thermostat circuit operated a vacuum tube relay to control a gas valve which supplied one or two Meker burners that heated the bath. A thermometer, calibrated against one certified by the National Bureau of Standards, reading to 1/10 degree was used in this investigation for temperature measurement. The recorded temperatures are accurate to within ± 0.02°C.

Pressure was generated by a hand pump which can be safely operated to 20,000 lb./in.^{2} without undue effort. The pump connected directly to an intensifier which permitted about a fourfold increase of pressure. Before this pressure could be used in the viscometer, however, means had to be provided for separating the transmitting liquid from the test liquid, and for measuring the pressure, the gauge on the pump being inaccurate for precise measurements. A cylindrical steel chamber connected between the intensifier and viscometer served both purposes; a flexible copper sylphon provided mechanical separation of the liquids, and a coil of manganin wire mounted on a suitable plug allowed the pressure to be measured by observing the change of its electrical resistance with pressure by means of a Carey-Foster bridge. It is known that the change of electrical resistance of manganin with pressure is linear.[11] The gauge was made of No. 40 B & S double silk covered manganin wire obtained from Driver Harris Company. The resistance was about 120 ohms at atmospheric pressure. Dr. L. H. Adams of the Geophysical Laboratory provided the important service of calibrating the manganin coil against the standard in his laboratory. The calibration obtained by Dr. Adams was 2.335×10^{-6} cm^2/kg. Finally, a connecting pipe from the cylindrical chamber led to a connection at the top center of the viscometer, thus completing the system under pressure.

Method of Computation and Data

The absolute viscosities of the three oils are desired at the three chosen temperatures of 100°, 130°, and 210.2°F at various pressures within the experimental range. Since lubricating oils freeze at fairly low pressures at moderate temperatures, the pressure range was more restricted in the present case than is usual for most liquids. Consequently, the highest pressures used in this study are of the order of 55,000 lb./in.^{2}; in every case the highest pressure recorded is considerably below that where solidification begins. The beginning of solidification is noticed when the viscosity becomes abnormally great; when it is complete, the ball ceases to roll. The recorded data for a viscosity determination were then: the roll time in seconds, the thermometer reading in degrees Fahrenheit, and the pressure read on the Carey-Foster bridge in terms of length of slide wire. The roll time was taken as the average of roll times in both directions of tilt, and readings were recorded both for increasing and decreasing steps of pressure. When the roll time was less than 10 seconds, twenty or thirty observations were taken but as it increased, the number of observations was accordingly decreased. The corresponding pressures were obtained by multiplying the equivalent lengths of slide wire by the pressure coefficient of manganin, and converting the result to pounds per square inch.

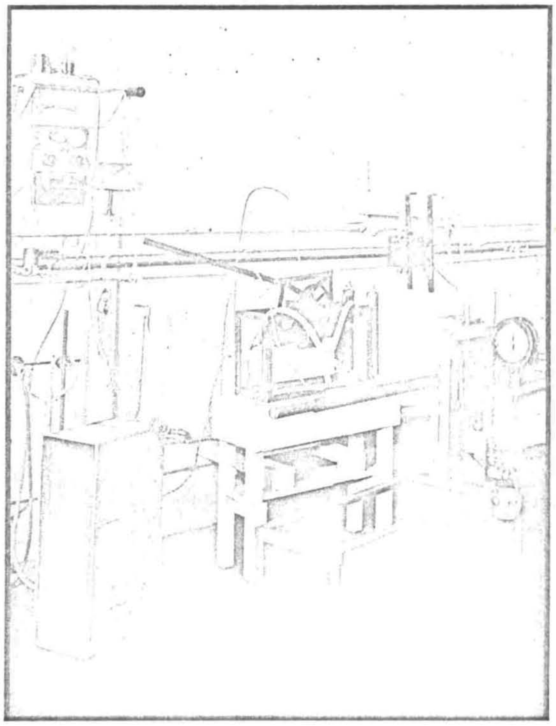

FIG. 1. Rolling-ball viscometer and auxiliary pressure apparatus.

The theory of the rolling-ball viscometer has been developed from a dimensional standpoint by

[11] P. W. Bridgman, *Physics of High Pressure* (Macmillan, 1931) p. 73.