United States Patent

Colgate et al.

[15] **3,696,750**

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[54] **ROD WARHEAD**

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[52] **U.S. Cl.** **102/67,** 102/68, 102/89

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

[58] **Field of Search**.....102/67, 89, 68

[56] **References Cited**

UNITED STATES PATENTS

1,241,095	9/1917	Courtesy	102/67 X
3,224,371	12/1965	Kempton et al.	102/67

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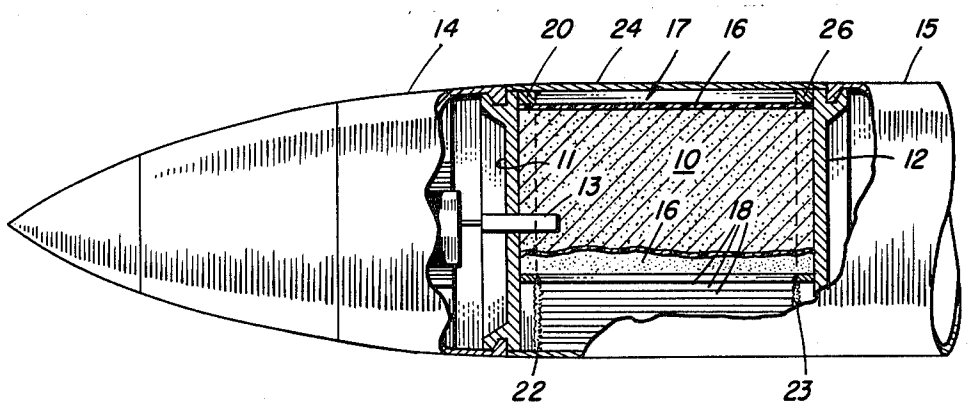
[57] **ABSTRACT**

A continuous rod warhead wherein each rod is of a comparatively small cross-section and is capable of achieving extremely high ribbon velocities. The rods are V-shaped in cross-section and are filled with a secondary propellant which, when activated by the primary warhead explosive, produces an additional thrust to the expanded continuous rod projectile.

10 Claims, 4 Drawing Figures



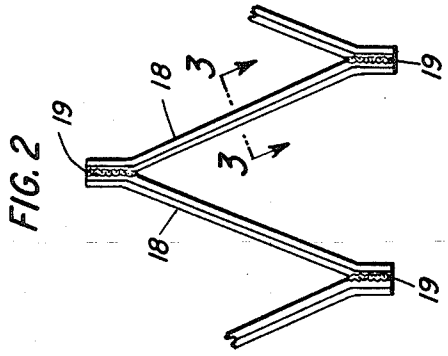


FIG. 2

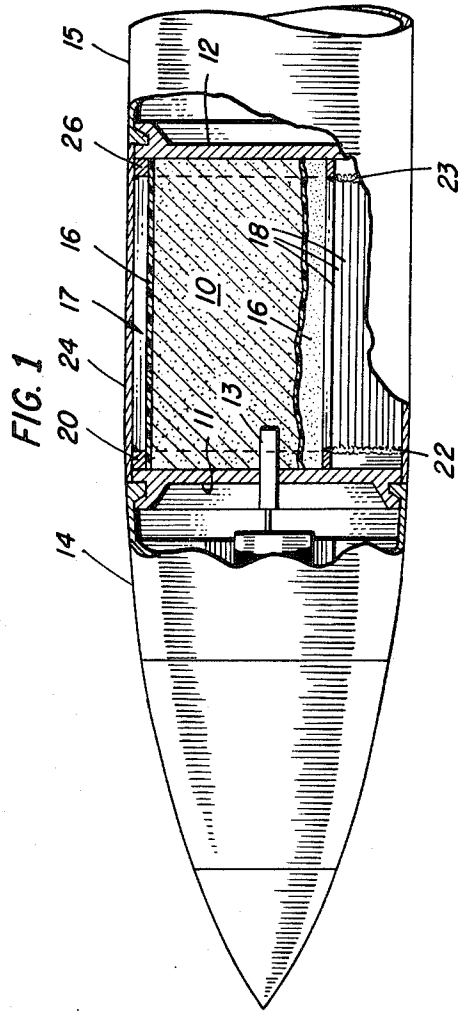


FIG. 1

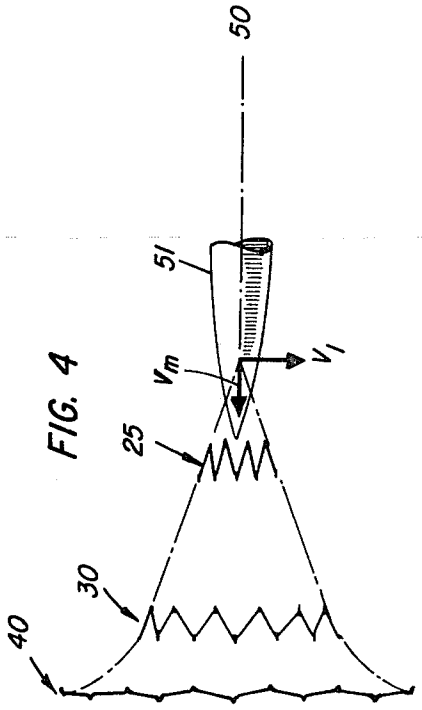


FIG. 4

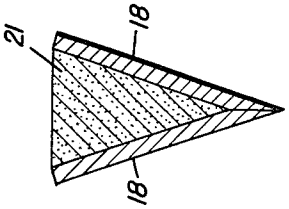


FIG. 3

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ROD WARHEAD

BACKGROUND OF THE INVENTION

This invention relates generally to an explosive projectile and, more particularly, to improvements in expandable continuous rod warheads utilized in the field of high speed rocket propelled weapons.

In the fabrication of continuous rod warheads, it has been the practice to assemble the warheads in a manner such as to provide a plurality of individual rods secured together at their ends to form a continuous rod bundle having an internal cavity for internally receiving an explosive charge. The rods are generally welded together at their ends to form hinge joints in order to provide an expansionable, continuous, ring-like member, permitting the bundle to be expanded to many times its original diameter upon detonation of the internally contained explosive charge for providing a lethal target intersecting device.

In most of the current continuous rod warhead designs, the internally contained high explosive charge is singularly responsible for producing radial velocity in the metallic continuous rod. The conditions to which the continuous rod projectile is subjected during and immediately after detonation of its associated high explosive charge, are already extremely severe. Explosive pressures resulting from the detonation of the high core explosive may reach several million p.s.i. with the continuous rod projectile expanding outwardly at a velocity of approximately 5,000 feet per second. Nevertheless, acceleration of the metallic ribbons at this velocity has been found inadequate against small, fast moving targets. In addition, even with the best available fusing, the probability of continuous rod projectiles striking moving targets at points of maximum vulnerability is relatively slight due to variation of target sizes and relative speeds, and to variation of the projectiles themselves, spacial approach conditions and other factors. The problems of a limited target-approach velocity and fusing for the continuous rod warhead, are treated by the instant design by providing a secondary propellant within V-shaped metallic rods. The propellant, when ignited, accelerates the metallic ribbon to velocities of over twice that capable of current continuous rod projectiles.

It is therefore an object of the present invention to provide a warhead consisting of a plurality of connected rods, expandable at high velocity by the detonation of a high explosive charge, into a continuous ring for projection into a target.

Another object of the present invention is to provide a means for further accelerating the expanded connected ring so as to increase the total kill probability of the projectile.

A further object of the present invention is to provide a rod warhead which is effective against fast targets without any increase in weight or overall dimension of the rod bundle.

A still further object of the instant invention is to provide a continuous rod warhead capable of reaching full expansion in a shorter time interval as compared to existing rod warhead designs.

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

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial sectional view in elevation of a warhead constructed in accordance with the invention as said warhead would appear installed in an aerial missile;

FIG. 2 is a detail elevation of a fragment of an expanded continuous rod assembly formed according to the invention;

FIG. 3 is a cross-sectional view of a rod taken at line 3—3 of FIG. 2; and

FIG 4 is a schematic representation showing shapes of a warhead rod assembly for use with a unitary warhead, after detonation of the warhead, as it spreads to its fully expanded position.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1, the warhead comprising the present invention. This design includes a bursting charge **10** which is confined between end plates **11** and **12**, and a detonator-booster **13** for said charge mounted axially on the end plate **11**. The charge **10** may conveniently be black powder. The warhead is shown mounted in an aerial missile, portions of which are illustrated at **14** and **15**. The diameter of the charge **10** is slightly less than that of the end plates **11** and **12** for defining a shallow annular chamber, the purpose for which will become apparent hereinafter. Completely enveloping the charge **10** is a buffer **16** which may be of a thermoplastic material. Mounted in the chamber and overlying the buffer **16** is a rod assembly which is shown generally at **17** and which defines a projectile. The rod assembly is formed of a plurality of rod elements **18**, each V-shaped in cross-section as clearly shown in FIG. **3**, laid side by side and connected at alternate ends so as to form a cylinder. As best seen in FIG. **2**, the ends of the rods are secured by substantial welds **19** and the assembly is retained in cylindrical form by end hoops **20** and **26** which are secured to opposite ends of the rod elements by running welds **22** and **23**. An outer covering or skin **24** surrounds the assembly and preserves the unbroken outer contour of the missile. The above description constitutes the current manner of incorporating a continuous rod warhead into an aerial missile. However, the square rod in the continuous rod warheads heretofore used are replaced with V-shaped metallic ribbons filled with a secondary propellant **21**. Rod elements of the type shown at **18** are relatively small in cross-section, about 0.100 inch in width, 0.400 inch in height, and approximately 0.025 inch thick.

A rod dimension of this type permits a substantially greater number of shorter rods with a consequent saving in space and overall dimension, while maintaining the same expanded continuous rod diameter. This greater number of rod elements have been shown to improve upon rod continuity and destructive power of the projectile.

In operation, upon initiation of the detonator **13** by the functioning of an influence fuse mechanism or the like, not shown, the charge **10** is exploded, whereupon the forces created by the said explosion will cause breaking of the assembly welds **22** and **23** and releasing

of the rod assembly 17 from between the end hoops 20 and 26. Forces of the exploding charge will cause the rod bundle to expand in a manner shown in FIG. 2, into a continuous ring which functions as a projectile. The blast from the high explosive 10 will accelerate the metallic ribbon to a velocity of approximately 5,000 feet per second. The buffer 16 sandwiched between the rod assembly 17 and the main charge 10 is devised as a means to delay the ignition of the secondary propellant 21 until the desired ribbon velocity is obtained from the high explosive action.

Referring momentarily to FIG. 4 of the drawings, such a desired ribbon velocity is attained, for example, at 30. By this time, the shock wave from the primary explosive 10 has had time to adiabatically compress the voids in the secondary propellant 21, causing the propellant to ignite throughout its mass, and thus to further accelerate the metallic ribbon to velocities of about 12,000 feet per second or more. Ignition of the secondary propellant 21 occurs at "igniter points" designed into the propellant mixture, as the shock wave, generated by the detonation of the explosion 10, passes through the propellant. However, the burn rate of the propellant 21 is controlled so as to occur at the proper later time by the size distribution of the particles in the heterogeneous mix of the propellant, and by the numbers and locations of the "igniter points" in the mix. Propellant particles are contained within the propellant mix and are of the size distribution to generate desired burn rates. Each particle is ignited at finite points by the passage of the shock wave from the primary explosive. The igniters are described as voids that are adiabatically compressed by the shock wave to produce igniting temperatures. Once the secondary propellant 21 has been expanded, the rod bundle will have reached the point at 40, FIG. 4, which is its fully expanded position. The metallic ribbon thereupon closes at low altitudes of burst from the air drag and at very high altitudes of burst by the force from the final thrust of the propellant 21 within the nose of the V-shape. Such a closed altitude of the V-shaped rods acts to produce more damage to air targets than would be produced from an opened configuration. Edge-on altitude is also maintained for a greater kill probability due to a delay in closing attitude until just prior to target impact. Since the rod thickness is very small and the striking velocity, because of the additional acceleration from the propellant 21, is very large, the V-shaped rods are not caused to close until the propellant 21 has been expended, thereby allowing for edge-on attitudes toward the target. The final shape of the V is, of course, dictated by the design considerations of aerodynamic stability.

In FIG. 4, which is a schematic representation illustrating the theoretical operation of the warhead of this invention, the tubularly arranged rod structure thereof is subjected to forces having a component acting generally parallel to the trajectory 50 of the missile 51, due to the velocity of the missile, and a component acting laterally outwardly, due to detonation of the main explosive charge 10. The first-mentioned component is designated V_m and the second-mentioned component is designated V_1.

Numeral 25 is used to designate a stage in the operation of the warhead, and, at this point, the rods are illustrated as having traveled beyond the point of detonation of the explosive charge, under the action of the force component V_m, and the rod structure has expanded during such travel, because of the action of force component V_1. A further stage in the travel of the rod structure is represented at 30 which indicates the expansion of the rod bundle into a continuous unbroken loop or ring. The stage at 30 is also the point at which the secondary propellant 21 is burned by the primary charge 10, as hereinabove described.

At a later stage 40, the continuous ring is shown fully expanded. At this stage, optimum probability of destruction of a target is attained. Interception with a target at full rod expansion is therefore achieved earlier through the use of the secondary propellant, as compared to those continuous rod projectiles employing only a primary core explosive. The increased acceleration produced by a firing of the secondary charge 21, is schematically shown in FIG. 4 by an exponential line between expansion points 30 and 40.

From the foregoing it is evident that the continuous rod warhead of the instant design will achieve about double the velocity of those continuous rod projectiles heretofore devised, because the high explosive detonation is followed by the burning of a propellant enclosed within V-shaped ribbons. The total unique design effort is directed to an increase in the radial rod velocity for the reason of aiding the fusing capability, producing a hit on small fast targets, and allowing for a more edge-on cutting attitude in fast targets made possible because of the use of very thin rods filled with a secondary propellant. Also, packaging size of the instant rod warhead will be smaller than current warhead sizes thereby making defensive missiles of smaller size possible, and, because of the greatly increased rod acceleration, a shorter time interval in reaching the target is permitted.

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.

What is claimed is:

1. A warhead comprising in combination:

a tubularly arranged rod structure including a plurality of elongated rods in parallel, juxtaposed relation to each other, with alternate opposite ends of said rods being hingedly interconnected;

a primary explosive charge contained within said rod structure, operable upon detonation for expanding said rod structure into a loop of generally end-to-end rods; and

a secondary propellant for providing an additional thrust radial of said loop to the expanding rod structure;

said elongated rods each being V-shaped in cross-section;

said secondary propellant being disposed within the confines of the V of said rods.

2. The warhead of claim 1 being further characterized by a tubular buffer disposed between said rod structure and said primary charge for providing a delay between the firing of said secondary propellant and said primary explosive.

3. The warhead of claim 1 further including

a pair of hoops, each secured to one end of said rods;

a pair of end plates, each secured to one of said hoops thereby providing a closed cylindrical container for said primary explosive; and

a single detonator-booster device mounted in one of said end plates whereby, upon initiation, said charge is exploded thereby causing said rod structure to expand into a continuous ring and the shock wave from said charge thereby adiabatically compressing the voids in said secondary propellant, causing said propellant to ignite throughout its mass and thus further accelerating the continuous ring.

4. The warhead of claim 2 further including

a pair of hoops, each secured to one end of said rods;

a pair of end plates, each secured to one of said hoops thereby providing a closed cylindrical container for said primary explosive; and

a single detonator-booster device mounted in one of said end plates whereby, upon initiation, said charge is exploded thereby causing said rod structure to expand into a continuous ring and the shock wave from said charge thereby adiabatically compressing the voids in said secondary propellant, causing said propellant to ignite throughout its mass and thus further accelerating the continuous ring.

5. A warhead comprising in combination:

a tubularly arranged rod structure including a plurality of elongated rods in parallel, juxtaposed relation to each other, with the alternate opposite ends of said rods being hingedly interconnected;

a primary explosive charge contained within said rod structure, operable upon detonation for expanding said rod structure into a ring of generally end-to-end rods; and

a secondary propellant contained within said plurality of rod elements for applying additional thrust to said expanding rod structure;

said secondary propellant being activated by a phenomenon resulting from the explosion which is caused by detonation of said primary explosive charge;

each of said plurality of rods having a particular portion of its periphery which faces outward during expansion; and

each of said rods having at least one open portion in a predetermined orientation relative to said outward facing portion, said open portion allowing said secondary propellant to escape after activation thereof and to thereby apply said additional thrust.

6. A warhead according to claim 5 wherein each rod's open portion is oriented so that said thrust is applied in the direction of expansion of said rod structure and thereby accelerates said expansion.

7. A warhead as claimed in claim 5 further including means for delaying the action of said phenomenon in activating said secondary propellant.

8. A warhead as claimed in claim 7 wherein said delaying means is interposed between said primary explosive charge and said secondary propellant.

9. A warhead as defined in claim 5 wherein said phenomenon is the shock wave emanating from said explosion.

10. A warhead comprising in combination:

a tubularly arranged rod structure including a plurality of elongated rods in parallel, juxtaposed relation to each other, with the alternate opposite ends of said rods being hingedly interconnected; and

a primary explosive charge contained within said rod structure, operable upon detonation for expanding said rod structure into a ring of generally end-to-end rods;

each of said rod elements being of V-shaped cross-section and being positioned so that the closed end of said V-shaped cross-section faces outward in the direction of expansion during the expansion of said rod structure into a ring.

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