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Stiefel et al.

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[54] **DISTRIBUTED PROPULSION FOR GUNS**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 818,140, April 21, 1969, abandoned.

[52] **U.S. Cl.** **102/38,** 102/103, 102/104, 149/3

[51] **Int. Cl.** **F42b 5/16**

[58] **Field of Search** 102/38, 39, 40, 105; 149/3, 149/9–11

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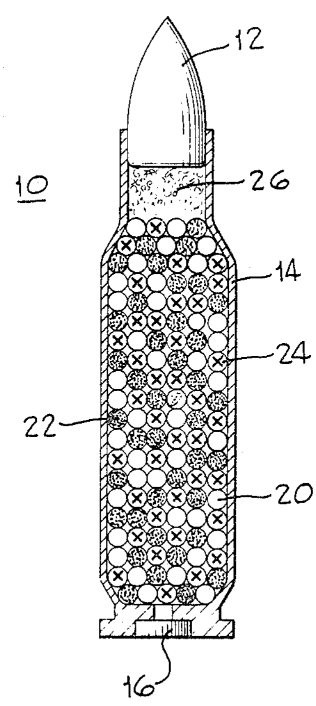
[57] **ABSTRACT**

Propellant charges for weapons, especially for the small caliber type, made of grains consisting of two layers, an outer slow burning composition and an inner or core composition for the control of interior ballistics. The charges consist of a plurality of increments of such type grains which differ in the thickness and composition of the outer layer and the thickness and composition of the core resulting in better control of interior ballistics, such, for example, as the obtention of higher velocities at lower peak pressure.

5 Claims, 1 Drawing Figure



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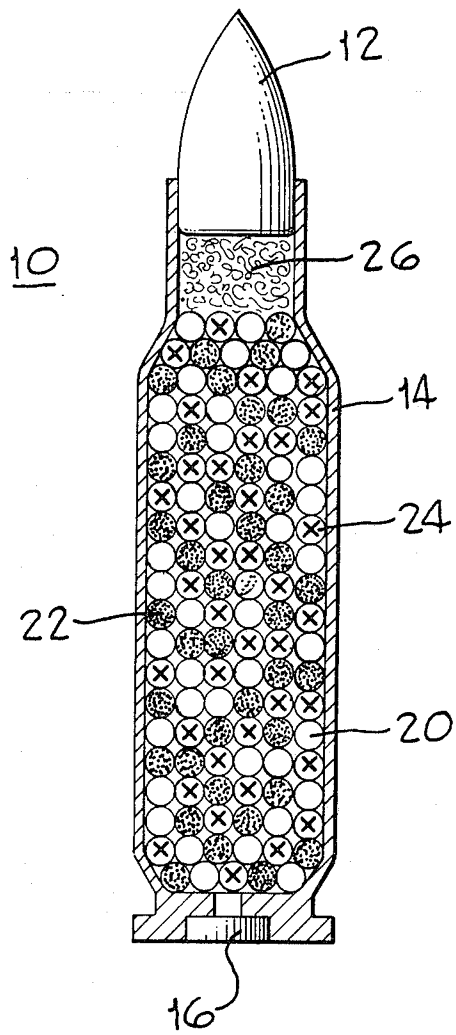

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DISTRIBUTED PROPULSION FOR GUNS

This application is a continuation-in-part of our application Ser. No. 818,140, filed 21 Apr. 1969, for "Distributed Propulsion for Guns", now abandoned, and relates to incremental propellant charges in the control of interior ballistics for small arms weapons wherein the propellant grains in a given increment will consist of two layers, a slower burning outer layer and a faster burning inner layer.

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

At present, the gas generation rate of small arms propellants may be modified through propellant composition, grain geometry, or deterrent coatings, any of which are capable of changing the pressure-time curve produced by the ammunition.

These current small arms ammunition charges are generally comprised of one type and size of propellant grain. Our invention contemplates propellant charges which comprise a plurality of increments, wherein propellant grains of different sizes, shapes and composition may be used therein, i.e., the grains may be solid cylinders, perforated cylinders, spheres, platelets or discs. Because of the very small sizes of the grains used in small arms ammunition, only grains of limited geometries heretofore could be economically manufactured. Consequently, the number of variables that could be manipulated to achieve a given specified performance was severely limited. Our invention, however, will permit the manipulation of a large number of variables to obtain desired controls. Furthermore, the charges can now be loaded in conventional loading machinery, there being no barriers or separate packages or capsules involved.

As aforediscussed, prior art small arms propellants are treated with a deterrent composition which is not a film or layer on the external surface of the grains, but a material which is absorbed into the outer portions of the grain matrix and thus serving to reduce the burning rate of outer portions of the grains.

In contrast therewith, our invention allows the gas generation schedule to be controlled by permitting the programmed burning of the increments without the use of any separately assembled barriers, capsules and the like. With regard to these smaller caliber cartridges, such barriers or capsules cannot readily be loaded into the narrow case necks, and furthermore, the very short ballistic time results in incomplete combustion of the barriers or capsules, to thereby cause deposition of unburned debris in the weapon, or the ejection of partially burned material from the gun. Our invention therefore, involves polymeric films, or layers, or coatings applied to the outer surfaces of the individual grains in such a way that the entire charge, including the scheduling coating is totally consumed by the time the bullet exits from the gun or weapon.

Briefly then, our invention lends versatility to propellant charges, especially small arms propellant charges, such that their gas generation schedule may be regulated by manipulating the thickness and burning rate of the outer layer and inner core respectively, as well as the number and size of the increments.

It is therefore the principal object of this invention to provide improved means for controlling the interior ballistics of weapons.

Other and further objects of the invention will be apparent to those skilled in the art upon study of this disclosure and wherein the single FIGURE illustrates a sectional view of an embodiment of our small arms cartridge.

Referring now to the drawing, a standard small arms cartridge **10** includes a projectile **12**, casing **14** and primer **16**. While three increments only are shown, mixed uniformly, any reasonable number may be employed. One of the increments comprises a ball propellant or inner core composition **20**, although single and double base extreded propellants may be used advantageously. The uncoated propellant is herein designated the inner core or faster burning composition. Another increment **22** is comprised of grains having an inner core composition with an outer layer of a suitable resin or polymeric coating, which may suitably comprise n-butyl methacrylate resin; methyl cellulose; or polyvinyl acetate; and others.

These scheduling coating materials should be soluble or dispersable in a solvent that does not react adversely with the inner core composition propellant. Upon evaporation of the solvent, a polymerization or cross-linking reaction should desirably occur to insolubilize the deposited film or coating with respect to the solvent to prevent softening of the previous layer when subsequent layers are applied. The coating solution will consist of about 5 to 15 percent solids by weight in the solvent, the exact concentration of coating solids in the solution being dependent only on the requirements of the specific coating process, for example, the types of spray devices being used. The actual proportions of solvent to solids is of little concern and within the skill of the art since the solvent will have evaporated leaving the deposited film, or layer, or coating on the desired surfaces.

Processes for coating our materials are many and varied. For example, the tablet coating process, fluidized bed process, airless spray process, microencapsulation techniques, vacuum deposition, phase separation from aqueous as well as organic-solvent solutions, interfacial polymerization and melt techniques, and the like, may be employed advantageously and successfully in carrying out our invention, while providing means for preventing the small grains from adhering to each other while the film is drying.

A third increment **24** which may comprise the same materials as **22** is also incorporated into the charge. Regardless of the composition of the outer material, it will be slower burning than the outer layer used for increment **22**, by virtue of its composition or thickness. The propellant contained within the coating may be identical with inner core **20** or that used for increment **22**, or may even be faster burning than either of these. Any air space remaining between projectile **12** and the propellant may be packed with cotton **26**.

The abovedescribed concept of charges consisting of increments of different types of overall propellant grains, where each coated grain consists of an outer slower burning composition and a faster core composition to yield controlled interior ballistics by means of the burning rates and thicknesses of the outer composition and burning rate and thickness of the inner composition for each type used and by quantities of each type used in the complete charge is referred to as "distributed propulsion."

The products and processes of our invention are illustrated by the non-limiting example hereinunder set forth, all percentages being by weight:

A 5.56mm cartridge, including a projectile weighing 56 grains, was loaded with 27.8 grains of a standard double base rolled ball propellant having a cut of 0.027 inch/.016 inch (grain passed through a screen having 0.027 inch openings but was retained on a screen having 0.016 inch openings) rolled to a uniform web of 0.015 inch, and a composition as follows:

Composition:	
Nitrocellulose (13.15% N)	81.59%
Nitroglycerine	10.52
Dibutylphthalate	5.68
Diphenylamine	0.98
Total Volatiles	1.23

The peak chamber pressure obtained was 49.0 kpsi (thousand pounds per square inch) and the projectile velocity, measured at 15 feet from the muzzle, was 3100 fps. Measurement of the velocity at a distance of 15 feet from the muzzle is accomplished by the standard 2-screen method whereby an average velocity at 15 feet from the muzzle is obtained using a 10 foot base line.

EXAMPLE I

1st Increment:	
Weight: 6.3 grains	
Propellant:	
Double base, extruded, no perforation, cylinders — 0.025"OD and 0.025"length	
Composition:	
Nitrocellulose (13.15% N)	87.9%
Nitroglycerine	9.8
Diphenylamine	1.0
Total Volatiles	1.3
Coating: None	
2nd Increment:	
Weight: 13.1 grains	
Propellant:	
Single base extruded, single perforation, 0.030"OD; 0.042"length; and 0.007"perforation	
Composition:	
Nitrocellulose (13.15% N)	97.7%
Diphenylamine	1.0
Total Volatiles	1.3
Coating: (a) Level:4% by weight of the propellant	
(b) Data:	
Solids: 75/25 polyvinylbutyral/melamine formaldehyde resin	
Solvent: 50/50 V/V Heptane-ethanol	
Coating Solution: 10% solids in the solution	
3rd Increment:	
Weight: 5.6 grains	
Propellant: Identical with second increment	
Coating:	
(a) Level:5% by weight of propellant	
(b) Data:	
Solids: 75/25 polyvinylbutyral/melamine formaldehyde resin	
Solvent: 50/50 V/V Heptane-ethanol	
Coating Solution: 10% solids in the solution	

These increments were mixed and loaded into the 5.56mm cartridge case. The 25 grains so mixed yielded a peak pressure of 48.9 kpsi and a velocity at 15 feet of 3160 fps. Although the peak pressures and velocities are substantially the same for our inventive distributed propulsion cartridge and the standard, our cartridge required only 25.0 grains to equal the performance of 27.8 grains of standard double base ball propellant. Further, the lower loading density of our charge of extruded propellant makes it even more difficult to achieve the values of the standard.

We wish it to be understood that we do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

We claim:

1. In combination with a cartridge having a primer, projectile and case, the improvement therewith for providing good control of interior ballistics in a weapon system using said cartridge, said improvement comprising
   a propellant charge disposed within said case and comprising
   a substantially uniform mixture of the propellant grains of a plurality of increments of propellant grains, each grain of at least one of said increments comprising two layers, said layers comprising an outer slower burning composition and an inner faster burning core composition, and each grain of at least one of said increments comprising at least one layer, said one layer being a core composition whose composition may be the same as or different from said first mentioned core composition and which is faster burning than any of said outer slower burning compositions, whereby upon ignition of said propellant charge, better control of interior ballistics is provided.

2. The cartridge of claim 1 wherein said cartridge is of 5.56mm size.

3. The cartridge of Claim 1 wherein said charge comprises a first increment of double base extruded propellant devoid of perforations therethrough, a second increment of single base extruded propellant grain, and a third increment of single base extruded propellant grain having a single perforation therethrough, said double base, extruded propellant comprising, by weight, 87.9 percent nitrocellulose having 13.15 percent nitrogen, 9.8 percent nitroglycerine, 1.0 percent diphenylamine, and 1.3 percent volatiles, and said single base extruded propellant grain comprising, by weight, 97.7 percent nitrocellulose having 13.15 percent nitrogen, 1.0 percent diphenylamine, and 1.3 percent volatiles.

4. The cartridge of claim 3 wherein said first increment comprises 6.3 grains, each of said grains having a 0.025 inch outside diameter and a 0.025 inch length, said second increment has a single perforation therethrough and comprises 13.1 grains, each of said second increment grains having an outer diameter of 0.030 inch, a length of 0.42 inch, and a perforation diameter of 0.007 inch with a 4 percent coating, by weight, therearound of 75/25 polyvinylbutyral/melamine formaldehyde, and said third increment comprises 5.6 grains, each of said third increment grains having dimensions equal to said second increment grains and having a 5 percent coating, by weight, therearound of 75/25 polyvinylbutyral/melamine formaldehyde.

5. The cartridge of claim 4 wherein said cartridge yields a peak pressure of 48.9 kpsi and a projectile velocity at 15 feet of 3160 fps.

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