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# VELOCITY INTERFEROMETER DEVELOPMENT

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DEVELOPMENT DIVISION

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*Normal Process Development*
*Endeavor No. 234*



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The purpose of this project is to develop the velocity interferometer method into a working technique for measuring the velocity history of shock loaded materials.



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Section II

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ABSTRACT

The results of four test firings with the interferometer are reported. No satisfactory signal has yet been obtained because of difficulties controlling the position and reflectivity of the specimen's mirrored surfaced. Plans for correcting these problems are presented.

DISCUSSION

Four test shots employing three different types of explosive and mirror assemblies have been made with the velocity interferometer. These followed several delays encountered replacing a piece of equipment and making further modifications to the "boom box" as described in the previous report. All test results obtained to date have been negative.

The first test used an internal mirror in Plexiglas made by evaporating aluminum onto a polished Plexiglas surface then cementing another polished piece over the mirror. This was done in hopes of eliminating spalling which would be associated with a free surface reflector, as well as providing a direct measurement of the particle velocity, independent of the free surface approximation. The driver used with this specimen was a 1/4-inch x 1/2-inch PBX 9407 pellet ignited with an EX-12B detonator. The delay leg of the interferometer was set at 69.6 cm giving a velocity per fringe constant equal to 0.136 mm/μsec per fringe. This should have provided approximately three fringes at an estimated pressure of 20 kbar at the mirror.

Instead, the photomultiplier signal decayed in a very fast, approximately exponential manner the instant the shock wave reached the mirror. Nearly complete turn-off was accomplished in less than 0.1 μsec with no information visible on the decaying signal. The mirror apparently either lost its reflectivity or tilted and deflected the laser beam out of alignment with the interferometer.

The very fast turn-off of the photomultiplier signal made the effect of tilt seem to be the most likely source of the difficulty. Therefore, two similar shots were built in which the 9407 pellet was replaced by a P-16 plane wave lens. Ideally, an even larger lens would be employed but the necessity of using a "boom box" to stabilize the shot limits the amount of explosive which may be used. It is felt that the P-16 is an upper limit for this box. One shot had an internal mirror as described above; the other had the mirror on a free surface with a greater thickness of Plexiglas (28.6 mm) between the driver and this surface to provide additional attenuation of the shock wave. Hopefully, this would increase the lifetime of the reflective film. The results, however, were much the same as before. In fact, the only significant difference was a pulse from the photomultiplier apparently representing light picked up from the detonation products. This pulse had a risetime of 0.5 μsec and a duration of 2.5 μsec—considerably shorter than would be expected from such a driver. But it was definitely not associated with the interferometer signal due to motion of the mirror as it arrived at least 3.5 μsec before the shock wave could have reached that point. This light would not have been picked up from the first shot using the 1/2-inch diameter pellet because the mirror completely covered the pellet as seen from the interferometer. The P-16 lens extended beyond the edges of the mirror and light from it could therefore travel directly to the photomultiplier tube. Obviously, precautions will have to be taken, in addition to the band pass filter used on the photomultiplier tube, to prevent this light from interfering with the desired signal.

One further test was made with a polished magnesium disc replacing the aluminized Plexiglas. The disc, 6 mm thick, was placed directly against the P-16 lens with no attenuating material between. A much better interference pattern was obtained with this mirror than was possible with the aluminized Plexiglas mirrors. More consideration will apparently have to be given to the optical quality of the mirror on future work. This had no effect on the results, however, which were again negative. The record was identical to the previous two shots with the exception that the pulse attributed to the explosive flash was missing. This was expected since the magnesium disc was of a larger diameter than the P-16 and therefore completely covered it.

## FUTURE WORK; COMMENTS; CONCLUSIONS

Difficulties had been anticipated with mirror tilt when explosive drivers were used with the velocity interferometer since all earlier work had been done with gas guns, and although they are intrinsically less susceptible to tilt than an explosive system, precautions still had to be taken to minimize its effects. Now, the negative results of four consecutive tests indicate the problems may be even more severe than expected. These difficulties have been discussed with a representative from a company which manufactures a velocity interferometer of the same basic design as the unit built here. Tests have now been made, under the company's direction, on the interferometer using explosive drivers and considerable difficulity with tilting of the mirror was reported. However, the technique has been made to work and the following suggestions were offered by the company:

1. *Use no aperture on the photomultiplier window. Instead, isolate the zeroth order fringe by expanding the interference pattern until this fringe fills the window.*

2. *Use short focal length lenses (about 75 mm) to focus the laser beam onto the specimen and to recollimate it upon reflection.*

3. *Provide the largest possible aperture through the interferometer.*

The first two suggestions can be implemented with little difficulty and will be tried soon; the third would require replacement of all the interferometer optics and therefore is not contemplated now. Also, an attempt will be made to emperically determine the maximum tilt of the reflecting surface which the interferometer can accommodate by using a mirror mounting with precision angular control.