ment at constant temperature. The fact that there is good agreement between the data of Bridgeman,[?] who used the piston displacement method, and that of Dow, and Dow and Fenske, who used the sylphon method, would seem to indicate, however, that the absolute error involved in the measurements under consideration at constant temperature might be somewhat less than what would otherwise be expected.

Probably the source of greatest error lies in the interpolation and extrapolation. Data were available at only three temperatures; namely, 77°, 104°, and 167°F. By interpolation and extrapolation of these data, a system was evolved by means of which densities can be calculated at intervals of 10° between the limits of 20° and 220°F. The method employed was to construct relative density-temperature isobars at atmospheric pressure, 10,000 lb./in.^{2}, and 20,000 lb./in.^{2} by reading off the relative densities at 77°, 104° and 167°F from the relative density-pressure curves already described. While only three points were used to determine these isobars, the uncertainty in locating the curves accurately was not so great as might be expected at first thought. Relative density increases slowly with temperature at constant pressure, and for the experimental range considered here does not depart greatly from linearity. Moreover, the isobar at atmospheric pressure could be located with extreme accuracy with the aid of the National Bureau of Standards tables[6] that show the change of density of petroleum oils with temperature at atmospheric pressure. At this point it is to be noted that the National Bureau of Standards tables indicate that oils in the range of specific gravity of the present ones under consideration have a thermal coefficient of expansion of 40×10^{-5} per °F at atmospheric pressure. The averages of the corresponding values reported by Dow,[2] and by Dow and Fenske[3] were 37×10^{-5} and 41×10^{-5}, respectively. This variation of the coefficient can be taken as the possible error in the temperature measurements, since the apparatus used at the National Bureau of Standards was doubtless better suited to measuring the atmospheric isobar than the sylphon apparatus used by these other investigators. Thus the atmospheric isobar was first corrected to bring it into line with the National Bureau of Standards values, and the other isobars were then corrected correspondingly. By using this system of correction, the actual shape of the density-pressure curves was left unchanged, and the intercept on the density axis was corrected only to bring the atmospheric densities into line with the National Bureau of Standards tables.

Density Equation

In order to express the graphical results in a simple form that can be used readily for the calculation of density at various pressures and temperatures when the density at atmospheric pressure is known at a particular temperature, the following empirical equation was developed,

$$\rho=\rho_0(1+ap-bp^2)_t. \qquad (1)$$

In this equation ρ is the density in g/cm^3 at any stated temperature t and pressure p, and ρ_0 is the density at the same temperature at atmospheric pressure. Temperatures are expressed in degrees Fahrenheit and pressures in pounds per square inch gage. The symbols a and b represent constants at any given temperature. Values for a and b are given in Table II.

Table II. *Density constants a and b as functions of temperature.*

Temp. °F	a	b	Temp. °F	a	b
20	3.96×10^{-6}	7.3×10^{-11}	130	4.50×10^{-6}	5.3×10^{-11}
30	4.02	7.0	140	4.53	5.1
40	4.08	6.8	150	4.56	5.0
50	4.14	6.6	160	4.59	4.9
60	4.19	6.4	170	4.61	4.8
70	4.24	6.2	180	4.63	4.7
80	4.29	6.0	190	4.64	4.6
90	4.34	5.8	200	4.66	4.5
100	4.38	5.7	210	4.67	4.4
110	4.42	5.5	220	4.68	4.4
120	4.46	5.4			

The method used to compute the values of a and b is readily explained. For each of the temperatures listed values of ρ/ρ_0 were taken from the isobars constructed as described in a previous section, and a and b were evaluated using simultaneous equations of the type of Eq. (1). The values so calculated were then plotted as shown in Fig. 1 and Table II was constructed

[6] National Bureau of Standards Circular C410, United States Government Printing Office, Washington, D. C. 1936.