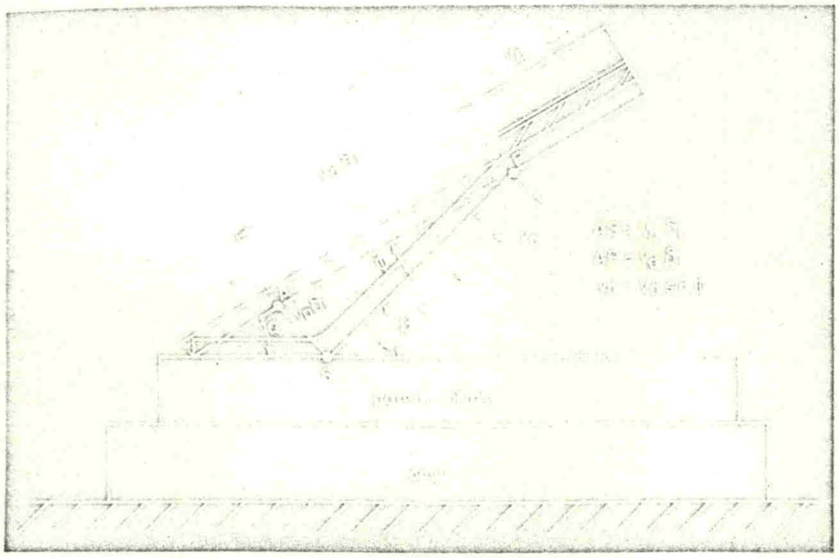
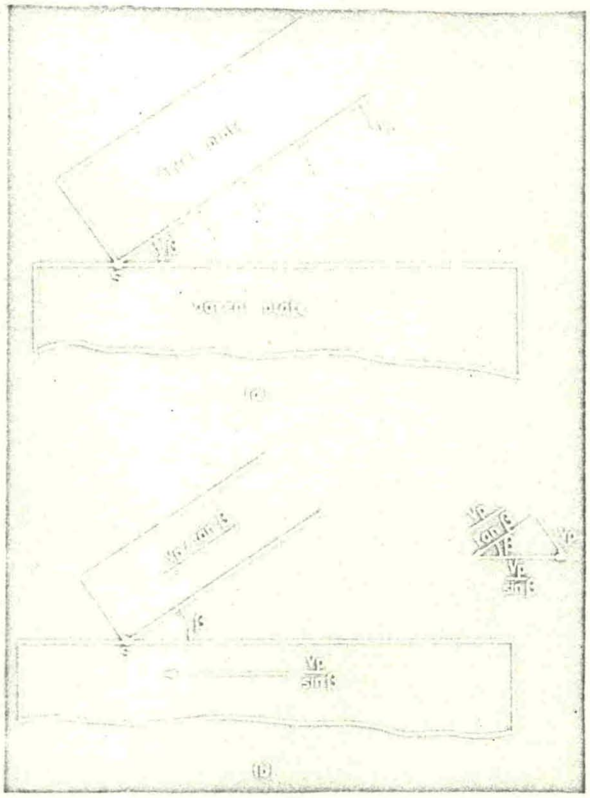


△

3 Mode of collapse of flyer plate



4 Change of co-ordinates for impacting plates. (a) Initial state; (b) change of co-ordinates.

Fig. 3 to rest and to do this it is necessary to apply a backward velocity of $V_P/\sin\beta$ to the parent plate, as shown in Fig. 4. If this backward velocity is applied to the system, then the velocity of the flyer plate is $V_P/\tan\beta$ towards S. Thus, the system becomes equivalent to a liquid jet of velocity $V_P/\tan\beta$ impinging a stream travelling at a velocity $V_P/\sin\beta$ at an angle of incidence of β. The liquid jet impinging the stream at S is deflected into a horizontal direction, still travelling at the same velocity, but this implies that the conservation of momentum in the horizontal plane has not been satisfied. Consequently, it must be concluded that the jet divides into salient and re-entrant jets, as shown in Fig. 5.

Applying the conservation of momentum gives

$$m\frac{V_P}{\tan\beta}\cos\beta = m_s\frac{V_P}{\tan\beta} - m_r\frac{V_P}{\tan\beta}$$

or

$$m\cos\beta = m_s - m_r \qquad \ldots [2]$$

Conservation of mass dictates that

$$m = m_s + m_r \qquad \ldots [3]$$

From equations [2] and [3]

$$m_r = \frac{m}{2}(1 - \cos\beta) \qquad \ldots [4]$$

$$m_s = \frac{m}{2}(1 + \cos\beta) \qquad \ldots [5]$$

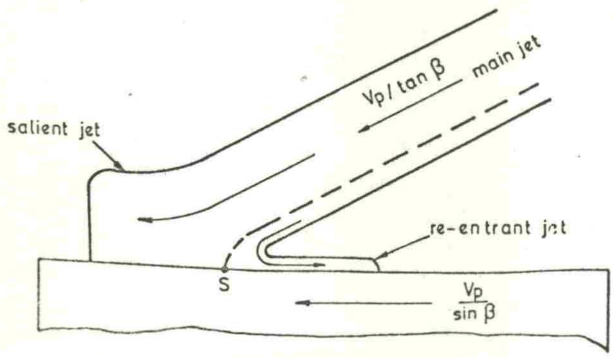
and the absolute velocity of the re-entrant jet will be

$$\frac{V_P}{\tan\beta} + \frac{V_P}{\sin\beta} = \frac{V_P}{\sin\beta}(1 + \cos\beta) \qquad \ldots [6]$$

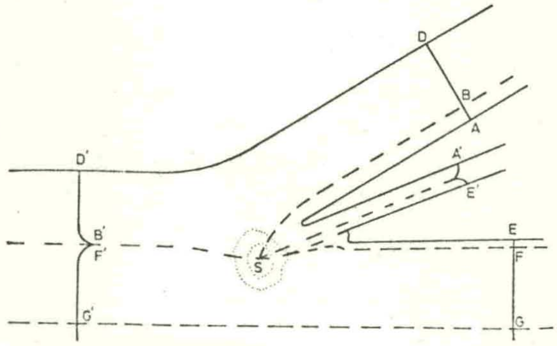
The analysis is of course strictly applicable only when the velocities of the flyer and parent plates relative to S are less than the velocity of sound in the materials of the two plates, as it ignores compressibility effects.

Walsh, Shreffler, and Willig[27] considered the case where the velocity of the main jet, $V_P/\tan\beta$, is supersonic by using compressible flow theory. If the main jet velocity substantially exceeds the sonic velocity, then attached shock waves in the flyer and parent plates will travel with the point of impact S and no re-entrant jet is produced. For a main jet velocity that is not substantially greater than the sonic velocity, there is a critical angle above which the shock wave becomes detached from point S and moves upstream so that the pressure is felt in front of the point of impact, and in these circumstances a jet can be formed.

The existence of a jet in explosive welding has been hotly argued, but its existence has been confirmed by Holtzman and Cowan,[21] who employed flash X-ray to



5 Formation of salient and re-entrant jet.



6 Flow configuration in the region of collision.