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[72] Inventor **Joseph I. Harrell**
Sussex, N.J.

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[73] Assignee **Hercules Incorporated**
Wilmington, Del.

[54] **PROPELLANT CHARGE FOR TELESCOPED CASELESS AMMUNITION HAVING A DETERRENT-COATED AFT-END**
11 Claims, 3 Drawing Figs.

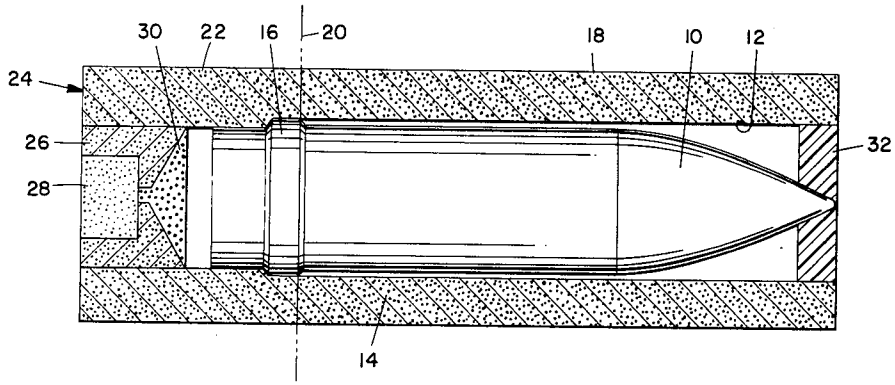
[52] **U.S. Cl.** **102/38,** 102/DIG. 1
[51] **Int. Cl.** **F42b 5/18,** F42b 9/16
[50] **Field of Search** ..... 102/38, DIG. 1, 104

[56] **References Cited**
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Primary Examiner—Robert F. Stahl
Attorney—Michael B. Keehan

ABSTRACT: An improved propellant charge for telescoped caseless ammunition is provided. A telescoped caseless round is a caseless round in which the projectile is fully contained within an axial bore in the propellant charge. The propellant charge has a burning rate deterrent applied to its aft-end which results in improved ballistic performance for the round.



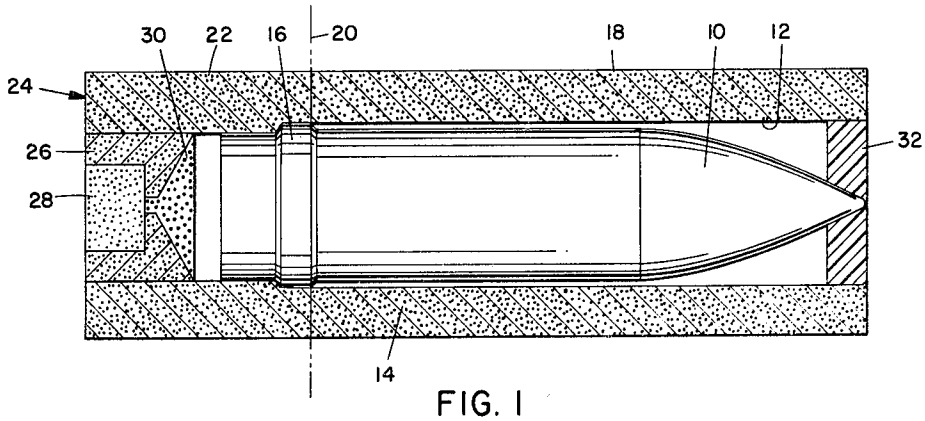


FIG. 1

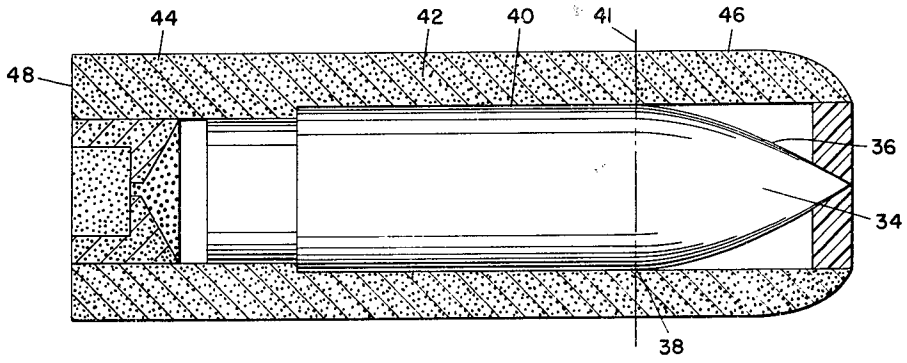


FIG. 2

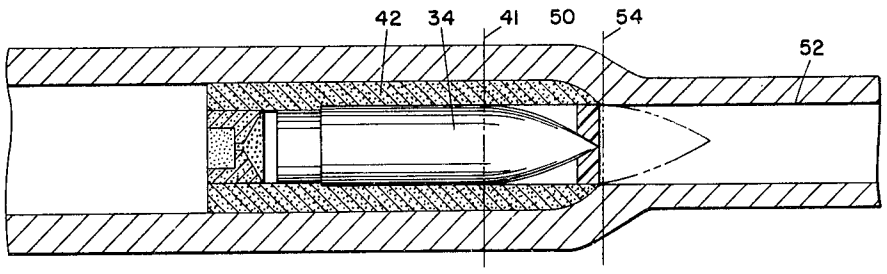


FIG. 3

JOSEPH I. HARRELL
INVENTOR

BY Michael L. Keehan

ATTORNEY

PROPELLANT CHARGE FOR TELESCOPED CASELESS AMMUNITION HAVING A DETERRENT-COATED AFT-END

This invention relates to telescoped caseless ammunition having improved ballistic performance. More particularly, this invention relates to a molded propellant charge for telescoped caseless ammunition in which at least a portion of the surface area provided by the propellant granules comprising the aft-end of the the propellant charge is coated with a burning rate deterrent.

Telescoped caseless ammunition is comprised of a propellant charge, a projectile, and a primer. The propellant charge has an axial cavity equal to or greater than the length of the projectile. The projectile is housed completely within the axial bore of the propellant charge. A primer is positioned behind the projectile. Various embodiments of telescoped caseless ammunition are disclosed in U.S. Pat. No. 3,482,516, filed Dec. 28, 1967 by L. J. Farmer et al., and entitled "Caseless Cartridges Having the Projectile House in the Propellant Charge."

When a telescoped round of caseless ammunition is loaded into the chamber of a gun, the projectile, which is housed in the propellant charge, is not seated in the barrel of the gun as is the projectile of a conventional round of ammunition when in a loaded position. Upon initiation of the primer of the telescoped round, the projectile is forced forward through the axial cavity in the propellant charge into the barrel of the gun and is seated therein. The projectile is subsequently ejected or "fired" from the gun due to rapid pressure buildup in the chamber and barrel of the gun resulting from burning of the propellant charge. The steps in the firing process of a gun as heretofore described are continuous and take place in very rapid succession, on the order of a few milliseconds. Prior to seating of the projectile in the barrel of the firearm, combustion gases from the initiated primer and propellant charge can escape ahead of the projectile. If these cases do escape ahead of the projectile, there is a loss of ballistic efficiency for the round.

Propellant charges for caseless ammunition are prepared from molded granules of smokeless powder which can be of the single-base, double-base or triple-base types. In order for the molded propellant charge to function as a typical gun propellant charge, it is necessary that the individual propellant granules comprising the charge break up and burn as individual granules during a firing. To achieve the foregoing result, propellant charges for caseless ammunition are molded from granules of smokeless powder under controlled conditions employing either binders for the powder or solvents to soften the surface of the granules of powder to aid in holding the molded granules in a consolidated mass. These molded granules retain their individual identity in the charge. Propellant charges for caseless ammunition prepared by molding processes have interstitial passages between and around individual propellant granules throughout the charge.

It is the principal object of this invention to provide a propellant charge for telescoped caseless ammunition of the type heretofore described which provides improved ballistics for telescoped caseless ammunition by reducing gas loss from an initiated propellant charge.

It is another object of this invention to provide a process for preparing propellant charges for telescoped caseless ammunition having improved ignition characteristics.

Other objects of this invention will, in part, be obvious and will, in part, appear hereinafter. For a complete understanding of the nature and objects of this invention, reference is made to the following detailed description.

The propellant charge of this invention is prepared by a process comprising contacting the aft-end of the charge with a burning rate deterrent. The burning rate deterrent must be applied as a liquid or as a solution of a solid burning rate deterrent dissolved in a solvent therefor. The burning rate deterrent can therefore pass throughout the interstitial passages in the aft-end of the charge whereby the deterrent is deposited over the internal and external surfaces comprising the aft-end of the propellant charge.

The aft-end of the propellant charge as the term is used herein is defined in relation to the projectile fully contained within the axial bore of the propellant charge. Projectiles for ammunition generally employ either a rotating band or a guilding metal jacket. When a telescoped round of caseless ammunition is fired, the projectile moves from its position within the propellant charge into the barrel of the gun. The initial surface of contact of the projectile with the gun barrel is referred to as the "contacting surface" of the projectile. Thus, when the projectile employed has a rotating band, the contacting surface of the projectile is the forward surface of the rotating band. The initial contacting surface of a pointed projectile having a guilding metal jacket with the rifling in the barrel of the gun is the base of the ogive of the guilding metal jacket.

The contacting surface of a projectile is the basis on which the forward surface of the aft-end of the propellant charge of this invention is defined. If a plane is passed through the contacting surface of the projectile in an assembled round of telescoped caseless ammunition and through the propellant charge, the surface defined by the plane passing through the propellant charge is defined as the forward surface of the aft-end of the charge. Thus, the aft-end of the propellant charge is that part of the propellant charge measured from the aft-surface of the propellant charge to the surface defined by a plane passing through both the propellant charge and through the contacting surface of the projectile. Thus the size of the aft-end of the propellant charge will vary with projectile employed in the telescoped round, and in particular will depend upon the position of the contacting surface of the projectile in the telescoped round.

In the preferred embodiment of this invention the total surface area of the aft-end of the charge is coated with burning rate deterrent. At least 10 percent of the total surface area of the aft-end of the propellant charge measured from the aft-surface of the aft-end of the charge should be coated with burning rate deterrent in order to achieve any appreciable improvement in ballistics. It is assumed for purposes of measuring the surface area, that the total surface area of the aft-end of the propellant charge, i.e., internal and exterior surface area, is linearly uniform.

The following drawings more fully illustrate this invention.

FIG. 1 is a longitudinal view partly in section of a telescoped caseless round employing a projectile having a rotating band and illustrating the propellant charge of this invention.

FIG. 2 is a longitudinal view partly in section of a telescoped caseless round having a guilding metal jacket and illustrating the propellant charge of this invention.

FIG. 3 is a longitudinal view partly in section illustrating the projectile of the telescoped round of FIG. 2 making contact with the rifling in the barrel of a gun.

In FIG. 1 a telescoped round of caseless ammunition comprising propellant charge, projectile and primer is shown. The projectile **10** is shown fully contained within the axial bore **12** of propellant charge **14**. Projectile **10** has a rotating band **16**. The forward end **18** of the propellant charge is defined by the total area of propellant measured forward of plane **20** passing through the propellant charge and through the contacting surface of rotating band **16**. The aft-end **22** of the propellant charge **14** is defined as that part of the charge measured from plane **20** passing through the forward surface of rotating band **16** to the aft-surface **24** of the propellant surface charge **14**. The projectile **10** is secured at the aft-end of propellant charge **14** in axial bore **12** with a primer plug **26** containing a primer **28** and an auxiliary ignition charge **30** prepared from black powder. The projectile **10** is secured in the forward end of axial bore **12** with a consumable disc **32**.

In FIG. 2 a telescoped round having a projectile **34** with a guilding metal jacket is illustrated. The ogive **36** of the projectile **34** is the curve defining the shape of the pointed projectile. The base **38** of the ogive is the contacting surface of the projectile **34**. The sides of the projectile **40** aft of the base of the ogive are parallel. The outside diameter of the projectile measured at the base **38** of the ogive **36** is equivalent to the maximum diameter of the projectile. An imaginary plane **41** passing through the base **38** of the ogive **36** of the projectile **34**

and through propellant charge 42 defines the forward surface of the aft-end 44 of the propellant charge 42 and thereby defines the forward end 46 of propellant charge 42. The propellant charge 42 has an aft surface 48.

In FIG. 3 the telescoped round of FIG. 2 is illustrated in a loaded position in the chamber of a gun 50. Projectile 34 is illustrated both in its normal position as fully contained within propellant charge 42 prior to firing, and as the projectile would appear as it makes contact with the rifling in the barrel 52 of a gun. The position of the contacting surface of the projectile 34 is illustrated at plane 54. This contacting surface defined by plane 54 is the same surface as the surface defined by a plane through base 38 of the ogive 36 of projectile 34 in FIG. 2.

The following examples more fully illustrate this invention. All parts and percentages are be weight unless otherwise specified.

EXAMPLE 1

Propellant charges for caseless ammunition are prepared by placing smokeless powder granules into a mold and adding a solvent mixture to said mold for softening the surfaces of the powder granules, said solvent mixture comprising 40 percent acetone and 60 percent ethyl alcohol. The ratio of solvent mixture to smokeless powder is about 1.0/2.5. After about 1 minute of contact time, the granules are compression molded to a pressure of 2,000 p.s.i. to form propellant charges in which the individual smokeless powder granules retain their identity. The solvent mixture is driven from the mold during compression. The resulting propellant charge is dried to remove residual solvent. After drying, the propellant charges are machined to appropriate dimensions. These propellant charges contain interstitial passages between the molded propellant granules.

Propellant charges prepared by the method heretofore described are coated with burning rate deterrent by partially submerging the propellant charge in burning rate deterrent solution comprising ethyl centralite (diethyldiphenylurea) dissolved in ethyl alcohol. The total aft-end of the charge as herein defined is submerged. The ethyl centralite solution readily flows through the interstitial passages in the propellant charge depositing a deterrent coating on the internal and external surfaces of the aft-end of the charge. After about 1 minute contact with the burning rate deterrent solution, the propellant charge is removed from the solution and is dried at 130° F. for about 12 hours.

EXAMPLES 2–9

Following the procedure set forth in example 1, four propellant charges molded from two lots of smokeless powder granules are coated with burning rate deterrent over the entire aft-end of the charge. The coated propellant charges are loaded with 25 mm. projectiles as shown in the drawing (FIG. 1) and fired. Propellant charges prepared from the same lots of smokeless powder are loaded as control rounds. These control rounds (rounds 4, 5, 8 and 9) are not deterrent coated. Rounds 2, 3, 4 and 5 are prepared from one lot of smokeless powder. Rounds 6, 7, 8 and 9 are prepared from a second lot of smokeless powder. Comparison of ballistic results for these rounds is set forth in table I below.

TABLE I.—COMPARISON OF BALLISTICS DETERRENT COATED AND NON-COATED TELESCOPED CASELESS AMMUNITION

Example	Smokeless powder granules web (in.)	Deterrent coating (wt. percent)	Propellant charge weight (grams)	Projectile muzzle velocity (ft./sec.)	Maximum chamber pressure (lbs./in.²)
Rounds:					
2	0.032	1.42	128.1	3,800	49,200
3	0.032	1.39	128.5	3,832	50,600
4	0.032	0	128.0	3,251	31,000
5	0.032	0	127.2	2,914	24,400
6	0.026	0.99	129.8	3,873	52,700
7	0.026	1.04	130.7	3,926	59,200
8	0.026	0	130.1	3,410	37,000
9	0.026	0	129.6	3,405	36,900

Results of the firing of rounds 2 and 3 with rounds 4 and 5 illustrate an average projectile muzzle velocity increase for the deterrent coated rounds over the noncoated rounds of 734 feet per second or about 24 percent increase in velocity. Comparison of ballistic results of rounds 6 and 7 which are deterrent coated rounds of this invention with rounds 8 and 9 (control) illustrate an average projectile muzzle velocity increase of 492 feet per second or about 14.5 percent increase in projectile muzzle velocity.

There are many well-known burning rate deterrents for use in controlling the ignition of smokeless powder. Any of these deterrent materials which are compatible with the propellant charge of the caseless round and which will deter the surface rate of burning of the propellant can be employed.

The burning rate deterrents must be applied to the propellant charge in the liquid state. Burning rate C.) which are normally solids can be applied in solution. Solvents employed with the burning rate deterrents preferably have no appreciable solvent action upon the propellant charge and are employed as a carrier for the burning rate deterrents so that the interior and exterior surfaces of the propellant charges can be contacted with deterrent. Illustrative burning rate deterrents which can be employed which are liquids at ambient temperature (22° C.) include dibutyl phthalate, dibutyl succinate, dibutyl adipate, triacetin, ethyl diphenyl phosphate, tributyl phosphate, and the like.

Other burning rate deterrents which can be employed are ethyl centralite (diethyldiphenylurea), methyl centralite (dimethyldiphenylurea), dimethyl phthalate, dioctyl sebacate, butyl benzyl phthalate, dinitrotoluene, and the like. These deterrents are solids at room temperature and are employed either above their melting points or in solution. It is preferable to employ normally solid burning rate deterrents in solution.

Other deterrents which can be employed to control ignition of the propellant charge of this invention are the well-known surface coatings for smokeless powder which are resins that have no appreciable solvent action on nitrocellulose. These resins are applied in the form of a solution which will readily flow through the porous propellant charge of the caseless round. Illustrative resins which can be employed include: alkyl esters of the fatty acids, as, alkyl esters of ribinoleic acid, alkyl esters of polymerized ricinoleic acid, etc.; rosin esters, such as, monohydric alcohol esters abietic acid, polyhydric alcohol esters of abietic acid, monohydric alcohol esters of pimaric acid, polyhydric alcohol esters of pimaric acid, synthetic lacquer resins, such as, the modified or unmodified polyhydric alcohol-polybasic acid resins (Alkyds, Rezyls), phenolformaldehyde-type resins; rosins, such as, wood rosin, gum rosin; hydrogenated rosins, such as, hydrogenated wood rosin, hydrogenated gum rosin, and the like. Thus, we may use butyl ricinoleate, butyl acetyl ricinoleate, butyl ester of polymerized ricinoleic acid, methyl abietate, ethyl abietate, hydrogenated methyl abietate, hydrogenated ethyl abietate, ester gum, hydrogenated ester gum, modified or unmodified glycerolphthalate resin, oil-modified phenolformaldehyde type resins, glycerol sebacate, glycol sebacate, glycerol-glycol sebacate, modified or unmodified ethylene glycol terpinen maleic anhydride resins, modified or unmodified diethylene glycol terpinene maleic anhydride resins, modified or unmodified triethylene glycol terpinene maleic anhydride resins, modified or unmodified glycerol terpinene maleic anhydride resins, and the like.

Illustrative solvents for burning rate deterrents which have no appreciable solvent action for propellant charges prepared from molded granules of smokeless powder are ethyl alcohol, propyl alcohol, isopropyl alcohol, petroleum hydrocarbons such as benzene and petroleum ether, ethyl alcohol containing a minor amount of alkyl acetate such as ethyl or butyl acetate, and the like.

The amount of burning rate deterrent applied to the aft-end of the propellant charge of this invention will vary, depending on the particular burning rate deterrent employed. In general, the deterrent weight applied is from about 0.5 to about 5.0 percent by weight, based on the weight of the propellant charge. The residence time required to deposit the desired

amount of deterrent will vary depending on the particular deterrent and solvent employed and can be easily determined by one skilled in the art.

Any convenient method of contacting the aft-end of the propellant charge with the solution of burning rate deterrent can be employed in this invention. A particularly suitable method is submerging or dipping the aft-end of the propellant charge in a bath of burning rate deterrent.

What I claim and desire to protect by Letters Patent is:

1. In a telescoped round of caseless ammunition comprising a propellant charge having an axial cavity, a projectile completely housed within the axial cavity and a primer, the improvement comprising a propellant charge having a forward-end and an aft-end and an aft-surface in which at least 10 percent of the total internal and external surface area of the aft-end of the propellant charge measured from the aft-surface of the propellant charge is coated with a burning rate deterrent, the aft-end of said charge being defined as that part of the propellant charge bounded from the aft-surface of the charge to the surface of the charge defined by a plane passing through both the charge and the contacting surface of the projectile housed within the charge, said contacting surface being the surface of the projectile initially contacting the barrel of a gun in which the telescoped round of caseless ammunition is fired.

2. The propellant charge of claim 1 wherein the burning rate deterrent is ethyl centralite.

3. The propellant charge of claim 1 wherein the burning rate deterrent is dinitrotoluene.

4. The propellant charge of claim 1 wherein the burning rate deterrent is dibutyl phthalate.

5. The propellant charge of claim 1 wherein all of the internal and external surface area of the aft-end of the propellant charge is coated with burning rate deterrent.

6. The propellant charge of claim 5 wherein the aft-end of the propellant charge is coated with from about 0.5 to about 5.0 percent by weight of burning rate deterrent based on the weight of the total propellant charge.

7. The propellant charge of claim 6 wherein the burning rate deterrent is ethyl centralite.

8. The propellant charge of claim 6 wherein the burning rate deterrent is dinitrotoluene.

9. The propellant charge of claim 6 wherein the burning rate deterrent is dibutyl phthalate.

10. The propellant charge of claim 6 wherein the projectile has a rotating band having a forward surface and the aft-end of the charge is defined as that part of the propellant charge bounded from the aft-surface of the charge to the surface of the charge defined by a plane passing through the propellant charge and through the forward surface of rotating band of the projectile.

11. The propellant charge of claim 6 wherein the projectile has a guilding metal jacket and the aft-end of the charge is defined as that part of the charge bounded from the aft-surface of the charge to the surface of the charge defined by a plane passing through the propellant charge and through the base of the ogive of the projectile.

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