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Polcha

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[54] **CONTROLLED FRAGMENTATION WARHEAD**

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Related U.S. Application Data

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

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

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

[56] **References Cited**

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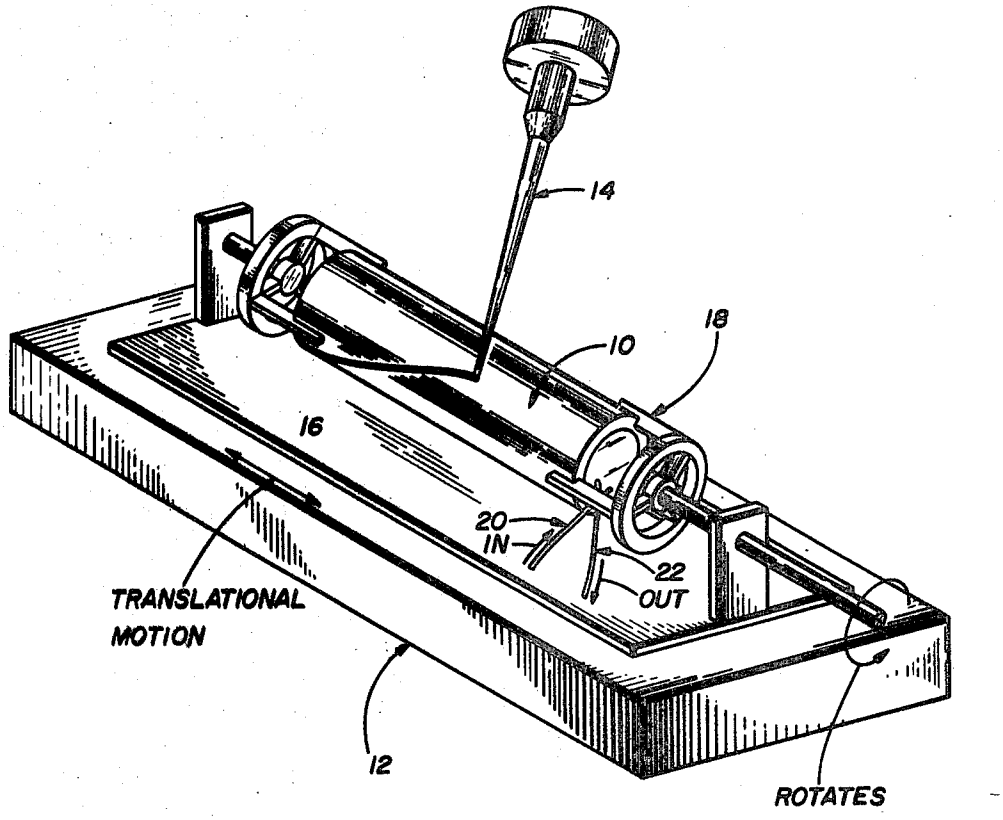
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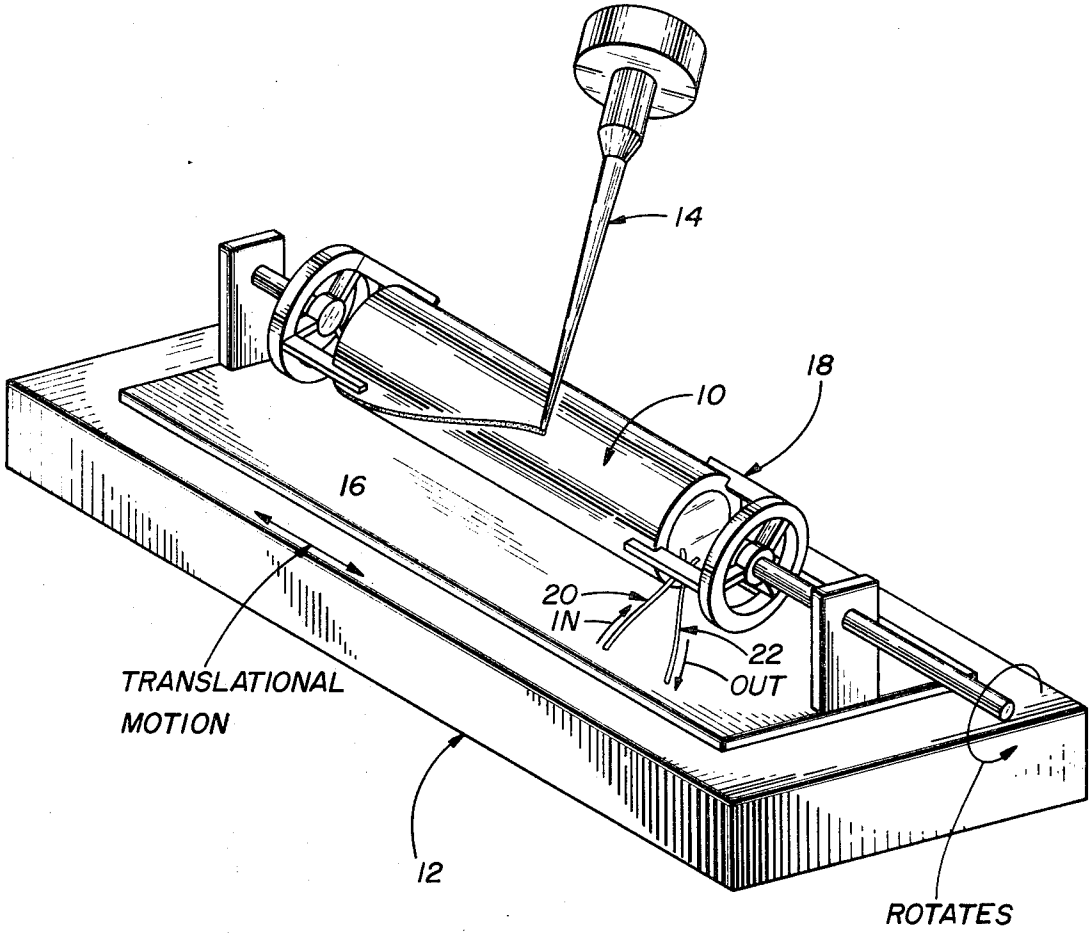
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[57] **ABSTRACT**

A method of producing fragmenting warheads that permits selecting sizes and numbers of fragments desired while allowing for assembly line production. The sizes and shapes of desired fragments are traced onto the outside of an explosive case by an electron beam welder. The electron beam creates a thin molten zone along its path of travel. Upon fast cooling of the molten zones by circulating a liquid coolant inside the case, a very hard and brittle martensite structure is created along the path of beam travel. When detonated, the explosive case will fragment along the brittle martensite zones created.

3 Claims, 1 Drawing Figure




14
18
10
16
20
IN
22
OUT
TRANSLATIONAL
MOTION
12
ROTATES

CONTROLLED FRAGMENTATION WARHEAD

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a division of application Ser. No. 145,977, filed May 21, 1971.

STATEMENT OF GOVERNMENT INTEREST

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.

BACKGROUND OF THE INVENTION

This invention relates to fragmenting warheads, and more particularly relates to an improved method of constructing the warheads.

Standard warheads have a fragmentation pattern which is nearly random in both direction and size. That is, one cannot be sure that a cylinder will produce fragments 360° about its axis without some sections having few or no fragments within them. This is due to the explosive case expansion before rupturing occurs. Furthermore the fragments are random in size and shape, have varying degrees of air drag and are not of such size that a great amount of damage would be done to several different types of targets.

Ideally one would desire a certain size fragment for defeating a given target and would want a sufficient number of these in a predictable pattern to achieve a high probability of achieving the desired damage. If several different types of targets (soft, liquid filled, armored, etc.) are to be encountered, one would like to have some of each of optimum fragment sizes to ensure damage or destruction of the target.

Several advances toward this goal have been achieved through the use of special steels and careful heat treatments but the result is generally to obtain better performance against only one type of target, and a uniform distribution of fragments is not assured.

Techniques have also been used where preformed fragments are bonded together in a matrix of an epoxy or a different metal. But structural integrity is difficult to achieve, and the inherent manufacturing complexity renders these techniques more costly and less reliable in some environments than performance requirements dictate.

Mechanical notching is also a satisfactory technique as far as fragmentation is concerned, but again it is costly and the physical stress concentration renders construction unreliable in some environments such as gun launching. Recent developments such as the polygon strip fragment concept are difficult to manufacture in production qudntities. Also, the sizes of fragments cannot be varied over a wide range without causing difficulties in the manufacturing of the configuration. The precision with which the manufacturing must be done is not desirable for production warhead.

SUMMARY OF THE INVENTION

The purpose of this invention is to provide a technique whereby the steel container or warhead may be constructed to fragment from a beam of electrons to melt the surfaces of two adjoining materials and causes them to melt together into a single structure.

The energy of an electron beam may be directed upon a surface in such a way as to produce a molten zone of almost any desired width and depth. There are limits to the combination, of course, but a thin zone can be produced. Furthermore, the above can be done at rates of about one hundred inches per minute (along the surface) while the surface is at almost any desired temperature.

As a steel workpiece is bombarded with the electron beam energy and the zone beneath the beam becomes liquid, heat is transferred into the adjoining regions. Upon removal of the beam the liquid zone solidifies and becomes cooler as adjoining regions become warmer. At some point in time the zone, which was once liquid, passes through the austenite phase and finally reaches equilibrium as a ferrite iron carbide solid solution which is at room temperature. The exact makeup of the solution is dependent upon the carbon content of the steel, and its grain structure is dependent upon its cooling rate.

There is an interesting phenomenon which occurs when steels are cooled rapidly from the austenite phase (typically 1500° F) in a very short time (typically less than one half second). A metastable body-centered tetragonal structure known as martensite is formed. This structure is very hard (Rockwell C hardness of 60 to 65) and brittle. It will break apart much more readily than ferrite when exposed to shock loads. Furthermore, it may be tempered (by holding it at some elevated temperature for a period of time) to any degree of hardness (and therefore brittleness) desired.

This invention induces the martensite formation phenomenon by cooling the inside of an explosive case with a chilled gas (such as Freon) or a chilled fluid (such as a brine solution) circulating at turbulent rates while inducing a thin molten zone from the outside with an electron beam welder. The exact temperatures will depend upon the material thickness and material composition, as well as the welding rate and the pattern to be induced into the case. In some circumstances natural cooling may be enough and circulation of a coolant may not be necessary to have the molten zone solidify at the proper rate.

Referring now to the drawing there is shown a warhead casing **10** mounted on an electron beam welding apparatus. The electron beam welder is comprised of an indexing support fixture generally indicated at **12** and electron beam gun **14**. The indexing support fixture **12** is comprised of a movable bed **16** and rotatable supports **18**. A coolant is circulated inside the warhead casing through supply tube **20** and exhaust tube **22**. The supply and exhaust **20** and **22** are provided by inserting flexible tubing in the opening left for explosive loading and sealing with a rubber seal.

The path which the electron beam is to trace is determined by moving the indexing support fixture. The indexing support fixture provides a translational as well as rotational motion to trace a predetermined path by the electron beam gun **14**. The warhead casing **10** is moved at the maximum speed permissible to achieve a molten zone depth down to 80–90 percent of the wall thickness. The phenomena has worked with a molten zone depth of 25 percent of the wall thickness but a depth of 80–90 percent is preferred. The indexing is numerically controlled into the size blocks desired.

Considering as a specific example a projectile made of AISI 1080 steel having a one-half inch thick wall which has been formed at an elevated temperature,

then normalized or annealed prior to machining the following steps would be performed:

Step 1) Anneal or normalize if not already.

Step 2) Into the opening left for explosive loading, insert tubes to supply and exhaust a coolant and seal with a rubber seal and flexible tubing.

Step 3) Attach to the electron beam welder indexing support fixture. (This would provide whatever path the electron beam is to uniformly into a predetermined distribution of fragment sizes when filled with explosives and detonated. This is accomplished by providing a pattern of brittle zones on a single unitary piece of metal constructed in the form of a warhead. An electron beam welder traces molten zones on a piece of steel formed in the shape of a warhead and then the zones are rapidly cooled to provide very brittle or weak sections in the structure. This technique provides a distinct advantage over prior art because of the ease of manufacture of an optimum warhead having a variety of shapes and sizes on a one piece explosive case.

OBJECTS OF THE INVENTION

It is an object of the invention to provide a method of producing fragmenting warheads which permit assembly line production.

It is a further object of the present invention to provide a fragmenting warhead which has a variety of fragment shapes and sizes on a one piece explosive case.

Still another object of the present invention is to provide a fragmenting warhead which will have a uniform distribution of fragments upon detonation.

Yet another object of the present invention is to provide a fragmenting warhead which will produce optimum performance against a number of different types of targets.

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.

BRIEF DESCRIPTION OF THE DRAWINGS

The FIGURE illustrates a warhead casing mounted on the indexing fixture of an electron beam welder.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

This invention utilizes a relatively new welding technique known as electron beam welding. This welding technique uses the energy trace on the surface of the projectile body).

Step 4) Insert into the welding chamber and evacuate the surrounding atmosphere (i.e. if a vacuum welder is used).

Step 5) Circulates coolant at 10° F. inside the projectile case.

Step 6) Heat along the path determined by the indexing support fixture at maximum speed permissible at energy sufficient to achieve molten zone depth down to 80–90 percent of the wall thickness.

Step 7) Remove from the welding chamber.

Step 8) Drain coolant.

Step 9) Detach projectile from indexing support fixture and begin new piece.

The resulting hardware piece when loaded with explosive and detonated, would fragment primarily along the path traversed by the electron beam welder. The reason for this would be the martensitic structure along the path having a Rockwell C hardness from 50 to 60.

Various alternatives to the method disclosed are acceptable. The welder does not necessarily have to be an electron beam welder. Any high energy heat source such as a plasma arc welder, or a laser welder would also be suitable and the welding gun could be moved instead of the piece. The production rate, of course, would vary according to how fast the welder can produce a molten state to the depth selected in the particular metal used. Molten zone depths as little as 10% of the wall thickness may be sufficient for the phenomena to work. A number of coolants are suitable such as brine or freon. Also coolant properties could be varied considerably to give necessary time and temperature characteristics at the weld zone. Further this method can be applied to any steel normally used for ordnance hardware. Any ordnance item such as bombs, projectiles, missile warheads, etc. may be improved; or optimized by utilizing this method.

Thus there has been disclosed a method of producing a fragmentation warhead of optimum design suitable for assembly line production. Obviously many modifications and variations of the present invention are possible in the light of the above teachings.

What is claimed is:

1. A controlled fragmentation warhead for projectiles and missiles comprising:

a tubular explosive case of generally cylindrical configuration; and

a plurality of cleavage lines formed in said explosive case to geometrically define a pattern of fragments of the desired size and shape;

said cleavage lines being zones of higher hardness and brittleness than the remainder of said explosive case whereby upon detonation of an explosive charge housed therein said case will separate into discrete fragments along said cleavage lines to produce controlled fragmentation.

2. A warhead as defined in claim **1** wherein said explosive case is metallic.

3. A warhead as defined in claim **1** wherein said explosive case is normalized steel and said cleavage zones are martensite.

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