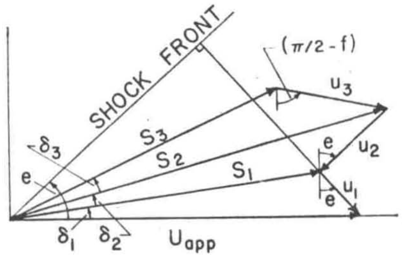

FIG. 3. Two-dimensional flow diagram for incident and reflected elastic shocks. Shock incidence and reflection results in streamlines S_1, S_2, and S_3 giving a surface rotation $\delta_1+\delta_2+\delta_3$.

velocity[8] as

$$u_2^2=(A_2/A_1)^2u_1^2, \tag{5}$$

and

$$u_3^2=(B_2/A_1)^2(\phi/\Psi)u_1^2. \tag{6}$$

A_2/A_1 is the amplitude ratio of the reflected compressional wave to the incident compressional wave. B_2/A_1 is the amplitude ratio of the reflected shear wave to the incident compressional wave. C_p and C_s are velocities for the compressional and shear waves respectively in

$$\phi[(U_{app}^2/C_p^2)-1]^{1/2}=\tan(\pi/2-e), \tag{7}$$

and

$$\Psi=[(U_{app}^2/C_s^2)-1]^{1/2}=\tan(\pi/2-f). \tag{8}$$

The angle e is the angle between the free-surface and the incident compressional wave. The angle f is the angle between the free-surface and the reflected shear wave. The amplitude ratios are

$$\frac{A_2}{A_1}=\frac{4\mu\phi\Psi-(\Psi^2-1)[\lambda+\phi^2(\lambda+2\mu)]}{4\mu\phi\Psi+(\Psi^2-1)[\lambda+\phi^2(\lambda+2\mu)]} \tag{9}$$

and

$$\frac{B_2}{A_1}=\frac{-4\mu\phi[\lambda+\phi^2(\lambda+2\mu)]}{4\mu^2\phi\Psi+(\Psi^2-1)[\lambda+\phi^2(\lambda+2\mu)]}, \tag{10}$$

where λ and μ are Lame′ constants.

The optical lever deflection can be related to the particle velocity $\mathbf{u}_1$ by extending the flow diagram of a hydrodynamic shock described in Ahrens and Gregson. This extension (see Fig. 3) will not depend upon the usual approximation that the free-surface velocity is twice the particle velocity. Instead, the optical lever deflection is equated to the surface rotations produced by each of the three shocks

$$1/2ad^{-1}=\delta_1+\delta_2+\delta_3, \tag{11}$$

where δ_1, δ_2, and δ_3 are the rotations associated with the incident compressional shock, the reflected dilatational shock, and the reflected shear stress shock respectively.

[8] W. M. Ewing, W. S. Jardetzky, and F. Press, *Elastic Waves in Layered Media* (McGraw-Hill Book Company, Inc., New York, 1957), Chap. 2, Sec. 2-1.

From the geometry of Fig. 3,

$$\delta_1=\tan^{-1}[u_1\cos e/(U_{app}-u_1\sin e)]. \tag{12}$$

The surface rotation of the reflected compressional rarefaction is

$$\delta_2=\tan^{-1}\{u_2\cos(e+\delta_1)/[S_1-u_2\sin(e+\delta_1)]\}, \tag{13}$$

where the streamline $\mathbf{S}_1$ has a magnitude

$$S_1=[(U_{app}-u_1\sin e)/\cos\delta_1]. \tag{14}$$

The surface rotation of the reflected shear stress rarefaction is

$$\delta_3=\tan^{-1}\left[\frac{u_3\cos(\pi/2-f-\delta_1-\delta_2)}{S_2-u_3\sin(\pi/2-f-\delta_1-\delta_2)}\right], \tag{15}$$

where the streamline $\mathbf{S}_2$ has a magnitude

$$S_2=\{[S_1+u_2\sin(e+\delta_1)]/\cos\delta_2\}. \tag{16}$$

Equations (5) to (16) are used in a digital computer program to find values of u_1, the incident compressional shock particle velocity. The necessary elastic wave velocities, material constants, and apparent velocity are used to calculate the amplitude ratios relating particle velocities u_2 and u_3 to u_1. Values of u_1 are selected and used in Eqs. (12) to (16) until Eq. (11) is valid to the numerical precision required in the experiment. Such values are 5% to 10% less than particle velocities computed by the free-surface approximation.

An additional feature to consider in this experiment that does not concern a plane wave or a two-dimensional steady-state experiment is an impact off the optic axis of the optical lever alignment. Figure 4 illustrates the geometry of this case. Assume an off-axis impact

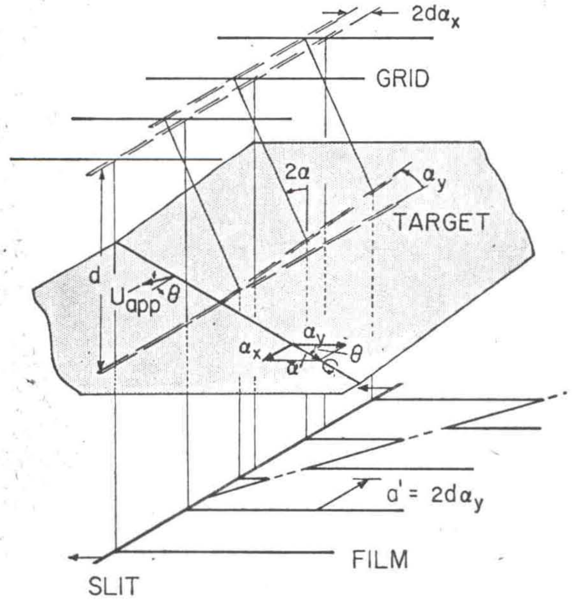

FIG. 4. Geometry of an off-axis impact.