Jan. 17, 1967 G. C. THRONER, JR 3,298,308

COMPOSITE CASING FOR FRAGMENTATION-TYPE EXPLOSIVE WEAPON AND METHOD OF FORMING SAME

Filed July 22, 1963

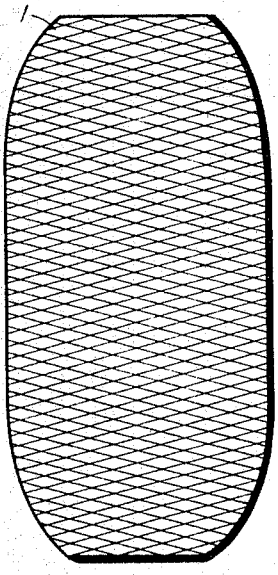


Fig. 1

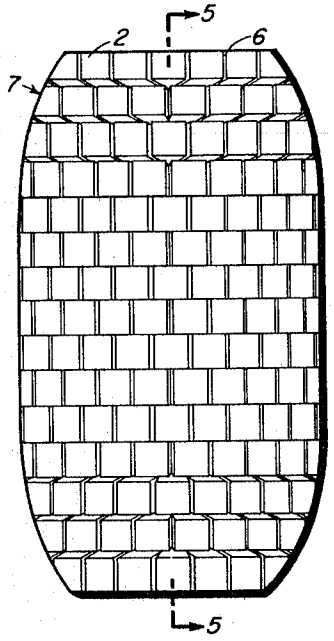


Fig. 2

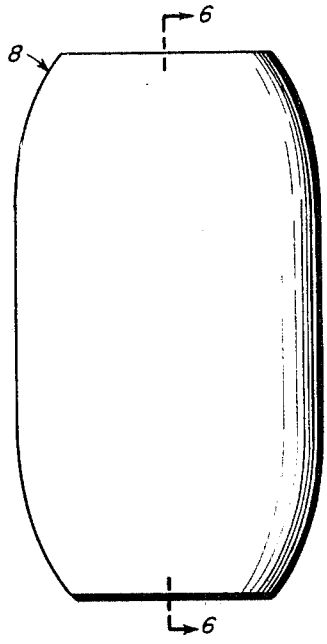


Fig. 3

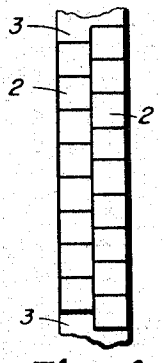


Fig. 4

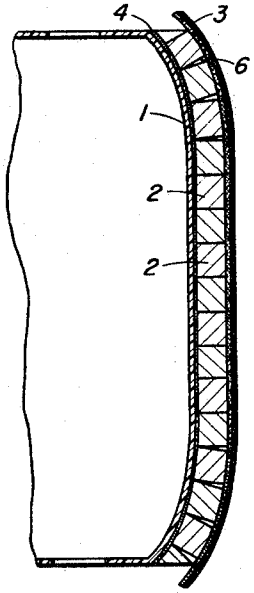


Fig. 5

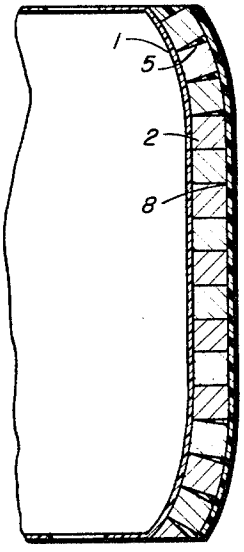


Fig. 6

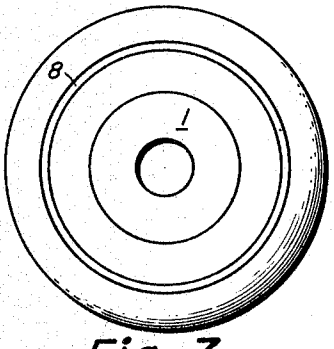


Fig. 7

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COMPOSITE CASING FOR FRAGMENTATION-TYPE EXPLOSIVE WEAPON AND METHOD OF FORMING SAME

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This invention relates to explosive weapons of the missile warhead, bomb, grenade or mine type, wherein the casing is fragmented upon detonation of the explosive charge therewithin, resulting in increased damage to equipment and to personnel within the vicinity of the equipment. This application is a continuation in part of my copending U.S. patent application Ser. No. 588,923, filed June 1, 1956, now abandoned.

More particularly, the invention relates to a fragmentation type of missile warhead, bomb, grenade or mine in which the explosive charge is contained within a composite casing comprising a shell of uniformly sized and spaced slugs of steel or other metal embedded in a matrix of cementitious material such as a plastic resin, whereby the weapon will break up into the maximum number of fragments of the most effective size when the explosive charge is detonated, with the least loss of energy and with a minimum ineffective weight and maximum ease of assembly.

There is a certain size range of fragments from a given missile which is most effective against a specific target. Typically, an ordinary steel body encasing an explosive charge will break into fragments covering a wide range of sizes when the explosive charge is detonated. Many of these fragments will be ineffective in causing damage to a specific target, since some of the fragments will be too large and some too small.

Various methods have been used heretofore to produce fragments of the desired size and shape when a fragmentation-type weapon is exploded. Such methods have included casting the steel body forming the outer casing which encloses an explosive charge with deep grooves to define casing sectors of appropriate size which form steel fragments when the explosive charge is detonated, as exemplified by the fragmentation hand grenade, or placing pre-sized fragments in a matrix carried in the body of a shell which are ejected from the shell when it is detonated upon reaching its target, as in the shrapnel-type bomb. Another procedure which has been suggested is the use of pre-sized fragments held in place by thin sheets of metal and adapted to be dispersed upon the detonation of an explosive charge associated therewith.

In the present invention, pre-sized fragments in the form of slugs are assembled uniformly in a matrix of plastic resin between inner and outer sheaths preferably formed from fiber glass impregnated with plastic resin. The advantages inherent in this construction, as compared to prior constructions are:

(a) Spalling of the slugs is alleviated by having tthe slugs shock energy absorbed in a less dense material. The slugs are held together in bonded relation as a shell. A shock wave, instead of being reflected from the outer surface of a fragment, passes through the slugs to be substantially completely absorbed in the matrix material bonding the slugs together and the outer sheath which is preferably made of fiber glass impregnated with plastic resin.

(b) A reduced amount of the energy obtained from the detonation of the explosive charge is used in rupturing the casing of the present fragmentation-type weapon as compared to fragmentation devices heretofore known. Therefore, more energy can be imparted by the explosive charge upon its detonation to the slugs.

(c) There is much less wasted weight of material than is entailed in loading precut fragments into a body of a shrapnel-type weapon. In a shrapnel-type weapon, the shell case itself comprises a large percentage of the weight of the missile but is of little value in causing casualties.

(d) The pre-sized slugs of the present fragmentation-type weapon can be made in optimum sizes, shapes and hardness for diverse intended purposes.

(e) The formation of the present fragmentation-type weapon is greatly simplified by the use of fiber glass impregnated with plastic resin as inner and outer sheaths for the slugs embedded in the plastic matrix.

(f) The composite casing, which includes the slugs and matrix material, has a high compressive strength giving the present fragmentation-type device structural integrity for shipping and handling, and yet a low or minimal strength in transverse section. As may be inferred, the low transverse or shear strength provides a minimum opposition to shearing forces when the explosive charge is detonated to insure proper area distribution of the slugs.

The following description and drawings of one embodiment of the invention are intended to be for illustrative purposes only, as the invention is not necessarily limited thereto but is of the scope defined by the appended claims.

In the drawings:

FIG. 1 is an elevational view showing the inner sheath of the fragmentation-type device according to the present invention before the pre-sized slugs have been applied thereto.

FIG. 2 is an elevational view of the fragmentation-type device after the pre-sized slugs have been secured in place on the inner sheath, but before the application of the plastic matrix and the outer sheath.

FIG. 3 is an elevational view of the completed fragmentation-type device.

FIG. 4 is a fragmentary plan view of a series of pre-sized slugs supported upon a strip of masking tape.

FIG. 5 is a longitudinal sectional view taken along the line 5—5 of FIG. 2 with the slug-carrying masking tape of FIG. 4 in place.

FIG. 6 is a longitudinal sectional view taken along the line 6—6 of FIG. 3.

FIG. 7 is an end elevational view, looking at the upper end of FIG. 3.

Referring to FIG. 1, the fagmentation-type weapon in accordance with the present invention comprises a composite casing which includes an inner sheath **1**. The inner sheath **1** is preferably composed of fiber glass impregnated with plastic resin, such as an epoxy resin. Other plastic materials can be used to impregnate the fiber glass, such as polyvinyl chloride polymers, phenol-formaldehyde resins, alkyd resins and heteropolymerized alkyd resins. A preferred plastic resin is "Shell, Epon, 828" which is an epoxy resin. This resin is cured with "Shell Curing Agent CL." The reason for using this particular resin is that it is compatible with Composition B or any RDX–TNT formulated explosive. One method of manufacture is to wind the glass fiber upon a rotating mandrel, the glass fiber being passed through a bath of plastic resin before being wound on the mandrel. The plastic resin is then cured in the usual manner. The mandrel is then removed, leaving the inner sheath **1**, as shown in FIG. 1. The thickness of the inner sheath **1** may be varied as desired. A wall thickness of 0.060 inch, having a tensile strength of approximately 80,000 p.s.i., has been found to be satisfactory.

After the optimum size of the fragments for the particular purpose intended has been determined, a sufficient quantity of steel slugs **2** (usually cubes), of that size are

cut from bar stock. Steel slugs are preferred, but other metals or alloys may be used. A satisfactory size range for the steel slugs is ⅜ inch to ½ inch, although larger or smaller slugs may be used if desired.

The pre-sized slugs or cubes 2 are then assembled on strips of tape 3 as shown in FIG. 4 in substantially abutting relationship. The slugs 2 are temporarily fastened to the tape 3 by the adhesive on the tape 3. The slugs 2 may be assembled in single rows or multiple rows depending upon the radius of the casing to be formed. A double row of offset slugs 2, as shown in FIG. 4, has been found to be satisfactory. Such positioning also provides a more effective separation of the slugs 2 upon detonation of the explosive charge within the casing in a manner which later will be described.

A coating of adhesive resin is then applied to the outer surface of the sheath 1 as indicated at 4 in FIG. 5. The assembled strips of slugs 2 and masking tape 3 are then wound around the sheath 1 in spiral or circular rows to secure the slugs 2 to the sheath 1. The tape 3 may be placed in contact with the coating of adhesive resin 4, but it is preferred to place the surface of the slugs 2 in contact with the adhesive resin 4, for reasons which will be explained. The sheath 1 and assembled slugs 2 with the tape 3 on the outside are then cured by the application of heat in the usual manner, after which the tape 3 is removed since the adhesive on the tape 3 does not cure. For these reasons, it is preferred that the tape 3 be on the outside with respect to the sheath 1 and the slugs 2.

If the sheath 1 is cylindrical, spherical or otherwise provided with a curved outer surface, and the slugs 2 are cubes, adjacent cubes 2 will tend to separate from each other from bottom to top, leaving V-shaped cavities 6 between adjacent cubes 2. These cavities 6 as well as smaller spaces between each cube 2 are then filled with a plastic resin 5 which is subjected to a curing operation in the usual manner. The plastic resin 5 comprises a plastic matrix of cementitious material in which the slugs or cubes 2 are embedded, with the plastic matrix 5 and the slugs 2 forming a shell. The slugs or cubes 2 are thereby held together and bonded to one another by the plastic matrix 5 in which they are embedded in place on the sheath 1 so that the outer surface of the cubes 2 can be machined or otherwise provided with a uniform, smooth outer surface as indicated at 7 in FIG. 2.

The last step in the manufacture of the composite casing is the application of an outer coating or sheath of fiber glass impregnated with plastic resin as indicated at 8 in FIGS. 3, 6 and 7 about the shell composed of the slugs 2 and the plastic matrix 5 in which the slugs 2 are embedded. A preferred method of applying the outer sheath 8 is to place the partially completed casing on a rotating mandrel and wind glass fiber impregnated with plastic resin around the partially completed casing in the same manner as described in connection with the formation of the inner sheath 1. The pre-sized fragments or slugs 2, when encased by the outer sheath 8 and bonded thereto form a composite casing structure adapted to be displaced about an explosive charge, wherein the casing has a high compressive strength but almost no shear strength. That is, the composite casing formed of the inner sheath 1, slugs 2, the plastic matrix 5 or other bonding material, and the outer sheath 8 has a strength prior to the detonation of an explosive charge contained therein which is tantamount to that of a steel case. Yet, when the bursting point of the composite casing is reached upon detonation of the explosive charge within the casing, the inner sheath 1, the plastic matrix 5, and the outer sheath 8 will disintegrate and the slugs 2 will disperse in the form of discrete high velocity particles. The composite casing covers substantially the entire surface of the fragmentation-type device so that the slugs 2 are impelled in directions other than radial with respect to the longitudinal axis of the composite casing.

After the casing has been completed, it may be provided with means (not shown) for fastening it to or incorporating it into a bomb or missile. The interior of the casing is filled with a suitable high explosive charge, and a detonator is inserted in the explosive charge.

The construction described above provides a fragmenting missile warhead, bomb, grenade or mine having maximum lethal effect for the amount of the explosive charge contained therein. This result is achieved by providing metal fragments or slugs of a predetermined size, uniformly distributed and securely held in place by a strong but rupturable plastic matrix. The construction also results in an explosive fragmentation-type weapon of minimum weight which breaks up into a maximum number of fragments of a predetermined size with a minimum number of fragments of a less effective size, whether larger or smaller. Upon detonation of the explosive charge within the casing, after a sufficient pressure increase occurs to rupture the inner sheath, the plastic matrix, and the outer sheath, the explosive energy is directed to impelling the slugs outwardly. Very little energy is required to rupture the composite casing in comparison with that required to rupture conventional metallic warhead bodies. There is also very little energy required to separate the slugs in view of their close positioning and the material of the plastic matrix bonding the slugs together.

Because of the materials utilized in the composite casing construction, a larger slug payload may be carried for a given weight. That is, a larger percent of the gross weight of the casing may be devoted to slugs or fragments made to optimum size, shape and hardness for the intended purpose than is possible in conventional metallic warhead bodies of the fragmentation type.

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.

I claim:

1. A method of forming the outer casing of a fragmentation-type weapon comprising the steps of: forming a hollow rupturable inner sheath by winding glass fiber impregnated with a thermo-setting plastic resin onto a mandrel, curing the thermo-setting plastic resin impregnating the glass fiber on the mandrel with a curing agent compatible with the explosive material to be contained within the casing, positioning a plurality of pre-sized metal slugs in juxtaposition on a length of adhesively coated tape, coating the outer surface of said inner sheath with a layer of adhesive thermo-setting resin, winding the tape around the adhesively coated outer surface of the inner sheath to adhesively dispose the pre-sized slugs against the adhesive layer coating the outer surface of the inner sheath for forming a layer of slugs covering the outer surface of the inner sheath, curing the adhesive layer coating the outer surface of the inner sheath to securely retain said slugs in position on the inner sheath, removing the tape from the slugs, filling all voids between the slugs with a thermo-setting plastic resin, curing the latter thermo-setting plastic resin, forming a rupturable outer sheath over said slugs by winding glass fiber impregnated with a thermo-setting plastic resin thereover, and curing the thermo-setting plastic resin in the outer sheath.

2. A method of forming the outer casing of a fragmentation-type weapon comprising the steps of: forming a hollow rupturable inner sheath by winding glass fiber impregnated with a thermo-setting plastic resin onto a mandrel, curing the thermo-setting plastic resin impregnating the glass fiber on the mandrel, coating the outer surface of said inner sheath with a layer of adhesive thermo-setting resin, positioning a plurality of pre-sized metal slugs against the adhesive layer coating the outer surface of the inner sheath for forming a layer of slugs covering the outer surface of the inner sheath, curing the adhesive layer coating the outer surface of the inner sheath to securely retain said slugs in position on the inner sheath,

filling all voids between the slugs with a thermo-setting plastic resin, curing the latter thermo-setting plastic resin, forming a rupturable outer sheath over said slugs by winding glass fiber impregnated with a thermo-setting plastic resin thereover, and curing the thermo-setting plastic resin in the outer sheath.

3. A method of forming the outer casing of a fragmentation-type weapon comprising the steps of: forming a hollow rupturable sheath, positioning a plurality of pre-sized slugs of hard material in juxtaposition on a length of adhesively coated tape, coating the outer surface of said sheath with a layer of adhesive, winding the tape around the adhesively coated outer surface of the sheath to adhesively dispose the pre-sized slugs against the adhesive layer coating the outer surface of the sheath for forming a layer of slugs covering the outer surface of the sheath, removing the tape from the slugs, and filling all voids between the slugs with a cementitious material.

4. A method of forming the outer casing of a fragmentation-type weapon comprising the steps of: forming a hollow rupturable inner sheath, positioning a plurality of pre-sized slugs of hard material in juxtaposition on a length of adhesively coated tape, coating the outer surface of said

inner sheath with a layer of adhesive, winding the tape around the adhesively coated outer surface of the inner sheath to adhesively dispose the pre-sized slugs against the adhesive layer coating the outer surface of the inner sheath for forming a layer of slugs covering the outer surface of the inner sheath, removing the tape from the slugs, filling all voids between the slugs with a cementitious material, and forming an outer rupturable sheath over said slugs in covering relationship with respect thereto.

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