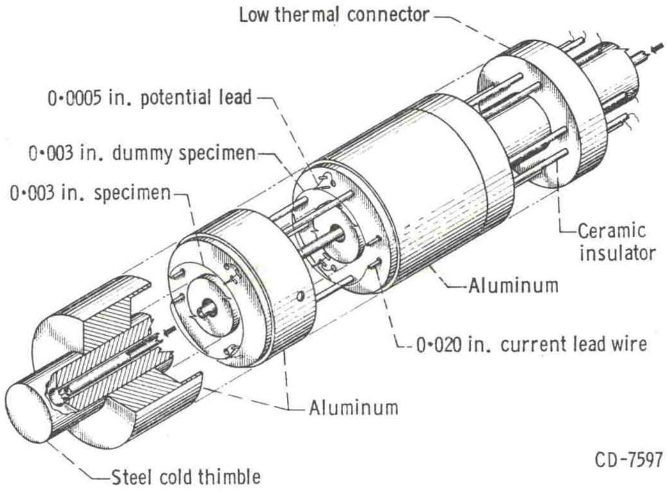

FIG. 1. Exploded drawing of specimen enclosure and cold thimble showing arrangement of specimen and dummy specimen wires.

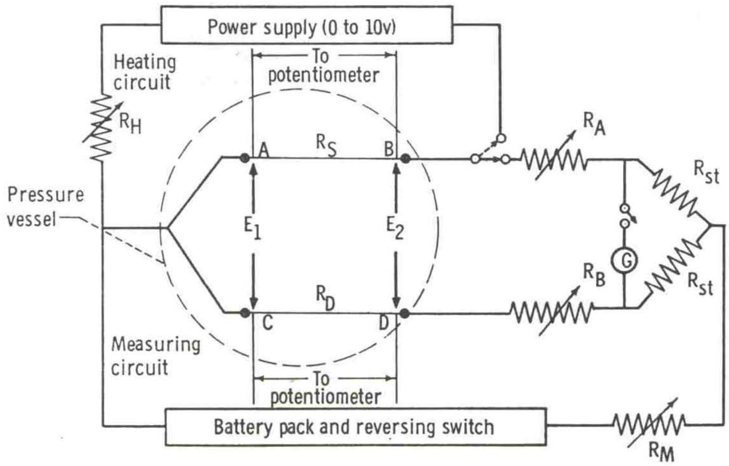

FIG. 2. Schematic diagram of circuit used for resistance measurements.

ambient temperature changes of the assembly before and after the quench.

To make a measurement, the bridge circuit, including the specimen, R_S, the dummy, R_D and two 1-Ω standard resistors R_{st}, was balanced by adjusting the variable resistors R_A and R_B. In the balanced bridge, the measuring currents in the specimen and the dummy could be maintained equal to 1 part in 10^5. The resistance difference between the specimen and dummy specimen was then determined by measurement of the potential differences E_1 and E_2 with a modified White potentiometer accurate to 10^{-8} V. Errors due to constant thermal e.m.f.'s were eliminated by reversing the measuring current flow in the circuit. The resistance difference was then given by

$$R_S - R_D = \frac{E_1 - E_2}{I}$$

where E_1 and E_2 are averages of the forward and reverse readings. The measuring current I (nominally 10 mA in each arm of the bridge) was determined by measuring the potential drop across one of the 1-Ω standard resistors. This value of measuring current was found to minimize heating of the specimen and the dummy specimen, while permitting the quenched-in resistance to be determined to within 1 per cent of the total value for most quenches.

The specimens and dummy specimens were, in all cases, fabricated from 0·003 in.-dia. gold wire from the same lot, quoted by the supplier[17] as better than 99·999% pure. Resistivity ratios of 1400, for annealed specimens at room temperature and 4·2°K, confirmed this purity.

The physical arrangement of the specimen and the dummy specimen are shown in Fig. 1. They are supported in a horizontal position by fine 0·0005 in.-dia. gold wire hangers, two of which serve as potential leads. The specimen length defined by the potential leads was nominally 2 cm for most specimens. The dummy specimen length was matched potentiometrically to the specimen to reduce errors due to ambient temperature changes in the whole assembly. The success of this matching procedure was indicated by the agreement of the quenching results from these specimens with other specimens 7 cm long similarly matched.

During the prequench anneal it was important to keep a reasonably uniform temperature over the test section of the specimen. In a series of preliminary experiments with the system just described, the temperature distribution along the test length was found to remain constant within 5°C at the quench temperature. This was determined by both optical pyrometry at atmospheric pressure and by thermocouple measurements at high pressures. Since no serious temperature fluctuations occurred along the specimens at high pressures, subsequent quench temperatures were measured by resistivity changes of the specimen. The proportionality between resistance and resistivity (i.e. length to cross-section ratio) was determined for each specimen by comparison of the specimen resistance measured at a known room temperature with the resistivity data of MEECHAN and EGGLESTON[18] for that temperature. The specimen temperature was continuously monitored during anneals using potentiometric strip chart recorders. During the normal prequench anneal, small cyclic fluctuations in temperature of approximately ±3°C were observed at higher pressures. A reasonable estimate of the total probable error in the measurement of the quench temperature is ±5°C.

Quench rates were measured as a function of pressure by an oscillographic technique. The specimen temperature was found to be nearly proportional to the potential drop across the specimen during most of the quench. The time rate of decay of this potential during the quench was observed on a calibrated persistent screen oscilloscope. From the quenching curves thus obtained, the initial quench rates (average slope over the first 100°C temperature drop) and the half-lives (time required to fall to one-half of the quench temperature) were recorded. A curve of half-life as a function of pressure (shown in Fig. 3) illustrates the marked increase in quenching rate obtained at high pressures. It is significant, however, that the variation with pressure above

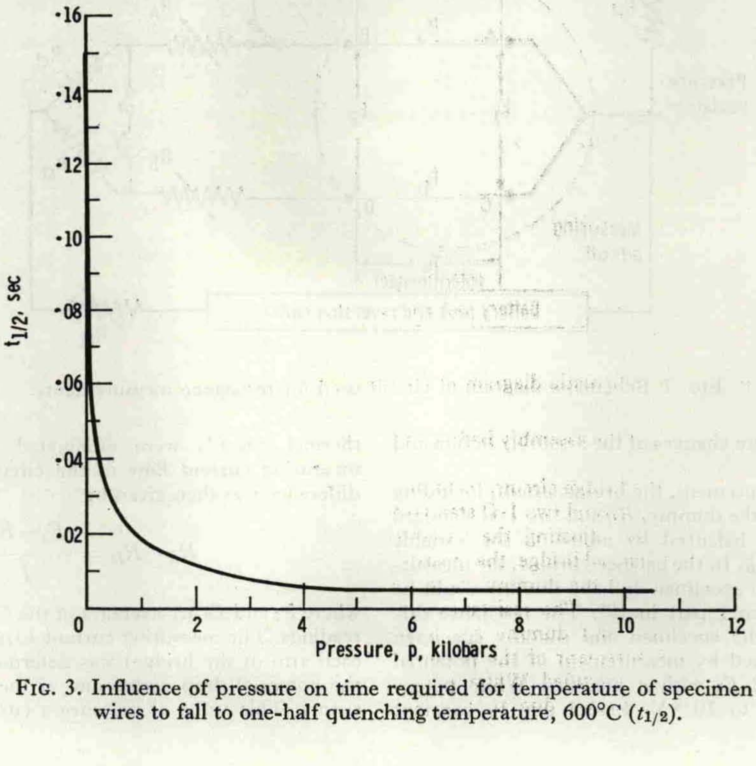

FIG. 3. Influence of pressure on time required for temperature of specimen wires to fall to one-half quenching temperature, 600°C ($t_{1/2}$).