

Dec. 23, 1969

R. I. WESSELLS

3,485,171

STABILIZING A SMOKE SHELL WITH AN INTERIOR PLASTIC LINER

Filed Oct. 23, 1967

Fig. 1

PRIOR ART

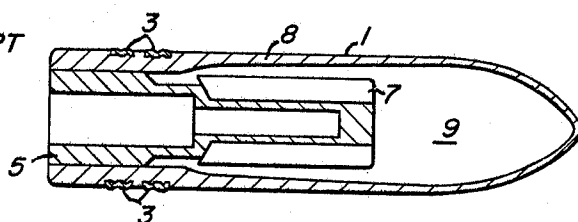


Fig. 2

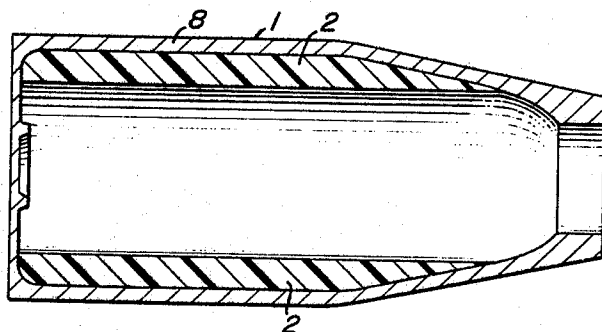
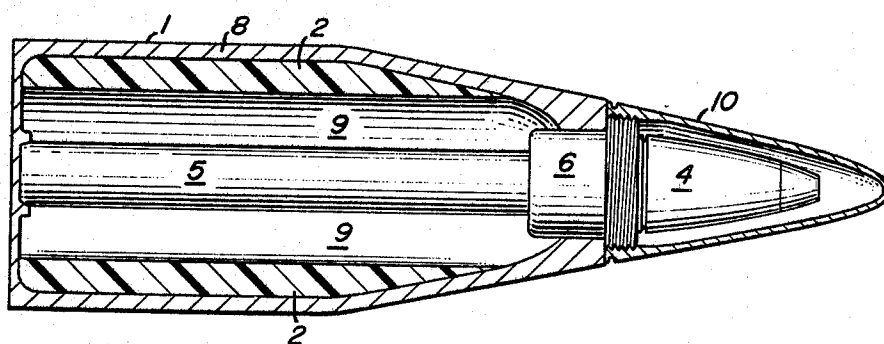


Fig. 3



INVENTOR

Russell I. Wessells

BY Harry M. Saragovitz,

Edward J. Kelly, Herbert Berl

& Jacob Ziegler

ATTORNEYS

1

3,485,171

STABILIZING A SMOKE SHELL WITH AN INTERIOR PLASTIC LINER

Russell I. Wessells, Baltimore, Md., assignor to the United States of America as represented by the Secretary of the Army

Filed Oct. 23, 1967, Ser. No. 677,467

Int. Cl. F42b 13/44

U.S. Cl. 102—56

5 Claims

ABSTRACT OF THE DISCLOSURE

The invention relates to stabilizing means and method for producing said means for various munitions utilizing a filled curable thermosetting resin as the said means forming a contiguous coating on the internal radial longitudinal wall of the projectile's cavity forming a hollow substantially cylindrical area which is substantially the central axis of the projectile.

DEDICATORY CLAUSE

The invention described herein may be manufactured, used and licensed by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to a munition and has for an object to produce one of great stability during trajectory with smoke screening means and at the same time in which the total weight of the munition has not changed substantially.

The object of the invention is carried forward by utilizing an internal liner of synthetic material to aid in the stabilization of the munition.

Various methods in the past have been investigated in order to bring about optimal projectile stabilization. The previous methods for stabilizing means include internal baffles, vanes or bellows all of which presented many problems in fabrication of the munition.

In the U.S. Patent No. 3,282,714 to Wessells, FIGURE 1, illustrates the internal fin stabilizing a white phosphorus shell. The shell body 1 with a pair of rifling band 3, main hollow body 8, buster casing 5 comprising an extruded or fastened to said casing a plurality of 3-12 radial and longitudinally extending straight fins or impellers 7, and said hollow body is filled with white phosphorus 9. The fins serve the purpose of preventing the free longitudinal movement or oscillation of the liquid white phosphorus that is the fins swirl the liquid white phosphorus in flight so that the void is reduced to a thin vortex on an axis of rotation of the shell, and the fins force the white phosphorus to act substantially the same as a solid substance.

The solving of the intricate problem of projectile stabilization has perplexed the engineers for many years. With the recent changeover to the thin-walled projectile, additional inquiry had to be made for stabilization since there is now a larger volume containing the warfare agent; this is so in view that the external configuration of the overall thin-walled projectile is identical to the projectile prior to the changeover to thin-walled munition.

FIGURE 1 is a longitudinal view of the prior art shell with internal fins.

FIGURE 2 is a longitudinal view of a shell illustrating the synthetic liner of my invention.

FIGURE 3 is a longitudinal view of a smoke generating projectile embodying the synthetic liner of this invention.

The ability to obtain the optimal stability of a munition containing white phosphorus is greater as compared with a high explosive fill for the reasons which follow. It is

2

required that all munitions be ballistically stable over the temperature range from -65° F. to 140° F. The high explosive warfare agent is a solid at room temperature and remains a solid over the aforesaid temperature range.

White phosphorus, to the contrary, becomes a liquid at about 112° F., and as a result changes from a solid to liquid during the firing cycle. It is this change of state to the liquid phase which brings about the stability problem. A projectile or shell utilizing white phosphorus requires a void space in the area of the nose section to compensate for the increase in volume as a result of the phase change. The prior art use of baffles, vanes or bellows interfere with the formation of the void space and thereby adding to the problem of in-flight stability. The position of the said void space creates not only problems during the firing cycle, but also the shift of the void space when the shell is in a horizontal position as experienced under combat conditions. This shift in position of the said void space occurs when the ambient temperature is sufficient to cause the white phosphorus to melt and then solidify upon cooling. The void space is now on the side wall of the shell and therefore is asymmetrical to the axis of rotation of the munition. With the asymmetrical void space, the high revolutions per minute imparted to the projectile during the firing cycle brings about instability in the form of a wobble or tumble. This greatly effects the calculated trajectory and causes the shell to fall in an undesired impact area and may injure friendly troops.

An investigation was instituted to bring about the required stabilization of a thin-wall projectile utilizing white phosphorus as the warfare agent. During the course of my studies, the concept emerged of utilizing an internal liner of thermosetting resins such as epoxies, urea-formaldehyde, phenolics, alkyds and combinations thereof for stabilization. It will be noted in the FIGURES 1-3 the cavity of the projectile is not cylindrical since the thickness and/or the internal configuration of the shell's wall varies along its longitudinal dimension. By reshaping the internal configuration of the shell, the principle involved is to construct the outer diameter of the shaped payload of the white phosphorus, for example, close to the axis of rotation of the projectile. As a result, the liquefied white phosphorus formed during the firing cycle can very quickly obtain substantially the same spin rate or angular velocity as that of the projectile and thereby eliminate forces that the liquid phosphorus may set up within the munition causing yaw or tumble during its trajectory.

Another unexpected result is that the liner acts as a heat shield and aids in substantially reducing the effect of the ambient temperatures in a tropic area where hitherto brought about the asymmetric shift of the void space. This effect of ambient temperature is very common in the use of tank-mounted guns where the munition is carried in the tank where the temperature is about the melting point of white phosphorus.

A further unexpected result is that upon the fragmentation of the projectile the liner acting as a heat sink will absorb a portion of the heat of explosion and as a consequence the white phosphorus burns more slowly and thereby giving a longer duration for screening effect. Moreover, the liner is also consumed during the burning of the white phosphorus and thus adding to the density of the smoke cloud.

As a result of the synthetic liner, it is now feasible to modify all shell cavities to take a shaped payload which is substantially cylindrical in figuration without the added expense of metal fabrication. The liner concept is not limited to munitions utilizing white phosphorus as the payload but to other warfare agents that are fluid or

become fluid during the firing cycle. The type munition shown in FIGURES 2-3 is representative of the 152 millimeter short projectile; this invention is equally applicable to 105, 107, 155 millimeter artillery shells, mortars, and rocket projectiles.

In FIGURE 2, numeral 1 is the shell body and the infusible synthetic liner 2 forming a coating on the internal radial longitudinal wall of the hollow body 8. The reshaped cavity of the shell is substantially cylindrical in configuration. FIGURE 3 is the longitudinal cross section of a projectile embodying the synthetic liner of this invention. A fuze 4, booster 6, and ogive 10 are provided at the forward end of the shell body 1. The fuze is responsive to impact although a time or proximity fuze may be employed. The main hollow body 8 is of steel or malleable cast iron adopted to be fragmented upon detonation of the burster casing 5 and thereby disseminating the warfare agent 9. The burster casing 5 is force-fitted within the axially positioned fill 9.

The synthetic resins employed in preparing the liner in accordance with the present invention are curable filled thermosetting resin such as Ren RP 3262 (Ren Plastics, Inc.), Dural 400 (Dural Materials Corporation), Devcon C or F (Devcon Corporation), or Pleuco 2000 (Plastics Engineering Company). The filler may be various powdered metals such as aluminum or magnesium varying in proportions from about 20% to 65% by weight of the thermosetting resin.

The above named curable thermosetting resins have the following characteristics as thermal coefficient of expansion about 3.0×10^{-5} to 3.8×10^{-5} (in./in./° F.), heat distortion about 145° to 185° F., tensile strength ULT-p.s.i. about 5600 to 7600, modulus of elasticity in flexure p.s.i. about 1.1×10^6 to 1.4×10^6 , flexural strength ULT-p.s.i. about 8800 to 9300, compressive strength ULT-p.s.i. about 14,000 to 15,600, hardness about M55 to M88, specific gravity about 1.70 to 1.81, pot life about 10 to 45 minutes, mixing ratio about 1 to 10 parts by weight of hardener or curing agent to about 1 to 100 parts by weight of the resin. The specific gravity value of the resin is critical since this number is to be substantially the same as the payload.

Generally, the curing cycle or pot life effecting the blended polymeric resin to remain usable is determined by the type of curing agent and the time to accomplish the desired hardening of the resin. Aliphatic primary or secondary amines and many of the tertiary amines begin the process of curing the resin at room temperature since the heat of the reaction may rise to approximately 100° F. or higher. If desired, an external heating source can be utilized in shortening the curing time. I have found it advantageous for the curing operation to proceed under as mild conditions that production will tolerate in order to minimize the number of defective shells caused by too rapid a curing cycle.

The following is an example illustrating the preparation of the filled curable thermosetting resin and the method of forming the internal liner.

Example 1

The filled curable thermosetting setting resin is flowable having the reacting ratio by weight of about 10/100 curing agent to said resin respectively, mixed viscosity about 60,000 cps., pot life (1 pt.) 35 minutes, specific gravity (cured) about 1.72, density 6.2×10^{-2} lbs./cu. in., coefficient of linear thermal expansion about 3.1×10^{-5} in./in./° F., hardness Shore D about 75, heat distortion about 164° F., compressive strength ULT-p.s.i. about 13,200 p.s.i., and about 20-65% by weight of aluminum based on the weight of the thermosetting resin. The mixing of the curing agent and said resin can be performed in any suitable container with stirring from about 1 to 10 minutes until the mixture assumes a "creamy" texture.

The method of forming the internal liner is carried out on a conventional lathe except that no provision is made for shaping the metal portion of the shell. The prepared flowable thermosetting resin from about 2-8 lbs., depending upon size of the projectile, is accurately weighed or measured and placed in the cavity of the shell which is immediately positioned along its longitudinal axis with the base of the shell attached to the rotating head of lathe being capable of turning between 150-600 revolutions per minute. The spinning operation varies from 20-120 minutes which is sufficient for curing and coating the internal radial longitudinal walls of the shell forming a hard and infusible liner which has a hollow substantially cylindrical core. There are no finishing operations required upon the liner or shell, and the munition or projectile is now ready to be processed in the conventional manner to receive the payload material.

I claim:

1. An artillery shell comprising an externally shaped body with an internal elongated shaped cavity having an opening in the nose end of said cavity and a cured thermosetting resin being contiguous with the entire internal radial longitudinal surface of said cavity forming a hollow substantially cylindrical area being substantially the central axis of said shell, said cylindrical area being filled with a payload of white phosphorus.
2. A shell according to claim 1, in which the specific gravity value of the said thermosetting resin and said payload is substantially the same.
3. A smoke disseminating projectile comprising:
 - (a) an externally shaped body with an internally elongated shaped cavity having an opening in the nose end of said cavity adapted to receive a burster casing
 - (b) a burster casing mounted within the said shaped cavity and in sealing relationship with said opening, extending a predetermined axial distance within the said cavity and adapted to receive a burster charge
 - (1) said burster charge casing comprising a fuze means sealed at its forward end being adjacent to the said opening
 - (c) a cured thermosetting resin is contiguous with the entire internal radial longitudinal surface of the said cavity forming a hollow substantially cylindrical area being substantially the central axis of the externally shaped body
 - (d) a liquefiable payload axially positioned between the inner surface of the formed said cylindrical area and the exterior surface of said burster casing.
4. A projectile according to claim 3 in which the said payload is white phosphorus.
5. A projectile according to claim 3, in which the specific gravity value of the said resin and said payload is substantially the same.

References Cited

UNITED STATES PATENTS

2,195,429	4/1940	Shaler	102-56
2,532,323	12/1950	Miller	102-90
2,589,129	3/1952	Ponder et al.	102-6
3,013,495	12/1961	Stevenson et al.	102-66
3,103,888	9/1963	Rosenthal	102-66
3,292,543	12/1966	Tisch	102-66
1,605,574	11/1926	Stewart	117-101

FOREIGN PATENTS

978,435	12/1964	Great Britain.
1,341,656	9/1963	France.

BENJAMIN A. BORCHELT, Primary Examiner
JAMES FOX, Assistant Examiner

U.S. Cl. X.R.

102-66