Pressure was measured with a wire resistance gauge. Such a gauge must be calibrated against a primary pressure standard or against pressure-fixed points, such as phase-transition pressures, which have been themselves accurately established relative to a primary standard. In this work the gauge was a loosely wound coil of 0.005-in.-diam Au–2.1% Cr alloy of about 13-Ω resistance. The details of the gauge preparation and calibration against a precision free-piston gauge have been given elsewhere.[33] The gauge resistance is determined with the aid of a six-dial potentiometer to an accuracy of 5 ppm, which means that it was possible to detect a pressure change on the order of 6 bar. The calibration of the gauge is given in Table I. The coefficients given there were obtained by a quadratic least-squares fit of the gauge-resistance-vs-pressure data. The standard deviation of the data from the least-squares curve was 0.00008 Ω in approximately 12 Ω, which is equivalent to 6 bar.

There is some difficulty with drift in the calibration of Au–Cr pressure gauges. A check on the gauge calibration at 21.9°C at the time of the velocity experiments showed that it had drifted by an approximately linear factor of 0.4%±0.2% over the eight-month period between the free-piston-gauge calibration and the velocity experiments in such a way as to make the relative change of resistance smaller for a given change of pressure. Since it would have been prohibitively difficult and expensive to check the calibration at the other two temperatures, it is assumed that the calibration drifted in the same way for those temperatures. The calibration in Table I represents the corrected calibration and is therefore reliable to about 0.4%.

TABLE I. Coefficients of the pressure gauge calibration curve, $\Delta R/R_0 = AP + BP^2$.

Temperature (°C)	A (bar$^{-1}\times10^{-6}$)	B (bar$^{-2}\times10^{-13}$)
21.9	1.070	−4.7
40.5	1.057	−7.4
52.9	1.044	−6.2

RESULTS

For the purpose of calculation, the measured pressure dependence of the sound velocity given in Table II is fitted to the equations

$$P = A + Bc_T + Dc_T^2, \tag{1}$$

$$c_T = A' + B'P + D'P^2, \tag{2}$$

where P is pressure and c_T is sonic velocity at temperature T. Equation (1) is found to give a better fit at each T since the standard deviation in each case is about a factor of 3 smaller than for Eq. (2). Equation (1) presents a more reasonable picture physically since it predicts a steady increase of velocity with pressure while Eq. (2) predicts a maximum in c_T with pressure and a subsequent decrease. The standard deviations from the least-squares curve of Eq. (1) for the three experimental temperatures are shown in Table III along with the coefficients of the curves. The solid curves in Fig. 4 represent the least-squares equations.

TABLE II. Sonic velocity in Hg.[a]

T=21.9°C		T=40.5°C		T=42.9°C	
Pressure	Velocity	Pressure	Velocity	Pressure	Velocity
1	1450.1	1	1441.5	1	1435.8
299	1457	516	1453	464	1447
584	1463	932	1463	925	1457
989	1472	1 458	1474	1 485	1469
1 276	1478	1 930	1484	1 942	1478
1 532	1483	2 144	1488	2 511	1490
2 106	1495	2 769	1500	2 537	1491
3 254	1517	3 080	1507	3 019	1500
3 264	1518	3 893	1522	4 232	1524
3 490	1522	4 298	1530	4 548	1530
4 565	1542	4 483	1533	4 942	1537
5 772	1564	5 539	1552	5 470	1546
5 907	1566	5 642	1555	6 885	1572
6 138	1570	6 518	1569	6 915	1573
7 542	1594	7 168	1581	7 746	1587
8 310	1606	7 175	1581	8 255	1595
8 858	1615	8 309	1599	9 533	1616
8 950	1616	8 538	1604	9 954	1623
9 894	1632	9 399	1618	10 939	1639
10 695	1644	10 318	1632	11 203	1642
10 926	1648	10 384	1634	11 503	1647
11 485	1656	11 830	1656	11 792	1651
11 532	1657	11 922	1657	12 968	1669
11 985	1664	12 315	1663	13 023	1670
12 035	1665	13 270	1677	13 332	1675
		13 709	1684		
		14 213	1691		
		14 695	1698		
		14 921	1701		

[a] Pressure in bars, velocity in meters per second.

It is possible to use the sound-velocity data described above, in conjunction with certain other data, to calculate the specific volume of Hg as a function of T and P. The calculation starts with the relation between the sound velocity and adiabatic compressibility

$$\beta_{\mathrm{ad}} = 1/\rho c_T^2 \tag{3}$$

and the relation

$$\beta_T = \beta_{\mathrm{ad}} + (T\alpha^2/\rho C_P), \tag{4}$$

where β_T is isothermal compressibility at temperature T,

TABLE III. Least-squares coefficients of the curve $P = A + Bc_T + Dc_T^2$ and the standard deviation (σ) of the velocity data.

Temperature (°C)	21.9°	40.5°	52.9°
A (bar$\times10^5$)	4.1489	3.9067	4.0715
B (bar per m/sec$\times10^2$)	−1.025	−0.9885	−1.006
C (bar per m^2/sec$^2\times10^{-2}$)	5.096	4.976	5.034
σ (m/sec)	0.2	0.3	0.3

[33] L. A. Davis and R. B. Gordon, Rev. Sci. Instr. 38, 371 (1967).