using the Eyring curved front theory, the reaction zone length is usually assumed to be unaffected by the change in detonation velocity. Since the method provides no information on the reaction zone length for a single value of the diameter, some such arbitrary assumption is necessary.

Explosives Studied

The explosive selected for systematic study by the method described was a mixture of 80% AN and 20% TNT. A two-component mixture was chosen because it was felt the effective reaction time in this type of material could be adjusted to fall in a convenient range for experimental observation. This expectation was based on the fact that over half the total energy release in 80/20 AN/TNT is derived from the mixing and interaction of the products of the decomposition of the separate components.[8] If the particle size of one component is much larger than that of the other, the mixing process will be dependent on the particle size of the component with the larger size. In the work reported here, the particle size of the major component AN was varied over a range of diameters (0.006–0.12 cm) which was very large compared to the constant size of the TNT particles (2–5μ). In these experiments, it is likely that the rate of decomposition of the TNT was so fast that it could not be resolved by the experimental technique. The measured values of pressure and density just behind the detonation front thus probably do not correspond to compressed unreacted explosive but rather to a compressed mixture in which much of the TNT has already reacted.

TABLE I. Ammonium nitrate particle sizes used in this study. (TNT particle size was approximately 2–5μ in all cases.)

Mix	Ammonium Nitrate Particle Diameter (cm)	Detonation Velocity (mm/μsec)
0	0.0053–0.0061	4.43
A	0.0124–0.0149	4.15
B	0.0297–0.0350	3.98
C	0.0419–0.0500	3.82
D	0.0589–0.0711	3.67
E	0.0711–0.0833	3.38
F	0.0833–0.1001	2.83
G	0.1001–0.1191	2.67

The TNT was prepared by a proprietary process from commercial material. The AN was prepared from commercial material by drying and double screening. The cells were loaded by vibrator packing the measured weight of material into the known cell volume. The mix designations are listed in Table I.

Experimental Results

The results [pressure P, density ρ, flow velocity q, and $(dP/d\rho)^{\frac{1}{2}}$] obtained by the grid reflection technique and the one-dimensional channel flow analysis on two of the eight mixes for $\frac{1}{2}$-in.-thick layers of explosive confined by $\frac{1}{4}$ in. stainless-steel plates are shown in Fig. 7. For comparison of the different mixes, the curves of P versus S are shown in Fig. 8,

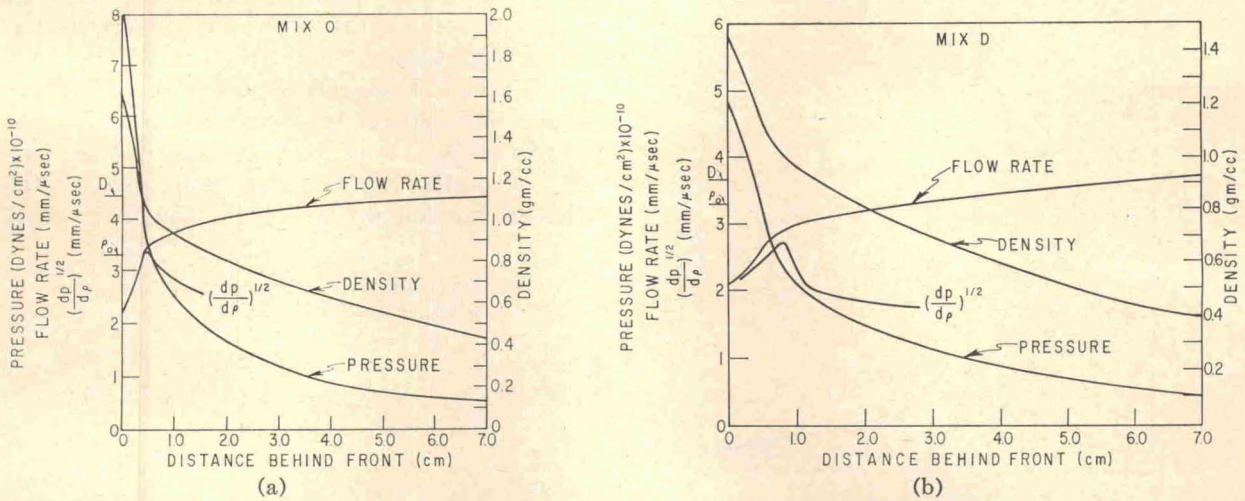

FIG. 7. Pressure, density, flow rate, and the derived quantity $(dp/d\rho)^{\frac{1}{2}}$ versus distance behind the detonation front for two of the mixes studied (see Table I).

[8] Reference 7, p. 307.

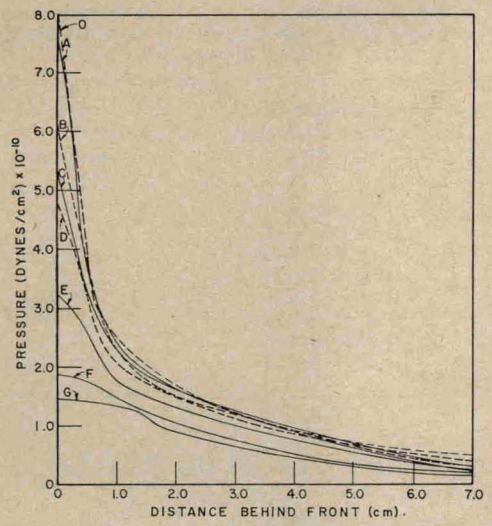

FIG. 8. Summary of pressure versus distance for all experiments in the large cells. Mix designations are indicated for each case.

and the curves of P versus specific volume V are shown in Fig. 9. Values of the effective reaction time t obtained by integrating Eq. 14 from the detonation front to the position of maximum $(dP/d\rho)^{\frac{1}{2}}$ are shown versus particle diameter d, of the AN in Fig. 10. t was found to vary with both particle diameter and "cell size" (explosive thickness and confining plate thickness changed by the same factor, 0.444). The heavy curve drawn through the horizontal bars (indicating the AN particle size range) shows a complex relation of effective reaction time to AN particle size for a fixed cell size. The circles

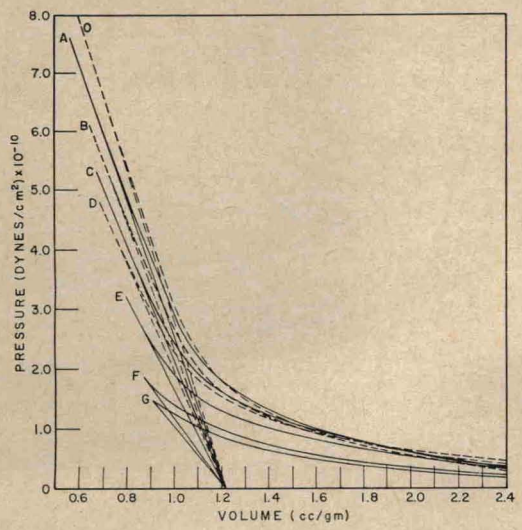

FIG. 9. Pressure versus specific volume for all experiments in the large cells. Rayleigh lines connect the state just behind the front to the initial (uncompressed) volume.

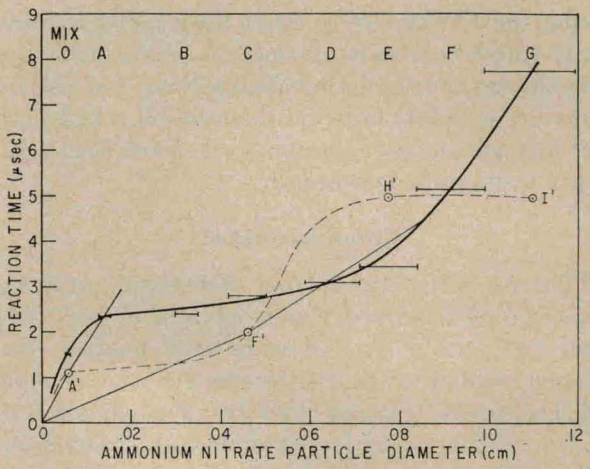

FIG. 10. Reaction time versus ammonium nitrate particle diameter. The horizontal bar lines represent the particle size ranges of the experiments in the large cells ($\frac{1}{2}$-in.-wide explosive layer) and the corresponding reaction times. The circled points indicate the reaction times for the scale shots at the average value of particle size. Straight lines have been used to connect the origin to the points on the scale shots and from the scaled points to the points on the large cell curve where the reaction time is in scale (1/0.444) with that of the smaller cells. The dashed line represents the probable shape of the reaction time curve for the smaller cells on the assumption that the observed scaling holds over the entire range of particle diameters.

indicate shots made with the smaller cell size, and the tie lines through two of these points connect them to points on the curve for the larger cell size where the reaction time is increased over the scale shot by the same factor as the cell size. It was found that the detonation velocities for the scale shots were within experimental error of the interpolated detonation velocities of the large shots (Tables I and II). As noted earlier, this indicates that only the time scale and not the form of the reaction varies in the scaled shots.

The amount of reaction occurring in the effective reaction zone between the detonation front and the peak of $(dP/d\rho)^{\frac{1}{2}}$ apparently decreases as the particle size of the AN increases. Some idea of the extent of reaction would be very helpful in inter-

TABLE II. Summary of results of scale shots.

Shot Designation	Detonation Velocity (mm/μsec)	"Full-Scale" Detonation Velocity[a] (mm/μsec)
A'	4.15	4.13
F'	3.17	3.12
H'	2.48	...
I'	1.97	...

[a] Interpolated detonation velocity of full size shot at that particle size for which the reaction time was increased by the scale factor 1/0.444.