EFFECT OF VALVE OPENING TIME ON GAS GUN PERFORMANCE

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In the design of a light gas gun to propel projectiles at very high velocities for impact and shock studies some controllable diaphragm or valve mechanism is required to release high pressure gas from the breech and introduce it into the barrel containing the projectile. The opening time of such a mechanism is expected to have an important effect on the acceleration of the projectile. A one-dimensional machine calculation was written to estimate the effect of opening times ranging from 1 to 50 milliseconds for a particular set of initial conditions described below.

A conical orifice was chosen to represent the valve mechanism for the calculations. Figure 1 shows the general shape of this orifice and its relation to the other parts of the gun. The solid lines represent the orifice in closed position at the start of each computation and the dashed lines represent the orifice in its fully open configuration after the elapse of some prescribed opening time. In each case the orifice opened such that its

cross-section at any point increased linearly with time until it reached the fully open position.

Figure 2 is a plot of projectile velocity versus projectile position in the barrel for opening times of 1, 10, and 50 milliseconds derived from these calculations. For programming convenience the initial position of the 500 gm projectile, $x = 0$, was placed at the center of the orifice. Helium gas under initial pressure of 6000 psi at $300^{o}K$ with a total mass of 3.55 times the projectile mass was chosen for this computation. The ratio of breech to barrel diameter was 2.25, the orifice length was 36 cm and the barrel diameter was 10.16 cm.

As expected for these initial conditions, the projectile velocity at any point down the barrel is strongly dependent on the opening time of the orifice. This means that careful attention to the design of such a valving mechanism is important and suggests that opening times of the order of less than 10 milliseconds are required in this case if serious limits on the projectile velocities are not to be imposed by such a device.

GAS GUN SCHEMATIC

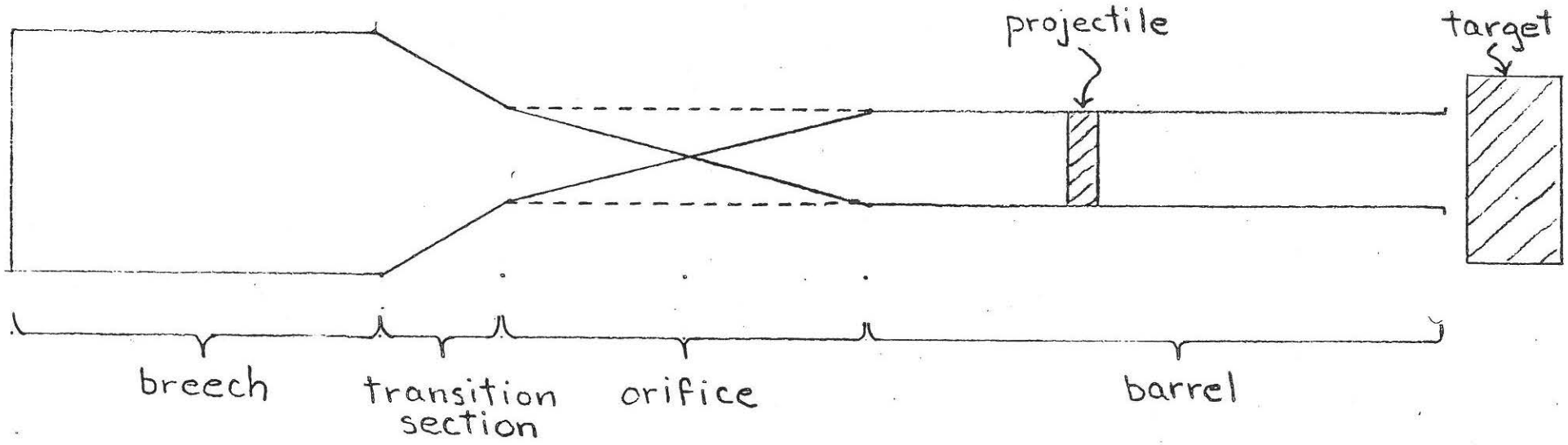

Figure 1

FIGURE 2