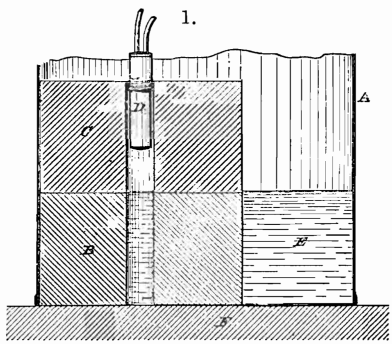
ART. V.—*Wave-like effects produced by the Detonation of Gun-cotton;* by CHARLES E. MUNROE. With Plate IV.

HAVING had occasion recently to determine how readily gun-cotton which was completely saturated with water could be detonated, I employed for the purpose a tin can, with a smooth flat bottom to hold the gun-cotton disk and then filled the can with sufficient water to just completely cover the disk. A paraffined dry disk of gun-cotton, to serve as a primer, was then laid directly on top of and in contact with the wet disk, and a detonator containing thirty-five grains of mercury fulminate was inserted in the primer for the purpose of firing it.

The arrangement is shown in fig. 1, where *A* represents the can, *B* the disk of wet gun-cotton, *C* the disk of dry gun-cotton, *D* the detonator, *E* the water and *F* the iron beam on which it rested. The gun-cotton disks had a diameter of 3½ inches each, while the can had a diameter of 5½ inches and, as the gun-cotton disks were placed with their cylindrical axes parallel to that of the can and with one face in contact with the side of the can, there was a crescent-shaped space about the gun-cotton at the bottom of the can, two inches wide at its greatest width, which was covered by water only.




The can, with its contents arranged as described, was placed on the smooth face of a heavy wrought iron beam and detonated. The effect produced on the iron is shown in fig. 2 (Plate IV), which is reproduced from a photograph of such pieces of the fractured beam as were recovered. Inspection of the impressed surface shows a comparatively smooth and deep indentation immediately under the place occupied by the gun-cotton, which has an area nearly equal to that of the base of the gun-cotton disk. Surrounding this is a crescent-shaped space, about five-eighths of an inch wide at its greatest width, which appears slightly undulating when examined by a low-powered lens, and then follows a series of breakers, concentrically arranged about the impression of the base of the gun-cotton disk, which are plainly visible to the naked eye. These breakers appear to consist of lines of waves which are undulating in paths nearly normal to the direction of propagation of the breakers, while the breakers or lines of waves appear to be divided pretty sharply into two groups of different amplitudes, the exterior group having the greatest amplitude. In all cases the crests of the waves are turned from the center, so that if the hand is passed from the center outward over the plate it glides freely, but if passed in the opposite direction it is caught by the sharp projecting points. This feature can easily be seen with a pocket lens.

The impression produced is shown in section in fig. 3 where *AE* represents the extreme area having a diameter slightly greater than that of the can. *B* the position of the wet gun-cotton disk before detonation. *B′B′* the impression produced by the base of the disks. *B′C* the space where the waves are not visible to the naked eye. *CD* and *DA* the spaces occupied by the two groups of breakers visible to the naked eye. *B′E* represents the eroded and fused metal which marks the most deeply indented part of the plate. The cross-section of the beam *F* shows very clearly that the area of marked depression extends much beyond the limit of area of the gun-cotton, and quite to, if not beyond, the extreme area of the base of the can. The experiment, as described above, has been repeated several times and always with the same result.

Dr. John Trowbridge has very kindly measured for me the intervals between the breakers in the outer group, these measurements being taken from crest to crest at six different points. As, owing to the nature of the object, nothing remained sharply in focus under the microscope of the comparator, the results are only approximate. The data are as follows, the lengths being given in millimeters:

| No. | R. | D. | R. | D. | R. | D. | R. | D. | R. | D. | R. | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |
| 2 | 3·6 | 3·6 | 3· | 3· | 3·1 | 3·1 | 3· | 3· | 2·6 | 2·6 | 2·8 | 2·8 |
| 3 | 5·7 | 2·1 | 4·7 | 1·7 | 4·8 | 1·7 | 4·3 | 1·3 | 4· | 1·4 | 3·9 | 1·1 |
| 4 | 7·7 | 2· | 6·5 | 1·8 | 6·6 | 1.8 | 5·7 | 1·4 | 5·5 | 1·5 | 5·7 | 1·8 |
| 5 | 9· | 1·3 | 8· | 1·5 | 8·3 | 1·7 | 7·5 | 1·8 | 7· | 1·5 | 7· | 1·3 |
| 6 | 11· | 2· | 9·5 | 1·5 | 10· | 1·7 | 9·1 | 1·6 | 8·8 | 1·8 | 8·5 | 1·5 |
| 7 | 12·5 | 1·5 | 11·5 | 2· | 11·3 | 1·3 | 10·8 | 1·7 | 10·3 | 1·5 | 10· | 1·5 |
| 8 | | | | | | | | | | | 11·9 | 1·9 |
| 9 | | | | | | | | | | | 12·5 | 6· |

These measurements were taken from the exterior toward the center of explosion, and it will be noticed that the first interval is about twice as great as any of the others in a set. Examination of the photo-engraving shows that at this point the propagation of the undulations must have been affected by the retaining walls of the containing vessel. Omitting this interval we find the average of each of the six sets of differences to be respectively 1·78, 1·70, 1·64, 1·56, 1·54, 1·39, and the average of all the differences to be 1·59.

Several hypotheses have occurred to me in explanation of this phenomenon, but as I have not as yet been able to put them to the test of experiment I am not prepared to submit any of them, though I intend to test them as opportunity offers. As, however, the objects for which this station is created does not embrace the carrying on of researches for purely theoretical purposes, it may be some time before the desired opportunity for experiments occurs, and hence I desire to place on record this preliminary observation. I ought to add however that the idea has suggested itself to me that we may possibly find in this phenomenon a means for distinguishing between and perhaps measuring the effects of different detonating explosives.

I am deeply indebted to Commander C. F. Goodrich, U. S. N., Inspector in charge of the Torpedo Station, for permission to publish this account, and to Mr. Arendt Ångstrom, C. E., for the precise drawings used in figs. 1 and 3.

Torpedo Station, Newport, R. I.

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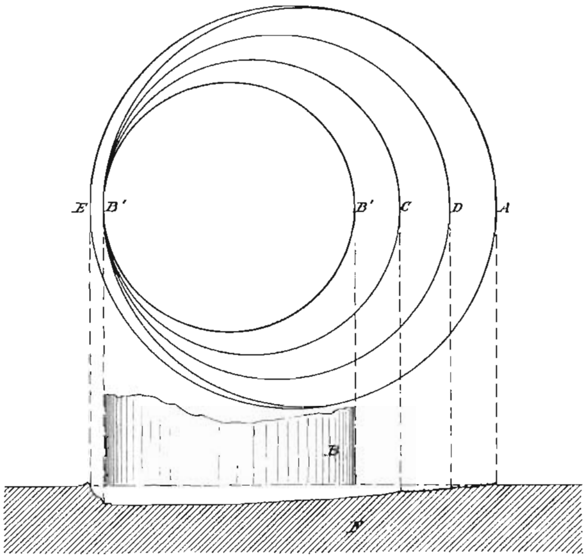


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