atm data of Hubbard and Loomis, since the velocity change is only a fraction of the calculated velocity.

The sample holder for the liquid Hg, shown in Fig. 2, was constructed from Type 303 stainless steel. It is closed at the bottom by the quartz transducer and fitted at the top with a 1.2-cm-diam reflector set accurately parallel to the transducer. Holes in the reflector top allow the pressure-transmission fluid (pentane or hexane) to bear on the Hg. A final cap, which contains small holes out of line with those in the reflector top, is threaded into the reflector top. This cap acts as a baffle for preventing Hg from escaping from the top of the holder. Loss of mercury into the steel pressure vessel often results in an embrittlement of the latter and an explosive failure.

The diameter of the transducer surface in contact with the liquid Hg (1.9 cm) constitutes the sample diameter. Since the wavelength of 5-Mc/sec ultrasonic waves in liquid Hg is about 0.03 cm, the sample-diameter-to-wavelength ratio is about 60, well above the figure of 20 which Mason[29] cites as the minimum allowable value if the sound pulses are to be propagated as if the sample were infinite. The sample length over which the sound pulse radiates as a plane wave (the Fresnel region) is determined by the diameter of the radiating surface and the wavelength of the sound.[30] In the present case, where the reflector diameter is the limiting diameter, it can be shown that the Fresnel region extends for 22 cm. Therefore, the echo of importance here (the first echo), which travels a distance of about 7.8 cm, is well within the plane-wave region.

The high-pressure system used in this work is the piston-and-cylinder apparatus shown in Fig. 3. The vessel is of three-piece construction. The inner cylinder is forced into the middle cylinder under a load of about 400 tons, placing the inner cylinder in compression. The outer cylinder is a soft-iron-pipe safety ring. This

vessel is capable of containing about 30 kbar pressure. The top of the vessel is sealed by a standard Bridgman seal. Load is applied to the piston from a 400-ton hydraulic ram. The bottom of the vessel is sealed by a tapered plug through which the necessary electrical leads are brought. Sheathed leads are sealed into a steel plug with epoxy cement.[31] The ability of this type of plug to retain the electrical leads at high pressure depends in part on the radial force developed as the plug is forced into the taper at the bottom of the pressure vessel. Consequently, the clearance allowed at the bottom of the plug is critical; excessive support of the plug will result in blowout of the leads. A disadvantage of this type of plug design is that it is sometimes difficult to control the quality of the plugs, with the result that a sheath may be ejected.

Sonic-velocity experiments were carried out at 21.9°, 40.5°, and 52.9°C. For the higher-temperature experiments the entire pressure vessel was heated. Temperature inside the vessel was determined by a Chromel–Alumel thermocouple brought through the tapered bottom plug; its calibration was traceable to a platinum resistance thermometer. At pressures up to 13 kbar the calibration of a Chromel–Alumel thermocouple changes by negligible amount.[32] A temperature gradient of less than 0.3°C existed across the sample at the higher temperatures; this gradient was found to be insensitive to pressure. The probable error in the stated temperature is about ±0.25°C.
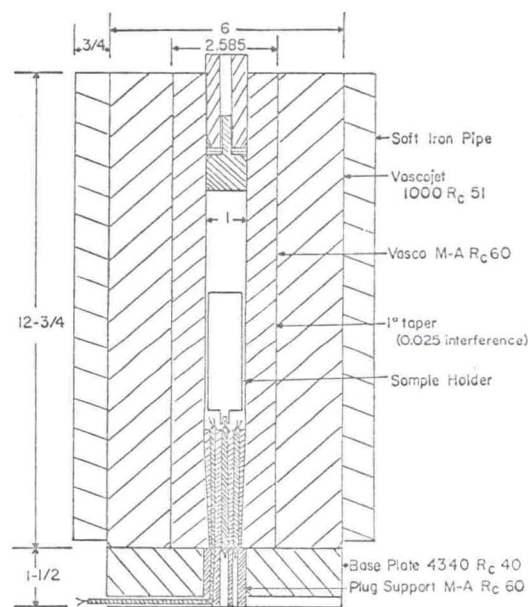

FIG. 3. The pressure vessel (dimensions in inches).

[29] W. P. Mason, *Physical Acoustics and the Properties of Solids* (D. Van Nostrand Co., Inc., Princeton, N.J., 1958), p. 40.
[30] W. P. Mason, Ref. 29, p. 96.

[31] L. A. Davis, R. B. Gordon, J. K. Tien, and R. J. Vaisnys, Rev. Sci. Instr. 35, 368 (1964).
[32] R. E. Hanneman and H. M. Strong, Symp. High Pressure Technology, ASME Winter Annual Meeting, New York, 1964 (1964), Paper No. 64 WA/PT-21.