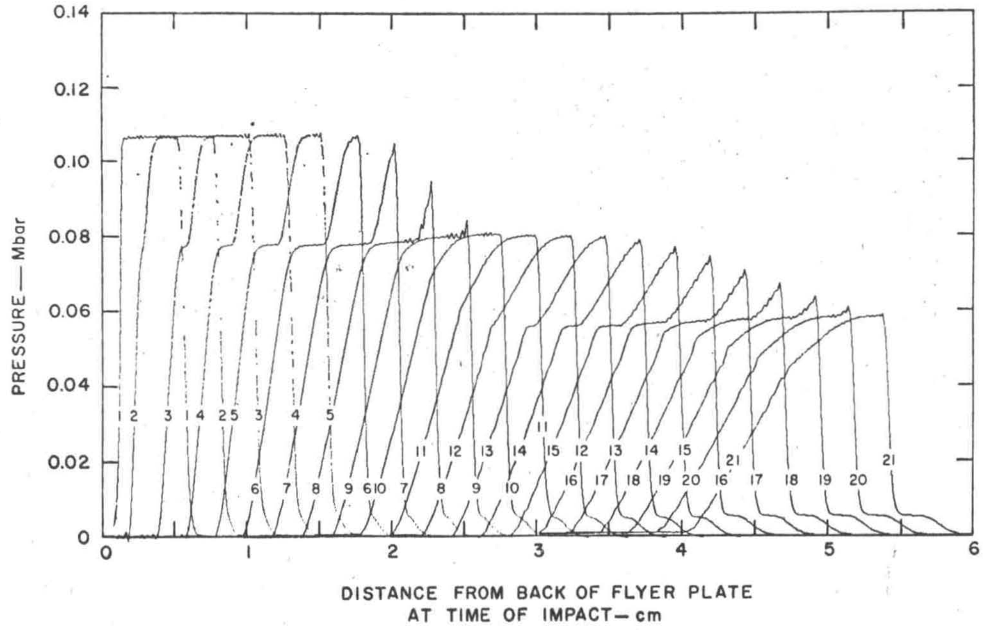

FIG. 8. Profiles of stress for aluminum projectile hitting an aluminum target (projectile thickness 0.322 cm, projectile velocity 0.125 cm/μsec).

hydrostat. Using Eq. (3) then gives

$$c=\left\{\frac{3(1-\nu)}{(1+\nu)}\left[\frac{d\sigma}{d\rho}-\frac{2}{3}\frac{dY}{d\rho}\right]\right\}^{\frac{1}{2}}, \tag{8}$$

so that the elastic sound speed computed from Hugoniot data depends on both ν and Y. This is the speed of sound in the shocked material and is associated with the head of the rarefaction wave BM shown in Fig. 7. The actual velocity of this wave is $u+c$, where u is the particle velocity in the shocked region. For flyer-plate experiments, the particle velocity is determined either by measuring the free-surface velocity of a thin target or by measuring the flyer plate velocity. The latter is more desirable in principle because u is exactly one-half the flyer-plate velocity, while it is only approximately one-half the free-surface velocity.[9] When the particle velocity has been determined, the sound speed is obtained from[11]

$$c=(U-u)[(x+x_0)/(x-x_0)], \tag{9}$$

where x_0 is the thickness of the flyer plate, x is the physical coordinate of the point M in Fig. 7, and U is the velocity of the shock front. Because u is known, U is determined from the Hugoniot relations. Equations (8) and (9) are important links between experimental observations and the theory.

Combining Eqs. (3) and (7) gives

$$\sigma_e-\sigma_f=[(1-\nu)/(1-2\nu)](Y_e+Y_f), \tag{10}$$

where the subscripts refer to the points e and f in Fig. 6 and Y is the yield stress. For $\nu=\frac{1}{3}$, and if Y does not depend strongly on the strain, the usual result,

$$\sigma_e-\sigma_f=4Y, \tag{11}$$

is obtained.

[11] G. R. Fowles, J. Appl. Phys. 31, 655 (1960).

Some results typical of those obtained with the constant ν model and the Q-code are given in Fig. 8. These results are for the case of an aluminum projectile 0.322 cm thick hitting a semi-infinite target. The pressure vs distance profiles are given at intervals of $\frac{1}{2}$ μsec following projectile impact. The parameters given in column 2 of Table II were used in the elastoplastic stress–strain relations. In Fig. 8, the elastic relief wave reduces the amplitude of the pressure wave by about 30 kbar. Similar profiles of the particle velocity can be obtained from the calculations. Figure 9 shows only the envelope of such particle velocity profiles, along with the results of the characteristic code used with Eq. (1). Comparison of the two sets of results shows the early attenuation which results when the elastoplastic stress–strain relations are used. Experimental results from two previously reported experiments are included in the figure.[3]

B. Arbitrary Shear-Modulus Model

It is not necessary to keep the value of Poisson's ratio constant. If ν is permitted to increase with stress the shear modulus changes with stress in a different way from that used in the earlier calculations [see

TABLE II. Values of parameters for constant ν stress–strain relations for aluminum.

Parameters	Variable-yield model	Constant-yield model	Fluid model
Y (Mbar)	0.0025	0.0025	0.0
M	0.055	0.0	0.0
ρ_0 (g/cc)	2.785	2.785	2.785
A (Mbar)	0.755	0.743	0.765
B (Mbar)	1.29	1.74	1.66
C (Mbar)	1.197	0.329	0.428