CHAPTER 2

EXPERIMENTAL CONCEPTS

In this chapter a number of relations are given for converting experimental data into more useful forms. Sections deal with basic relations, wave propagation, and free surface velocity measurements.

2.1. Basic Relations

The equations for plane one-dimensional flow, independent of material properties, are:

$$\frac{\partial \rho}{\partial t} + \frac{\partial \rho u}{\partial x} = 0 \ , \qquad (2.1)$$

$$\rho \frac{du}{dt} \equiv \rho \frac{\partial u}{\partial t} + \rho u \frac{\partial u}{\partial x} = - \frac{\partial P}{\partial x} \ , \qquad (2.2)$$

$$\frac{dE}{dt} = -P \frac{dV}{dt} \quad \text{and} \quad V = \frac{1}{\rho} \ , \qquad (2.3)$$

where t is time, x is Eulerian space coordinate, V is specific volume, u is mass velocity, E is specific internal energy, and P is stress in the x direction, positive in compression. Thermal conductivity is assumed to be negligible.

For steady waves the flow equations lead to the following jump conditions for a shock discontinuity:

$$\rho_2(U_2-u_2) = \rho_1(U_2-u_1) \ , \tag{2.4}$$

$$P_2 - P_1 = \rho_1(U_2-u_1)(u_2-u_1) \ , \tag{2.5}$$

$$E_2 - E_1 = \frac{1}{2}(P_2+P_1)(V_1-V_2) \ , \tag{2.6}$$

where U_2 is shock velocity. Subscript 2 is for the state behind the shock front while subscript 1 is for the state ahead of the shock. Density at room temperature and atmospheric pressure is given by ρ_0. The measurement of any two parameters of the set (P,V,E,U_2,u) for known conditions ahead of the shock is sufficient to determine the other three. The two measured parameters for this work are shock velocity and change in free surface velocity, which is assumed to be twice the change in particle velocity; i.e.,

$$\Delta u_{fs} = 2\Delta u \ . \tag{2.7}$$

Walsh, <u>et al.</u>[37] have shown that particle velocity obtained from Eq. (2.7) is accurate to 1 percent for a single shock in iron with final stress of 400 kbar.

Free surface velocity produced by reflection of a shock from an unconfined surface is the sum of particle velocities produced by the shock, u, and by the reflected rarefaction, u_r, respectively; i.e.,

$$u_{fs} = u + u_r \ . \tag{2.8}$$