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AUTOMATIC RECORDING McLEOD GAUGE

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The use of a conventional McLeod Gauge design to measure gas pressures requires the constant attention of an operator during any particular pressure determination. In addition, a permanent record of pressure readings must be made by hand at the time of the measurement. To alleviate these problems, a modified McLeod gauge has been constructed and used to record pressures automatically. With the assumptions of the same general limitations of usage as far as practical applicability, chemical inertness, etc., in a particular system, the gauge described has proved to be satisfactory.

The overall gauge design selected is shown in Fig. 1 and was chosen for its relative strength of construction. In principle, other designs may be used. The gauge consists of the measuring volumes and the reservoir. Provision was made in the reservoir for an air bleed and a vacuum (fore pump) source. Mercury was caused to rise and recede in the gauge by controlling the on-off cycle of the fore pump in a fashion similar to the operation of a Toepler pump. In practice, air was constantly bled into the reservoir and the fore pump was operated continuously. The fore pump was isolated from the vacuum control valve by a vacuum solenoid valve. The vacuum and air valves were adjusted so that the fore pump, when engaged, could overcome the effect of the air bleed.

The electrical circuits of the cycling and measuring portions of the operation are shown schematically in Fig. 2. The leads from the

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holding contactor relay were connected to 0.010-inch tungsten electrodes, A, B, and C of the McLeod Gauge. Electrode C is common. Electrodes A and B activate the holding contactor relay. When electrodes B and C were joined, the solenoid was isolated from the fore pump thus causing mercury to rise into the gauge. When electrodes C and A were joined, the pump was activated through the solenoid valve and the mercury receded into the reservoir. The period of the cycle can be adjusted within practical limits by controlling the air-bleed and exhaust rates. Rushing of the mercury against the gauge cutoff is, of course, to be avoided.

The measurement of the pressure was accomplished by measuring the change in current passing through two 5-mil Pt wires drawn through the closed end of a constant-diameter bore capillary portion of the gauge. The idealized construction is shown in Fig. 1 (inset). The internal portion of the closed end was slightly rounded. The electrical measuring circuit shown in Fig. 2 is quite standard. Of particular importance, however, is the insertion of an isolation transformer in the a-c input of the cycling circuit to eliminate ground loops from interfering with the d-c circuit. A current of 16 ma was set in the closed circuit. As the mercury rose into the capillary, electrical contact was made between the two Pt wires via the Hg, which acted as a constant-resistance electrical bridge. The current passing through the exposed portion of the Pt wires was passed through a standard resistor and monitored as a voltage change. This voltage was recorded and a calibration established between the voltage (scale divisions) and gas pressure.

In the case discussed above, the automatic McLeod gauge was calibrated with a conventional manual McLeod gauge and thus must be considered as a secondary standard. Absolute calibration of the gauge can be accomplished at least in theory in the usual manner (1) by subtracting a volume correction for the volume of platinum contained in the capillary volume.

No leak problems were encountered with the Pt through glass seal. No detectable change in pressure was observed after a 2-day seal-off of the closed end capillary. Had leaks developed, they probably could have been sealed with a commercial vacuum sealing compound.

A typical plot of the data obtained for a decreasing pressure is shown in Fig. 3(a). Equilibrium measurements are illustrated in Fig. 3(b) for several representative pressures (in mm) and show the excellent reproducibility and stability of the measurement.

REFERENCE

1. Dushman, Saul: Scientific Foundations of Vacuum Technique. John Wiley and Sons, 1962.

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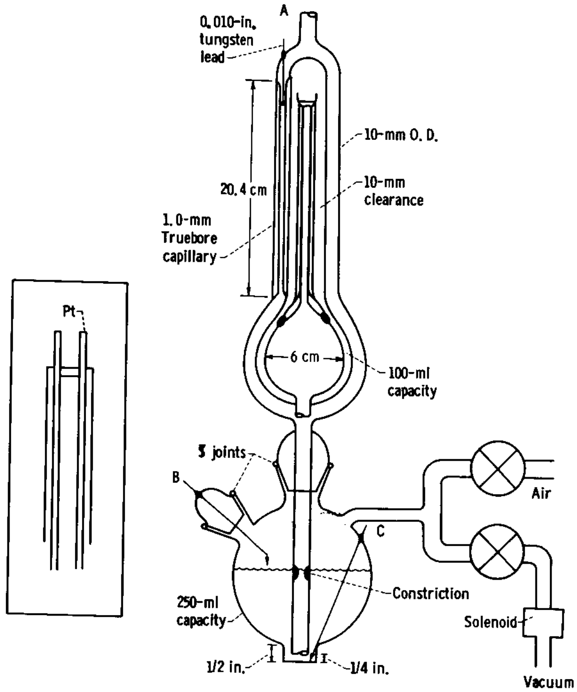

Fig. 1. - Automatic recording McLeod gauge.

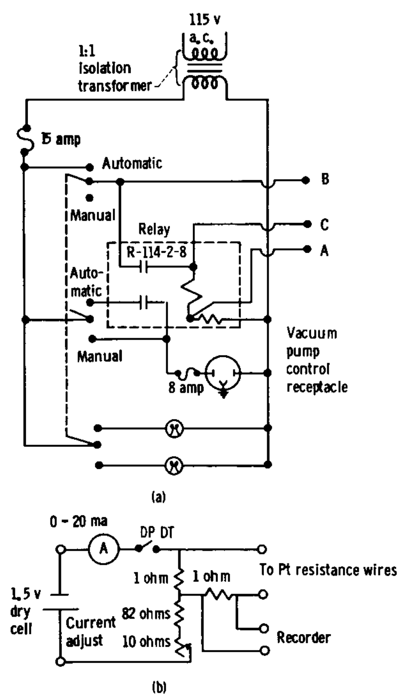

Fig. 2. - (a) Control circuit and (b) measuring circuit.

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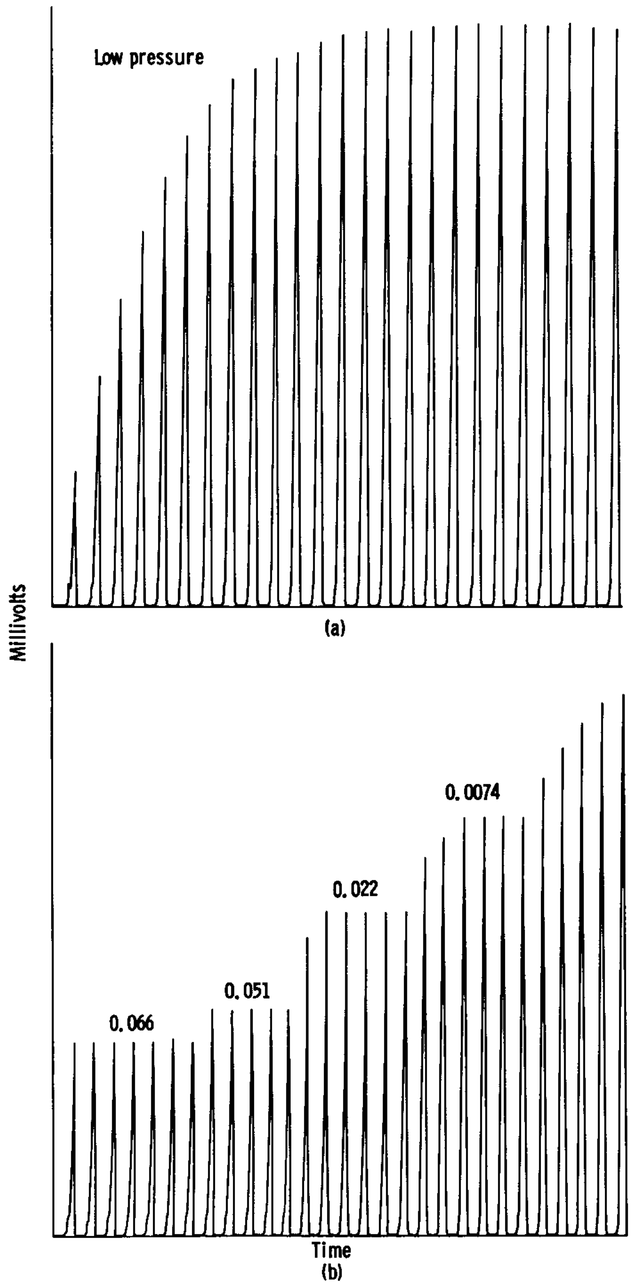

Fig. 3. - Typical recording of (a) pump down and (b) equilibrium pressures.