

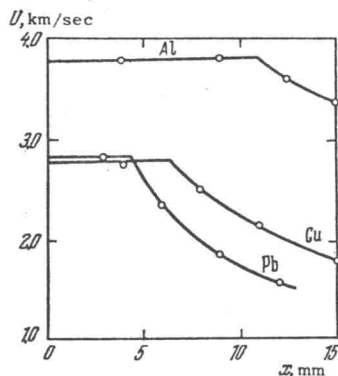


FIG. 29. Curves showing the attenuation of shock waves in targets made of aluminum, copper, and lead^[37]. The waves were produced by the impact of a thin 1.5 mm disc, flying with a speed 5.71 km/sec.

The leading front of the relaxation wave moves through the striker and the target with a speed exceeding that of the shock front. The attenuation of the shock wave begins at the overtaking point K.

By recording at an arbitrary point m in the attenuation region the coordinates t_m and x_m of the shock wave, and also the mass velocity U_m , it is possible to find the slope of the m-characteristic $\alpha_m = (x_m - x_n)/(t_m - t_n)$ and the speed of sound $C_m = \alpha_n - U_m$. The organization and interpretation of the experiments remain in principle the same as when different materials are made to collide.

The experimental curves of shock-wave attenuation of shock waves^[37] moving through the target are shown in Fig. 29. The striker used in these experiments was a 1.5 mm plate of iron, moving with a velocity 5.71 km/sec. The speed of sound behind the shock-wave front in copper, lead, aluminum, and iron up to pressures of several megabars was determined in^[37]. The isentropic moduli

$$K_S = \rho C^2 = \frac{dP}{d \ln \rho}$$

for three metals are shown in Fig. 30. In shock compression by a factor 1.70, the elasticity of the copper increases by a factor 7.4, that of iron by 8.6 times, that of aluminum by 10 times, and that of lead by 10.8 times.

The passage of shock waves is connected with irreversible heating of the medium and with an increase in its entropy. Consequently, the shock adiabat is steeper than the isentropes everywhere, except at the origin, and crosses these curves at acute angles.

The upper limit of the possible positions of the zero isotherm is obtained by unifying segments of isentropes into a single curve:

$$J(\rho) = \int_{\rho_0}^{\rho} \left(\frac{\partial P}{\partial \rho} \right)_{S_H} d\rho = \int_{\rho_0}^{\rho} C_H^2 d\rho. \quad (16)$$

The subscript H denotes here and throughout that the isentropic derivatives and speeds of sound were determined for the states of the shock adiabats. Inas-

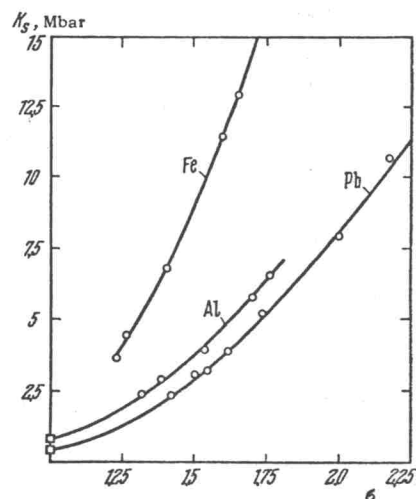


FIG. 30. Dependence of the isentropic modulus K_S of iron, aluminum, and lead on the degree of shock compression^[37].

much as the heating at constant volume leads with rare exception, to an increase in elasticity, we have

$$C_H^2 = \left(\frac{\partial P}{\partial \rho} \right)_{S_H} > \left(\frac{\partial P}{\partial \rho} \right)_{S=0} = \frac{dP_C}{d\rho}$$

and consequently $J(\rho) > P_C(\rho)$.

The relative positions of the curves P_H , J , and P_C are shown schematically in Fig. 31.

The function J makes it possible to calculate also the lower limit of the increase in thermal energy

$$\Delta E_{T \min} = \frac{1}{2} P_H(v_0 - v) - \int_v^{v_0} J(v) dv < \Delta E_T. \quad (17)$$

The positions of the curves $J(\sigma)$ of^[37] relative to the dynamic adiabats and zero isotherms of copper and lead obtained by another method (see Secs. 2 and 4) are shown in Fig. 24. It follows from the diagram that the representation of the zero isotherms by the functions (16) is in itself a fair approximation. On the other hand, we can now conclude that the "cold"

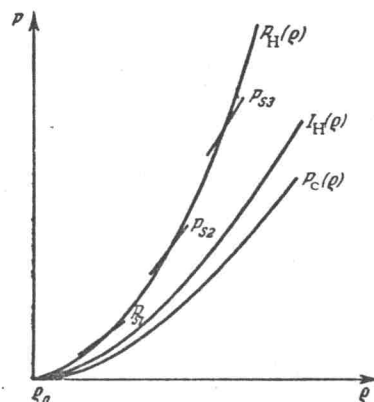


FIG. 31. Relative positions of the shock adiabat P_H , the isentropes P_S , the zero isotherm P_C , and the function

$$J(\rho) = \int_{\rho_0}^{\rho} C_H^2 d\rho.$$