

Multiple Lead High Pressure Plug*

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THE necessity of introducing electrical leads into a high pressure vessel has traditionally presented manifold problems to the designer and builder of such apparatus, especially if several leads are to be incorporated in the same plug.

The most successful methods to date are described by Bridgman,¹ Yoder,² and Cornish and Ruoff.³ While these methods are good, problems are still present. These methods require either long, small holes drilled through the plug or coaxial holes drilled from each end of the closure. The leads are seated in the plug body, so if successive experiments require different thermocouple materials passing through the plug, one must either have a duplicate plug assembly, or remove and replace existing leads. If the plug is damaged in any manner, the entire

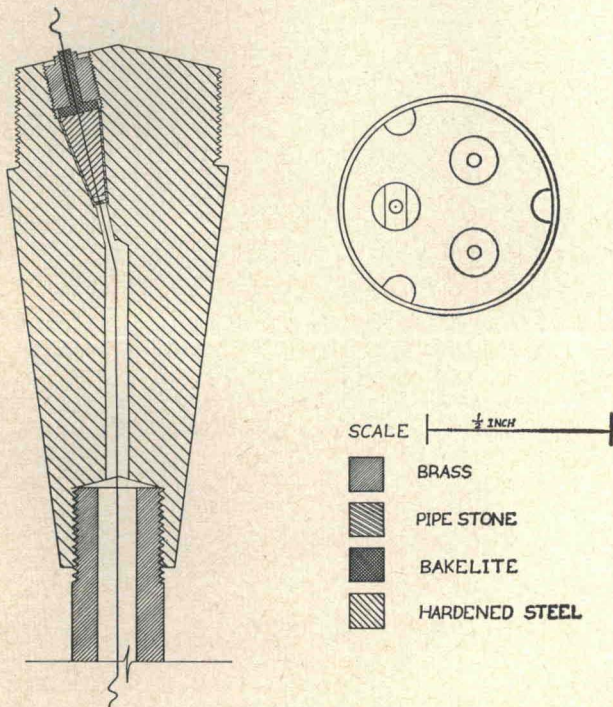


FIG. 1. The large cone, in sectional and top view, showing one complete thermocouple lead assembly.

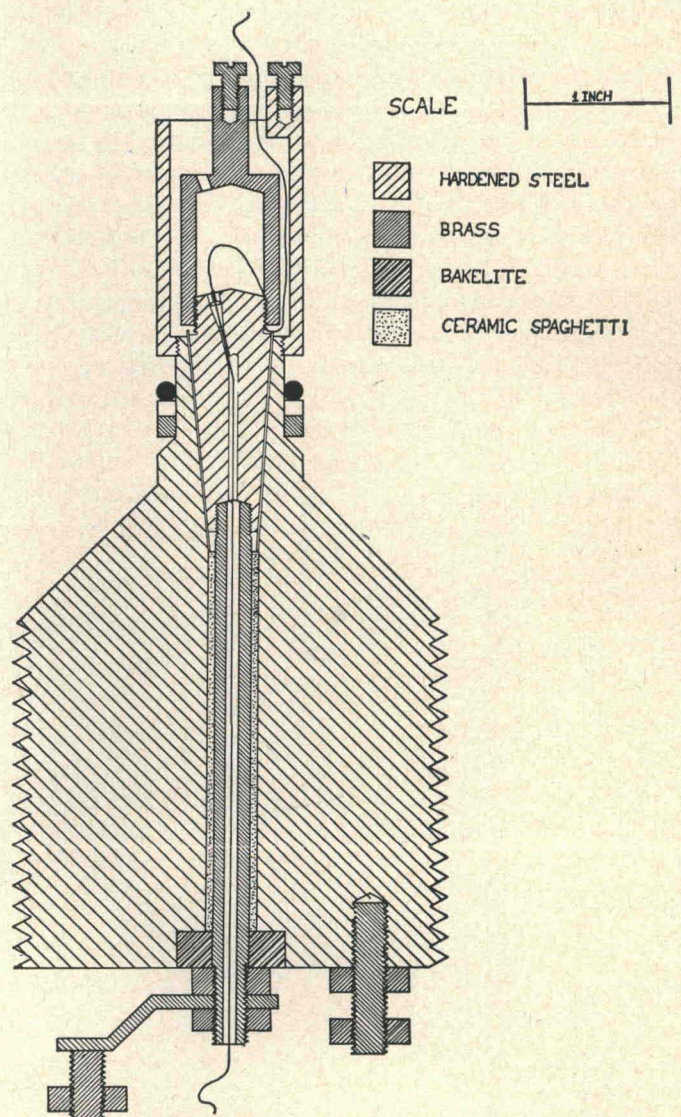


FIG. 2. The assembled plug, showing the large cone in place and the course of one of the three thermocouple wires.

assembly must be replaced. When cones of the usual size, about 1/2 in. long and 1/4 in. in diameter, are used in the

Bridgman design, appreciable heating is encountered at currents as low as 10 amp. If the size of the cones is increased to increase their current carrying capacity, they become too large to construct a plug with more than one or two such cones. Plugs with as many as seven Bridgman-type leads have been described.^{1,4}

We have developed a plug containing three thermocouple leads and a high current lead which has alleviated most of the difficulties just mentioned. The basic idea is an elaboration of one given by Korndorf,⁵ in which the thermocouple leads are contained within the high current lead. Figure 1 shows the high current lead with thermocouple leads, Fig. 2 shows the assembled plug.

The body of the plug, which is the part most prone to damage, differs from a solid closure only to the extent of having a hole drilled all the way through and a conical cavity, to receive the high current cone, bored in the nose.

In the large end of the high current cone three tapered holes spaced 120° apart are drilled and reamed. The tapers have included angles of 16°, and their axes are inclined at angles of 13.5° to the axis of the large cone. The large or current-carrying cone is the only intricate part to machine. It is made of Teton steel, and heat treated to Rockwell C55. If the thermocouple materials are to be changed often, extra high current cones can be made, and the change of thermocouple materials can be effected by breaking only one seal.

The small cones are made of high carbon steel. A hole slightly larger than the thermocouple wire to be used is drilled all the way through. The wire is inserted and silver

soldered in place. The thermocouple wires are insulated by Teflon spaghetti in all passages. The small cones are insulated from the large one by pipestone, while the large cone is insulated from the plug by a wrapping of 0.005-in. Teflon sheet cut to go around the cone twice in the manner developed by Sidirov and described by Tsiklis.⁶ The resistance between the cone and plug body is greater than 2 meg. Paper may be substituted for Teflon as the dielectric material with a resultant decrease in resistance and an increased probability of leakage. The main current-carrying assembly as shown in Fig. 2 has a resistance of 0.001 ohms, and is capable of carrying a current of at least 50 amp without appreciable heating.

After initial assembly leaks usually exist around all of the cones. Our procedure for seating the cones is to apply a pressure of about 2000 bars with a hydraulic hand pump. The pressure is maintained until the leaks almost cease, then is raised to 3000 bars, and left over night. The assembly is then leakfree and ready for service.

To date we have had no occasion to take this assembly past 7000 bars. To this pressure it functions perfectly.

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¹ P. W. Bridgman, Proc. Am. Acad. Arts Sci. **76**, 57 (1948).

² H. S. Yoder, Trans. Am. Geophys. Union **31**, 827 (1950).

³ R. H. Cornish and A. L. Ruoff, Rev. Sci. Instr. **32**, 639 (1961).

⁴ W. Paul, G. B. Benedek, and D. M. Warschauer Rev. Sci. Instr. **30**, 874 (1959).

⁵ B. A. Korndorf, *Hochdrucktechnik in der Chemie* (VEB Verlag Technik, Berlin, 1956), p. 266.

⁶ D. S. Tsiklis, *Tekhnika fizio-khimicheskikh issledovani pri vysokikh davleniyakh* (Gosudarst. Nauch.-Tekh. Izdatel. Khim. Lit., Moscow, 1958), p. 176.