Hence, on the leading c_+ characteristic,

$$dP/dt = -F/2$$

Measurements of the rate of change of peak stress thus yield a measure of the plastic strain rate at the elastic front. Since no time is assumed available for dislocation multiplication the plastic strain rate in turn determines the velocity of propagation of mobile dislocations.

In the general case, use of this theory to deduce constitutive relations from experiments requires that the constitutive relation be varied by postulating the function, $F(P,\rho)$, and comparing computed wave profiles with observations until agreement is achieved. A possible weakness is that "viscous" stresses are not permitted.

The relation between F and the phase velocities c_p and c_u is:

$$dP - a^2 d\rho = -F dt \quad (\text{on } h = \text{const})$$

and

$$dP = (\rho_o{}^2/\rho^2) c_p c_u d\rho \quad (\text{on } h = \text{const})$$

Therefore,

$$-F = [1 - (a^2\rho^2/c_p c_u \rho_o{}^2)](\partial P/\partial t)_h$$

or if the speed of elastic longitudinal waves is expressed in Lagrangian coordinates:

$$a^* = a\rho/\rho_o$$

and

$$F = [(a^{*2}/c_p c_u) - 1](\partial P/\partial t)_h .$$

This relation can be used, within the context of the assumptions implied by Eq. (25), to determine the plastic strain rate associated with a measured pressure profile at any point of the profile. Note that vanishing of the plastic strain-rate implies that $c_p c_u = a^{*2}$ and that, in general, the product $c_p c_u$ is less than a^{*2}. To determine F from experiments, however, requires independent knowledge of a^*. It is not clear how this quantity can be unambiguously measured in wave experiments. However, acoustic measurements under hydrostatic pressure could provide the necessary data.

IV. EXPERIMENTAL RESULTS

A. Equations of State

At higher shock stresses, substantially exceeding the yield stress, the hydrostatic component of the stress tensor dominates and shock experiments effectively yield a hydrostatic equation of state. This is the Rankine-Hugoniot relation (Eq. (3)) mentioned earlier, with the x-component of stress, P, replaced by the mean stress, $\bar{P}$. At these pressures the elastic wave is either small enough to be neglected compared to the "plastic" or deformational shock, or may be overtaken by the plastic shock, i.e. a single shock may be stable. The shock rise-times are also usually very small so that the transition is effectively steady state whether or not the final state is a true equilibrium state. Hence, the R-H jump conditions can be applied to relate the shocked state to the initial state and the more elaborate analysis of Section III.A. is unnecessary.

A very large amount of data has been generated on equations of state, particularly of metals and rocks.[3,41-43] Where comparisons can be made with hydrostatic data the agreement is satisfactory,[44] and, in fact, shock data are used to calibrate static pressure apparatus in the higher pressure ranges.[45]

A principal uncertainty at the present time is the temperature of the shocked state, which can only be calculated with independent knowledge of, or assumptions about, the Gruneisen ratio and the specific heat.[3,41]