of Grüneisen, it is about 0.5 in the quantum-statistical analysis.[6]

The relation of McDonald and Dugdale

$$\gamma_l(v) = -\frac{1}{3} - \frac{v}{2}\frac{d^2(P_c v^{5/3})/dv^2}{d(P_c v^{5/3})/dv}, \qquad (2)$$

which connects the Grüneisen coefficient of the lattice with the "cold" compression curve $P_c(v)$, leaves one unknown function $P_c(v)$ in the system (1). This function can be determined by substitution in Eq. (1) of the parameters of the Hugoniot adiabats —the pressure P_H, the specific volume v_H and the specific energy

$$E_H = \tfrac{1}{2} P_H (v_0 - v_H) + 3RT_0 D(\Theta/T_0) + \tfrac{1}{2}\beta_0 T_0^2 + E_c(v_0). \qquad (3)$$

($T_0 \sim 300°K$ is the temperature of the specimens in the initial state, v_0 is the volume at $P = 0$, $T = T_0$).

A similar method, which requires the numerical solution of equations of the form (1), was applied in a number of researches.[3-5] As was shown by Kormer and others,[8] this method does not lead to unique values of γ_l for small compressions, and does not give analytic expressions for $P_c(v)$ that are suitable for extrapolation.

Another way of obtaining the equations of state from the results of dynamic experiments was based on the furnishing of $P_c(v)$ in analytic form. This contains a certain number of free parameters, selected according to the experimental data. Experimental data on Al, Cu, and Pb were treated in this fashion by Kormer, Urlina, and Popov[8] and are shown in [3].

The new treatment gives a result for $P_c(v)$ which is identical with that of [3]. Here, we represent the zero isotherms in the form

$$P_c(\delta) = Q'\delta^{5/3}\exp(-q\delta^{-1/3}) - Q\delta^{4/3}, \qquad \delta = v_{0k}/v, \qquad (4)$$

which contains three free parameters Q', Q, and q. By eliminating Q', and using the condition $P_c(1) = 0$, we get the following simple expressions for the pressure and the energy:

$$P_c(\delta) = Q[\delta^{5/3}\exp\{q(1-\delta^{-1/3})\} - \delta^{4/3}], \qquad (5)$$

$$E_c(\delta) = (3Q/\rho_{0k})[q^{-1}\exp\{q(1-\delta^{-1/3})\} - \delta^{1/3}] \qquad (5a)$$

with two unknown constants Q and q.

For ionic compounds, the first terms in (5) are determined by the repulsive potential of the ions, and the second by the Coulomb attraction. For metals, the positive term in (5) expresses approximately the sum of the repulsive forces (kinetic pressure of the electrons, interaction of closed shells of ions, etc.), and the negative the attractive forces (Coulomb and exchange forces, etc.). Expressions of the form (5) were used earlier for description of the equations of state of rock salt[9,10] and iron.[9,11]

On the basis of (5) and (2), the Grüneisen coefficient for the lattice

$$\gamma_l(\delta) = \frac{1}{6}\frac{q^2\delta^{-4/3}\exp\{q(1-\delta^{-1/3})\} - 6}{\delta^{-1}q\exp\{q(1-\delta^{-1/3})\} - 2} \qquad (6)$$

depends on the single parameter q. For $\delta = 1$ ($v = v_{0k}$) we have

$$\gamma_l = (q^2 - 6)/6(q - 2). \qquad (6a)$$

In order to estimate the unknown parameters, the system (1) was solved [after substitution of E, P_c, E_c, and γ_l from (3), (5) and (6)] for P_H with different values of Q and q. The chosen combinations of these quantities were best approximated by the experimental adiabats on their lower parts from zero to 4×10^6 atm.

The parameters $\rho_0 = 1/v_0$, $\rho_{0k} = 1/v_{0k}$, q, Q, γ_e, and β_0 are given for five simple metals and nickel (see the next section) in Table V, together with the computed and experimental values of $\gamma_l(v_0)$ and the isothermal bulk moduli $K = -dP/d\ln v$[12] for $v = v_0$ and $T = T_0$. The zero isotherms and the shock adiabats under consideration are drawn as functions of $\sigma = v_0/v$ as solid lines in Figs. 3—6. For Cu and Pb, the course of the zero isotherms virtually coincides with the curves obtained in [3].

As the tables and graphs show, a great divergence takes place between calculation and experiment for strongly compressible metals. A notable difference in the experimental modulus of volume compression and the Grüneisen coefficient is observed in lead for $\rho = \rho_0$ and $T = T_0$. The computed adiabats of cadmium and tin (for a pressure of the order of 350×10^3 atm) are higher than the experimental points (by ~ 8—10 per cent, i.e., by 30×10^3 atm), and for $\sim 1.6 \times 10^6$ atm by somewhat less (by ~ 5 per cent, i.e., by 80×10^3 atm).

Significant divergences between calculation and experiment are observed in the upper parts of the shock adiabats for the highest temperatures of the shock compression, requiring a consideration of the anharmonicity of the thermal vibrations. For an estimate of the temperature corrections,* the "free volume" approximation was used.[13] In this approximation, an interaction of the atom with its nearest neighbors is considered which is symmetric over the sphere. In an elementary consid-

*These calculations were completed by V. N. Zubarev at the request of the authors.