# United States Patent

[11] 3,566,794


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[73] Assignee United States of America as represented by the Secretary of the Navy


[54] CONTROLLED FRAGMENTATION OF MULTI-WALLED WARHEADS
3 Claims, 3 Drawing Figs.


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[51] Int. Cl. ..... F42b 13/18
[50] Field of Search ..... 102/67, 68, 64, 2; 29/1.11, 1.2, 1.21, 1.22, 1.23, 1.3



[56] References Cited

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,303,727 | 5/1819 | Rice | 102/67 |

FOREIGN PATENTS

| | | | |
|---|---|---|---|
| 542,463 | 1/1942 | Great Britain | 102/67 |
| 409,465 | 2/1945 | Italy | 29/1.3 |

OTHER REFERENCES

Procedures of the Royal Society (London) Vol.189, Series A1947-pp 300— 308 102-67X



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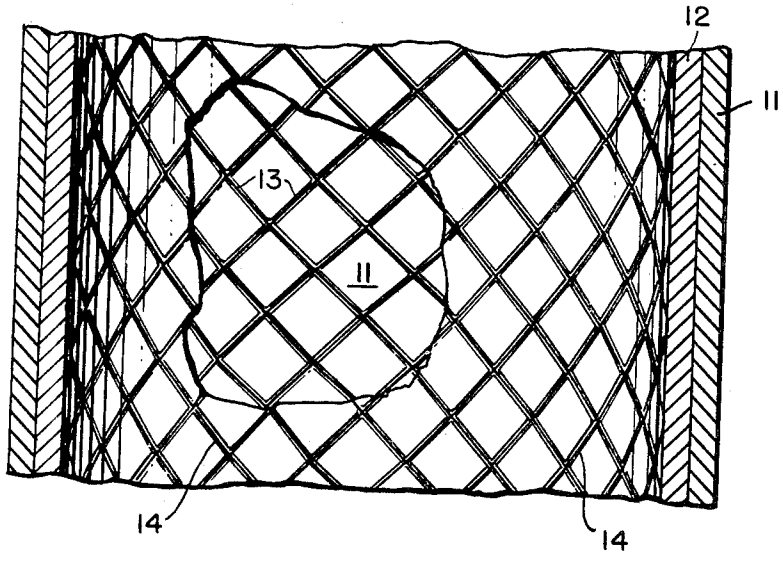
**CLAIM:** A fragmentation device comprising; an inner fragmentation casing comprising a right circular cylindrical tube of fracturable material of uniform wall thickness adapted to be impulsively loaded internally thereof, said wall having intersecting sets of equally spaced helical stress-forming grooves therein disposed circumferentially about the inner surface thereof and extending in the longitudinal direction of the tube, the spacing and depths of said grooves with respect to the thickness of said wall being such that upon a predetermined amount of internal impulse loading, cleavage surfaces due to shear propagation and emanating at a groove, are formed in two outward directions at 45° away from a diametrical plane containing the axis of the tube and a groove and each cleavage surface intersects, at the outer surface of the tube, with a like cleavage surface emanating from an adjacent groove and an outer like fragmentation casing surrounding said inner casing with its inner surface engaging the outer surface of the inner casing, whereby impulsive loading within the inner casing transmits forces to the outer casing prior to fragmentation of the latter and both casings fragment simultaneously.

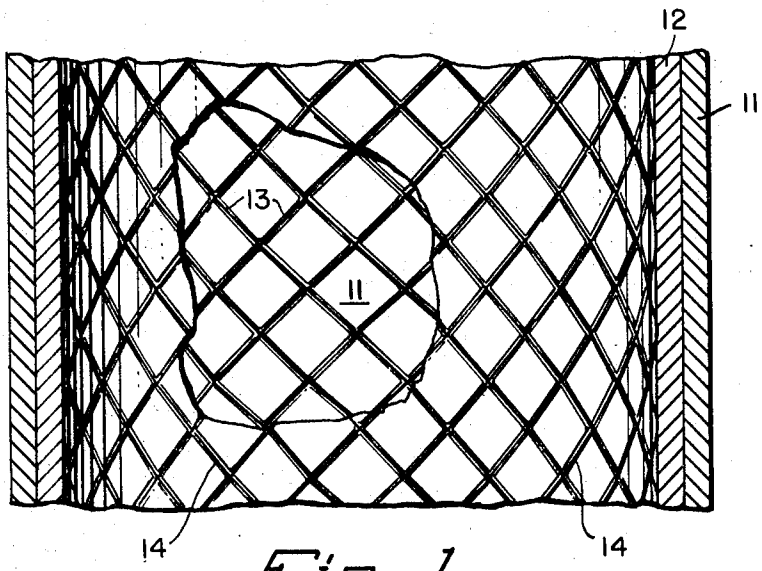



Fig. 1

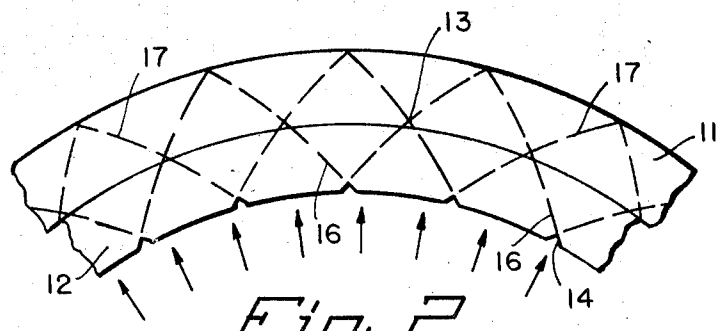



Fig. 2

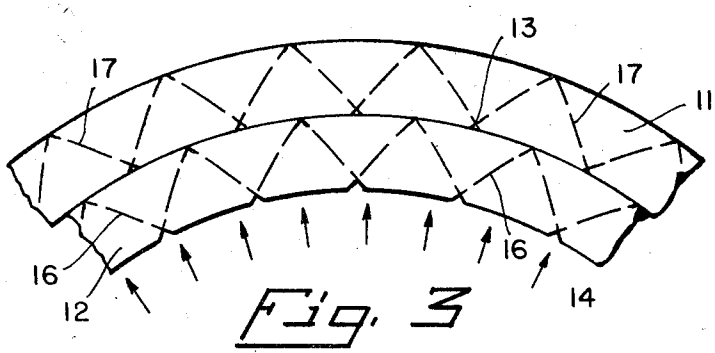



Fig. 3

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# CONTROLLED FRAGMENTATION OF MULTI-WALLED WARHEADS

The invention herein described may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to explosive warheads; more specifically it relates to fragmentation warheads for antipersonnel use.

This application is similar to application Ser. No. 582,896, filed 4 May 1956, but goes beyond the scope of said application in applying the teachings thereof to multiwalled warhead casings.

Prior attempts at fragmentation control in impulsively loaded bodies such as warheads have generally involved the cutting of grooves on the surfaces, both inner and outer, of such bodies or the placing of plastic liners of predetermined shape between the inner surfaces of such bodies and the explosives contained therein. Such practices produced local regions of high stress which initiated points of fracture, but complete fragmentation control did not result therefrom.

As pointed out in the aforementioned application fragmentation is a function of wall thickness as well as the groove pattern.

Applicants have discovered that further control of fragmentation may be attained by utilizing a plurality of walls in the warhead casing, by cutting grooves on the inner surface of each such wall, and by the orientation of the groove patterns so cut on the walls.

Accordingly, it is an object of this invention to provide a method for closer control of the fragmentation of impulsively loaded bodies than the methods of the prior art.

Another object is to produce a greater number of lethal fragments from a given mass of metal through the elimination of very large fragments and very fine ones. Applicants believe that fragments ranging from one-half to 4 grams are the most lethal against personnel and light military equipment.

Other objects and features of this invention will become apparent to those skilled in the art as the disclosure is made in the following detailed description taken in connection with the accompanying drawing in which:

FIG. 1 shows a cross-sectional plan view of the cylindrical part of a fragmentation casing partially cutaway to show the inside surface of the outer wall;

FIG. 2 shows a partial end elevational view of the casing of FIG. 1 with the inner and outer walls oriented so as to produce the maximum number of fragments, and represents the preferred embodiment;

FIG. 3 is a partial end elevational view of the casing of FIG. 1 with the inner and outer walls oriented completely out of phase for the maximum production of fragments.

Referring now to the drawing wherein like reference characters designate like or corresponding parts throughout the several views, there is shown an outer wall **11** having grooves **13** in its inner surface which form a grid pattern. Inner wall **12** is positioned next to outer wall **11**, said inner wall having grooves **14** in the inner surface thereof which form a grid pattern. The outer grid pattern is made so as to be superimposable upon the inner grid pattern such that the diamonds formed by such superimposition are symmetrical.

FIG. 2 shows the proper orientation of the grid patterns for optimum control of fragmentation. The broken lines **16** and **17** indicate the trajectories of maximum shear. The grid patterns are oriented such that the trajectories are continuous in both walls.

FIG. 3 shows the superimposing of the outer grid pattern on the inner with the grids placed completely out of phase to the orientation of FIG. 2. The trajectories of maximum shear **16** and **17** are not continuous.

The fragmentation casing may have any number of walls and is conventionally a hollow cylinder with a somewhat pointed end though other shapes may conceivably be used.



The casing is conventionally made of low carbon steel, which shears easily and is cheap, but many other metals may be used.

The thickness of the fragmentation casing can have any value, the only limitation being that the impulsive loading to which it is subjected be sufficient to cause a shear fracture entirely through with the absence of tensile fractures. The thickness of casing may be made up of any number of walls. The thickness of the individual walls are related to the groove spacing upon the walls. In a plane normal to the longitudinal axis of the wall, the trajectories of maximum shear occur at approximately 45° to the tangent to the inner circumference of the wall. Thus 45° lines drawn from two adjacent paraliel grooves would intersect at some point behind the inner surface and this intersection determines the thickness of the wall, the intersection being on the outer surface of the wall.

The helical stress raising grooves are conventionally V-shaped in cross section and about one-thirty second inch deep but such a requirement is not mandatory; further, the "V" may be of any type and ease of machining would probably be the controlling factor in the type "V" employed.

In practice, the grooves are formed on the inside surfaces of the walls by drawing a tool through. The first set of grooves or grid lines are first machined on the inner wall at a positive helix angle and then the second set machined on at a negative angle; usually the two angles are the same. The outer wall has the same number of lines that the inner wall has, but the lines are slightly further apart since the outer wall is slightly larger in diameter. Thus to make the outer grid pattern superimposable upon the inner with the maintenance of symmetry in the diamonds so formed, the helix angle of the grid on the outer wall must be slightly larger than the angle of the grid on the inner wall.

The positive helix angle grooves may be omitted on the inner wall with the negative helix angle grooves omitted on the outer wall, or vice versa, with the result that fragmentation control is somewhat less than with walls having grid patterns on both walls, but still much greater than with no grooves at all.

The notches may be omitted entirely on the inner cylinder and the desired pattern put on the outer cylinder only. Upon impulsive loading from within, the inner cylinder experiences plastic flow into the grooves on the outer cylinder and thus points of fracture are initiated. Control of fragmentation is good though not as good as with the preferred embodiment.

The walls are assembled with a smooth sliding fit and the casing loaded with conventional explosive and detonator.

Test data presented below will point out the effectiveness of the present method. Double-walled warheads, each wall about three-sixteenth inches thick, were loaded with about 8¾ pounds of high explosive, a detonator affixed to the nose, and the warhead placed nose up on a stand about 4 feet high. Six celotex pads were spaced surrounding the warhead, equidistant from each other and about 20 feet from the warhead so as to catch and hold fragments. The various warheads were exploded and the fragments recovered, counted and weighed.

Round 1 was used as a control and had no grooves at all. Round 2 had a series of right-hand spiral grooves applied to the inner wall and a series of left-hand spiral grooves applied to the outer wall. Round 3 had a grid pattern on the outer wall only. Round 4 had grid patterns on both walls, the outer grid superimposed upon the inner grid as illustrated in FIG. 2. Round 5 had grid patterns on both walls but the grids were misaligned as shown in FIG. 3.

TABLE I

| Round | Total fragments recovered | Total weight of fragments, grams | Wt. percent 1 g. or below | Wt. percent 0–4 g. |
|---|---|---|---|---|
| 1 | 547 | 1,488.1 | 8.0 | |
| 1 | 547 | 1,488.1 | 8.0 | 39.3 |
| 2 | 650 | 1,614.6 | 4.7 | 65.0 |
| 3 | 734 | 1,685.1 | 4.4 | 62.3 |
| 4 | 787 | 1,577.1 | 6.5 | 73.8 |
| 5 | 565 | 1,509.7 | 1.9 | 64.3 |

Round 4, the preferred embodiment, produced the greatest number of fragments both in the 0—4 gram range in the 1—4 gram range. Round 5 had the same grid patterns as Round 4 but the grids were misaligned as in FIG. 3; the effectiveness of Round 5 is noticeably less than that of Round 4. Rounds 2 and 3 compare with Round 5, but all four rounds are quite superior to Round 1, the control, as regards the aforementioned fragment distribution.

It is thus apparent that the fragmentation can be more closely controlled in multiwalled warheads by the choice of groove patterns on the walls and more so with a proper orientation of the patterns. Furthermore, more fragments in the 1—4 gram range result from the aforementioned arrangement.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. A fragmentation device comprising; an inner fragmentation casing comprising a right circular cylindrical tube of fracturable material of uniform wall thickness adapted to be impulsively loaded internally thereof, said wall having intersecting sets of equally spaced helical stress forming grooves



therein disposed circumferentially about the inner surface thereof and extending in the longitudinal direction of the tube, the spacing and depths of said grooves with respect to the thickness of said wall being such that upon a predetermined amount of internal impulse loading, cleavage surfaces due to shear propagation and emanating at a groove, are formed in two outward directions at 45° away from a diametrical plane containing the axis of the tube and a groove and each cleavage surface intersects, at the outer surface of the tube, with a like cleavage surface emanating from an adjacent groove and an outer like fragmentation casing surrounding said inner casing with its inner surface engaging the outer surface of the inner casing, whereby impulsive loading within the inner casing transmits forces to the outer casing prior to fragmentation of the latter and both casings fragment simultaneously.

2. A fragmentation device in accordance with claim 1 wherein the grooves of the inner casing are misaligned radially with the grooves of the outer casing a circumferential distance equal to one-half the groove spacing, whereby the intersection of cleavage surfaces emanating from adjacent grooves in the inner tube intersect a groove in the outer tube.

3. A fragmentation device in accordance with claim 1 wherein the grooves of the inner casing are radially aligned with the grooves of the outer casing.