United States Patent

Sternberg et al.

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[54] ROD WARHEAD

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

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[52] **U.S. Cl.** **102/67**

[51] **Int. Cl.** **F42b 13/48**

[58] **Field of Search** 102/64, 65, 67, 68, 69

[56] **References Cited**

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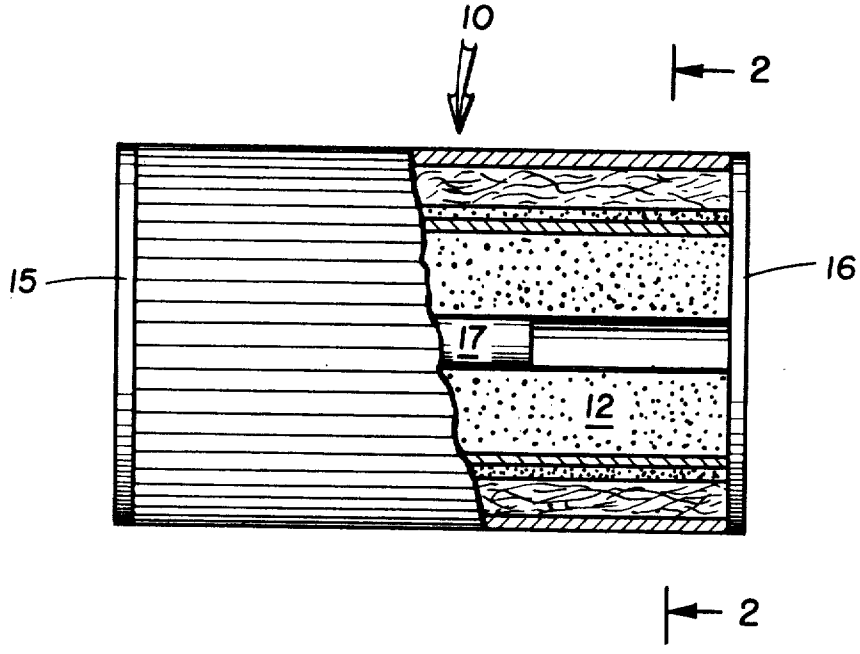
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EXEMPLARY CLAIM

1. An explosive warhead comprising,
inner and outer metallic cylinders concentrically disposed about a common axis,
first and second annular bodies of explosive material concentrically disposed about said axis,
said first body being disposed within the inner cylinder,
said second body being positioned radially between said cylinders in contact with one of said cylinders and being radially spaced from the other cylinder, and
means connected to the first body for igniting the first body of explosive material prior to the detonation of the second body of explosive material.

10 Claims, 4 Drawing Figures



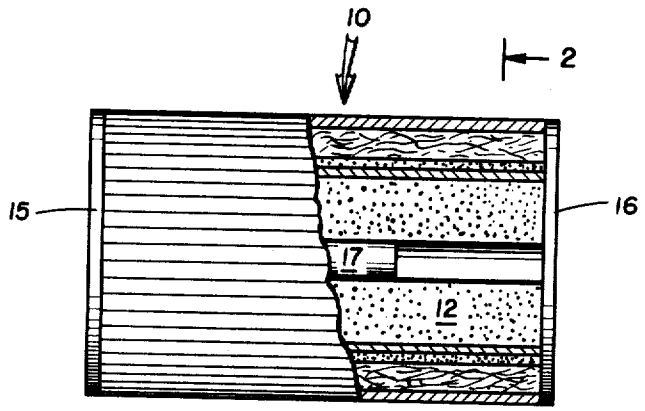


FIG. 1 2

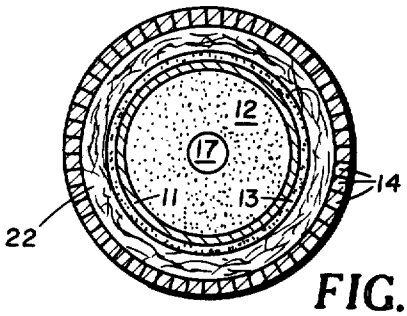


FIG. 2

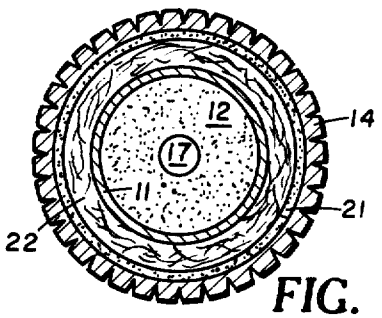


FIG. 3

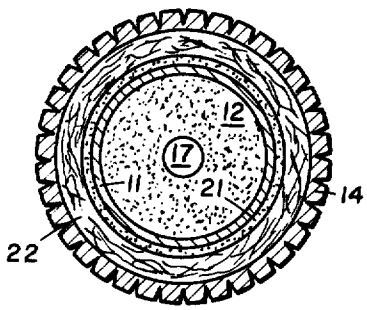


FIG. 4

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ROD WARHEAD

The invention described herein 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 and more particularly to a warhead adapted to be carried by a missile and constructed in such a manner as to disperse a fragmenting casing or an expansion-link type of continuous rod assembly with very high velocities being imparted thereto.

It has been found that the damage caused to aircraft structures decreases rapidly when the angle between the rod path and the normal to the path of the target exceeds 50°. When the aircraft is struck a glancing blow by either a fragmenting casing or a continuous rod assembly, the damage inflicted is substantially less than the damage which might have been inflicted if the rod path has been normal to the path of the target. Most modern continuous rod warheads and fragmenting casing warheads have expansion velocities in the order of 4,000 to 6,000 feet per second, which is rather slow when it is considered that the closing speed or relative speeds of the target and the missile in modern warfare approaches 10,000 feet per second. Consequently, when using conventional warheads having slow expansion velocities in situations where the missile to target closing speeds approach 10,000 feet per second, the angle between the rod path and the normal to the target path is undesirably large and the warheads are therefore unable to inflict their optimum amount of damage upon the target.

The use of a higher energy explosive in continuous rod warheads to obtain these velocities is not feasible because higher pressures would result in the rods and contribute to reduced continuity in the continuous rod assembly. In fragmenting warheads, these higher pressures could result in smaller sized fragments than desired. The use of larger explosive charges in both fragmenting and continuous rod warheads is not feasible because of warhead weight limitations. The present invention, however, utilizes a unique design geometry whereby the energy of the explosive material is more efficiently transferred to the expanding materials and acts upon the expanding materials in two stages to impart velocities to the fragmenting casing or continuous rod assembly of magnitudes heretofore not practically obtainable.

It is an object of the present invention to provide a continuous rod warhead which, upon detonation, has high rod velocity and yet maintains the continuity of the rod assembly.

Another object of the invention is to provide a continuous rod warhead having an efficient transfer of energy from the explosive material to the rod assembly whereby high rod velocities may be obtained with smaller amounts of explosive than used in conventional warheads and which is constructed in a manner to eliminate problems of aerodynamic heating of the explosive material.

A further object of the invention is to provide a fragmenting case type of warhead capable of imparting high velocities to the fragmenting materials.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a view in elevation and partly broken away of a warhead of the present invention in accordance with a preferred embodiment thereof;

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a sectional view of a second embodiment of the present invention; and

FIG. 4 is a sectional view of a third embodiment of the present invention.

Referring now to FIGS. 1 and 2 of the drawings, there is shown a continuous rod type warhead rod assembly shown generally at 10. The warhead has a metallic tube 11 which receives the main body of the explosive material 12. The explosive material 12 completely fills the tubular member 11 with the exception of a through aperture formed therein at the

common axis of the tube 11 and the main charge 12. The outer peripheral surface of tube 11 is coated with a layer 13 of explosive material and the whole core of the warhead, comprising the main charge 12, the tube 11, the layer of explosive material 13 and a gas or foam filled space 22, is positioned within an expansible link type of continuous rod assembly 10. The continuous rod assembly may, for example, comprise a plurality of rods arranged in a cylindrical bundle and positioned side by side to one another and having the opposite ends of each rod welded or otherwise secured to different adjacent rods. The rod assembly is of substantially the same length of the core of the warhead but has a diameter larger than the diameter of the explosive layer 13 and is concentrically positioned about and radially spaced from the core assembly and mounted thereto by means of a pair of end caps 15 and 16. The annular space or chamber defined by the concentrically disposed explosive layer 13 and the continuous rod assembly 14 is filled with a gas at a pressure near ambient or, if desired, may be filled with a low density foam material 22, to provide an additional means to control the loading of the continuous rod assembly. Connected to the main charge is a conventional detonation device 17, which may be positioned along the axis of the main charge or at an end thereof and may be either a single or multipoint detonator system, to initiate the explosion of the main charge, which in turn causes the detonation of the annular charge 13.

In operation, when detonator 17 initiates the explosive of material 12, the detonation charge accelerates the inner metal tube 11 radially outwardly and the accompanying shock wave causes the initiation of the outer explosive layer 13. When the gas from the explosive layer first reaches the outer tube or continuous rod assembly 10, the pressure within the annular space therebetween is near ambient at the gas metal interface because the gas has been expanding across the space. However, the pressure builds up rapidly at the interface, thus producing a shock in the metal of the continuous rod assembly which accelerates the rod assembly radially outwardly. At the same time a shock wave is reflected back into the gas in a radially inward direction. As this shock wave travels radially inwardly it impinges upon the inner metal tube 11, which is expanding radially outwardly under the pressures developed by the main charge 12, and is again reflected and caused to travel in a radially outward direction. The shock wave then moves radially outwardly and impinges upon the inner surface of the continuous rod assembly for a second time to further accelerate the rod assembly. The first impact of the shock wave upon the inner peripheral surface of the continuous rod assembly causes an acceleration of the rod assembly in a radially outwardly direction and the second impact of the reflected shock wave upon said inner peripheral surface of the rod assembly causes a further acceleration in the radially outwardly direction to import an even higher velocity to the expanding rod assembly. By virtue of the construction of the rod assembly 10, this assembly is capable of expanding to a circumference almost equal to the combined length of the individual rods in the rod assembly. The two stage warhead of the present invention accelerates the continuous rod assembly by means of two separate shock waves, each of which is of lesser magnitude than the single shock wave of a single stage conventional warhead, and in so doing maintains continuity of the expanding rod assembly while imparting velocities much higher in magnitude than those able to be developed by a conventional type of warhead while maintaining continuity.

The two stage warhead of the present invention is capable of imparting to the rod assembly velocities in the order of 12,000 to 14,000 feet per second, which is much larger than the velocities obtainable in the same size conventional single stage warhead, and produces these velocities with the use of peak pressures which are 35 to 55 percent lower than those pressures required in conventional single stage warheads. Because the peak pressures are so much lower than those in the conventional systems, preservation of the continuity of the rod assemblies is more likely and it may be seen that the

design in the present invention would permit the use of more powerful explosives and therefore lends more versatility to the selection of the explosives employed. Furthermore, the annular space between the rod assembly **10** and the explosive layer **13** eliminates problems of aerodynamic heating of the explosive material which are inherent in conventional guided missile warhead systems and thereby lends further versatility in the selection of the explosive material. The two stage warhead expansion velocities of the order of 12,000 to 14,000 feet per second insures a more favorable impact angle with the target and therefore enables the warhead to deliver a more destructive blow to the target. It should also be noted that the two stage warheads of the present invention are usually about 40 percent lighter than conventional single stage warheads.

This two stage system may also be employed in a warhead of the fragmenting type such as shown in FIGS. **3** and **4** wherein the outer casing **14**, for example, may be a solid continuous cylindrical body having weakened sections such as those formed by grooves in the surface thereof so that, upon detonation of the explosive material, the casing **14** will separate into fragments having a high velocity of expansion, which fragments then disperse into a pattern for collision with the target. If the particular explosive material employed is of such a nature as to not be effected by aerodynamic heating, the explosive material comprising the layer **21** may be secured to the inner surface of the outer casing **14**. If however the layer **21** of explosive material is of a type which is sensitive to heat, it should be secured to the outer peripheral surface of inner metal tube **11**, as shown in the FIG. **4** embodiment of the invention. In either case, the annular space adjacent to the layer of explosive material may be filled with a low density foam material, if desired, to provide an additional means for controlling the loading of the casing upon detonation. The two stage fragmenting warhead shown in FIGS. **3** and **4** has a substantially better efficiency of energy transfer from the explosive material to the outer casing than does a conventional warhead, for reasons explained in the operation of the embodiments disclosed in FIGS. **1** and **2**.

As is seen from the foregoing, the two stage warhead of the present invention provides means for controlling the loading of the continuous rod assembly or, alternatively, the loading of the fragmenting casing, i.e., the pressure-time history for the inner surface of the rods. More specifically, the peak pressure developed by the warhead may be manipulated by varying any one of the following factors: the dimensions of the inner metal tube, the dimensions of the explosive layer, the dimensions of the annular void between the second stage explosive layer and the rod assembly, or the particular explosive materials use in the warhead. It should also be noted that the explosive material comprising the main charge **12** may be a different explosive than that used in the second stage charge, for example, in the embodiment of FIGS. **3** and **4** the second stage explosive layer **21** may be selected of an explosive which is insensitive to aerodynamic heating while the main explosive charge **12** may be any explosive desired since it is isolated from the aerodynamic heating.

The two stage warhead of this invention provides a very efficient means for transferring energy from the explosive material to the continuous rod assembly or to the fragmenting casing, whichever type warhead is used, and therefore a guided missile warhead may be 40 percent lighter than a conventional single stage warhead but yet will achieve expansion velocities much higher than those obtainable with the conventional warheads. The two stage warhead creates the high expansion velocities with peak pressures which are 35 to 55 percent lower than the peak pressures developed in conventional systems, thus enhancing continuity of the rod assembly and enabling the use of more powerful explosives if desired. The annular space between the outer casing of the warhead and the second stage explosive layer eliminates aerodynamic heating problems which are inherent in conventional single stage systems, thus giving two stage warhead a greater versatility in the selection of the explosives employed. Furthermore, the high expansion velocities obtainable with a two stage warhead guarantees a favorable impact angle of the rod assembly with the target and therefore enables the two stage warhead to inflict a much greater damage to high speed targets than is possible with a single stage conventional warhead.

Obviously many modifications and variations of the present invention are possible in 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.

What is claimed is:

1. An explosive warhead comprising,
inner and outer metallic cylinders concentrically disposed about a common axis,
first and second annular bodies of explosive material concentrically disposed about said axis,
said first body being disposed within the inner cylinder,
said second body being positioned radially between said cylinders in contact with one of said cylinders and being radially spaced from the other cylinder, and
means connected to the first body for igniting the first body of explosive material prior to the detonation of the second body of explosive material.

2. The explosive warhead of claim **1** wherein,
said outer cylinder comprises a bundle of elongated rods connected together to form an expansion-linkage type of continuous rod assembly, and
said second body of explosive material is in intimate contact with the outer peripheral surface of the inner cylinder.

3. The explosive warhead of claim **2** further comprising an annular body of low density foam material positioned within and completely filling the annular space defined by said second body of explosive material and the outer cylinder.

4. The explosive warhead of claim **1** further comprising,
first and second end caps disposed on opposite ends of said warhead and fixedly secured to opposite ends of said inner and outer metallic cylinders to define a closed chamber within said warhead.

5. The explosive warhead of claim **1** wherein,
said outer cylinder is a continuous metallic cylinder having a plurality of grooves formed therein to create weakened portions in the outer cylinder to facilitate fragmenting thereof upon detonation of the explosive material, and
said second body of explosive material is in intimate contact with the inner peripheral surface of the outer cylinder.

6. The explosive warhead of claim **5** further comprising an annular body of low density foam material positioned within and completely filling the annular space defined by said second body of explosive material and said inner cylinder.

7. The explosive warhead of claim **1** wherein said outer cylinder is a continuous metallic cylinder having weakened portions therein to facilitate fragmenting thereof upon detonation of the explosive material, and
said second body of explosive material is in intimate contact with the outer peripheral surface of the inner cylinder.

8. The explosive warhead of claim **7** further comprising an annular body of low density foam material positioned within and completely filling the annular space defined by the second body of explosive material and the outer cylinder.

9. A two stage explosive warhead comprising,
a cylindrical metal tube,
a first annular body of explosive material filling said tube and having a longitudinal axial bore formed therein,
a second annular body of explosive material concentrically positioned about said tube and being in intimate contact with the tube throughout the periphery thereof,
a plurality of rods interconnected to form an expansible-linkage type or rod assembly,
said rod assembly being positioned around the second annular body of explosive material,
support means for maintaining said rod assembly radially spaced apart from the second annular body of explosive material, and

means mounted within said bore for initiating the first annular body of explosive material,

whereby the rod assembly is radially expanded outwardly by the gases of the explosion with high velocity.

10. The two stage explosive warhead of claim 9 further comprising

an annular body of low density foam material positioned between the inner peripheral surface of the rod assembly and the outer peripheral surface of the second annular body of explosive material and completely filling the space therebetween.

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