FIG. 1. Piezometer. Exploded view to show internal construction.

flexible brass bellows after the piezometer had been washed, dried, and weighed. The filling operation took place in a large glass tube, evacuated to a pressure of about 10^{-3} mm of mercury in order that the liquid hydrocarbon be freed of dissolved gases and that no gas bubbles be trapped in the bellows. After being filled the piezometer was removed from the vacuum system and sealed with a set screw. The loaded piezometer was again washed externally, dried and weighed to ascertain the mass of the sample. The loaded piezometer was then inserted into a brass container and the slide-wire contact was mounted in the container so as to bear on the slide wire.

Application of hydrostatic pressure produced a compression of the bellows and movement of the attached slide wire under the slide wire contact. Since the bellows compressed without change in cross-sectional area, except for small variations due to compressibility and thermal expansion of the brass, the change in bellows length is proportional to the volume change of the enclosed liquid.

A potentiometric method was used for measuring change in bellows length. The piezometer slide wire carried a constant current. Potential leads, which were separate from current leads, were arranged to measure the potential drop over the total length of the wire and the potential drop from one end of the wire to the sliding contactor. The change in the ratio of these two potential drops is proportional to the change in bellows length. This ratio is independent of changes in resistance per unit length of the slide wire with pressure.

Two calibrations were required to convert changes in the ratio of potential drops to changes in volume. The first of these determined the change in length of the bellows for a given change in ratio of potential drops. For this the piezometer was held in a special rig and the bellows compressed known amounts by a micrometer screw which could be read to 0.0001 in. Potential drop ratios were determined for each micrometer setting. The second calibration determined the change in bellows volume per unit change in bellows length. The bellows was loaded with n-hexadecane and arranged in the rig so that when the bellows was compressed with the micrometer screw the liquid was forced up a precision bore glass tube of known cross-sectional area.

The volume changes computed from changes in ratio were corrected for the volume effects arising from the thermal expansion and the compressibility of

brass. It was also necessary to take account of the change in compressibility of brass with pressure.

The observed data consist of a series of values for the potential ratio with the corresponding pressures under isothermal conditions. Values of the volume change were computed from the observed changes in the potential ratio. Values of the volume change were ascertained at both ascending and descending pressure, with an observation of the volume change being made at least every 175 bars.

The volume changes computed from the observed data were plotted against pressure to large scale and then smoothed by drawing the best possible curve through the plotted points with a flexible ruler. Volume changes were read from the curve at 345-bar intervals and these volume changes were fully corrected for the thermal expansion and compressibility of brass. The correction for the compressibility of the brass in the piezometer was laborious in that it involved two quantities that were pressure functions, the compressibility of the brass and the volume of the liquid sample. Therefore, only smooth curve values of the volume change at regular pressure intervals were corrected instead of correcting all observations. It is emphasized that the smoothing operation described involved no major numerical change in the data, the smoothing process being largely a matter of mathematical convenience.

EXPERIMENTAL RESULTS

The atmospheric pressure properties of the high-purity liquid hydrocarbons used are listed in Table I. The changes in specific volume with pressure are compiled in Table II. The data in Table II are the fully corrected, smoothed data. Volume changes were measured at six temperatures, 37.8°, 60.0°, 79.4°, 98.9°, 115.0°, and 135°C, except where necessary to omit the lower temperature because of proximity to the melting point. A maximum pressure of 10 000 bars was reached where possible but some of the work was limited to lower pressures to avoid solidification of the sample or because of extreme viscosity of the sample.

An examination of the volume changes determined in this study in regard to deviation of points from the smooth curves gave an average deviation of 0.0003 cc/g. In addition to the uncertainty in a reported volume change because of the average deviation from the smooth curves, the calibration constants have a possible cumulative error of $\pm 0.3\%$. The total uncertainty in the reported volume change depends on the magnitude of the volume change which is dependent, in turn, on the sample being studied and the pressure. The total uncertainty in the reported volume changes ranged at the worst, from $\pm 1.6\%$ at 345 bars to $\pm 0.4\%$ at 10 000 bars. The effect of this uncertainty on the accuracy of the density values obtained