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Fabrication of Epoxy Electrical Lead Insulation for Pressure Vessels*

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IN high pressure experimentation the method of introducing electrical leads into the high pressure region often consists of a metal cone and an insulating conical shell.[1] The difficulty involved in obtaining an initial pressure seal with good electrical insulation has lead to the investigation of various insulating materials, and, in recent years, the use of epoxy has been reported by several sources.[2–6] The pressure vessel[7] used in this laboratory was initially supplied with electrical leads having epoxy insulation made by dipping the metal cone in Eccocoat D30.[8] This note describes a method of fabricating the electrical insulation that eliminates the problem of making an initial pressure seal. The techniques and modifications described apply to a rather large pressure chamber, but should be applicable to many pressure vessels that now use a cone and shell electrical lead.

The metal cones were machined to the shape shown in Fig. 1 from Berylco 25 rod and large thermocouple wire (Chromel-Alumel). The object of the long extension on the high pressure side is to allow the closure and metal cones to act as a male pin socket. The metal cones were placed in Teflon molds (also shown in Fig. 1) and potted in an epoxy consisting of Epon 828 resin and DEAPA (diethylaminopropylamine), 100 and 6 parts by weight, respectively. The top of the mold was wrapped with masking tape to retain the epoxy during degassing and the epoxy then cured at 165°F for 4 to 5 h. The potted metal cones were freed from the molds (by applying pressure between the ends of the mold) and placed in the lathe using a live center in the wire hole on the low pressure side to give an accurate alignment. The epoxy was then turned into a conical shell approximately 0.012 in. thick that extended around the high pressure side and tapered along the extension on the low pressure side to give an interference fit with the Teflon spaghetti insulation used on the lead wires (see Fig. 1.)

The conical surfaces of both the closure and the epoxy coated metal cone were then coated with a mixture of Epon 828 and DEAPA and the cone tightened into position in closure by the Teflon bushing and steel screw. It was necessary to repeat the tightening several times, allowing sufficient time ($\sim$1 h) for the high vicsosity fluid to flow between tightenings. The epoxy coating was allowed to set up overnight at room temperature before subjecting the seals to pressure.

Although the experiments[9] carried on within the pressure vessel were not designed to test the seals, the seals were subjected to many pressure cycles to above 150 000 psi. The most severe cycle was a week in duration culminating in a 24-h hold at 150 000 psi. The seals (being embedded in the large steel closure) were not subjected to wide temperature variations although the temperature within the pressure vessel ranged from -10 to 125°C. The insulating characteristics of the seals were tested, and then the metal cones were removed for visual inspection. All seals withstood several kV (up to 15 kV) before electrical breakdown. Visual inspection disclosed no extrusion of the metal cones or the epoxy seals.

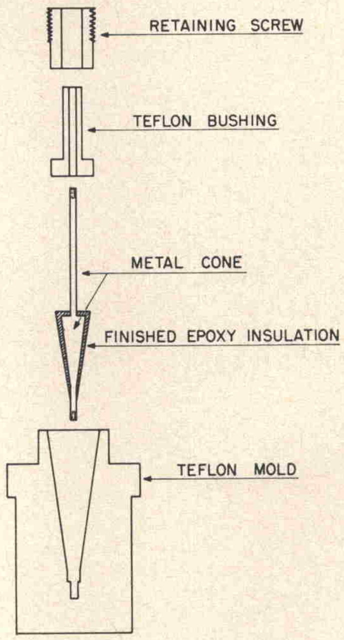

FIG. 1. Component parts for a high pressure electrical lead and epoxy potting mold.

The procedures described above have given an initial pressure seal with good electrical insulation in every case. It is believed that these procedures will also yield satisfactory seals at pressures well beyond the capabilities of our apparatus.

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