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[54] **SEGMENTED PROPELLANT CHARGE FOR TELESCOPED CASELESS AMMUNITION**
6 Claims, 1 Drawing Fig.

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[50] **Field of Search** ..... 102/38, 40, 39, 43, 99—104

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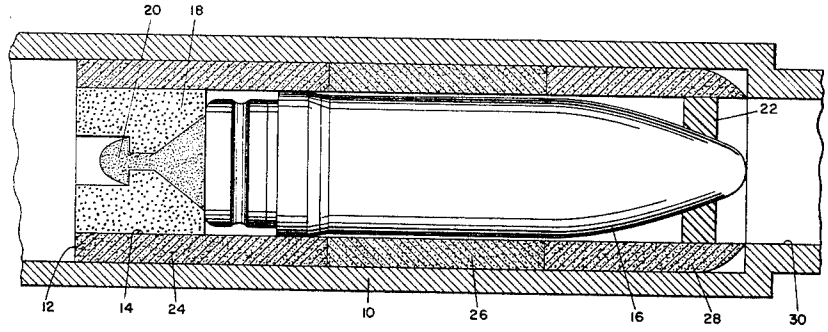
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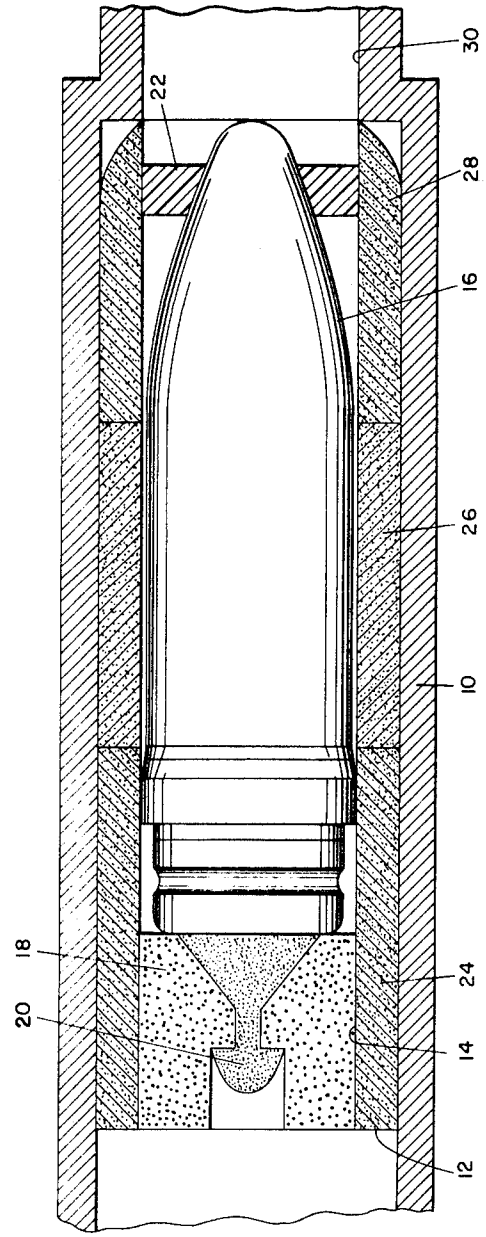
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ABSTRACT: A segmented propellant charge for telescoped caseless ammunition is provided. The propellant charge is prepared from at least two sections of molded propellant granules having differing burning rates. These sections are united in order of increasing burning rate to form the segmented propellant charge. The segmented propellant charge provides increased ballistic efficiency for telescoped caseless ammunition.





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SEGMENTED PROPELLANT CHARGE FOR TELESCOPED CASELESS AMMUNITION

This invention relates to a propellant charge for a telescoped round of caseless ammunition in which the propellant charge is comprised of two or more segments or sections of propellant having different burning rates. More particularly this invention relates to a propellant charge for a telescoped round of caseless ammunition comprised of two or more sections of molded propellant granules, the sections being arranged in order of increasing burning rate from the aft-section to the forward-section. The propellant sections are exposed to burning in the reverse order of their burning rates, the slowest burning or aft-section being exposed to burning first.

Telescoped caseless ammunition is comprised of a propellant charge having an axial bore or cavity, a projectile housed entirely within the axial bore of the propellant charge and a primer positioned behind the base of 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 Housed in the Propellant Charge."

When a telescoped round of caseless ammunition is loaded into the chamber of a weapon, the projectile, which is housed in the propellant charge, is not seated in the barrel of the weapon 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 into the barrel of the weapon passing through the axial cavity of the propellant charge, and is seated in the barrel of the weapon. The projectile is subsequently ejected or "fired" from the weapon due to rapid pressure buildup in the chamber and barrel of the firearm resulting from burning of the propellant charge. The steps in the firing process of a weapon as heretofore described are continuous and take place in very rapid succession, on the order of a few milliseconds.

Ballisticians have long recognized that the ballistic efficiency of a firearm would be significantly improved if it were possible to maintain or increase the pressure on the base of a projectile as the projectile moves down the barrel of the firearm during a firing sequence. Duplex loading of conventional ammunition was an attempt to achieve this result. In duplex loading, several propellant granulations having differing burning rates are charged to a cartridge case either as an admixture, or in successive layers with each layer comprised of propellant granules of differing burning rates. Duplex loading of conventional ammunition failed to achieve increased efficiency of the firearm because there was no way to effectively segregate the propellant charge so that controlled ignition of successively faster burning propellant granules could be accomplished. Duplex loading of conventional ammunition often resulted in excessive chamber pressures since all the propellant granules were ignited essentially simultaneously.

Accordingly, it is an object of this invention to provide a propellant charge for telescoped caseless ammunition capable of increasing ballistic efficiency of the firearm in which the caseless ammunition is fired.

It is another object of this invention to provide a propellant charge for caseless ammunition in which controlled ignition of successively faster burning propellant not heretofore possible with conventional ammunition, is accomplished.

In accordance with this invention a propellant charge for telescoped caseless ammunition is provided comprising at least two sections of propellant, each propellant section prepared from molded propellant granules having a burning rate different from that of the other propellant sections. The propellant sections are united in order of increasing burning rate to form the propellant charge, the section of molded propellant having the slowest burning rate being the aft-section of the propellant charge. Increased ballistic efficiency of the segmented propellant charge results from incremental uncovering and ignition of charge. As the projectile moves down the axial cavity of the propellant charge, the propellant charge is uncovered incrementally with the uncovered increments nearly simultaneously being ignited and broken into individual propellant granules. There is a slight delay in the ignition and breakup of each additional increment of propellant, resulting from the time required for the projectile to pass any given increment of propellant. The increased burning rate of the propellant sections from the aft-section to the forward-section provides increased gas generation as the projectile moves into the barrel of the firearm. Chamber pressure is not significantly increased since the volume into which the gases from the faster burning propellants expand is greatly increased by movement of the projectile into the barrel of the weapon.

The attached drawing which further illustrates this invention is a vertical section of a longitudinal view of a round of caseless ammunition wherein the segmented propellant charge is comprised of three sections of propellant, each section having a successively faster burning rate. A telescoped round of caseless ammunition is shown loaded into the chamber **10** of a weapon. The telescoped round is comprised of a cylindrical propellant charge **12** having an axial cavity **14** throughout its length, and has a projectile **16** housed within cavity **14**. A propellant plug **18** secures projectile **16** at the aft-end of the axial cavity **14** and has a primer **20** secured therein. A centering ring **22** is adhesively secured to the inside of the forward end of the axial cavity **14** and secures the projectile **16** at the forward-end of the propellant charge **12**.

The propellant charge **12** is comprised of three sections of propellant, an aft-section **24**, a central-section **26** and a forward-section **28**. The aft-section **24** is comprised of slow burning rate propellant granules relative to the central-section **26** and forward-section **28**. The central-section **26** of propellant has an intermediate burning rate between that of the aft-section **24** and the forward-section **28**. The forward-section **28** of propellant has the fastest burning rate.

During a typical firing sequence of a telescoped round, the primer **20** is struck and initiated by a firing pin (not shown). The primer **20** in turn initiates burning of the propellant plug **18** and the aft-section **24** of the propellant charge **12**. The pressure at the base of projectile **16** resulting from initiation of primer **20** causes the projectile **16** to start moving through the axial cavity **14** in propellant charge **12** into the barrel **30** of the firearm. As the projectile **16** moves forward incremental portions of the aft-section **24**, the central-section **26**, and forward-section **28** of propellant charge **14** are sequentially uncovered. Movement of the projectile past each increment of propellant results in removal of the physical support and protection of these increments from the hot gases and flame from the primer **20** and ignited propellant charge **12**. The uncovered propellant increments are ignited. As the projectile **16** moves forward increasing the total volume into which the gases from the burning propellant expand, the faster burning rate propellant sections are ignited producing gases at a faster rate and, maintaining pressure at the base of the projectile **16** as it passes through the barrel **30** of the weapon. The overall efficiency of the telescoped round is thereby increased.

This invention is further illustrated with reference to the following examples. All parts and percentages are by weight unless otherwise specified. Example 1 illustrates one method of preparation of a segmented propellant charge for a telescoped round of caseless ammunition having three burning rate sections.

Example 1

A mold is partially filled with 50 parts of small granules of double-base smokeless powder having a linear burning rate of about 10 inches per second at 50,000 p.s.i. said charge forming the aft-section of the propellant charge. About 25 parts of double-base smokeless powder granules having a linear burning rate of 12 inches per second at 50,000 p.s.i. is charged to the same mold forming the second section of propellant. A third and final charge of about 25 parts of smokeless powder granules having a linear burning rate of about 16 inches per second at 50,000 p.s.i. is charged to the mold forming the forward-section of the propellant charge.

Following the filling of the mold with smokeless powder granules, a solvent mixture comprised of about 40 percent acetone and 60 percent alcohol is poured into the mold, covering all of the smokeless powder granules. After about 1 minute the solvent wet granules are molded at about 1,500 p.s.i. The solvent mixture is squeezed from the mold during compression. The resulting consolidated propellant charge which has the shape of a right cylinder with an axial cavity throughout is removed from the mold and dried to remove residual solvent. As is illustrated in the attached drawing a projectile is inserted into the axial cavity. a propellant plug containing a primer is adhesively secured in place in the aft-end of the cavity and a centering ring is adhesively secured in the forward-end of the cavity resulting in a fully assembled round of telescoped caseless ammunition.

The following examples illustrate the increased ballistic efficiency of telescoped caseless ammunition wherein a segmented propellant charge comprised of multiple burning rate sections is employed.

Example 2

Three segmented propellant charges are prepared employing the process, propellants and weight ratios thereof as illustrated in example 1. Three propellant charges are also prepared employing the process of example 1, wherein the entire propellant charge is prepared from double-base smokeless powder granules substantially identical to those of the aft-section of propellant of example 1. Each of the above propellant charges is assembled into a telescoped round of caseless ammunition as described in example 1 and each contains a projectile weighing 79 grams. Round 1, 2 and 3 have segmented propellant charges containing three sections of propellant prepared essentially as described in example 1. Rounds 4, 5 and 6 are prepared from propellant of the same granulation and burning rate as employed in the aft-section of the propellant charge of example 1. Results of test firing of these rounds is given in table I.

TABLE I

	Propellant sections	Propellant charge weight (grams)	Velocity (ft./sec.)	Efficiency (velocity propellant charge weight)
Round:				
1	3	39.70	3,027	76.24
2	3	43.90	3,182	72.48
3	3	45.00	3,209	71.31
4	1	47.98	3,337	69.54
5	1	47.17	3,158	66.90
6	1	48.03	3,305	68.81

Ballistic efficiency for the above round is evaluated as the ratio of projectile velocity to the total weight of propellant charge employed. In the above firings higher efficiency is achieved for rounds 1, 2 and 3 having segmented propellant charges wherein successive burning sections burn at increasingly faster rate than for the nonsegmented propellant charges of rounds 4, 5 and 6.

While the drawing and the foregoing examples illustrate a segmented propellant charge prepared from three united burning rate sections, two sections or any number of sections in excess thereof can be employed. It is generally preferred to prepare a propellant charge with at least three sections. The weight percent of each charge section is dependent on the burning rates of the molded propellant granules comprising these sections. The percentage of a given section of propellant having a particular burning rate can be varied. The only limitation on these sections is that they be arranged so that the slowest burning section is the aft-section and the remaining sections are arranged in order of increasing burning rate. With a three section propellant charge the preferred weight distribution of the sections is an aft-section of from about 25 percent to about 60 percent by weight, a central-section from about 20 percent to about 40 percent by weight, and a forward-section from about 20 percent to about 40 percent by weight, based on the weight of the total propellant charge. The amount and rate of propulsive gas generated from each section of propellant is dependent on the propellant composition, the configuration of the individual propellant granules and the presence of burning rate deterrents on the individual propellant granules.

Propellant granules which can be molded to prepare the burning rate sections of the segmented propellant charge include the single base, double base, and triple base type granules. Illustrative single, double and triple base formulations which can be employed are given below in table II.

TABLE II

	Weight percent						
	Single base			Double base			Triple base
Nitrocellulose	99.0	83.0	90.0	93.3	59.0	78.3	20.0
Nitroguanidine							54.7
Nitroglycerin				5.0	40.0	20.0	19.0
Diphenylamine	1.0	1.0	1.0	0.7		0.7	
Dinitrotoluene		10.0	8.0				
Dibutyl phthalate		5.0					
Potassium sulfate		1.0	1.0	1.0		1.0	
Ethyl centralite					1.0		6.0
Cryolite*							0.3

* $3NaF \cdot AlF_3$.

The process by which the sections of multiple burning rate propellant are prepared is not limited by the process described in the foregoing examples. Other methods known in the art for molding of smokeless powder wherein various binders such as collodion and acetone are employed and in which the propellant charge will break up upon ignition into individual granules of propellant can be employed. The burning rate sections can be prepared by filling a mold with successive layers of propellant granules and molding the granules as described in example 1 or the sections can be molded separately and bonded together. Suitable adhesives for bonding propellant sections are epoxy cements. Propellant sections can also be united by wetting the adjoining surfaces of the sections with a solvent for the propellant and pressing the surfaces together. Suitable solvents for bonding sections of single, double, and triple base propellants are acetone and methyl-ethyl ketone.

As will be evident to those skilled in the art, various modifications can be made or followed, in light of the foregoing disclosure and discussion, without departing from the spirit or scope of the disclosure or from the scope of the claims.

I claim:

1. In a round of telescoped caseless ammunition having in combination a propellant charge having an axial bore throughout its length, a projectile housed entirely within the axial bore of the propellant charge and a primer positioned behind the base of the projectile, the improvement comprising a segmented propellant charge comprising at least a forward-section and an aft-section of propellant, each propellant section comprising molded propellant granules said granules having a burning rate different from that of the molded propellant granules comprising the other propellant sections, said propellant sections united in order of increasing burning rate to form the segmented propellant charge, the section of molded propellant prepared from propellant granules having the slowest burning rate being the aft-section of the propellant charge said segmented propellant charge incrementally breaking up into propellant granules from the aft-section to the forward-section of the propellant charge upon firing of the caseless round.

2. The propellant charge of claim 1 comprising three sections of molded propellant granules, an aft-section, central-section, and forward-section.

3. The propellant charge of claim 2, wherein the aft-section is from about 25 percent to about 60 percent by weight, the central-section is from about 20 percent to about 40 percent by weight, and the forward-section is from about 20 percent to about 40 percent by weight, based on the total weight of the propellant charge.

4. The propellant charge of claim 2 wherein the molded propellant granules are of single base-type.

5. The propellant charge of claim 2 wherein the molded propellant granules are of double base-type.

6. The propellant charge of claim 2 wherein the molded propellant granules are of the triple base-type.