4. EXPERIMENTAL RESULTS AND DISCUSSION

At five temperatures, 3.000°, 3.500°, 4.000°, 4.500°, and 5.000° K, n–P isotherms were measured. At each steady temperature, the cell was filled to a pressure slightly over 4.5 atmospheres. Then the cell pressure was slowly decreased to the SVP at that temperature, while fringes were recorded. The pressure in the cell was marked on the fringe record as the pressure fell. Figure 1 is a photograph of a portion of the chart record of the 3.000° K isotherm. Due to a slight viscous pressure drop in the capillary tube leading to the optical cell, these recorded pressures were occasionally as much as 0.01 atmosphere lower than the actual pressures. Furthermore, as the density of the liquid helium in the cell was a pronounced function of temperature, the unavoidable slow temperature drifts of ± 0.5 mdeg during an isotherm required small corrections to be applied to the fringe numbers obtained to make them appropriate to the nominal temperature of the isotherm being taken. Thus the extreme precision to which a fringe number could be read, viz. about 0.05 of a fringe, corresponding to about 2.35×10^{-7} in refractive index, was much better than the actual accuracy of the measurements. However, small changes in n with pressure P could be measured fairly accurately and give values of the isothermal compressibility k_T. We estimate the increase of the length of the optical cell itself due to an internal pressure of 4.5 atmospheres to be only about 3.5×10^{-4}%. The resulting correction to n, ρ, and k_T has been omitted as entirely negligible. The *absolute* values of refractive index obtained all depend on the accuracy of the one absolute value at 3.700° K, $n = (1.026{,}124 \pm 0.000{,}035)$ (Edwards 1958) and upon the accuracy of the comparison of changes from this one value. Values of n at the SVP have been determined in separate experiments (Edwards 1958; Edwards and Woodbury, to be published) for temperatures from 1.6° to 5.2° K. From these known values at the SVP the absolute value anywhere along an isotherm ending at the SVP could be determined.

The results of these measurements are given in Table I at the SVP and at intervals of 0.5 atmosphere to 4.5 atmospheres pressure. Because of limitations of space, the original data of fringe numbers versus pressure are not shown, since at 5.000° K, for example, about 950 fringes were obtained. The absolute values of the refractive index are believed to be within $\pm4\times10^{-5}$, while relative values along any isotherm are probably within $\pm5\times10^{-6}$. The absolute uncertainty in the liquid densities, obtained through equation (3.2), is about ±0.15% or roughly $\pm2\times10^{-4}$ g cm^{-3}, while relative values along any isotherm are probably within $\pm5\times10^{-5}$ g cm^{-3}. Figure 2 shows these isobaric densities of liquid He^4 as a function of temperature for pressures up to 4.5 atmospheres. Keesom and Keesom's smoothed 1933 values (Keesom 1942, p. 242) of the liquid density at 1.0 and 2.5 atmospheres, at 3.0°, 3.5°, and 4.0° K (after correction to the 1958 temperature scale), vary between 0.1 and 0.7% lower than the present results. Edeskuty and Sherman's (1957) values of the liquid density at 3.0° K at 1.0 and 2.0 atm are 0.06% and 0.08% lower than the present results.