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TERMINAL OBSERVATIONS PROGRAM, PROGRESS REPORT TO APRIL 15, 1944

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A. MOMENTUM STUDIES

The previous series of shots (Progress Report March 29), made to study effect of air-gap on momentum transfer from H. E. to target, was subject to systematic experimental error, in that the slabs of H. E. were backed by steel plates whose inertia was greater than that of the projectile. Under such conditions, the air-gap would be expected to have little effect - as was actually found. Moreover, this arrangement does not simulate gadget conditions, where a relatively thin case is envisaged. The series has been repeated with a light frame support for the H. E. charge, made of 3/4" thick wood stock. The charges were slightly modified, consisting of circular slabs 6" in diameter, instead of 4" x 8" rectangles. The slab thickness was maintained at 1/2", and the projectiles were again 10 kilo. steel cylinders, 4" in diameter and 6" high. Results for the two cases are given in the appended graph. It is seen that while the total flight time is markedly decreased by lightening the H. E. backing, the fractional change in momentum is still a slow function of the air gap thickness.

B. SLAB SHOTS

The effect of air and cork spacers on plate damage due to detonation wave interaction has been studied. The criterion of shock was taken to be the area of Neumann banding (Progress Report, March 29). It was found that with an air-gap of 1/4" and a 1/2" thick H. E. slab, the banding under the line of intersection of the waves is indistinguishable in the region of general banding at the top of the test plate. On the other hand, cork spacers (sheets interposed between H. E. slab and plate) proved very ineffective in shielding the plate from shock. The shots with air-gap were made with two-point initiation at one end of the slab, to study at the same time the effect of changing angle on wave interaction (see again, previous report). A slot 1/16" wide and 1/32" deep was milled across the middle of the plate to help determine the location of the fragments with reference to the detonation points. The fragments were sectioned transversely at different lengths along the plate and etched. As was found previously, the violence of the interaction decreases with increasing angle of intersection of the wave fronts. Further details are given in a report of Walter Kauzmann, April 10, 1944.

C. TERMINAL OBSERVATIONS

Work is now being directed mainly toward overcoming the effects of wave interaction.

1. **Air-gaps:** The experiments on slabs have been extended to spheres on the 3" scale, using 1/4" air-gaps with 3/4" of cork-pentolite mixture #21 (50/50 pentolite - 10 percent cork retained on 60 mesh - 3 percent cork finer than 170 mesh).

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(a) Preparation of shots: Charges were made in a 3-section hemispherical mould designed for tamping, in which the sections were made thinner toward the poles. A face-plate was fitted to the mould, permitting tamping from the poles and providing a smooth face at the equator, without cutting or scraping of the charge. Castings were much more uniform than those made previously, with moulds designed for pouring, and the hemispheres fitted together more closely. The gaps were made by casting around a 3 1/2" diameter lead hemisphere, removing the form, and supporting the 3" steel sphere within the cast by six 1/4" cork cubes. All spheres were 1/2" wall, since the 1/4" wall spheres fragmented under the charges used.

(b) Results with one-point initiation: The effect on the sphere in the region opposite the booster is much more violent in the air-gap case than when a solid charge is used. Fig. 1 presents a comparison between the two shots, one with gap made as described above (#147), and one in which the charge was 1" thick, without gap (#153).

Fig. 2 shows the general appearance of the blast wave in an air-gap between a shell of H. E. and a metal target. The angle at which the blast front strikes the target is $\alpha = \tan^{-1} V_B/V_D$ where V_B = blast velocity and V_D = detonation velocity. For a thin gap, V_B is roughly constant, and $\sim V_D$, whence $\alpha \sim 45^\circ$. The situation at the point opposite the booster is shown in Fig. 3. It is seen that the air-blast pattern is similar to that developed by an unlined cavity charge. The essential difference introduced with the air-gap thus appears to be the formation in the gap of a Munroe jet, directed toward the sphere. Such a jet is, of course, absent when a solid charge is used.

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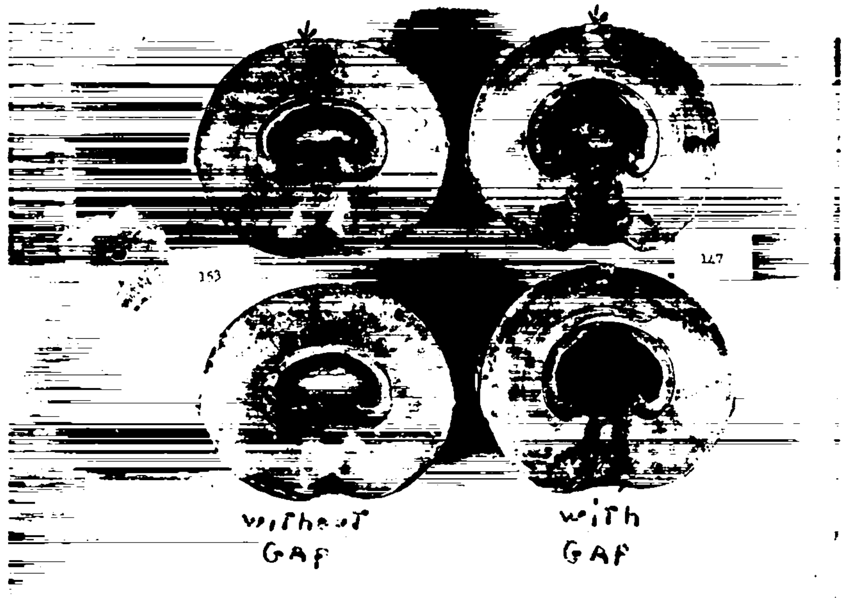

Fig. 1 It is probable that the difference is due to a simulated Munroe effect, developed as follows:

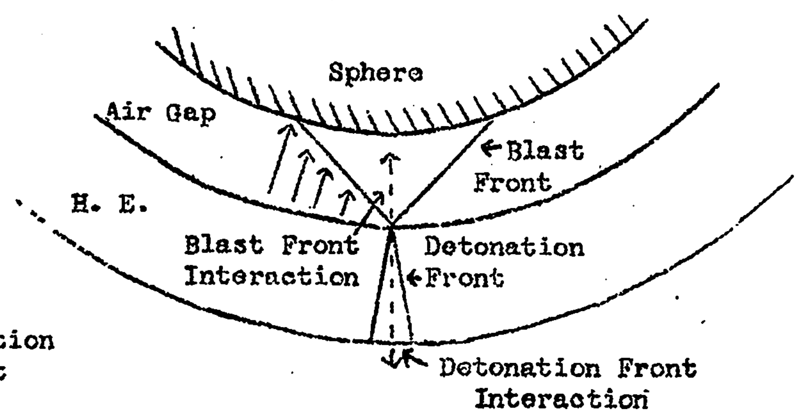

Fig. 3

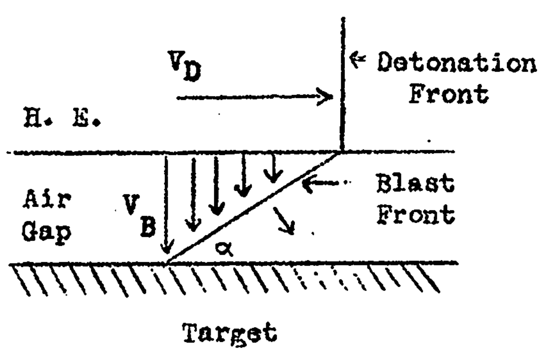

Fig. 2

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In the light of the foregoing remarks, it is hard to see why the slab tests apparently gave such marked improvement. However, some moderating effect might be expected from the divergence of the waves in the slab case. Thus, the Munroe jets at the line of wave interaction in the slab (Fig. 4) move outward from the center instead of converging toward a point.

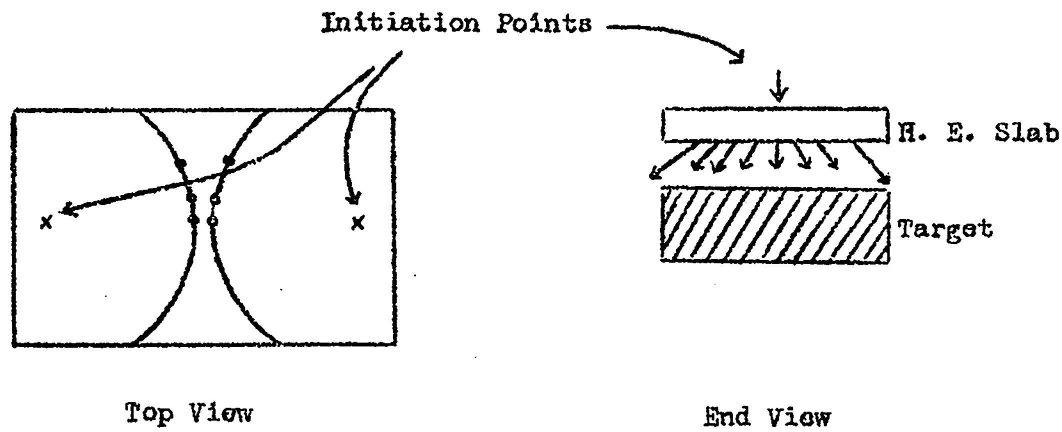

Figure 4

(c) Results with 2-point initiation: Strong interaction effects are observed in this case also. However, the effect seems to be distributed over a somewhat broader region on the sphere with air-gap than without. Comparison between the two cases is difficult, because the 1/2" spheres used were fragmented (1" thickness of Mixture #21) while the air-gap shots, made with 3/4" cork mixture, remained constant.

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2. <u>Jets:</u> The complete history of jet formation in spheres imploded with 2-point initiation is now available and confirms the mechanism previously surmised. Fig. 5 shows three stages in the process.

<u>Fig. 5</u>

Shots #148 and #163 were made in connection with section 1c above, using 3/4" cork charges, 2-point initiation, and 1/4" air-gap. Shot #42 was fired with 1/2" of pentolite and no gap. It is clear that the steps in jet formation are as follows:

(a) Building up of high pressure in plane halfway between boosters.

(b) Extra flow of metal in this plane, so that walls meet along line connecting two boosters.

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(c) Squirting of metal backward towards initiation points. It appears that the hole at each end of the line of intersection may not be entirely due to erosion by the jet, but in large part is a residual space, left by the unequal flow.

3. Tracers: Solid bronze and stainless steel balls have been received and are being tested. The range of terminal observations can be somewhat extended using bronze (up to 3/4" pentolite on 1/2" wall, 3" sphere). Although the balls are somewhat brittle, they are more resistant than the hollow copper spheres plugged with solder that have been used hitherto.

4. Thick charges - multiple point initiation: Experiments along these lines seem to be the most direct and straightforward attack on the main implosion problem. The highest thickness ratio yet fired has been 1" of cork-pentolite on a 1/2" wall, 3" OD sphere. When initiated at 6 points, the fragments showed excellent radial flow and little evidence of jets.

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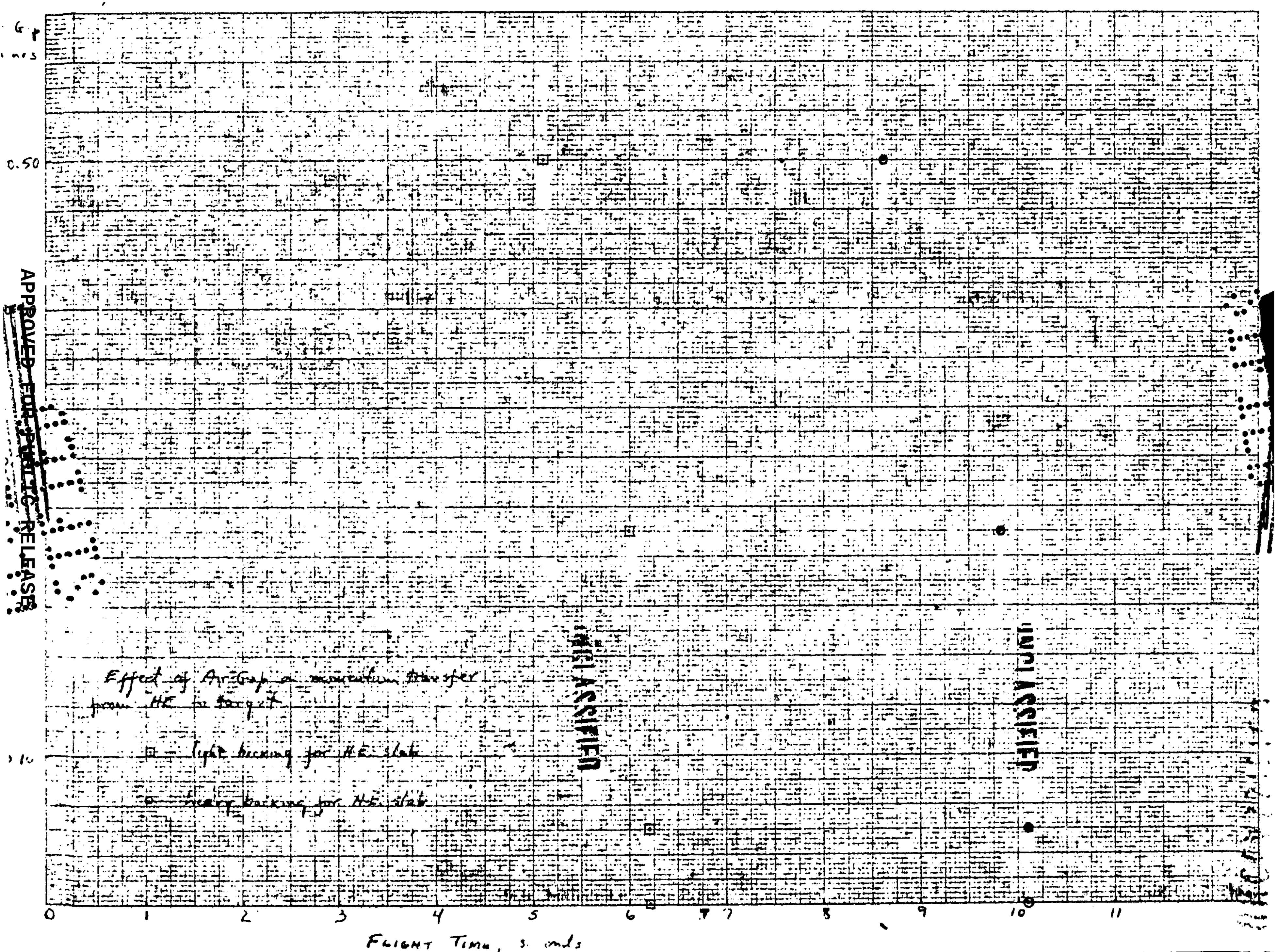
0.50
Effect of Air Gap on momentum transfer from HE to target
□ — light backing for H.E. slab
○ — heavy backing for H.E. slab
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Flight Time, seconds

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